Article

JIM
ISSN: 2183-0606
(CC BY 4.0)
Vol. 12, 4 (2024)
p. 50-72
AM: Aug/2024
SM: Feb/2024

Exploring the Intersection of Big Data and Open Innovation: Synergies and Challenges in Emerging Contexts

Ana Clara Cândido[1], Jean Pierre Seclen-Luna[2], and Cristina Sousa[3]

[1]Federal University of Santa Catarina, Information Science Postgraduate Program, Florianopolis - Brazil | *ana.candido@ufsc.br*
[2]Pontifical Catholic University of Peru, Department of Management Sciences, Lima, Peru | *jseclen@pucp.pe*
[3]Iscte - University Institute of Lisbon, CEI-Iscte - Centre for International Studies, Lisbon, Portugal | *cristina.sousa@iscte-iul.pt*

Abstract

This study explores the symbiotic relationship between Big Data and Open Innovation. They work together to accelerate innovation and generate value for organizations. Different sectors and organizations go through decision-making processes that range from operational and routine aspects to managerial and strategic decisions, such as the implementation of a new product or the purchase of a new production unit. All these decisions require data and information that can mitigate risks and support choices. This study draws insights from real-world case studies, emphasizing the transformative potential of Big Data for open innovation. It analyzes evidence of the use of Big Data in Open Innovation practices in a group of Peruvian software companies. The results show the gap in the use of Big Data to support collaborative practices in the sample. In fact, often, those companies do not see a direct relationship between Big Data experience and the adoption of Open Innovation practices. The findings underscore the need for integrated approaches and suggest that bridging the gap between Big Data and Open Innovation offers a promising avenue for thriving in an information-rich environment.

Keywords: big data, open innovation, strategic information, software sector, Peru.

Cite paper as: Cândido, A.C., Seclen-Luna, J.P., Sousa, C., (2024). Exploring the Intersection of Big Data and Open Innovation: Synergies and Challenges in Emerging Contexts, *Journal of Innovation Management*, 12(4), 50-72.; DOI: https://doi.org/10.24840/2183-0606_012.004_0003

1 Introduction

Currently, generating, accessing, and analyzing information is crucial for business decisions and organizations' performance (Saeed et al., 2022). At the same time, the amount of information generated globally is exploding exponentially, driven by social media, sensors, digital transactions, and other sources. As information proliferates, the ability to extract insights and make informed decisions becomes even more critical (Davenport et al., 2001).

Big data offers the potential to unlock patterns and connections (Gandomi & Haider, 2015). It develops business intelligence by consolidating information that facilitates decision-making and consequently has a positive impact on business innovation (Niebel et al., 2019; Lin & Kunnathur, 2019). Researchers on innovation management agree on the advantages of adopting Open Innovation practices. Following the seminal work of Chesbrough (2003), it is considered that innovation is stimulated by using ideas, resources, and technologies available in the external

environment and which can be inserted within the boundaries of the company, as well as by making these resources available to the external environment (e.g. by commercializing intellectual property, which could then be used as a strategic asset by the organizations that own it) (Chesbrough, 2003; Dahlander & Gann, 2010; Chesbrough & Brunswicker, 2013).

According to the Open Innovation rationale, collaborative activities are essential for the development of inventions (Maalouf & Bahemia, 2023). There are various possibilities for implementing collaborative strategies. Examples include crowdsourcing platforms, from broad issues aimed at the general public to technical challenges aimed at specialists in a given subject; Research and development (R&D) consortia, which can involve universities and research institutes to develop stages of a project such as basic research; Rounds of co-creation with customers and suppliers to develop solutions and improvements are also considered an Open Innovation practice. These examples show that there are different and particular paths to adopting Open Innovation and that each company must define its implementation strategy and the combination of practices to adopt that best meets its strategic objectives.

Despite the limited number of studies on the interface between Big Data and Open Innovation, previous research suggests a symbiotic relationship between them (Aspiranti et al., 2023; Bresciani et al., 2021; Kim et al., 2022; Salih et al., 2024). On the one hand, Big Data fuels Open Innovation. First, by analyzing vast datasets from diverse sources (customer feedback, social media, sensor data, etc.), organizations can obtain strategic knowledge to uncover hidden patterns, unmet needs, and emerging trends (Bresciani et al., 2021). This informs the direction of Open Innovation efforts, ensuring they address relevant challenges and opportunities and enables responding to consumer needs more rapidly (Del Vecchio et al., 2018). Second, strategic information sharing is an important part of collaborative work, and its use and processing is an important skill for the partners in a given project. Therefore, structuring internal processes in terms of information management through Big Data can be crucial for the good performance of partnerships (Bresciani et al., 2021; Del Vecchio et al., 2018). Finally, Big Data algorithms can match specific problems with external partners who possess the expertise and resources to solve them. This matchmaking process creates a more efficient and targeted approach to Open Innovation (Meulman et al. 2018).

On the other hand, Open Innovation has the potential to amplify the value of Big Data. By collaborating with a diversity of external actors, organizations gain access to new and different data streams, enriching their overall data landscape and fostering more comprehensive insights (Janssen et al., 2017; Kim et al., 2022).

The symbiotic relationship is not guaranteed, however. It is contingent on several factors, namely the alignment between business strategy and information technology. It is, therefore, important to ensure that data analytics is always supporting the business strategy, and not the other way around (Sharda et al., 2018). According to Salih et al. (2024) this means that companies should invest more in big data because it is crucial for predicting the future; they also should combine open innovation techniques and strategic foresight methods to seize new business opportunities.

Research on how this symbiotic relationship occurs in real contexts is still scarce and thus there is the need to gain more knowledge to understand how Big Data can support an effective innovation process by using the Open Innovation practices, as well as the challenges that organizations face when integrating Big Data analytics with existing Open Innovation practices (Del Vecchio et al., 2018). So, in-depth empirical studies are required to examine how Big Data and Open Innovation can be tailored to specific sectors, addressing their unique challenges and opportunities. Moreover, there is a need to create systematic frameworks that integrate open innovation principles with Big

Data, to get a deeper understanding of how these two domains intersect. This understanding can inform strategic decisions to practitioners and policymakers.

Despite previous arguments, it is important to mention that in certain contexts, Open Innovation practices are not used, and organizations prefer to carry out innovations internally (Deichmann & Jensen, 2018; Manzzini et al., 2017; Trott & Hartmann, 2009). Therefore, there is still an important debate around the paradigm of open innovation, and relatively few studies on these issues in Latin American countries for service companies (Seclen-Luna et al., 2024).

This study addresses these gaps by analyzing the use of Big Data as an ally in Open Innovation practices and proposing a framework that systematizes the potential synergies between them. It resorts to in-depth case studies of the use of Big Data and Open Innovation practices in a group of small and medium-sized Peruvian companies in the software sector. The software sector has some specific characteristics in terms of human resource qualifications and the presence of emerging technologies in its solution development processes that make it an interesting sector to analyze the profile of Big Data and Open Innovation practices. Considering that the sample in this study is mostly made up of SMEs, and assuming the benefits and challenges already identified in previous studies, this study looks at the way these companies deal with the integration of Big Data and Open Innovation practices.

