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The evolving nature of open innovation governance: A study of a digital platform development in collaboration with a big science centre

Angelo Cavallo^{a,*}, Henri Burgers^b, Antonio Ghezzi^a, Vareska van de Vrande^c

^a Politecnico di Milano, Department of Management, Economics and Industrial Engineering, Via Lambruschini, 4/B, 20156, Milano, Italy

^b The University of Queensland, St Lucia QLD, 4072, Brisbane, Australia

^c Rotterdam School of Management, Erasmus University, Burgemeester Oudlaan 50, 3062, PA, Rotterdam, the Netherlands

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ABSTRACT

There is growing recognition that the governance of open innovation is interdependent with the outcome being developed. In this paper, we address the dynamic nature of open innovation governance through an in-depth, longitudinal case study of a commercial software firm and a big science centre co-developing a digital platform. We identified five processes through which the open innovation governance and its outcome – i.e., the platform – influenced each other. Specifically, we found that the governance of the collaboration played a major role in resolving tensions between the two partners, which had a profound impact on the design of the digital platform. In turn, the decisions surrounding the platform started to change the open innovation governance. Based on these insights, we develop implications for governing open innovation in the context of collaborating with a big science centre.

1. Introduction

Governance has become a central theme in open innovation to manage potential conflicts, coordinate efficient knowledge sharing between collaborators, and achieve the goals of the collaboration (Bagherzadeh et al., 2019; Bogers et al., 2017; Demil and Lecocq, 2006; Felin and Zenger, 2014; Perkmann and Schildt, 2015). Open innovation governance includes the higher-level governance modes and associated governance mechanisms that enable organisations to lead and control open innovation processes (Bogers et al., 2017; Felin and Zenger, 2014). The choice of open innovation governance is shaped by the innovation's problem (Bagherzadeh et al., 2019; Felin and Zenger, 2014). It guides the search for the solution (Nickerson and Zenger, 2004) and how organisations deal with uncertainty in the open innovation process (Van de Vrande et al., 2009). Notwithstanding these insights, at least two key challenges remain.

First, previous studies tend to take a rather static approach that does not account for the changing nature of governance during a collaboration. The innovation problem shapes the choice of governance, while the governance subsequently shapes the innovation solution. Yet, the development of the solution may introduce new problems, calling for a more dynamic view on open innovation governance (Felin and Zenger,

2014; Zobel and Hagedoorn, 2020).

Second, although an important element of governance is managing potential conflict (O'Mahony and Bechky, 2008; Poppo and Zenger, 2002), we know little about the inter-organisational governance issues that arise when two organisations engaging in open innovation have different objectives. For example, companies' objectives are mainly commercial, while research organisations such as universities also have a public mission of scientific knowledge development and diffusion (Perkmann and Schildt, 2015). Such differences in objectives may create tensions in industry-research collaborations, making governance a particularly important topic.

Yet, most studies in this area view it as a technology transfer problem in which one party, typically the research organisation, acts as the supplier and the other as the buyer (Perkmann and Walsh, 2007). Big science centres are an interesting, but under-researched organisation, as they not only facilitate the build-up of a learning environment for their industry partner (Autio et al., 2004), but also have addressed the reverse direction in which the company acts as the supplier to the big science centre (Autio et al., 2004; Florio et al., 2018). Expanding on these arguments, we contend that big science centres provide a unique setting to foster our understanding of the evolution of open innovation governance beyond the linear mechanism of technology transfer based on a

* Corresponding author.

E-mail addresses: angelo.cavallo@polimi.it (A. Cavallo), h.burgers@uq.edu.au (H. Burgers), antonio1.ghezzi@polimi.it (A. Ghezzi), vvrande@rsm.nl (V. van de Vrande).

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supplier-buyer type of relationship in which both the big science centre and the industry partner learn how to collaborate as peers. In this research setting, we aim to address the following research question: How does the governance of an open innovation collaboration between a company and a big science centre evolve over time?

We address the research question through an in-depth, longitudinal case study of a collaboration between a company and a big science centre aimed at developing a digital platform. Due to the novelty of the phenomenon and the depth of the investigation required to grasp the mechanisms and logics of open innovation governance (Bogers et al., 2017; Filatotchev et al., 2020), an in-depth case study of a single collaboration is appropriate. We used a longitudinal design to better capture the evolution of governance during the open innovation process. Both primary and secondary data informed our case study, as governance involves both more formal, contractual arrangements as well as more relational arrangements in which the collaborating parties attempt to govern more informally to resolve tensions (Faems et al., 2008; Poppo and Zenger, 2002). We argue that the platform as the outcome of the innovation collaboration makes our research setting even more promising in light of the aforementioned challenges of open innovation governance research. Platforms involve a high degree of technological complexity as well as behavioral complexity, making it likely that tensions are further exacerbated (Cennamo, 2019; Brunswicker and Schechter, 2019). Platforms are thus a particularly interesting outcome to study the evolution of open innovation governance, as a platform is both the solution being developed in the open innovation collaboration as well as an open innovation governance mode (Felin and Zenger, 2014).

Through studying the governance of an open innovation collaboration with a big science centre, we make at least two contributions to the literature. First, building on prior literature to argue how innovation outcomes and the governance choices are interdependent (Felin and Zenger, 2014; Tuertscher et al., 2014; Zobel and Hagedoorn, 2020), we explicate the effects they have on each other and show that the open innovation governance and innovation outcome evolve through five processes. Second, our study contributes to the growing literature on big science centres' roles in innovation processes (Tuertscher et al., 2014; Vuola and Hameri, 2006). Moving beyond the role of scientists and companies as suppliers, we show how an open innovation collaboration as peers between a commercial firm and a big science centre can be governed in a way that resolves tensions regarding the direction of the innovation.

2. Theoretical background

2.1. Open innovation governance

Open innovation is commonly recognised as a distributed innovation process based on the purposive use of knowledge flows across organisational boundaries (Chesbrough and Bogers, 2014). To result in positive outcomes, such collaborations transcending organisational boundaries will need to be governed (Felin and Zenger, 2014). Governance refers to the rights available to members of an entity, the practices and decision-making processes that conduct power and resources, and coordinating stakeholders and help them to achieve their goals (O'Mahony and Bechky, 2008). Governance assumes managers assess the problem, potential knowledge sets, technologies, and parties able to address the problem, and then set the governance that will maximise the potential for high-value solutions (Nickerson and Zenger, 2004). Open innovation governance has typically been addressed as higher-level governance modes or lower-level governance mechanisms within a specific mode. Higher-level governance modes for open innovation include licensing, acquisitions, R&D contracts, spin-outs and corporate venture capital (Bianchi et al., 2016; Keil et al., 2008; Van de Vrande et al., 2009). More recently, this has been extended to more open modes such as hackathons (Lifshitz-Assaf et al., 2020), innovation contests (Boudreau et al., 2011), crowdsourcing (Afuah and Tucci, 2012) and

platforms (Chen et al., 2020). Intermediaries, such as boundary organisations, are receiving increasing attention as a governance mode to deal with diverging objectives between science and industry (Perkmann and Schildt, 2015), or companies and solvers in innovation contests (Lampel et al., 2012). Boundary organisations can mitigate differences among partners by enabling governance mechanisms that reinforce convergent interests while allowing divergence to persist (O'Mahony and Bechky, 2008). Tuertscher et al. (2014), for example, show how a boundary infrastructure through cycles of contestation and justification governed the selection of competing solutions in a collaborative project involving a large number of scientists at the European Organisation for Nuclear Research.

While the governance modes offer a high-level framework to guide the overall collaboration, the mechanisms govern the day-to-day behaviour in a collaboration. These governance mechanisms are instrumental to allocate decision and property rights (Gambardella and Panico, 2014), offer incentives to engage in the innovation process, and establish communication channels (Felin and Zenger, 2014). Such governance mechanisms may range from contractual to more relational such as trust and inter-firm socialisation (Zobel and Hagedoorn, 2020). Moreover, open innovation governance is increasingly becoming a socio-technical phenomenon where tacit coordination and inter-organisational processes can be enabled through digital technologies. Simulation software, databases and web repositories can act as governance mechanisms to further align interests through generating a common ground by making knowledge transparent and available to all parties (Tuertscher et al., 2014).

Open innovation governance is often portrayed as a discrete choice between alternative governance modes and mechanisms, but is in reality more a hybrid of various governance modes and related mechanisms (Felin and Zenger, 2014; Zobel and Hagedoorn, 2020). Both modes and mechanisms are therefore essential to include in our understanding of governance (Bogers et al., 2017). Based on these prior studies, we define open innovation governance as the higher-level governance modes and lower-level governance mechanisms that enable organisations to lead and control open innovation processes. The fundamental premise in open innovation is that the governance matches the problem and solution's complexity, uncertainty and knowledge needs (Bagherzadeh et al., 2019). This creates a challenge of setting the open innovation governance when innovation problems are inherently complex and fraught with uncertainty, and solutions are unknown ex-ante (Felin and Zenger, 2014; Nickerson and Zenger, 2004). Governance literature has worked around this issue by relying more on informal governance mechanisms offering flexibility in highly dynamic contexts where contingencies and evolutions of complex project development are difficult to be pre-determined (Poppo and Zenger, 2002; Kim, 2014; Zobel and Hagedoorn, 2020).

An alternative view suggests that if aspects of the problem and solution change over time, the optimal governance solution should as well. For example, studies have shown that the nature of innovation activities changes from more exploratory to exploitative over time, which requires changes in how these activities are best managed and organised (Bianchi et al., 2016; Burgers et al., 2008; Van de Vrande et al., 2009). Relational views of governance have also shown that the nature of the problems and therefore the governance requirements change during the evolution of an interorganisational alliance (Faems et al., 2008). While calls have been made to focus on the entire process of an open innovation collaboration to observe the alignment of governance with the evolution of the open innovation over time (West and Bogers, 2014), research to date provides little insight as to how governance mechanisms and open innovation co-evolve.

2.2. The role of big science centres

Open innovation governance is idiosyncratic to the nature of the organisations involved in the open innovation processes, such as

startups (Weiblen and Chesbrough, 2015), universities (Perkmann and Schildt, 2015), competitors (Gnyawali and Park, 2011) and customers (Bogers et al., 2010; Von Hippel, 1976). Different organisations have different interests and objectives, which can undermine the results of such collaborations. This tension becomes even more pronounced when we refer to industry-research collaboration. Indeed, while companies' objectives are mainly commercial, universities and research institutes also have a public mission of scientific knowledge development and diffusion (Perkmann and Schildt, 2015). However, prior research in this area has focused primarily on universities and government research laboratories (Perkmann and Walsh, 2007), leaving the role of peculiar research institutes such as big science centres under-researched.

Companies have long considered universities and other research institutes as valuable innovation partners, especially in scientific-intensive fields (Autio et al., 2004; Perkmann and Schildt, 2015). However, scholars have primarily focused on relations where research institutions are the knowledge producer and industrial partners the knowledge receiver or vice versa (Autio et al., 2004). Little research investigates open innovation and governance challenges beyond the traditional supplier-buyer type of relationships since few research institutes can work with companies as peers in the technology transfer process. Big science centres are a notable exception, as they have particular features that allow them to work more closely with industry partners in innovation (cf., Florio et al., 2018). Such features (see Table 1) include large-scale research facilities employing highly sophisticated, even frontier-pushing technologies, and involving multidisciplinary engineering knowledge in the pursuit of ambitious research missions (Autio et al., 1996, 2004) with a focus on leveraging technologies into practical uses (Vuola and Hameri, 2006).

Big science centres differ from universities and other research institutes in that they work on a predetermined schedule, leveraging complex and large-scale experiments and offering broader and unique opportunities for technological learning to industrial companies (Autio et al., 2004). Moreover, to orchestrate a wide set of suppliers and collaborators and achieve innovation outcomes, big science centres developed great organisational and governance capabilities (Autio et al., 2004). These features may point to the relevance of big science centres in open innovation processes, but to date, we know little about the governance of collaborations between big science centres and companies as peers. To shed light on this issue, our research was guided by the following questions: How does the governance of an open innovation collaboration between a company and a big science centre evolve over time?

Table 1
Big science centre features.

Big science centre features	Support
Large network of suppliers and collaborators in science, government and business	Kollmer and Dowling (2004); Vuola and Hameri (2006); Boisot (2011); Tuertscher et al., (2014); Florio et al. (2018)
International collaborations	Kollmer and Dowling (2004); Florio et al. (2018)
Working on predetermined schedule by leveraging large and complex research facilities	Autio et al. (2004); Schmied (1982); Autio et al., 2004; Boisot (2011); Tuertscher et al., 2014; Florio et al. (2018)
Conducting large, multi-technology and multi-disciplinary experiments	
Employing highly sophisticated, even frontier-pushing technologies	Autio et al. (2004); Tuertscher et al. (2014); Florio et al. (2018)
Financed by public sources	Autio et al. (2004); Tuertscher et al. (2014); Florio et al. (2018)

3. Methods

3.1. Research design

Developing a digital platform through an open innovation collaboration is a complex and multifaceted phenomenon (West and Bogers, 2017). Consequently, we opted for a qualitative investigation of an in-depth single, longitudinal case study, allowing us not to be constrained by preliminary decisions regarding tools or types of data (Eisenhardt, 1989; Yin, 2009). Specifically, we analyse the governance of an open innovation collaboration by considering the relationship between a software firm and a big science centre as the main unit of analysis. From this perspective, we look at the evolution of its governance throughout the development of a digital platform.

3.2. Case selection

We investigated the collaboration between a multinational software firm offering vertical solutions, which we refer to with the pseudonym VertiSol, and a big science centre, which we refer to with the pseudonym BSC. Both organisations are headquartered in northern Italy. VertiSol provides their clients with software solutions and consulting services encompassing vertical applications in domains such as digital marketing, e-commerce, mobile apps and web design, as well as solutions for remote controlling and monitoring, and digital public services. Vertisol has over 200 million dollars in annual revenues and close to 2000 employees. BSC is a big science centre specialising in artificial intelligence. Due to its size and computing facilities, the centre is emerging as one of the few centres in Europe able to deal with large scale experimentation in artificial intelligence. Together, they built a digital platform during a six-year-long strategic partnership.

3.3. Data collection

Our extensive data collection took place over approximately five years, using various data sources such as interviews, surveys, observations, and internal and external documents. The main data collection period was 2015–2017, with follow-up data gathering to further delve into findings taking place from 2018 to 2020. Using different sources of information helped us triangulate and validate the data to increase the trustworthiness and persuasiveness of our results (Eisenhardt, 1989;

Table 2
Data Sources.

Data Type	Quantity	Data Source
Semi-standardised interviews (face-to-face)	39	25 interviews with 17 informants – including Chief Executive Officer (CEO), Chief Technology Officer (CTO), 7 product managers and 8 project managers of VertiSol (2 informants – CTO and CEO – were interviewed 4 times) 14 interviews with the 10 informants – including Director, CTO, Head of Research and 2 junior and 5 senior scientists of BSC (Head of Research was interviewed 4 times)
Follow-up interviews (via call)	9	2 with a Product Manager of VertiSol 2 with a Project Manager of VertiSol 2 with Head of Research of BSC 3 with CTO of VertiSol
Participant observation	4 (strategic meeting)	4 meetings with the CEO and CTO of VertiSol, the Head of Research, CTO and Director of BSC
Internal documents	67 (pages)	Meeting minutes, notes, memos and the annual corporate strategy report (9 documents and 1 report)
External documents and sources	47 (pages)	BSC and VertiSol website, news articles, industry reports.

Siggelkow, 2007; Yin, 2009). Table 2 summarises all our data sources. The main source of data was 39 face-to-face interviews with 27 interviewees. At VertiSol, 25 interviews were conducted with 17 informants including the Chief Executive Officer (CEO), Chief Technology Officer (CTO) and product and project managers, and at BSC, 14 interviews with 10 informants including the Director, CTO, Head of Research and junior and senior scientists. Our main contact points (CEO and CTO of VertiSol, Head of Research of BSC) were interviewed four times. All the informants were directly involved in the collaboration. To check the validity and usefulness of our initial conceptual findings (Lincoln and Guba, 1985), we conducted nine follow-up telephone interviews.

The interviews lasted between 30 and 140 min (60 min on average) and resulted in 321 pages of transcripts. Interview data were recorded and transcribed within two days in order to maintain high-quality data (Gibbert et al., 2008). We opted for semi-structured interviews to give voice to people directly involved in the collaboration and obtain both real-time and retrospective accounts, a practice that Morgan (1983) defined as “research as engagement”. The interviewees of both organisations were asked to describe and comment on different facets of the collaboration and their innovation processes, including motives, outcomes, the governance processes and mechanisms used in the collaboration.

To avoid any misunderstanding due to theoretical and practitioner nomenclatures, we provided informants with a glossary containing a literature-derived definition of key terms. The semi-structured interview format also allowed interviewees to obtain further explanation at any point during the interview. Questions were updated regularly to avoid redundancy and gain further specific details about emerging findings regarding the ongoing collaboration. This practice allowed us to move from abstract concepts to the underlying managerial implications and business logics. Our data collection ended once we achieved conceptual saturation. To encourage the candour of interviewees, the anonymity of the respondents and their organisations was agreed upfront (cf. Ozcan and Eisenhardt, 2009), with the respondents referred to by their role and the organisations referred to with pseudonyms.

In addition to the interviews, the lead authors participated as observers in four strategic meetings totalling 260 min, to gain further understanding. These meetings were all held at the co-innovation lab, located at BSC facilities. To further increase the validity and reliability of our case study findings, we complemented primary data with archival data from internal documents, such as presentations, emails, reports, additional memos and minutes from meetings, as well as external documents in the form of news articles and industry reports (see for details Table 2).

3.4. Data analysis

Our data analysis follows established procedures in qualitative research aimed at iteratively analysing data to ensure that emerging themes are plausible and grounded in data (Gioia et al., 2013; Strauss and Corbin, 1990; Van Maanen, 1979). Table 3 provides the data structure representation of how we moved from raw data to first-order codes, leading to the identification of second-order themes using research-centric codes and terms (Van Maanen, 1979; Gioia et al., 2013).

We began by coding both primary and secondary data through textual analysis using NVivo software (Perkmann and Schildt, 2015). We started an in-depth analysis considering all the collected data by applying the “open coding” transcription technique (Corbin and Strauss, 1990), letting data speak to identify concepts and keywords that seemed to emerge considering multiple actors’ perspectives on inter-organisational practices that guided the platform co-development and actions taken to reduce tensions and enhance the collaboration among the parties involved. The text related to the same concepts was grouped to assign them representative first-order codes (Corbin and

Table 3

Data structure.