The paper is organized into six sections. Following this introduction, Section 2 is dedicated to the topic of Open Innovation, presenting the practices and dimensions of analysis. Section 3 addresses the topic of Open Innovation with an integrated view on the definition of Big Data. In section 4, the methodological procedures of the study are explained. Section 5 presents the results obtained, demonstrating evidence about the use of Open Innovation and Big Data practices by software companies in Peru, bringing some findings already evidenced in other previous empirical studies. Section 6 provides final considerations of the study with the effort to reinforce the contributions to theory and the importance of empirical studies of this type. Limitations and opportunities for future studies are also mentioned.

2 Theoretical Background

2.1 Open Innovation: Practices and Dimensions

Open Innovation (OI) is increasingly regarded as one of the most prominent strategic drivers of innovation (Chesbrough, 2003). Also, it is a well-established topic when it comes to strategic organizational good practices. Recent studies view OI as more collaborative innovation (Bogers, Chesbrough et al., 2018), that has become a frequent item on the agenda of organizations in various sectors and contexts (Chesbrough, 2024).

From the seminal studies of Chesbrough (2003), it is recommended to utilize concepts, materials, and technologies that are present both within and outside of the organization. Scholars have distinguished three different OI dimensions (Chesbrough, 2014; Gassmann et al., 2010): the inbound, the outbound and the coupled process. In the inbound dimension, organizations absorb external resources, utilizing ideas and technologies acquired from the external environment. Chesbrough & Crowther (2006) provide a nuanced definition of inbound OI, characterizing it as the process of generating ideas and results in R&D through information sourced from suppliers, customers, and other external entities, whether through acquisition or joint development of technologies. In contrast, in the outbound dimension, the organization disseminates ideas, technologies, and other resources to its external environment. Inbound and outbound dimensions can be used simultaneously, either in different projects or even in the same project at different stages, creating the coupled dimension (Dahlander & Gann, 2010; Battistella et al., 2017).

In the context of inbound OI, relevant practices include offering innovation awards to suppliers, engaging with external suppliers for R&D services, licensing (e.g., intellectual property rights), hosting competitions for business ideas and startups, availing specialized services from OI intermediaries (e.g., KIBS), establishing research scholarships in universities, engaging in co-creation with customers and consumers, leveraging crowdsourcing to address innovation challenges, participating in informal networks (e.g., fairs, networked organizations), and collaborating in R&D consortia supported by public funds.

The inbound practices are indicative of a strategic approach to garner resources, ideas, and technologies from the external environment to benefit the organization. Notably, companies can adopt intellectual property strategies involving licensing, where royalties are paid to inventors for utilizing their intellectual property. This practice may extend to partnerships beyond licensing, contingent upon mutual interests. Identifying key partners is facilitated by active participation in established network associations and organizations within informal networks, such as fairs and events. Promoting competitions of ideas, like hackathons and crowdsourcing, serves as a proactive means of identifying potential partners (Chesbrough & Brunswicker, 2013). Additionally, co-creation initiatives with customers and users yield valuable insights, contributing to enhancements or the conceptualization of new products and services through prototyping processes. Also, collaborations with universities through R&D contracts, with or without the backing of public funds, particularly, in the initial stages of their projects (basic research).

These inbound practices are widely used by companies (Almeida 2021; Mubarak et al., 2021). For example, studies that focus on innovation in service companies, especially in knowledge-intensive business service (KIBS) highlight the relevant role played by interactions with their clients in improving their processes or services (Rodríguez et al., 2017). However, in the context of Latin American countries, a recent study on service firms conducted by Crespi & Vargas (2015) concluded that market sources of information are not associated with any innovation by KIBS from Chile, Colombia and Uruguay. Additionally, recent research in the Peruvian service companies showed that ideas or external environment do not affect KIBSs innovation capacity (Moya-Fernández & Seclen-Luna, 2023).

The outbound OI practices are based on the external exploitation of ideas, knowledge and technology that were developed inside the firm. They enable firms to profit from un- or under-used resources (ideas, knowledge or other assets), by allowing other organizations to exploit them (Chesbrough & Borgers, 2014). They include the commercialization of patents and other intellectual property rights, incubation of corporate business, venture capital for startups, spin-offs, sale of market-ready products, participation in standardization programs (e.g., ISO), joint venture activities with external partners, and contributions to for-profit or nonprofit organizations. Here the role of intermediaries may be relevant; for example, the role of the technological knowledge-intensive business service (T-KIBS) contributes to facilitating the adoption and implementation of innovations in companies (Seclen-Luna et al., 2024).

Several studies have been carried out, over the last few years, with the aim of analyzing the phenomenon of OI in diverse contexts. These include the analysis of the adoption of OI by small and medium-sized enterprises (e.g. van de Vandre et al. (2009); Vanhaverbeke (2017); Vanhaverbeke et al. (2018); Brunswicker & Vanhaverbeke (2011)). When deciding to implement these collaborative practices, SMEs may encounter several associated challenges and risks. The study conducted by Vanhaverbeke, Vermeersch & Zutter (2012) with eighteen small and medium-sized companies (SMEs) based in European countries was one of the first studies to prove the benefits and potential of the model for companies of this size. The authors identified that most of the companies interviewed were not, at that time, interested in OI per se but were engaged and

seeking to adopt such practices to achieve changes in their business models, to take advantage of new business opportunities and to increase profitability. In addition, limited financial and human resources, as well as the lack of certain technological capabilities, were factors that made SMEs to look for different types of partners. Vanhaverbeke (2017) emphasizes that the implementation of OI in SMEs needs its own framework and that it is wrong to replicate models used by large companies. In Latin America, the study carried out by Cândido & Sousa (2017) with software companies from a Brazilian technology hub identified OI practices, demonstrating the potential of the model in an emerging technology at the time: cloud-based services.

Overall, existing studies have shown that OI practices can provide gains to SMEs (Tsai et al., 2022). However, these are not universal and as stated by Livierato et al. (2022, p.1), "How SMEs manage the balance between potential benefits and associated risks remains an overlooked topic in the literature". Data and information can contribute to and support certain decisions, as explained in the following section.

2.2 Big Data and Open Innovation

The notion that information governance and internal data can serve as the cornerstone for laying the groundwork for executing collaborations is not new (Davenport, 2014). Choo (1998) focused on studying knowing organizations and pointed out the three arenas in which organizations use information strategically: I. sensemaking; II. knowledge creation through organizational learning; III. decision-making processes.

Therefore, it is safe to say that all organizational processes require data and information in order to operate. Some of this data can be internal and structured, for example, with routine manufacturing activities to fulfill customer orders. Or in the case of strategic decisions that involve a more in-depth analysis of the external environment, for instance, the acquisition of a new business unit or entry into a new market (Urbinati et al., 2019). Kim et al. (2022) stress the role of data and information to make correct decisions, comply with regulations and manage risks.

In this context, the theme of Big Data (BD) on the organizations' agenda is consensually defended in the literature as an important resource for building sustainable competitive advantage. Added to this is the cost and time reduction that insights obtained from BD can promote in the innovation process (Niebel et al., 2019). Regarding the implementation of OI practices, data and information remain equally relevant, as data sharing is essential for trust-building among partners, contributing to the success of collaborative efforts (Wang, Wang & Mardani, 2023).