First-order concepts	Second-order themes
Platform complexity driving peer involvement Coordinating knowledge access Need for contract flexibility Dealing with divergent interests Ensuring trust	Setting the open innovation collaboration’s governance
Using experimentation to solve regulation of IP Enabling continuous experimentation and innovation Enabling standardisation Leveraging modularity	Resolving the core’s design issues
Introducing co-innovation days to involve others Creating an incentive system for researchers outside the co-innovation lab Engaging the company’s salesforce Balancing openness and control of continuous improvements Allowing organisations outside VertiSol and BSC to join the co-innovation lab	Opening the open innovation collaboration’s governance
Lack of familiarity with open-source Embracing open source as an opportunity Using experimentation and testing to solve tensions towards open source Ensuring protection to third-party developers Shaping the periphery with the customers	Shaping the periphery
Attracting new contributors through technological leadership Ensuring quality and control of new contributors	Changing to platform governance

□ Platform shaping the governance of the open innovation collaboration.

□ Open innovation collaboration governance shaping the platform.

Strauss, 1990). The first-order codes covered a variety of topics, such as the actions carried out and the needs that guided the decision-making process regulating the open innovation collaboration and ensuring the open innovation outcome development (i.e., the platform). The coding process was iterative. The authors discussed and merged their different interpretations and revised the full coding to better grasp both the development and implications of the VertiSol-BSC collaboration. Specifically, our first-order codes included in-vivo codes (i.e., informant-centric terms and codes) as well as descriptive statements in case an in-vivo code was not available (Strauss and Corbin, 1990). Appendix A- Table A.1 provides more detail on the data underlying the codes, including sources, occurrences, and representative quotes. In total, we re-coded four times, identifying 21 first-order categories. The narratives were verified with the organisations under investigation.

Next, we grouped first-order codes into second-order themes by relating them to each other and by engaging with the literature. This second step of the data analysis had several iterations until an agreement was reached among the authors. The results were analysed and then confirmed by the interviewees to avoid any error or bias and ultimately enhance the accuracy of our interpretations’. Overall, five second-order themes emerged. During the final step, the second-order themes were grouped into two overarching dimensions that captured the interdependency between open innovation governance and the platform.

Following this data structure and analysis process and considering the relevant literature, we spotted the emergent theory rooted in the data, as “a statement of concepts and their interrelationships that shows how and why a phenomenon occurs” (Corley and Gioia, 2011, p.12). It is noteworthy to emphasise that while representing the first step into “thinking about data theoretically, not just methodologically” (Gioia et al., 2013, p.21), the data structure presented in Table 3 does not capture the dynamic relationships among second-order themes, rather serves as the basis for the grounded theory model articulated in the findings section (Fig. 2).

3.5. Empirical setting

Before we delve into the findings, we provide an overview of the genesis of the open innovation collaboration between the commercial company and the big science centre as the context for our findings.

3.5.1. Genesis of the collaboration

The Agenzia per l'Italia Digitale, the national agency to promote digitalisation in Italy, introduced regulation towards interoperability requirements for public administration agencies, in line with the European Interoperability Framework. VertiSol saw an opportunity to develop a digital platform to connect public administration agencies with suppliers, including Vertisol's software solutions. BSC had a similar plan for a platform in accordance with their mission to support public administration agencies. There was a history of prior collaborations between BSC and VertiSol in which BSC had been a technology supplier of VertiSol. In the end, they decided to collaborate in the development of the platform for two main reasons. First, they had complementarity competences. VertiSol's management soon realised that *"we needed artificial intelligence competencies that we did not have nor did we have the budget to develop them."* (CTO VertiSol). BSC possessed the needed skills to complement VertiSol's skills in data integration. Second, both had great interests in supporting public administration agencies. VertiSol develops software solutions for public administration agencies as its "core" business. BSC also had a strong interest in supporting public administration agencies, not in the least, because a local public administration agency was one of BSC's funding partners.

Summarising, early discussions about the platform development project made both organisations increasingly aware of a need for a strategic partnership. After deciding to co-develop the platform through a partnership, Vertisol and BSC established a joint innovation lab – called the "co-innovation lab" – to govern the open innovation collaboration. The findings section will elaborate in greater detail on why and how their platform plan influenced and shaped the governance of the open innovation collaboration. The following section will introduce the platform as the desired innovation outcome to contextualise the emerging tensions and key strategic decisions the co-innovation lab had to govern.

3.5.2. The platform

The platform development started in 2016, and it took about 18

months to develop a first operating version. The platform is what Cennamo (2019) labels a complementary innovation market platform, "providing the core technological architecture other companies build upon to create new products that extend the core functionality and reach of the platform to final users" (2019: p.8). The platform core technological architecture consists of three cloud-based layers (see Fig. 1). The first "data" layer processes the data for cloud-based storage and preparation for further use. The second is the "authentication" layer that manages secure access to the data. The third is the "interfaces" layer connecting the data with applications. Overall, these three layers connect data and offer interoperability between different applications for users, i.e. the public administration agencies. The applications constitute the second part of the platform, the periphery. The platform periphery consists of core applications developed by the co-innovation lab and complementary applications developed by third party companies as well as by VertiSol. Core applications on the platform include accounting, human resources and various public services to citizens such as social security. These core applications play a central role in collecting data, which third parties could build on to develop new solutions to complex societal issues. For instance, third-party companies specialised in smart city services used the data from core applications to develop AI-based applications to solve pollution and mobility problems. In other words, the platform core and data offer value to the applications in the platform periphery, and the complementary applications increase the value of the platform core architecture (Cennamo, 2019).

While an initial platform plan existed in both organisations, the platform's design evolved during the open innovation collaboration with key decisions on the platform core and periphery shaped by emerging tensions between BSC and Vertisol, which we will outline in the next section.

4. Findings

From the findings it emerged that the governance of the open innovation collaboration and the development of the digital platform mutually influenced each other. In analysing the evolution of the partnership and the digital platform together, we not only generated insights into "how" the open innovation collaboration and the platform were governed, but also "why" such governance decisions were made. Fig. 2 visualises the five main processes in which the platform was influenced by the open innovation collaboration's governance and how the

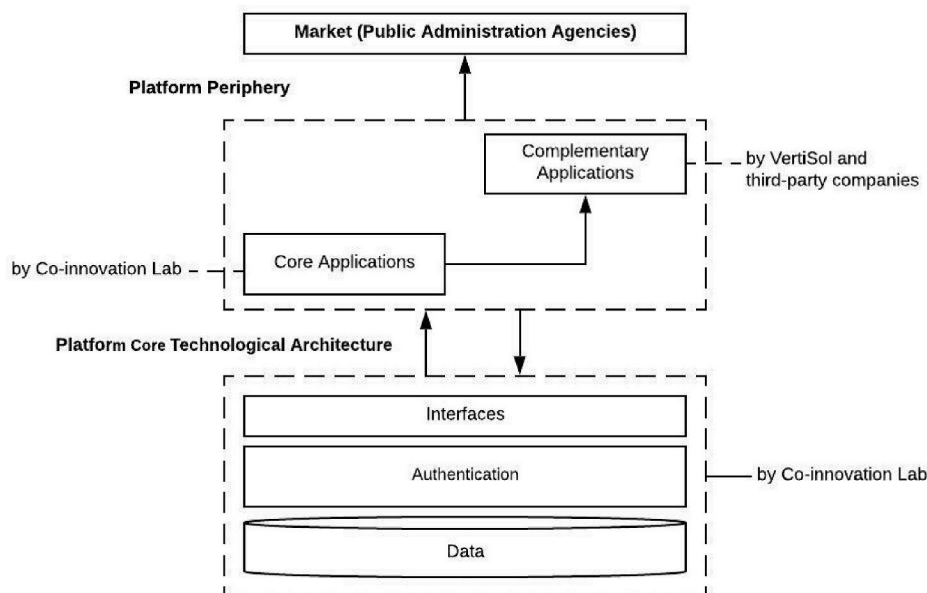


Fig. 1. The platform.

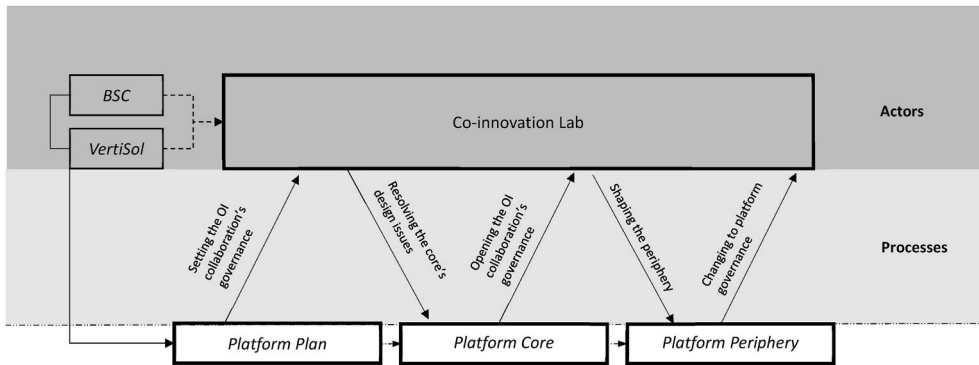


Fig. 2. Inter-organisational governance processes of an open innovation (OI) collaboration for platform development.

platform design altered the governance of the open innovation collaboration. These are: setting the open innovation collaboration’s governance, resolving the core’s design issues, opening the open innovation collaboration’s governance, shaping the periphery, and changing to platform governance. Fig. 3 shows the timing related to these organisational processes.

4.1. Setting the open innovation collaboration’s governance

After VertiSol and BSC had decided to jointly develop an interoperability platform, they engaged in a process of setting the governance for their open innovation collaboration. This culminated in the creation of a co-innovation lab.

4.2. Resolving the core’s design issues

The co-innovation lab took an active role in facilitating the development of the platform core while resolving the tensions emanating from the divergent interests of BSC and VertiSol regarding the platform’s design. One of the key outcomes of governing these tensions was to allow for the continuous improvement of the platform core.

4.3. Opening the open innovation collaboration’s governance

The decision to continuously improve the platform led to significant tensions between VertiSol, concerned about future costs, and BSC, interested in continuous learning and updating. Realising the continuous improvement was difficult to govern inside their existing governance structure, they opened the governance of the co-innovation lab to allow other parties to join the lab. While to date, no other parties have joined, the meaning of this governance change was significant.

4.4. Shaping the periphery

After developing the platform core infrastructure, the two leading organisations had to decide on the platform periphery setting. While it was not originally set up to do so, the co-innovation lab took an active role in shaping the platform periphery, guiding strategic decisions, including open-source code for the core applications welcoming other

third-parties to join the platform. In this decision-making process, the co-innovation lab was still mainly orchestrating the two leading organisations’ interests. However, this set of strategic decisions had shaped the periphery towards involving an ecosystem of actors that warrants a specific set of rules and governance mechanisms.

4.5. Changing to platform governance

The open nature of the periphery required the development of a set of governance mechanisms, such as basic access rules and certification, and training service. In addition, a technological leader was needed to guard these core rules and mechanisms. As a result, the platform’s open design led to the co-innovation lab’s changing role from governing the open innovation collaboration between BSC and VertiSol to the body governing the platform, operating increasingly independent from VertiSol and BSC. Interestingly, the platform emerges both as an outcome of the open innovation collaboration as well as the open innovation governance mode in which the partnership evolved.

4.6. Setting the open innovation collaboration’s governance: establishing a co-innovation lab

Interviews as well as secondary evidence revealed that the original platform plan envisaged by BSC and VertiSol included a core technological architecture and a periphery open to external contributors. Taken from an email exchange between the BSC Director and CTO of VertiSol prior to starting the platform development: “Our plan is to develop the technological architecture – and by joining forces this would be much easier and faster. But an interoperability platform needs to be open at the periphery to have more data and more services for our public administration agencies.” (BSC Director). The response by the CTO of VertiSol: “That is our plan too. We are on the same page on this. We will have some resistance internally in my organisation so we will have to prove there are no other options if we want to build a successful interoperability platform”.

Both organisations recognised the technological and social complexity of building an interoperability platform where several actors are involved. It would require merging distinctive know-how and interests through an alignment structure and governance practices.

After deciding to co-develop an interoperability platform, Vertisol



Fig. 3. The timeline for executing the inter-organisational governance processes.

and BSC established a joint innovation lab – called “co-innovation lab”. BSC and VertiSol went through the effort of setting up a co-innovation lab to govern the collaboration, despite both organisations having a history of collaborations with each other. Co-developing a digital platform had, however, a much higher degree of complexity than previous collaborations in which BSC developed technological solutions for VertiSol, and this complexity warranted a strategic partnership ‘as peers’. Taking from the very words of VertiSol’s CTO:

“Building an interoperability platform is not a one-shot game that you can easily outsource. These are objects that need continuous improvements and maintenance, something that, with our current set of skills, we cannot do alone. We need a partner like BSC fully into the project just like us, as peers.”. Internal notes and meeting minutes reinforced this statement and showed how the view that a plan to co-develop a platform would lead to more complex challenges and involvement of other parties gradually formed within VertiSol. It became clear to both organisations that this warranted a more elaborate governance solution.

As a result, the co-innovation lab was set up to govern the open innovation collaboration. VertiSol and BSC created an open-ended contract to formalise some key aspects of the co-innovation lab’s functioning, such as specifying the location, the aim of the project, the team involved from both organisations and investment rules, but maintained flexibility to update the contract in the future. An open and flexible contract in such situations of ambiguity surrounding the platform’s development is aligned with recommendations to govern open innovation collaborations (Parkhe, 1993; Zobel and Hagedoorn, 2020).

The lab was located inside BSC’s facilities and consisted of an operations unit and a strategic unit, with VertiSol and BSC equally splitting the needed investments. For example, the operations unit was responsible for developing the platform and employed four junior scientists, two of whom were recruited by VertiSol and two by BSC to work full-time on developing the interoperability platform. In addition, the operations unit consisted of two project managers from VertiSol and two senior scientists from BSC. The strategic unit was responsible for the strategic decision-making process within the co-innovation lab. It included representatives from both organisations: the CEO and CTO of VertiSol, and the Head of Research, CTO, and the Director of BSC. The involvement of the organisations’ top management in the strategic unit showed their commitment to the project. Complex innovation projects require continuous interaction of the involved parties. The strategic unit played an important role in facilitating such continuous interaction and access to knowledge in VertiSol or BSC: *“If the strategic unit [co-innovation lab] brought in a manager from VertiSol who we needed to talk to since he had the know-how of interest to us, things happened quite fast. If I had to do that [involve someone from Vertisol], and I did when I first started on this project, it’s much slower ... The same can be said with regard to involving someone from BSC.”* (Junior Scientist, BSC).

BSC’s Head of Research explained the vision behind this: *“Now we [strategic unit] are making quite big efforts, at least in terms of time, to converge and work together. But our goal is that the kids [junior scientists] will be guaranteed a much more natural alignment in the future, drastically reducing the communication barriers among the two organisations until they are operating as a single entity”*.

Interviews and participant observation of meetings with the strategic unit revealed that the co-innovation lab was considered a powerful organisational mechanism to increase trust and collaboration between VertiSol and BSC. As explained by the CTO of VertiSol: *“After two months, I’m already confused about who is ours [two VertiSol Junior Scientists] and who is yours [two BSC Junior Scientists]. Putting them physically together is working; they trust each other, they are open to exchange information and knowledge.”* (CTO VertiSol). Trust is a known driver for collaboration (Bogers et al., 2017) and creating a co-innovation lab worked well internally, but also externally as VertiSol used the co-innovation lab to leverage BSC’s reputation as a known and trusted centre towards public administration agencies as potential customers.

On the other hand, there were lingering tensions between VertiSol’s

commercial interests and BSC’s interests in conducting research. The organisations had earlier shown an awareness of the risk of divergent interests, which had reinforced the idea of setting up a co-innovation lab. According to the CTO of VertiSol: *“We could have been superficial and decide to avoid the creation of a further organisation such as the co-innovation lab since we already had a good historical relationship with BSC. But eventually, we decided not to skip this burden, and I say this was important in light of what happened afterward between us.”*

We observed first-hand how the co-innovation lab was a trusted environment for both organisations since they were represented within the co-innovation lab’s strategic unit to ensure a balanced resolution of any tensions. Strategic meetings emerged as an important governance mechanism within the co-innovation lab to resolve tensions through frequent communication (over 40 meetings a year between the operations and strategic unit as emerged from internal documents): *“We have a different focus, and we put more emphasis on research and less on commercialisation and making money, while they [VertiSol] do the opposite. But if we know the interest of the parties and we put them all on the same table, it’s easier to find solutions that are good for all of us; and we are seeing that we operate as a single entity in making decisions.”* (Director BSC).

In conclusion, these findings describe why and how the two organisations set the open innovation collaboration’s governance by establishing the co-innovation lab. Specifically, it emerges how the plan for a platform shapes decisions on governance of the collaboration. This logic of the problem and intended outcome of an innovation process (the platform) driving the governance of the collaboration is aligned with extant literature (cf. Bagherzadeh et al., 2019; Felin and Zenger, 2014). In the following sections, we will describe how the governance also shaped the outcome, going beyond findings of prior literatures.

4.7. Resolving the core’s design issues

Soon after the first release of the platform core, tensions emerged between VertiSol and BSC regarding the platform that would put the collaboration’s governance structure to the test. In VertiSol, some people favoured protecting their contribution to the development of the platform core, while BSC held the opposite view that any legal form of protection would undermine their researchers’ ability to use the platform as a research infrastructure. We were able to witness the efficacy of the co-innovation lab in resolving this tension. The co-innovation lab offered VertiSol’s legal department an opportunity to regulate the platform’s intellectual property rights. VertiSol tried, but it proved unfeasible to regulate the intellectual property of the platform core. Taken from internal documents: *“We tried to regulate IP to control their researchers’ access [BSC] as we were instructed. But we considered it too complex, and risks are low.”* (VertiSol Legal Director). Allowing VertiSol to try to regulate the platform core made VertiSol’s management feel that their concerns were taken seriously. Such an experiment-based approach towards decision making resonates with cycles of contestation and justification to resolve tensions in big science centres (Tuertscher et al., 2014). It was partly BSC’s trust in such approaches that allowed the co-innovation lab to effectively resolve this tension and shape the platform.

With the decision to open the platform core, a second tension emerged regarding the platform core’s maintenance and continuous development. VertiSol’s intent was to pursue high standardisation of the core to enable amortisations of fixed costs. As reported in a strategic meeting, BSC had a different opinion: *“Continuous experimentation, fed by our researchers at core components, it will give us a high-level platform. You’ll see.”* (CTO BSC). Promoting innovation and constant experimentation is fundamental for researchers (Boisot, 2011). For BSC, it was clear that the platform core warranted continuous innovation, which in their opinion, made it also in VertiSol’s best interest to pursue continuous innovation. The co-innovation lab resolved this tension through continuous dialogue between the two organisations until a decision was reached. VertiSol and BSC agreed to keep experimenting on the data and

authenticating layers of the platform's technological infrastructure while maximising standardisation on the interfaces connecting the two layers to applications in the platform periphery. During a strategic meeting we observed, BSC's Head of Research concurred that *"interfaces at the core can be standardised"*. The decision to continuously experiment with the platform core aligns both research needs for BSC with increasing platform uptake and usage for VertiSol: *"... with this approach, if our researchers use the platform internally to conduct their experiments on AI, we can guarantee a platform that is always state of the art ..."* (Head of Research BSC). VertiSol's cost concerns were alleviated as it was agreed that the costs of continuous experimentation would be part of the regular research activity, which BSC had already paid for.