However, the use of BD is not a simple task. As Niebel, Rasel & Viete (2019, p.1) state: "The ability to analyze such data, extract insights and appropriate value from it represents a key challenge to firms". To guide companies in this process, Sharda et al. (2018) list the crucial factors for successful BD analysis:

- A clear business need (alignment with the vision and the strategy)
- A strong and committed sponsorship (executive champion)
- Alignment between the business and IT strategy
- A fact-based decision-making culture
- A strong data infrastructure
- The right analytical tools
- Staff with advanced analytical skills

Moreover, Sharda et al. (2018), stress the need to understand the main BD characteristics that together define its particularities, which are named the five Vs: volume, variety, velocity, veracity, and value.

Volume is one of the most widespread characteristics, as data creation has grown significantly in recent years. One of the reasons for this is the access to and spread of new technologies such as the Internet of Things and artificial intelligence, which interact with devices and generate new data beyond that produced by humans.

The **variety** of data is related to the proliferation of different data sources, such as social media and various indicators from applications and platforms drived by changes in customer and user behavior. The organization of this variety of data and the creation of value from it is among the main organizational challenges faced by companies.

In a dynamic and constantly changing environment, **velocity** is as much about data production as it is about the pace of processing it (capturing, storing, analyzing) to meet demands in a timely manner. The velocity of information can be the key to obtaining a competitive advantage, as keeping up with the velocity of data and information allows scenarios to be anticipated.

The **veracity** of data is a current concern, since the spread of fake news emphasized the importance of checking the source of data. When working with a high volume and diversity of data it is important to maintain a checking protocol to ensure reliability. This characteristic was coined by IBM and refers to the accuracy, quality, trust, and reliability of the data.

The **value** of data is the result of efforts to manage and use data and transforming it into information for decision-making demonstrates its results for organizations. Creating and capturing value for the development of new products, for example, is interesting and useful for the routine of organizations and contributes to activities inherent in the development of new products/services, as well as their improvement in incremental innovations. Thus, data analysis has become essential for organizations in any sector.

Ghasemaghaei & Calic (2020) examined the volume, variety, and velocity factors in order to evaluate the effect of BD on the innovation performance of firms. The study's findings reveal that the variety and velocity have a positive impact, while the volume did not, suggesting that having more data is not always better. Velocity emerged as playing a primary role in the impact of BD, which was to be expected given the dynamic scenario in which, for example, some decisions need to be made quickly.

The literature provides some important insights on the relationship between BD and OI. Firstly, studies demonstrate the potential of BD for OI and its practices, advocating that it is a source of sustainable competitive advantage for organizations (Radojević & Heumüller, 2023), and a driver of innovation performance in organizations that use more external sources of knowledge (Radziwon et al., 2024).

This is the case of Del Vecchio et al. (2018, p. 14) who state that "to unlock and sustain most of the benefits of the OI paradigm, BD analysis represents an incredible technological opportunity to grasp valuable information that has been hidden until now. Business opportunities created by BD can help firms to share knowledge and redefine relationships between companies". The authors also present three ways through which the integration of BD creates opportunities to support the adoption of an OI strategy: (1) the creation of new business models; (2) spin-out as an asset and secondary markets; (3) organizational change.

In this sense, BD facilitates the process of identifying opportunities in the external environment by enabling the use and/or processing of data from other organizations, both public and private. Not surprisingly, Big Data Analytics has assumed an important role in obtaining a more profound understanding of customers' preferences that goes beyond the conventional techniques of gathering

data, particularly in relation to the latent needs of the customer. However, Radojević & Heumüller (2023, p.59) state that "Big Data innovation has been so far primarily driven by attempts to generate value from mere data, to improve analytics, or to commonly push data and technology to the market – but not to meet existing market needs unless they can be matched by existing data and technology". This limited understanding of the potential of Big Data innovation as a process and as a result is also reflected in the field of practice by organizations.

Previous research has also stressed the need to integrate BD and OI practices "in order to integrate, process and analyze both external and internal data sources and translate them into value" (Lukić, 2014, p. 302). Different types of OI practices may denote different experiences in terms of use and information as a result. Some practices can generate a greater volume of data and information depending on the objective of the initiative, for example, those that aim to capture ideas and perceptions from the external environment will probably result in a greater data volume. This situation is exemplified by Del Vecchio et al. (2018, p. 11) according to whom "[...] the usage of OI strategies through communities of customers who generate BD has been translated into different initiatives, such as markets of ideas or crowdsourcing".

Regarding the potential of BD for collaborative work through the implementation of OI practices, Del Vecchio et al. (2018, p. 10) note that:

> "The characteristics of Big Data match positively with the principles of Open Innovation defined by Chesbrough (2003). Specifically, it is possible to see, in light of Big Data, that Chesbrough's assumptions about good ideas are widely distributed: the absence of a monopoly of ideas, the lack of assurance of commercial advantage due to the timing of discovery, that the goodness of a business model can be preferred to the technological performance [...]"

Prior studies have also highlighted that the use of BD raises challenges. Among them aspects of internal organization, such as the volume of data, process efficiency and costs, stand out (Kim et al., 2022; Sharda et al., 2018). The implementation of OI practices requires internal adaptation efforts, as Chesbrough (2024) points out: the biggest problems that organizations face when adopting the model generally arise from within the organization and not from outside its borders. Sharda et al. (2018) also mention challenges related to approaching customers, along with factors related to customer attraction and retention.

Challenges related to data and information management and protection are also stressed. Data and information are present in the development of diverse collaboration forms. Companies need to manage diverse data resulting from the adoption of BD in order to succeed in idea generation (Johnson, Friend & Lee, 2017; Ghasemaghaei & Calic, 2020). At the same time, companies involved in collaborations with different actors need to consider that each partner has its own objectives and perspectives (Wang et al., 2023). Therefore, it is essential to work on data sharing issues so that trust between the partners is not weakened, which could jeopardize the success of the work.

Sharing of sensitive information requires protocols and the formalization of contracts that ensure the secrecy of such information even when a relationship of trust has already been established (Dahlander & Gann, 2010). Some initiatives, such as DataPitch an EU-funded Open Innovation program, were developed to deal with the challenge of data sharing in OI practices between startups and SMEs (van de Vandre et al., 2009; Vanhaverbeke, 2017; Vanhaverbeke et al., 2018). Assuming that sharing data is essential for the effective construction of collaborations, the program focuses on agreements that will strengthen trust between participants, and thus result in an environment in which data can be accessed, used and shared. The program advocates sharing

data, among other things, to create value, new insights into business challenges and economic benefits.

Recently scholars started to reflect on ethical, legal and social issues related to the development of digital technologies, and particularly of artificial intelligence, under the concept of responsible innovation. A recent study by Zhou (2024) highlights that transparency and accountability in the collecting, using, and processing of data and information become crucial and need to be combined with privacy and security concerns. This ensures both compliance with applicable laws and the trust that exists between the parties involved in a project. This is essential for implementing OI practices.

In addition, according to Zhou (2024), responsible innovation has an important role to play in the identification and mitigation of biases in data collection and algorithmic decision-making processes to ensure fairness and equity. In some areas, artificial intelligence technology has made it possible to process vast amounts of data and information more automatically, but human intervention is still necessary to make sure that everything is proceeding as planned and that there are no deviations from reality. Therefore, the role of responsible innovation goes beyond mitigating the risks and problems associated with inappropriate use. It is about enabling technological development to bring about positive change for a given context and/or society.

To sum up, theoretical background was built drawing on relevant theoretical contributions to the field of OI and BD, as shown in Table 1.