In the previous process of "setting the open innovation collaboration's governance" we observed the influence of the platform plan in shaping the collaboration's governance. In "resolving the core's design issues" we witnessed how the co-innovation lab as a structure governing the collaboration actively shapes the outcome. By resolving tensions surrounding the platform core's IP protection and standardisation, other actors needed to be involved to continuously improve the platform core. This required the co-innovation lab to open up and govern the involvement of those actors, which we will explain in more detail in the next section.

4.8. Opening the open innovation collaboration's governance

With the platform core being open and designed to allow for continuous innovation, the co-innovation lab introduced governance mechanisms coordinating the involvement of other units within BSC and VertiSol such as "co-innovation days". Twice a year during these days, the co-innovation lab presented the development team and the platform project to researchers from BSC and employees from VertiSol. The aim was to get these researchers and employees to collaborate regarding the platform and provide new ideas for solutions, experiments and applications through ensuing discussions. As it emerged from the interviews, our own observations and from internal documents, a particular group of employees that were targeted through co-innovation days was VertiSol's sales force. They had direct access and knowledge about market needs and represented an important vehicle for collecting feedback from the users of the platform to suggest improvements.

The co-innovation lab also introduced a new incentive system to further encourage the involvement of BSC's researchers. The incentives included a research budget and recognising the person who came up with the initiative. The incentives and co-innovation days supported the continuous development of the platform core through opening the governance from being focused on managing the direct collaboration within the co-innovation lab to managing the involvement of other actors throughout BSC and VertiSol.

While VertiSol's and BSC's staff could suggest improvements to the platform, the implementation of such improvements required further resources from BSC and VertiSol, and this had to be governed. The co-innovation lab instilled a process in which researchers had to document the technical and economic feasibility of the proposed changes, show coherence with the platform's standards and report the need for change in terms of pros and cons for VertiSol and BSC. Similarly, VertiSol's sales force would need to provide concrete evidence of feedback from clients when suggesting improvements. VertiSol and BSC had to approve any change to the platform core technological architecture before implementing it, because uncontrolled openness may be problematic for the platform and a source of further tension between the two leading organisations (Wareham et al., 2014). Ensuring control was an essential part of increasing the accessibility of people outside the co-innovation lab to contribute. Moreover, there was a feeling that the involvement of other personnel from BSC and VertiSol would be insufficient to keep abreast with the platform's evolving needs. In the words of BSC's Head of Research: *"... who knows whether, in the near future, their [VertiSol] or even our competencies are enough for the continuous*

development of the platform? We can't guarantee to possess all the needed knowledge for future challenges". As a result, the co-innovation lab's boundaries shifted to a more open configuration in which other companies with distinctive ability could participate in the co-innovation lab. A candidate organisation would have to provide documented evidence about the value that they could bring to the platform's development. A five-person committee (two from VertiSol and two from BSC, and an external expert) evaluated the candidates, their contributions and their ability to support the platform. Although until the time of writing no other company had joined the co-innovation lab, the co-innovation lab's more open governance motivated VertiSol to ensure the protection of investments through a committee in addition to continuously innovating the platform core. BSC had some concerns that VertiSol could use the extensive approval processes to stifle the implementation of new ideas generated through their researchers and put the continuous improvement of the platform at risk. The more open co-innovation lab served as a safeguard to bypass VertiSol by allowing other organisations to join.

The above process shows how earlier decisions about the platform shapes the collaboration's governance through introducing additional governance mechanisms. The co-innovation lab changed to a mode which becomes more open by involving other parts of the two organisations and setting the stage for potential partners willing to join the lab. The co-innovation lab set the rules of who could collaborate, how they collaborate and introduces governance mechanisms such as joint committees and procedures to mitigate risks.

4.9. Shaping the periphery

After developing the platform core and changing the open innovation collaboration's governance, the attention shifted to developing the platform periphery where user applications are provided. VertiSol and BSC had co-developed several core applications to assist public administration agencies through the co-innovation lab. The core applications offered data integration and usage applications such as geolocation, which could then be used in a range of complementary applications such as managing mobility and pollution, accounting and human resources services. The firm and the big science centre started a discussion on whether to make these applications open source to stimulate the development of an ecosystem of complementors and potentially competitors (Tilson et al., 2010). For VertiSol, the idea of an open-source model was something new outside their innovation department. VertiSol's CTO said *"we [staff in the innovation department] have backgrounds in open-source environments, but for the rest of the company, it was a new thing"*. In the minutes of strategic meetings it was also noted as a threat that others may develop something they could develop themselves. BSC on the other hand, with its mission to improve the public good, favoured a broader ecosystem of suppliers providing innovative solutions for the benefit of public administration agencies.

To deal with this tension, we witnessed an interesting dialogue within the co-innovation lab's "walls" about the ability of BSC and VertiSol to satisfy all the needs of public administration agencies and local entities. Similar to what had happened regarding the IP rights of the platform, the co-innovation lab allowed VertiSol's management to show them that they were able to solve all the problems and needs of public administration agencies. Once again, it emerged how an experiment-based approach towards decision making allowed the co-innovation lab to effectively resolve a tension. In strategic meetings, the more sceptical people slowly started to embrace an open-source model for the platform periphery when it became evident that BSC and VertiSol would not be able to deliver on such an ambitious target. The agreed solution retained both views by opting to make the core applications developed by the co-innovation lab open source and to protect the source code of complementary applications developed by third-parties. The decision to open the periphery to third parties would increase the number of suppliers available on the platform to develop solutions for public administration agencies. VertiSol could also offer

complementary applications that would be granted the same protection level as those developed by third parties.

However, there was still an unresolved question regarding the engagement of suppliers with public administration agencies. BSC envisaged a model in which local public administration agencies engage predominantly with their local suppliers on the platform. VertiSol saw the benefits of the local public administration agencies having opportunities to engage with the entire pool of suppliers on the platform. The co-innovation lab was instrumental in resolving this tension through their close interaction with the market, as described in the minutes of a meeting we attended of the co-innovation lab's strategic unit: *"We jointly agreed that the best way to deal with this is to ask our central customers [public administration agencies] and their local suppliers of information systems directly, following what we call a 'bottom-up approach' ... and run some tests."* (Head of Research BSC). Through conducting 23 interviews and five focus groups, the co-innovation lab identified two important requirements for the interaction of public administration agencies with their suppliers. First, public administration agencies wanted to continue working with their existing ecosystem of local suppliers to support their local communities. Second, each public administration agency had very different needs due to large differences in their local situations and the issues they were addressing. Vertisol's CEO explained: *"We were biased by the fact that we are in a global world, and we need to create a global platform connecting everybody. But when we go out there and talk with local communities, we see there are local issues, and closeness to territories is essential to be able to solve them. We can't change this, we won't, we are solving a technological issue these local small companies have, and clearly, we have the chance to offer our support and enter in many local ecosystems."*

Summarising, in the "shaping the periphery" process we can see how the collaboration's governance shapes the outcomes (i.e., the platform periphery) by opening it up for other actors to offer applications. The more open platform periphery in turn made it clear to both VertiSol and BSC that they had to find ways to not only involve local suppliers, but also how to govern the overall access to the periphery aligned with the needs of their customers, the public administration agencies. Interestingly, the co-innovation lab not only shaped the platform's architecture, but also the platform's governance through for example allocating decision rights to participants and offering protection. This created a discussion on how to change to a platform-wide governance, which we will explain in more detail in the next section.

4.10. Changing to platform governance

The decision to open the platform periphery to third parties created further tension on how to govern this. The co-innovation lab understood that there was a need for decentralising some of the platform's governance to individual public administration agencies so that each agency could create their "rules of the game" by setting access rules for how and who could join their local platform. Public administration agencies organised thematic meetings around specific challenges to express their needs to the co-innovation lab and third-parties and select the solutions. That best suited their needs.

While there was general agreement on the need for decentralising some of the platform's governance, Vertisol and BSC disagreed on the extent of required decentralisation. VertiSol wanted the co-innovation lab to keep a "keystone" role and create a centralised set of governance mechanisms for third-parties and all the public administration agencies. BSC was sceptical about the feasibility of Vertisol's proposal and preferred to decentralise those decision rights to the public administration agencies while keeping technological leadership over the platform through certifications, training, etc. The co-innovation lab attempted to build a single governance scheme to suit all public administration agencies. This type of "experimenting" by testing directly with customers to validate solutions draws important parallels with the approach used internally to resolve conflicts about the potential

appropriation rights at the platform core and about the open-source model for the periphery. The co-innovation lab's attempt showed severe challenges in generalising an organisational governance structure for all public administration agencies and their local service providers.

Instead, it was decided to let public administration agencies determine which third-parties could gain access to their "localised platform". BSC and VertiSol agreed to change the co-innovation lab's role from governing the open innovation collaboration between BSC and VertiSol to becoming the platform's technological leader. While the public administration agencies had autonomy regarding which third-parties to accept into the platform, the co-innovation lab was not fully decentralising the platform's governance (Boudreau, 2010; Parker and Van Alstyne, 2017). Rather, it seemed to create a "meta-governance" model in which they monitored and kept control over the platform's use and diffusion. It led to further tension regarding the platform's generativity and the systems' ability to facilitate unprompted innovative inputs from large, uncoordinated audiences (Nambisan, 2017; Cavallo et al., 2019). The set of access rules to the periphery had to include governance mechanisms with a dual function: encourage innovation, but reduce the risk of uncontrolled creative output – e.g., low-quality complements – that could undermine the platform's reputation (Boudreau, 2012; Wareham et al., 2014).