Table 1. Structure and basic materials for building the interview guide

Category	Subcategory	References
Open Innovation (OI)	Practices, typology	Chesbrough & Crowther (2006); Chesbrough & Brunswicker (2013)
	Dimensions: inbound, outbound and coupled	Dahlander & Gann (2010); Chesbrough & Brunswicker (2013); Almeida (2021); Mubarak et al., 2021; Maalouf & Bahemia (2023)
	Small and medium enterprises	Vanhaverbeke (2017); Vanhaverbeke, Vermeersch & Zutter (2018); Brunswicker & Vanhaverbeke (2011); Radziwon & Vanhaverbeke (2024)
	Data and information for Open Innovation	Del Vecchio et al. (2018); Radojević & Heumüller (2023)
Big Data (BD)	Information management	Choo (1998); Wang et al. (2023)
	Use, dissemination and storage of data & information	Davenport (2017); Urbinati et al. (2019)

Source: Authors' own elaboration

3 Methodological Procedures

We conducted the study using ten in-depth cases of Peruvian software companies that perform OI and practices. We opted for a qualitative study with a grounded theory building approach (Glaser & Strauss, 1967) as it responds better to "how" questions than quantitative research's input–output models (Yin, 2018). Moreover, our multiple case studies generated rich, field-based insights into the OI and BD practices.

3.1 Research setting and sample

In order to investigate how BD practices, approach the development of OI in companies, we adopted an inductive case study design. The present study is based on ten Peruvian software companies. Multiple case studies allow to generate multiple observations on complex and simultaneous processes (Eisenhardt & Graebner, 2007) and to develop detailed insights of the theoretically novel phenomenon (Edmondson & Mcmanus, 2007). This research design was particularly useful since there is limited knowledge about the relationship between BD and OI practices in developing context. Information from real-life cases can help identify new aspects and factors derived from reality (Yin, 2018). In addition, according to Langley & Royer (2006), the rationale behind analyzing multiple cases is to find commonalities or differences between them. Each case can be described in some detail, as not all cases within a group must be conducted exactly the same way; some cases may have particular goals and require less intensive investigation than others.

Ten Peruvian software companies participated in the research. The sample was selected from a Peruvian software sector association - Peruvian Association of Software developers and related services (APESOFT). This is an interesting factor for the study as some similarities can be highlighted when companies from the same sector collaborate and participate in the same network.

The choice of the sector was motivated by the fact that software companies reveal potential in terms of team qualification and competences on emerging information technologies. Thus, the phenomenon regarding BD and OI practices in these companies can reveal complementarity of existing prior knowledge that contributes to the advancement of the analysis. The cases were selected considering the rigor mentioned about the importance of the selection carried out by the researcher for the progress of the study (Yin, 2018). In light of the study's aim, companies that, on a first contact, disclosed that they have engaged in some form of OI within the previous five years were selected. All of them have agreed to participate in the research.

3.2 Data collection

Between September and November 2023, the authors gathered data primarily through cross-functional interviews (Yin, 2018). A semi-structured interview guide was developed that aimed to understand the OI and BD practices. It is important to mention that the structure and basic materials for building the interview guide was according to Table 1 mentioned before. In total, authors conducted ten interviews with key informants such as CEOs, founding partners, directors and managers of the participant companies. The interviews were conducted online via a free videoconferencing platform and lasted an average of 40 minutes. The interviews were recorded with the consent of the interviewees and stored in files generated by the OBS Studio platform.

The informants were identified by snowball sampling though the Peruvian Software Association (APESOFT), where president of these association was asked to recommend CEOs companies who had an active OI practice. So, the first contact with the interviewees and the awareness-raising for the relevance of the study, to make the collection of data possible, relied on the support of the APESOFT Director. These informants gave us a wider understanding of the case studies. We concluded the data collection when theoretical saturation was reached (Glaser & Strauss, 1967). Table 2 summarizes the case studies and the data collection efforts.

Table 2. Description of case studies and data collection efforts

Companies	Number of employees	Founding time (years)	Sector of activity	Additional market information
Company A	100	22 years	Software solutions for supply chain management	Belongs to Bolivia and Peru with business in several countries in Latin America
Company B	30	8 years	Robotic process automation solutions	National market
Company C	860	4 years	Software development, artificial intelligence and disruptive software	The company was born in Lima and is present in nine countries. The only unit outside Latin America is in Spain
Company D	18	25 years	Software solutions	The main customers are in Peru, Colombia, Mexico, the United States, Canada and the Caribbean
Company E	12	7 years	Software and telecommunications	Peru and Argentina market
Company F	11	4 years	e-learning	National market
Company G	5000	More than 50 years	Consultancies from traditional information technologies to the most disruptive ones	Global consultancy company, present in more than 80 countries
Company H	60	30 years	Hospital management	Sells software in 10 Latin American countries
Company I	30	20 years	Information technology and business intelligence	Company headquarters in Argentina but is present in Peru
Company J	30	15 years	Software and telemedicine	National market

Source: Authors' own elaboration

3.3 Data analysis and processing

The data analysis was based on a thematic analysis approach, which provides ways to identify patterns in large, complex data sets (Braun & Clarke, 2006). Moreover, the thematic analysis offers means to effectively and accurately identify empirical themes that are grounded in the case study context. Through a series of iterations and comparisons (Alvesson & Sandberg, 2011), the authors grouped empirical themes into the conceptual categories. Moreover, the conceptual categories reflected the theoretical constructs from the literature (Corbin & Strauss, 2015). Next, the authors performed a cross-case analysis (Eisenhardt, 1989) to identify similar empirical themes and categories across the cases (Miles & Huberman, 1994). Finally, the conceptual categories were clustered into the aggregate dimensions (Gioia et al., 2013). Therefore, we followed a three-step process similar to that described in the literature (Braun & Clarke, 2006; Gioia et al., 2013).

In short, to analyze and process the data from the interviews, Braun and Clarke's Thematic Analysis (2006) was used. The research objective of identifying evidence on the use of OI practices and BD is supported by this type of analysis, which employs steps for constructing the results that involve the researchers' prior knowledge and continual consultation of the database of collected data. As a result, the following six phases of Braun & Clarke's Thematic Analysis (2006) were applied in this study:

1. Familiarizing yourself with your data
2. Generating initial codes:
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report

In step 1, familiarization with data, the researcher who conducted the interviews listened to the recordings of the interviews for the first time. After this first review of the data, the researcher listened to the interviews again with the aim of documenting them using the adapted interview transcription method, which eliminates occurrences that are considered irrelevant to the context being analyzed. This was one of the most time-consuming steps of the process, but it was important in terms of familiarization and initial insights based on what the interviewees said.

During the manual transcription of each interview, the data was separated by company by the time horizon of application for the interviews. The responsible researcher used the recordings more than once to capture the details of the speeches. This research activity followed recommendations by Davidson (2009) and Tracy (2010). Thus, from the material originating from the transcription of the interviews in step 2, codes based on the grouping of topics were generated. Given the specific content, this step identified the different types of OI practices mentioned by the interviewees. All transcriptions and data processing were performed by the same researcher to avoid discrepancies in the analyzes and avoid inter-coder reliability issues. The materials (recording videos and transcripts) are stored in cloud files under the responsibility of the researchers, preserving the confidentiality of the identification of the participating companies.

In step 3, we created a concept map by grouping the themes (in a more comprehensive way) found in the previous steps. With the support of a visual image (see Figure 1), it is possible to identify and project relationships between the themes and make new associations about the reality described in the interviews with a greater understanding of the studied context.

In step 4, we reviewed the themes. This step was the basis for refining the codes that mark step 5 of the analysis, as it is an evolution through more in-depth associations, grouping of themes and the result of a synthesis of the codes shown in Figure 2 of the next section.

Step 6 of the Thematic Analysis materializes the results, draws on some passages mentioned by the interviewees and also provides some counterpoints to other empirical studies.

4 Big Data and Open Innovation practices: empirical evidence

This section presents the results of the analysis on the identification of evidence of BD in OI practices adopted by the interviewed software companies. Different internal teams and the management of collaboration between partners are involved in different OI practices in the companies studied. Companies that already have an OI strategy generally have the capacity to implement multiple types of practices. Most of the practices implemented were in the outbound

dimension, thus corroborating the studies conducted by Dahlander & Gann (2010), Almeida (2021) and Seclen-Luna et al. (2024).

The profile of the OI practices adopted by the software companies in this study's reveals interesting evidence of how the OI model has been implemented, whether deliberate and in a structured way or even with isolated collaborative initiatives. The results are consistent with previous studies in the context of South America such as of Cândido & Sousa (2017), which analyzed a group of Brazilian software companies which established partnerships with companies in the same sector in the form of commercial alliances. That is the companies acknowledge the benefits of adopting these OI practices. In addition, the analysis reveals similarities in the use and systematization of data and information (BD) in the implementation of collaborative projects.

By applying the steps of the Thematic Analysis described in section 3, it was possible to structure the main elements of the interviews into a concept map. Figure 1 shows the results of step 3 of the Thematic Analysis, in which the central themes of BD and OI permeate the themes extracted from the interviews.

Similar to the study of Vanhaverbeke et al., (2012), the BD experience was not directly associated to the adoption of OI practices by the interviewees. Although the interviewees recognized the value of the information resource for organizational routine, they did not point out many elements related to how they could use the benefits of BD in their collaboration with partners. However, each company has its own initiatives for using and storing internal and customer information. Companies expressed their concerns about complying with legislation on the use of customer data and information beyond what they could use as a source of customized solutions. On this theme, for example, the interviewee from company A stated: "*Internal information is accessible to everyone but follows security governance and it is guarded*". Company G also reports that "*We have structured processes and a strong compliance policy. We follow several international (European) regulations. Therefore, those who relate to us are committed to following safety, compliance and quality guidelines*".

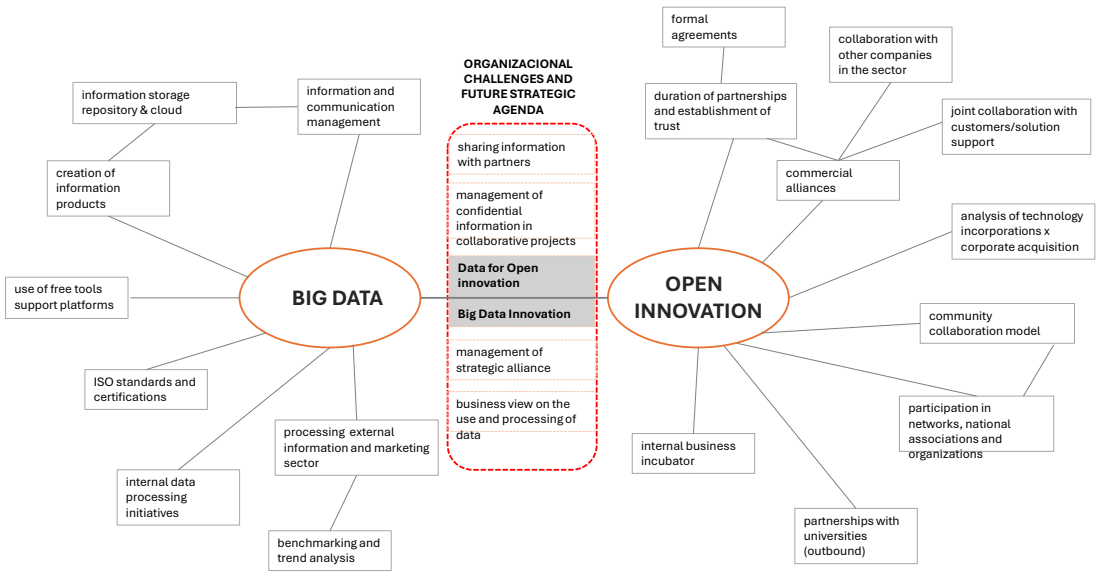

Figure 1. Mind map of Thematic Analysis in Step 3
Sources: Author's own elaboration.

Another relevant theme is related to the duration of the partnerships. The innovation projects have a deadline to be met, but usually the partnership does not end with this deadline. In fact, all the companies interviewed reported the importance of building trust as an important factor in maintaining collaborative strategies with external partners, as already pointed out by Wang, Wang & Mardani (2023). Partnerships extend beyond the duration of projects and can be maintained through follow-up or after-sales work on jointly developed solutions, or even for the development of new ideas that emerge during the interaction. In the words of the interviewee from company D: "*In general, strategic alliances are continuous. In some cases, they are relations already established for a longer time. Even if they are activities developed by the time of the project, there is a continuity of communication"*.

The interviews revealed that all companies use formal contracts for co-development. This is the case even with partners who have been working together for a long time and have had the opportunity and time to build trust.

The companies analyzed are part of a sectoral association, and they all reported the importance of being part of this network. One of the strongest aspects that characterizes the collaboration of this group is the networking that continues to be strengthened on informal communication platforms for the exchange of experiences between companies. Through these channels, there are referrals of professionals and other companies, and even the exchange of ideas in their early stages as a way of identifying potential partners. This is a way to get in touch quickly and directly with those who work in the same market and can collaborate, whether in support areas or in the business itself. About this, the interviewee of company D stated: "*When I need new knowledge for some technological development, for example, a new programming language we use a Whatsapp group with colleagues from technology and software companies*".

As mentioned above, commercial alliances were the most frequent type of practice. They were mentioned by all the interviewees, with software companies partnering with other companies in the same sector to complement their solutions and/or enter new markets. This enables them to achieve better results, with the access to the expertise of their commercial partners, in line with the evidence already found by Cândido & Sousa (2017).

Low interaction with universities was also found, this result is consistent with the study of Moya-Fernandez & Seclen-Luna (2023) who analyzed this relationship in Peruvian KIBS firms. Only four the ten companies interviewed reported collaborating with domestic universities. This type of practice takes place with an outbound flow, as companies are involved in building new course curricula and/or improving and updating the curricula of existing courses. The interviewee of the company G clearly points this out: "*With universities, although I wish it were the other way around, it is mostly characterized by the outbound dimension*". Company A is a part of a conglomerate that owns a private university, yet even in this case, the cooperation is limited to the outbound dimension.