The co-innovation lab retained a key role in approving decisions to ensure "coherency" with the platform's standards and offering technical support for the platform's adoption through the freemium service model and certification processes for third-parties. The co-innovation lab offered an extensive tool kit with code libraries, project management templates, open-source code solutions and access to user and researcher forums free of charge to third-parties wanting to develop new solutions on the platform. The co-innovation lab also provided other free services such as technical support, advice and training. VertiSol offered fee-based premium services such as consulting and co-development solutions for third-parties wanting more customised and specialised services. Allowing VertiSol to capture value through premium services protected common interests by maintaining VertiSol's commitment to co-invest in the core applications and the platform's overall architecture.

The co-innovation lab also instigated a certification process for solutions developed by third-parties. The Head of Research BSC stated: *"This is not the Apple Store; this is not consumer; we have to ensure high-quality standards and assess the need for new applications. Our customers are public administrations which makes all the difference."* Solution assessment criteria to gain certification were: i) "uniqueness" for an unsolved and pressing need; ii) degree of "customisation" at the local level; and iii) "coherency" with platform standards. Solutions that scored high in all three assessment criteria were certified as Platform Solutions – Level A. The "uniqueness" criterion reduced the risk of generating redundant solutions and promoted useful innovations. As emerged from internal documents, Level A solutions were promoted through co-branding with the co-innovation lab. The co-branding helped third parties gain legitimacy and build their reputation. This often led to new business opportunities, as the co-innovation lab would often suggest certified Level A solutions to other public administration agencies having similar issues. Taken together, this supported those actors investing in unique and innovative solutions. The downside of Level A certification is that it provides higher bargaining power to some third-parties, which could raise prices for public administration agencies. To offset the higher bargaining power, the co-innovation lab introduced an additional certification level – Platform Solution – Level B, for solutions which were not unique, but still offered high customisation and coherency. Giving public administration agencies the options of both Level A and Level B solutions introduced more competition and choice between solutions.

In short, the case evidence shows how the co-innovation lab had to deal with a much larger ecosystem of actors and related interests due to the decision to open the platform periphery to third-parties. While initially set up as to govern the open innovation collaboration, the co-

innovation lab in this final “changing” process evolved into a governance structure to manage the platform through technological leadership of setting rules, providing services and certifications. Together the five processes illustrate how the open innovation started as a collaboration between Vertisol and BSC had grown to include many organisations collaborating on a platform. Simultaneously, the co-innovation lab as the initial governance mode focused on managing two parties had evolved to governing a platform, and throughout its evolution introduced a range of more open governance mechanisms.

5. Discussion

In this paper we set out to investigate how the governance of an open innovation collaboration evolves through its interdependency with the innovation problem. Through an in-depth, longitudinal case study of a commercial software company and a big science centre co-developing a platform, we offered an original setting where the open innovation governance and its outcome influenced each other through five processes (conceptualised in Table 4). The first process illustrates how the organisations set up the co-innovation lab as a type of boundary organisation to govern the open innovation collaboration. In the second process the lab became the central actor in resolving tensions between BSC and VertiSol regarding key decisions relating to the platform core’s development and maintenance. In doing so, the open innovation governance directly influenced the development of the platform. During the third process strategic decisions regarding opening the platform core changed the nature of the co-innovation lab from governing the collaboration between BSC and VertiSol to a more open governance structure in which other organisations could also join the lab. In the fourth process the co-innovation lab played a decisive role in shaping the platform periphery through making the core applications open source and providing users with decision rights regarding the third-party companies they wished to engage with on the platform. During the fifth and final process the decisions regarding the platform periphery also changed the co-innovation lab’s role from governing the open innovation collaboration to becoming the technological leader of the platform, responsible for certifying third-parties and interacting with users.

The open innovation governance and the digital platform evolved and influenced each other to the extent that the co-innovation lab both governed the collaboration between BSC and VertiSol as well as the platform. Most fundamentally, we show that the governance evolved to more open modes and mechanisms (Felín and Zenger, 2014). Below, we

Table 4
Conceptualising the open innovation governance processes for platform development.

Inter-organisational open innovation governance processes for platform development	Constructs
Setting the open innovation collaboration’s governance	The process by which two (or more) partners define a type of boundary organisation and its functioning to govern an open innovation collaboration for platform development
Resolving the core’s design issues	The process of resolving inter-organisational tensions on the platform core’s development and maintenance
Opening the open innovation collaboration’s governance	The process by which the platform core’s decisions influence governance towards more open forms
Shaping the periphery	The process of shaping the platform periphery through solving inter-organisational tensions
Changing to platform governance	The process by which the platform periphery’s decisions influence governance towards more open forms (i. e., platform governance)

elaborate on these insights and discuss theoretical and managerial implications while also paving the way for future research directions.

5.1. Implications for theory

Our findings explicate how over time the open innovation governance and the innovation outcome became increasingly intertwined through five distinct processes, with the co-innovation lab not only governing the open innovation collaboration but also the platform’s technological side. These insights build on recent developments in the open innovation governance literature that has started to unpack how interdependencies emerge between the outcomes and the governance choices (Felín and Zenger, 2014; Tuertscher et al., 2014; Zobel and Hagedoorn, 2020). We find further support for prior notions that such changes to the open innovation problem and solution can be dealt with through including upfront flexibility in the chosen governance mechanisms such as incomplete contracts or more relational governance mechanisms (cf. Zobel and Hagedoorn, 2020). Our study, however, goes beyond those insights by showing open innovation governance is dynamic in nature and co-evolves with the related innovation outcome towards more open forms of governance. The implication for future studies is to study open innovation governance and its outcome longitudinally, to fully capture those dynamics.

Our study also contributes to the understanding of governing open innovation with big science centres. While collaborative open innovation practices between big science centres and companies are increasingly common (Scarrà and Piccaluga, 2020), they mostly focus on collaborations where the company is the supplier of innovations (Autio et al., 2004; Castelnuovo et al., 2018; Florio et al., 2018; Mazzucato and Robinson, 2018). We extend the existing body of research by showing how big science centres can co-develop innovations with companies as peers. We show that co-developing as peers is a careful co-evolutionary process in which the organisations learn how to collaborate and address emerging tensions both through the governance as well as through adjusting the governance based on evolving insights. The tensions surrounding the platform’s development were resolved through justifying and gathering evidence for competing views to let the best solution emerge through experiments and dialogue. This aligns with Tuertscher et al. (2014) observations of a scientific approach of cycles of contestation and justification to resolve complex problems between scientists in a big science centre. We extend this by showing that governance mechanisms evolved to higher levels of openness in response to new problems, as opposed to repeating the same cycle. The increased openness of the governance was key to benefitting more from the open innovation. Previous studies have shown how R&D scientists in and with big science centres have to permeate boundaries to benefit from outside knowledge (Lifshitz-Assaf, 2018; Tuertscher et al., 2014). Our findings suggest the key role of the evolving governance was to allow others to permeate boundaries and become part of the open innovation and the platform as its outcome.

Furthermore, our study highlights how the innovation outcome and governance became increasingly open through the role of the co-innovation lab as a boundary organisation. Whereas previous literature has shown the effectiveness of boundary organisations in managing collaborations involving large communities of scientists (Tuertscher et al., 2014; Perkmann and Schildt, 2015) and innovators (O’Mahony and Bechky, 2008), we show it can also be an effective mechanism to manage diverging interests between a company and a big science centre. The co-innovation lab seemed to go beyond merely aligning interests to truly operating as a single entity and building a common ground (Srikanth and Puranam, 2011). Interestingly, while the co-innovation lab as the boundary organisation initially focused purely on governing the open innovation collaboration between the two parties, it evolved to a more external, open organisation that includes other organisations and actively governs interactions on the platform, as opposed to staying an intermediary between the two originally involved organisations

(Perkmann and Schildt, 2015; O'Mahony and Bechky, 2008). In that sense, it extends prior work from Perkmann and Schildt (2015), which shows the important role of a boundary organisation in selective revealing to keep scientists separated from companies. In our study, a key part of the open innovation's success was that the boundary organisation brought the big science centre and the company closer together through creating more openness in the governance.

In addition, our results show how the co-evolution of a boundary organisation with a platform resulted in the boundary organisation developing a set of boundary resources such as APIs, code libraries, code solutions. While both boundary resources and boundary organisations play similar roles in governing the access of parties to the open innovation process, boundary resources have typically been associated with governing platforms (cf. Ghazawneh and Henfridsson, 2013) and boundary organisations with governing collaborations (cf. Perkmann and Schildt, 2015). Our results reveal a much deeper connection of the boundary organisation developing boundary resources, and the boundary resources subsequently governing the role and involvement of the original partners in the collaboration. This not only suggests a need for future research to include boundary organisations as a mode of open innovation governance in existing typologies (cf. Bagherzadeh et al., 2019; Felin and Zenger, 2014), but also to focus on how modes and mechanisms of open innovation governance shape each other.

Finally, our findings have implications for the burgeoning body of research on platforms by providing a first framework to conceptualise the open innovation governance processes for platform development. Specifically, we point to the important role of the developers and the development process in understanding the platform and its governance. Extant empirical investigations have looked at how this tension shapes the collaboration between a single platform leader, users and third-parties on the platform (Eckhardt et al., 2018; Ghazawneh and Henfridsson, 2013; Saadatmand et al., 2019). Our study presents an original context where two leading organisations co-develop the core of the platform.