Although there were no reports of R&D projects with universities, there is recognition of their role in training qualified professionals. The following transcript of the interviewee from company A reflects this situation: *"The importance of this alliance is, above all, to strengthen the ties between institutions in the same conglomerate and to mutually nurture our expertise. The company benefits from the intellectual capital of the universities, which offer qualified professionals, and the university benefits from the improvement of curricular processes with the practical knowledge of the company".*

The outbound dimension characterized most of the practices mentioned by the companies, which is also explained by the size of most companies (SMEs), thus corroborating the analysis carried out by Almeida (2021). In that study, the author argues that one of the reasons why SMEs

have more outbound practices may be because they are easier to adopt and there is less needed to restructure internal innovation processes.

The companies with a structured innovation process reported OI practices in the inbound dimension that require a structure of financial and human resources and use them to obtain knowledge by other means. For example, company E has a business incubation program. In this program, they invest financial and intellectual resources in ideas with business potential that interest them, for a period of up to two years. They reported that this practice has not yet shown effective results in financial terms, but it is understood that there is a need to improve the strategy for implementing this practice. For its part, company A is analyzing technology incorporations that could lead to more advanced negotiations for the acquisition of other corporations, namely the acquisition of startups. Company F described using collaborative customer communities as an inbound practice to enhance its offering and get an idea of user requirements. They mention that "We do not make alliance with a specific actor but in community, use for the same alliance more partners and not just one. Thus, we create these spaces, invite people to a co-creation, as an OI laboratory for development of products and to identify values, concerns and interests". They also believe that maintaining a close relationship with customers ultimately makes them loyal, as they feel part of the business. The search for international certifications, such as the International Organization for Standardization (ISO), was mentioned by two companies (A and B) and was carried out with the motivation of meeting the requirements for relations with specific partners. According to company A "*An important initiative was also to seek standardization of processes, we have four ISO certifications which are: anti-corruption, quality, business continuity, information security and companies providing electronic services*".

Regarding the preparation and possible adaptation of internal processes for the establishment of partnerships, most of the interviewed companies report that there have been one-off changes so that the projects would follow the flow of the partners, especially in projects with an outbound dimension. In other words, projects led by other organizations, and where interviewed companies participate as partners at specific stages, may require occasional and specific adaptations. In this respect, company C also stresses that adaptations in project management override any internal operational management. It is important to note that these adaptations go beyond those required during the COVID-19 pandemic.

After a critical revision of the themes (step 4 of the Thematic Analysis), a final map was created corresponding to the step 5 of the Thematic Analysis (Figure 2). In this evolution of the mind map an effort is made to relate the identified themes to BD and OI, that was previously absent. In this analysis it was considered that the characterization of use, the attention to confidentiality, and the organizational routines that can be developed in information governance are crucial to the work of managing strategic alliances and other partnerships.

In terms of OI, as highlighted earlier, commercial alliances were the most common type of practice used by companies, and this is where they recognize the most direct impact of collaboration. Although the interviewed companies have long-standing relationships with some partners, which have made it possible to develop trust, any commercial alliance requires a formal contract. This contract is a fundamental piece in managing the collaboration and its outcomes and aligning expectations and raises questions about the management of confidential information.

In terms of BD, the themes that stand out in the interviews are close to Choo's (2018) procedural model, for example: information needs, the use of support tools and platforms that can be free, paid for or developed in a customized way. Also, the dissemination of information, both for the internal environment (organizational communication) and for communication with

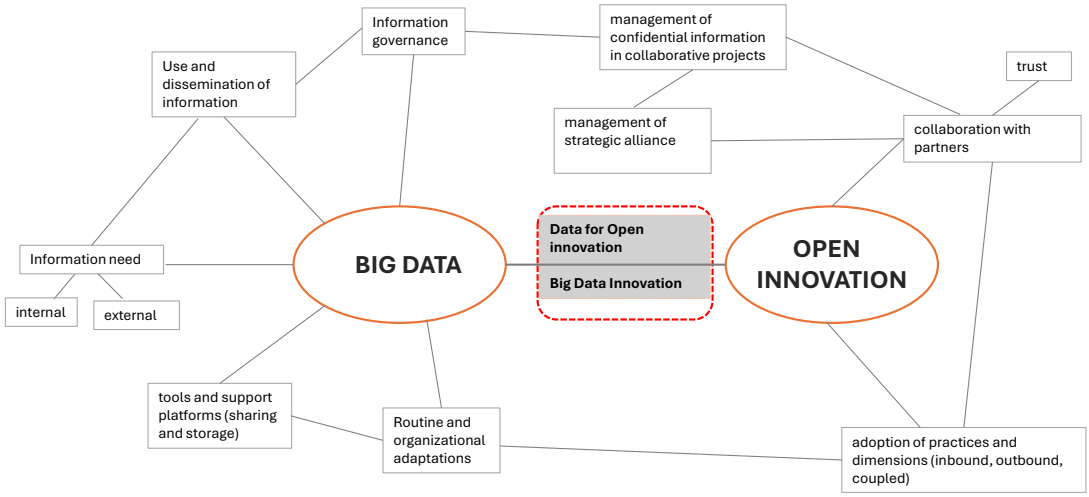

Figure 2. Mind map of Thematic Analysis in Step 5
Sources: Author's own elaboration.

the external environment and marketing. This is also close to the recommendations proposed by Ghasemaghaei & Calic (2020).

Returning to the evidence observed in the interviews, in terms of information management and the use of BD in OI practices, the companies have not systematized their processes as a way of obtaining results to support the development of solutions and/or innovations. Companies have used their own measures to seek the internal organization of this resource. This is evidenced by the interviewee of company A who mentioned that: "*We do not use specified tools and solutions for sharing information with partners, but we follow the information management policy already implemented internally through repositories with specific access*".

However, companies recognize the potential of BD to support the organizational strategy, as mentioned by the interviewee from company B: "*There is no systematization for the use of Big Data. Moving forward with the processing of data that the company already has and that can be used for our solutions is a topic included in the strategic planning*".

Another theme is the unit or sector where the internal teams process data and information: four of the ten companies mention that the data and information processing activities (use, dissemination, and storage) are carried out by the company's marketing department. This is illustrated by the following statement of company's B interviewee: "*For us external information has a lot to do in the marketing department*".

Although companies recognize that they do not have a structured process in terms of the use of data and information, they all agreed that they pay close attention to complying to the data protection laws in force in the country. In this regard, the interviewee from company B states that "*Client information is confidential, protected by confidentiality legislation, so it is only for internal use with the clients themselves. Commercial information is, in fact, what we use to improve products, analyzing the market and trends based on competing trends and solutions*".

5 Discussion and Concluding remarks

The paper contributes to the strengthening of empirical studies exploring the relationship between Open Innovation and Big Data. Although both concepts have consolidated literature, their joint

analysis with an integrated perspective is still incipient. The paper complements existing research on the benefits of the adoption of collaborative practices and data and information management.

In fact, this study explores the intersection of Open innovation and Big Data, shedding light on their symbiotic relationship. Based on a comprehensive analysis of real-world case studies, we propose a framework that provides new insights into how organizations can leverage Big Data to enhance their Open innovation practices. Specifically, we identify key mechanisms through which Big Data can facilitate collaboration, idea generation and business development, and knowledge sharing across organizational boundaries.

Big Data as a strategic factor for business competitiveness is justified, according to Del Vecchio et al. (2018); Bresciani et al. (2021) and Aspiranti et al (2023) due to its comprehensive potential for different types of organizations and businesses in different sectors. The results of the study show the types of practices mentioned by the interviewed companies, as well as listing a series of aspects that are considered a gap in the use of Big Data to support collaborative practices and which reinforce the need for future empirical studies using data for Open Innovation, Data-Driven Open Innovation and Big Data Innovation approaches, converging by Bresciani et al. (2021).