We provide novel insights on how the stability-variety tension occurred between collaborators developing the platform core technological infrastructure. Supporting prior views that variety is also important at the platform core (Wareham et al., 2014), our findings reveal for instance that incentive systems for BSC' researchers ensure resourcing at the core level, balanced by a securing process of providing technical and economic feasibility and coherency with the platform's standards before approving any change at the core. Interestingly, the company's tendency towards a prevailing securing process for the platform core's development was managed and mitigated inside the "wall" of the boundary organisation, which resulted in a co-evolutionary process where resourcing to further open the platform started to dominate. This co-evolutionary process of governance is an important development to the platform literature (Wareham et al., 2014) and, in contrast with prior findings (cf. Ghazawneh and Henfridsson, 2013), we found that securing and resourcing happen together. Therefore, our study provides detailed evidence on how specifically some inter-organisational governance mechanisms worked so as to ensure resourcing and securing to face the paradox of change at the core level for technology ecosystems.

5.2. Implications for practice

The current study offers several implications for practice regarding open innovation collaborations. First, managers of companies and big science centres intending to engage in open innovation collaborations with partners having diverse interests, such as big science centres, should set up a formal entity to govern the collaboration. A boundary type of organisational structure may be particularly useful when the collaboration aims to develop a complex solution such as a platform. Second, managers should be aware that the governance of the collaboration is interdependent with the outcome being developed, meaning

that the open innovation governance is not a one-shot game, but it needs to evolve throughout the innovation development process. Carefully managing those interdependencies and associated tensions are key to a successful open innovation collaboration. Third, we suggest that companies and big science centres adopt an experiment-based approach for governing a decision-making process with their innovation partners. Our study revealed the effectiveness of such an approach in resolving disagreements while co-developing a complex technological system such as a digital platform. Fourth, our study suggests that – by choosing the right partner – smaller companies have an alternative strategic path they could follow to play a more central role in a networked economy by drawing on the resources of a big science centre in developing a platform. For big science centres a platform opens opportunities to conduct research experiments due to the availability of a vast amount of data and being close to the users.

6. Limitations and future research

Our original empirical setting of an open innovation collaboration with a big science centre to develop a digital platform as peers contributed new insights into how to govern open innovation. While our single case design is the dominant approach with reference to big science centres (cf. Tuertscher et al., 2014), it is not without limitations. First, most case studies on big science centres, including ours, focus on successful cases. However, a lot can be learned from comparing and contrasting these with unsuccessful collaborations with big science centres. Doing so may provide deeper insights into the boundary conditions on the use of governance mechanisms. For example, how important is a history of prior collaboration with the big science centre in successfully governing open innovation collaborations? The organisations we studied had a history of collaboration, and alliance literature suggests that prior experience with the same partner is an important driver in the success of the current collaboration (Kale and Singh, 2009). Future research could take such boundary conditions into account to further improve our understanding of governing open innovation collaborations.

Second, as we have uncovered some of the dynamics in open innovation governance and how these change over time, it is important to acknowledge that open innovation governance is a complex phenomenon where different permeable boundaries need to be managed (Zobel and Hagedoorn, 2020). Further research may benefit from a more fine-grained analysis into the specifics of open innovation governance dynamics, for example, by using a large sample or different analytical techniques.

Third, following recent trends regarding the multiplexity of open innovation partnerships, another area for future research is to what extent our findings on collaborating with big science centres can be generalised to a broader category of research institutions such as universities. Contrasting our findings with Perkmann and Schildt (2015) suggests that there are both similarities and differences in using boundary organisations to govern open innovation. More research is needed to understand the "uniqueness" of the big science centre context and its implications for open innovation governance.

Finally, focusing on platforms, we point to the necessity for a deeper investigation into the role of other organisations such as users, third-parties, universities and suppliers in these open innovation collaborations. Platform literature suggests that such partners have an important role in further shaping the platform and open innovation collaboration (Saadatmand et al., 2019). In particular, this may be relevant for big science centres, which already consist of a large number of partners such as universities, funding and technology providers.

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Appendix A

Table A.1

Representative data underlying second order-themes

Second-Order Theme 1: Setting the open innovation collaboration's governance			
Codes	Data	Data Source	Occurrence
Platform complexity driving peer involvement	<p>"building an interoperability platform is not a one-shot game that you can easily outsource. These are objects that need continuous improvements and maintenance, something that, with our current set of skills, we cannot do alone. We need a partner like BSC fully into the project just like us, as peers". (CTO, VertiSol).</p> <p>Interoperability platforms are complex technological objects with even higher complexity to manage when several actors are involved.</p>	Interviews	3 times
Coordinating knowledge access	<p>"If the strategic unit [co-innovation lab] brought in a manager from VertiSol who we needed to talk to since he had the know-how of interest to us, things happened quite fast. If I had to do that [involve someone from Vertisol], and I did when I first started on this project, it's much slower ... The same can be said with regard to involving someone from BSC". (Junior Scientist, BSC)</p>	Interviews	4 times
	<p>"complex innovation project like developing a platform, require the involvement of more actors to access more knowledge, and the interaction and sharing process has to be fast as these projects need iterative adjustment overtime". (CTO, VertiSol).</p>	Interviews	3 times
Need for contract flexibility	<p>"but there is not yet detail on the platform [in the contract], as we don't know everything yet, it will depend on the development process, and we will update it [the contract] in case we need to do so." (Director, BSC).</p>	Interviews	5 times
	<p>The platform feature and its detailed access and control norms will be updated in the contract during the development, if necessary.</p>	Internal documents	3 times
Dealing with divergent interests	<p>"the idea was to work on a common goal [building the interoperability platform], but at the same time, we couldn't ignore that we also had different souls and interests. So, we decided to bring the divergent interests together and find a synthesis in a transparent manner." (CTO VertiSol).</p> <p>"we have a different focus, and we put more emphasis on research and less on commercialisation and making money, while they [VertiSol] do the opposite. But if we know the interest of the parties and we put them all on the same table, it's easier to find solutions that are good for all of us." (Director BSC).</p> <p>"we aren't a non-profit organisation like they are [BSC]. We have to do all the checks precisely (to ensure) the return of our investments ... at the same time, we need to discuss and keep in consideration their [BSC] interests. The co-innovation lab was where this happened." (CEO VertiSol).</p> <p>... we [BSC] seek benefits for the territory through science, not profit".</p> <p>"we [VertiSol] are a major player in the IT sector with X millions of revenues".</p> <p>"now we [strategic unit] are making quite big efforts, at least in terms of time, to converge and work together. But our goal is that the kids [junior scientists] will be guaranteed a much more natural alignment in the future, drastically reducing the communication barriers among the two organisations until they are operating as a single entity." (Head of Research BSC).</p>	Interviews	7 times
	<p>"in the public sector, it is even more important that your client trust you and your work. Making it clear we are working with a research institute with a public mission can be very helpful in this regard." (CTO VertiSol)</p>	Interviews	5 times
	<p>"we need to inspire trust to the outside, to the clients, but it is important that people from our organisations also trust each other, to better cooperate on a complex innovation project." (Head of Research BSC).</p>	Interviews	5 times
	<p>External documents</p>	External documents	4 times
	<p>Interviews</p>	Interviews	2 times
<p>Interviews</p>	Interviews	6 times	
Ensuring trust	<p>"in the public sector, it is even more important that your client trust you and your work. Making it clear we are working with a research institute with a public mission can be very helpful in this regard." (CTO VertiSol)</p>	Interviews	5 times
	<p>"we need to inspire trust to the outside, to the clients, but it is important that people from our organisations also trust each other, to better cooperate on a complex innovation project." (Head of Research BSC).</p>	Interviews	5 times
Second-Order Theme 2: Resolving the core's design issues			
Codes	Data	Data Source	Occurrence
Using experimentation to solve regulation of IP	<p>"I understood their position. During a [co-innovation lab] meeting I told them [VertiSol], to let their legal team try to regulate IP over an AI platform's core co-developed." (Head of Research BSC).</p>	Follow-up interviews	3 times
	<p>"we already had the feeling that it wasn't easy nor possible to regulate it, but it was good to try and discuss it so that there was then no doubt in the decision process." (CTO VertiSol).</p>	Interviews	6 times
	<p>"we tried to regulate IP to control their researchers' access [BSC] as we were instructed. But we considered it too complex, and risks are low." (VertiSol Legal Director).</p>	Internal documents (e-mail exchange)	1 time
Enabling continuous experimentation and innovation	<p>"continuous experimentation, fed by our researchers, at core components; it will give us a high-level platform. You'll see." (CTO BSC).</p>	Participant observation	3 times
	<p>"... with this approach, if our researchers use the platform internally to conduct their experiments on AI, we can guarantee a platform that is always state of the art... ." (Head of Research BSC).</p>	Interviews	4 times
	<p>"we just had to confront this by looking each other in the eyes [co-innovation lab meeting], then it was clear that favouring continuous experimentation was in our best interests." (CTO BSC).</p>	Interviews	5 times
	<p>"continuous experimentation by their researcher is done at no cost to us ... this was made clear in one of our co-innovation lab meeting." (VertiSol Product Manager).</p>	Follow-up interviews	5 times
Enabling standardisation	<p>"interfaces at the core can be standardised." (Head of Research BSC).</p>	Participant observation	3 times
	<p>"where possible, we needed to standardise, so we keep control over investments in terms of time-effort and economics, of course" (CTO VertiSol).</p>	Interviews	6 times
	<p>"few co-innovation lab meetings ... and they [strategic unit - co-innovation lab] agreed upon keeping standard interfaces." (Junior Scientist BSC).</p>	Interviews	3 times
	<p>"we were on the same page regarding interfaces, but [during a co-innovation lab meeting] made it clear also to our staff [operative unit]." (CTO VertiSol).</p>	Interviews	5 times