The analysis of the use of Big Data and Open Innovation by Peruvian software companies corroborates the characteristic aspects of the adoption of Open Innovation practices, for example, in SMEs, and which highlight the challenges of the practical context of organizations. In operational terms, information management and the strategic vision of Big Data are incipient in relation to the adoption of Open Innovation practices by the interviewed companies.

The findings of the Thematic Analysis reveal the symbiotic relationship between Big Data and Open Innovation, mentioned in the introduction. This study shows that the proper use of Big Data facilitates the implementation of Open Innovation. In turn, the management of strategic alliances (in other words, a strategy and governance of Open Innovation) encompasses a series of activities that involve decisions about the use, storage, sharing, and access policy of internal and external data and information related to networked work, which need to be planned in advance.

The point is that all types of practices require data and information and, when processed and used strategically, they can be important allies for the success of projects. There have been efforts to raise awareness of the importance of managing the 'information' resource (Choo, 1998) and it is a topic that has been involved in the practical context of organizations. The developments of Open Innovation add to other open movements, such as open source and open science, and stimulate empirical analysis from different perspectives and contexts, such as sustainability, social aspects and emerging technologies. Therefore, associating technologies and methods for collaboration contributes to understanding the scope of the open model and its specificities. In fact, there have been initiatives by companies to adopt different Open Innovation practices, just as there is awareness about the need to integrate data and information into their processes. Therefore, another contribution of the study is that it verifies that these initiatives occur in isolation and detects which aspects and themes represent convergence for the integration of organizational activities. In this case, the existing integration gap could be the starting point for implementing an integrated Big Data and Open Innovation agenda.

So, the themes resulting from the Thematic Analysis are directly related to a perspective of integrating the concepts of Big Data and Open Innovation and offer a framework to guide companies in achieving it. This integration is represented by the concepts of data for Open Innovation and Big Data Innovation, which are seen here as opportunities for future studies that add to existing advances and may result in new tools and methods for use by organizations.

While our study provides valuable insights, it is important to acknowledge its limitations. First, our framework relies on case studies, which may not fully capture emerging trends or

future developments. The companies in the sample are not as developed in terms of adopting Open Innovation practices and the advanced use of insights from data and information. So, the evidence observed in the study reflects the gaps and particularities of the sample, demonstrating opportunities for future proposals, but without actually reporting more advanced cases in which these initiatives are already a reality. Second, contextual factors such as industry-specific nuances and organizational culture may influence the effectiveness of the interaction between Big Data and Open Innovation. Future research should explore these limitations and address them to enhance the practical applicability of our findings. More specifically, we recommend extending the analysis to other contexts, as well as applying methods that allow for more in-depth analyses in the case of companies that have a more structured internal structure regarding the use of Big Data, as well as an Open Innovation strategy. Two hypotheses can guide research to understand the current state of data utilization in open innovation and the integration of data governance in the innovation governance framework: (1) Organizations do not yet have sufficient access to or effectively utilize data for their open innovation strategies. (2) Organizations' open innovation strategy does not fully integrate data and information Governance. An important contribution of empirical studies along these lines would be to bring theoretical aspects closer to the formulation of instruments for practical application.

Managerial Implications

The findings of this research outlined in the paper have several management and policy implications for organizations seeking to improve their innovation processes, particularly through the integration of Big Data and Open Innovation. Our findings underscore the transformative potential of Big Data for open innovation. By leveraging Big Data analytics, organizations can optimize resource allocation, improve decision-making, and foster creativity. At the same time, the integration of open innovation principles with data-driven practices enables firms to tap into external expertise, co-create value, and accelerate product development cycles.

As practitioners and policymakers grapple with the challenges of the digital age, our research provides actionable recommendations for harnessing the power of data to drive innovation. Practitioners can use the proposed framework to assess their current practices, identify gaps, and adopt data-driven approaches. It can be the basis for a roadmap for implementing open innovation strategies in the context of data-rich organizations. The results highlight that organizations should strategically align their data management practices with their open innovation initiatives. This includes not only leveraging Big Data for innovation, but also ensuring that data governance, sharing and access policies are aligned with the collaborative nature of Open Innovation. Results emphasize the importance of adopting an integrated perspective when considering the relationship between Big Data and Open Innovation. Managers should recognize the symbiotic nature of these concepts and explore how they can reinforce each other to drive innovation. In this context, it is also important to mention the importance of organizations adhering to governance policies that address data privacy and security issues.

Acknowledgements

PLEASE CONFIRM/CORRECT: The author(s) received no financial support for the research, authorship, and/or publication of this article.

6 References

Almeida, F. (2021). Open-Innovation Practices: Diversity in Portuguese SMEs. J. Open Innov.Technol. Mark. Complex., 7, 169. DOI: https://doi.org/10.3390/joitmc7030169.

Alvesson, M., & Sandberg, J. (2011). Generating Research Questions through Problematization. Academy of Management Review, 36, 247-271.
http://dx.doi.org/10.5465/AMR.2011.59330882

Aspiranti, T., Ali, Q., & Amaliah, I. (2023). Big Data Analytics to Support Open Innovation Strategies in Banks. *Risks, 11*(6), 106.

Battistella, C., De Toni, A. F., & Pessot, E. (2017). Practising open innovation: a framework of reference. *Business Process Management Journal, 23*(6): 1311-1336.

Bogers, M., Chesbrough, H., & Moedas, C. (2018). Open Innovation: Research, Practices, and Policies. *California Management Review, 60*(2), 5-16. https://doi.org/10.1177/0008125617745086

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Bresciani, S., Ciampi, F., Meli, F., & Ferraris, A. (2021). Using big data for co-innovation processes: Mapping the field of data-driven innovation, proposing theoretical developments and providing a research agenda. *International Journal of Information Management, 60*, 102347. https://doi.org/10.1016/j.ijinfomgt.2021.102347

Brunswicker, S., & Vanhaverbeke, W. (2011). Beyond open innovation in large enterprises: How do small and medium-sized enterprises (SMEs) open up to external innovation sources?. *Available at SSRN 1925185*.

Cândido, A. C., & Sousa, C. P. de. (2017). Open Innovation Practices in Strategic Partnerships of Cloud Computing Providers. *Journal of Technology Management & Innovation, 12*(2), 59–67. https://doi.org/10.4067/S0718-27242017000200007.

Chesbrough, H. (2003), The New Imperative for Creating and Profiting from Technology, Harvard Business Publishing, Harvard Business School, Vol. 2006, Boston, https://doi.org/10.1111/j.1467-8691.2008.00502.x.

Chesbrough, H. (2024). Twenty Years of Open Innovation. MIT Sloan Management Review, 65(2), 1-3. Available in: https://sloanreview.mit.edu/article/twenty-years-of-open-innovation/.

Chesbrough, H. and Bogers, M. (2014), "Explicating open innovation: clarifying an emerging paradigm for understanding innovation keywords", in Chesbrough, H., Vanhaverbeke, W. and West, J. (Eds), New Frontiers inOpen Innovation, Oxford University Press, Oxford, pp. 1-37.

Chesbrough, H., Brunswicker, S. (2013). Managing Open Innovation in Large Firms. Stuttgart: Fraunhofer Verlag.