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Table A.1 (continued)

Second-Order Theme 1: Setting the open innovation collaboration's governance			
Codes	Data	Data Source	Occurrence
Leveraging modularity	"in our discussions [co-innovation lab meeting], we just realised that modularity was a key feature of the platform so that we could standardise where possible [interfacing], while continuing to experiment by leveraging their researchers' competences on core parts [BSC]." (VertiSol Product Manager).	Follow-up interviews	3 times
	"despite our different views, in our discussion, I have to say that the platform [modularity] itself made it easier to find agreement on where to keep updating and where not to." (Head of Research BSC).	Semi-standardised interviews (face-to-face)	5 times
Second-Order Theme 3: Opening the open innovation collaboration's governance			
Codes	Data	Data Source	Occurrence
Introducing co-innovation days to involve others	Plenary presentation of the co-innovation lab and platform project to let both organisations know.	Internal documents	3 times
	"twice a year, we have these events [co-innovation days]. We need both the full organisations to know that we have this platform project." (Head of Research BSC)	Interviews	3 times
Creating an incentive system for researchers outside the co-innovation lab	"they [BSC's researchers not part of the co-innovation lab] have as a reward some research budget corresponding to the improvement proposed that the [co-innovation] lab evaluates." (CTO BSC).	Interviews	
	"some of them based on the improvement proposed can gain a promotion from junior to senior or senior getting stuff working for them etc." (Head of Research BSC).		
Engaging the company's salesforce	"they [VertiSol sales force] must know the benefit of the platform as they will help us with the diffusion of it among public administrations." (VertiSol Product Manager).	Participant observation	6 times
	"they [VertiSol] have the market connections, thus, it is important that their people working on the market know what we are doing here." (Head of Research BSC).	Interviews	4 times
	"our sales force can give us important feedback from the market." (CTO VertiSol).	Interviews	4 times
Balancing openness and control of continuous improvements	"implementing continuous improvements proposed by researchers can be beneficial, but we really have to see if there is a clear need for them ... we can't afford investments due to exclusive research purpose." (CTO VertiSol).	Interviews	6 times
	"through the co-innovation lab, we evaluate economic and technical aspects before investing money and make innovation happen at the core." (Senior Scientist BSC).	Participant observation	3 times
	"our sales force needs to document that suggestions for improvements may solve their customer issues, and we have to evaluate if that is a peculiar case or we are talking of a diffused need for change." (CTO VertiSol).	Interviews	5 times
Allowing organisations outside VertiSol and BSC to join the co-innovation lab	"... who knows whether, in the near future, their [VertiSol] or even our competencies are enough for the continuous development of the platform? We can't guarantee that we will possess all the knowledge needed for future challenges." (Head of Research BSC).	Interviews	7 times
	"other organisations should be able to join us, to bring their contribution to the project." (Director BSC).	Interviews	4 times
Second-Order Theme 4: Shaping the periphery			
Codes	Data	Data Source	Occurrence
Lack of familiarity with open-source	"others may develop something we could develop ... our organisation is probably not ready ... this [open source] is new for most of us." (Project Manager VertiSol)	Participant observation	3 times
	"we [staff in the innovation department] have backgrounds in open-source environments, but for the rest of the company, it was a new thing." (CTO VertiSol).	Interviews	6 times
Embracing open source as an opportunity	"we need to make open source the platform so that others can build, for instance, on our application to ensure useful services for public administrations and society." (Senior Scientist BSC).	Interviews	7 times
	The benefit of making open-source applications.	Internal documents	1 time
	"I knew the benefit of open source." (CTO VertiSol).	Follow-up interviews	5 times
Using experimentation and testing to resolve tensions towards open source	"when challenged during the co-innovation lab's meeting to show concretely that we didn't need an open-source, even our most sceptical people realised it was unfeasible to pretend we could develop and solve all the issues our clients have, and neither could BSC." (CTO VertiSol).	Semi-standardised interviews (face-to-face)	6 times
	"our concrete and testing approach helped us to come to the conclusion that we needed an open-source model. In meetings, different opinions can emerge but by making our opinions concrete, we can find common understanding." (Head of Research BSC).	Semi-standardised interviews (face-to-face)	5 times
	"are you sure you can develop anything public administration needs? If you believe so, show us in the next meeting the applications and problems you can solve." (Senior Scientist BSC).	Participant observation	5 times
Ensuring protection to third-party developers	"we should keep open only the core application ... if we provide other applications, we will need protection just like any other third-parties would need. Otherwise, they will not join the platform." (VertiSol Product Manager).	Participant observation	6 times
	"it is in the interests of both to ensure protection for third-parties, and us when we join as them to offer new customised services." (CTO VertiSol).	Interviews	7 times
	"we agreed that a regulated open-source model, thus open with reference to the core and core application only, would be a better model for both organisations' interests." (Head of Research BSC).		
Shaping the periphery with the customers	"we jointly agreed that the best way to deal with this is to ask our central customers [public administration agencies] and their local suppliers of information systems directly, following what we call a 'bottom-up approach' ... and run some tests". (Head of Research BSC)	Interviews	8 times
	"we were biased by the fact that we are in a global world, and we need to create a global platform connecting everybody. But when we go out there and talk with local communities, we see there are local issues, and closeness to territories is essential to be able to solve them. We can't change this, we won't, we are solving a technological issue these local small companies have, and clearly, we have the chance to offer our support and enter in many local ecosystems". (CEO VertiSol).	Interviews	7 times

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Table A.1 (continued)

Second-Order Theme 1: Setting the open innovation collaboration's governance			
Codes	Data	Data Source	Occurrence
	"we can't choose the best supplier for them [public administrations]; some public needs are very much linked to the territory." (Head of Research BSC)		
Second-Order Theme 5: Changing to platform governance			
Codes	Data	Data Source	Occurrence
Attracting new contributors through technological leadership	"we are offering all the services other companies need to help us solve the pressing needs of public administrations with innovative solutions; the lab is ready for this." (Head of Research BSC).	Interviews	6 times
	"we support those that are not familiar with our type of platform; we train them free of charge ... We need to convince companies to join us and offer innovative products." (Project Manager VertiSol)		
	"big societal challenges require the best effort from several players. We will give a tool kit to all those willing to work on our platform." (CTO VertiSol)	Interviews	7 times
	Joining the platform with innovative solutions – no initial cost.	Internal documents	1 time
Ensuring quality and control of new contributors	"the co-innovation lab provides technical support, advice, training and education for other third-parties free of charge." (CTO VertiSol)	Follow-up interviews	6 times
	"the co-innovation lab is in charge of the coherency with platform standards." (CTO VertiSol).	Follow-up interviews	8 times
	Level A solutions would also have the co-branding with the co-innovation lab.	Internal documents	4 times
	Level A solutions need to be unique, highly innovative.	Internal documents	4 times
	"Education and training for third-parties also serve to ensure quality." (Head of Research BSC).	Interviews	7 times
	"both level A and B are good, and consistent with platform standards. Level A are more innovative." (Project Manager VertiSol).	Interviews	5 times
	"this is not the Apple Store; this is not consumer; we have to ensure high-quality standards and assess the need for new applications. Our customers are public administrations which makes all the difference." (Head of Research BSC)		
	"we support and guide the public administration by giving them our advice ... on third-parties' solutions ... clearly we consider only those that access the platform, basically only the certified solutions." (CTO BSC).	Interviews	6 times

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Angelo Cavallo, Ph.D. is Assistant Professor at Politecnico di Milano. His main research areas include Strategic Management, Entrepreneurship and Digital Transformation. His research interests are focused in understanding how digital technologies as pervasive enablers are reshaping organisations, influencing innovation process, strategy-decision making and entrepreneurial process of both existing large organisations and new ventures. He is author of journal articles (appearing in outlets such as *Journal of Business Research*, *Technological Forecasting and Social Change* and the *International Entrepreneurship and Management Journal*), and conference proceedings.

Henri Burgers is a Senior Lecturer in Strategy and Entrepreneurship at The University of Queensland. He obtained his PhD from the RSM Erasmus University, and worked at the Queensland University of Technology prior to joining UQ. His research focuses on the intersection of corporate entrepreneurship, managerial and organisational capabilities, and institutional contexts with the aim of helping individuals and organisations unlock their entrepreneurial potential. He has published in top journals such as *Strategic Management Journal*, *Journal of Business Venturing*, *Long Range Planning*, and the *International Journal of Human Resource Management*.

Antonio Ghezzi, Ph.D. is Associate Professor of Strategy & Entrepreneurship at the Department of Management, Economics and Industrial Engineering – Politecnico di Milano. His main research field is Strategy, Entrepreneurship and Digital Transformation, with a focus on startups' business model design, innovation and validation. He is author of more than 100 refereed journal articles (appearing in outlets such as, *International Journal of Management Reviews*, *Technological Forecasting and Social Change*, *Journal of Business Research* and *R&D Management*), books, book chapters and conference proceedings.

Vareska van de Vrande is Professor of Collaborative Innovation and Business Venturing at the Rotterdam School of Management, Erasmus University. Her expertise focuses on the areas of corporate venturing and collaborative innovation, including external technology sourcing, corporate venture capital investments, strategic alliances, and corporate-startup collaboration. Other research interests include (corporate) entrepreneurship, patents, and venture capital. She has published articles in leading academic journals, including the *Strategic Management Journal*, *Research Policy*, the *Strategic Entrepreneurship Journal*, the *Journal of Product Innovation Management*, *IEEE Transactions on Engineering Management*, and the *Journal of Business Venturing*.