Chesbrough, H., Crowther, A.K., (2006). Beyond high tech: early adopters of open innovation in other industries. *R&D Management, 36*, 229–236.

Choo, C. W. (1998) *The Knowing Organization: How Organizations Use Information for Construct Meaning, Create Knowledge and Make Decisions*. New York: Oxford Press.

Corbin, J., & Strauss, A. (2015). Basics of Qualitative Research. Thousand Oaks, CA: Sage.

Costa, A., Crupi, A., Marco, C.E., Minin, A. (2023) SMEs and open innovation: Challenges and costs of engagement. Technological Forecasting & Social Change, Vol. 194, DOI: https://doi.org/10.1016/j.technovation.2022.102591.

Crespi, G., & Vargas, F. (2015). Innovación y productividad en las empresas de servicios en ALC. Evidencia a partir de encuestas de innovación. En Aboal, D., Crespi, G. y Rubalcaba, L. (Eds.) La innovación y la nueva economía de servicios en América Latina y el Caribe: Retos e implicaciones de política, (pp. 105–135). Centro de Investigaciones Económicas, Banco Interamericano de Desarrollo.

Dahlander, L., Gann, D.M. (2010) How open in innovation? Research Policy, 39(6):699-709. DOI: http://dx.doi.org/10.1016/j.respol.2010.01.013.

Davenport, T.M. (2014). *Big Data at Work: Dispelling the Myths, Uncovering the Opportunities.* Harvard Business Review Press.

Davenport, T. H., Harris, J. G., De Long, D. W., & Jacobson, A. L. (2001). Data to knowledge to results: building an analytic capability. *California management review, 43*(2), 117-138.

Datapitch | Helping startups and SMEs innovate with data. (s.d.). Datapitch | Helping startups and SMEs innovate with data. Retrieved from https://datapitch.eu/.

Davidson, C. (2009). Transcription: Imperatives for qualitative research. *International Journal of Qualitative Methods, 8*(2), 36–52. https://doi.org/10.1177/160940690900800206

Del Vecchio, P., Di Minin, A., Petruzzelli, A. M., Panniello, U., & Pirri, S. (2018). Big data for open innovation in SMEs and large corporations: Trends, opportunities, and challenges. *Creativity and Innovation Management, 27*(1), 6-22.

Deichmann, D., & Jensen, M. (2018). I can do that alone . . . or not? How idea generators juggle between the pros and cons of teamwork. *Strategic Management Journal, 39*(2), 458–475. https://doi.org/10.1002/smj.2696.

Edmondson, A. C., & McManus, S. E. (2007). Methodological Fit in Management Field Research. *The Academy of Management Review*, *32*(4), 1155–1179. http://www.jstor.org/stable/20159361

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, *14*(4), 532–550. https://doi.org/10.2307/258557

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32. https://psycnet.apa.org/doi/10.5465/AMJ.2007.24160888.

Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International journal of information management, 35*(2), 137-144.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management, 40*(3), 213–221.

Ghasemaghaei, M., Calic, G., (2020). Assessing the impact of big data on firm innovation performance: Big data is not always better data. *Journal of Business Research*, Elsevier, vol. 108(C), pages 147-162. DOI: https://doi.org/10.1016/j.jbusres.2019.09.062

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. *Organizational Research Methods*, *16*(1), 15-31. https://doi.org/10.1177/1094428112452151

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Sociology Press.

Janssen, M., Van Der Voort, H., & Wahyudi, A. (2017). Factors influencing big data decision-making quality. *Journal of business research, 70*, 338-345.

Johnson, J. S., Friend, S. B., & Lee, H. S. (2017). Big Data facilitation, utilization, and monetization: Exploring the 3Vs in a new product development process. *Journal of Product Innovation Management, 34*(5), 640–658.

Kim, J., Kim, Y., Jung, S., Choi, H. & Kwon, J. (2022) The effects of cluster collaboration and the utilization of big data on business performance: A research based on the expansion of open innovation and social capital, *African Journal of Science, Technology, Innovation and Development, 14*:4, 1032-1049, https://doi.org/10.1080/20421338.2021.1925394

Langley, A. & Royer, I. (2006); Perspectives on Doing Case Study Research in Organizations. *Management, 9*(3), 73-86.

Lin, C. & Kunnathur, A. (2019). Strategic orientations, developmental culture, and big data capability, *Journal of Business Research, 105*, 49-60. https://doi.org/10.1016/j.jbusres.2019.07.016

Livieratos, A. D., Tsekouras, G., Vanhaverbeke, W., Angelakis, A. (2022) Open Innovation moves in SMEs: How European SMEs place their bets? Technovation, Vol. 117, DOI: https://doi.org/10.1016/j.technovation.2022.102591

Lukić, Jelena. (2014). The Adoption of Open Innovation Practices in Serbian ICT Industry. In book: Entrepreneurship: Factors Affecting Small-scale Business Performance and Development. Chapter: The Adoption of Open Innovation Practices in Serbian ICT Industry. Publisher: Visoka škola za poslovnu ekonomiju i preduzetništvo. https://scindeks-clanci.ceon.rs/data/pdf/0353-443X/2014/0353-443X1406294L.pdf.

Maalouf. E.N., Bahemia, H. (2023) The implementation of inbound open innovation at the firm level: A dynamic capability perspective. *Technovation* 122: 1-18.

Manzini, R., Lazzarotti, V., & Pellegrini, L. (2017). How to remain as closed as possible in the open innovation era: The case of Lindt & Sprüngli. Long Range Planning, 50(2), 260–281. https://doi.org/10.1016/j.lrp.2015.12.011.

Meulman, F., Reymen, I. M., Podoynitsyna, K. S., & L. Romme, A. G. (2018). Searching for partners in open innovation settings: How to overcome the constraints of local search. *California Management Review, 60*(2), 71-97.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Publications, Inc.

Moya-Fernandez, ´ P.J., Seclen-Luna, J.P., 2023. Evaluating the effects of information sources on innovation outcomes: are there differences between KIBS and manufacturing firms from a Latin America country? J. Know. Econ. https://doi.org/10.1007/s13132-023-01305-w.

Mubarak, M. F., Tiwari, S., Petraite, M., Mubarik, M., & Rasi, R. Z. R. M. (2021). How Industry 4.0 technologies and open innovation can improve green innovation performance?. *Management of Environmental Quality: An International Journal, 32*(5), 1007-1022.

Niebel, T., Rasel, F., & Viete, S. (2019). BIG data–BIG gains? Understanding the link between big data analytics and innovation. *Economics of Innovation and New Technology, 28*(3), 296-316.

Radojević, N., Heumüller, E., (2023). Drivers and Loci of Big Data Innovation: A Review, Synthesis, and Future Research Directions. *Journal of Innovation Management, 11*(2), 42-70.; DOI: https://doi.org/10.24840/2183-0606_011.002_0003.

Radziwon, A., Chesbrough, H., West, J., & Vanhaverbeke, W. (2024). The Future of Open Innovation. In: Chesbrough, H., Radziwon, A., Vanhaverbeke, W. & West, J. (Eds.), The Oxford Handbook of Open Innovation. Oxford University Press. Chapter 57.

Radziwon, A., & Vanhaverbeke, W. (2024). Open Innovation in Small and Medium-Sized Enterprises. In Chesbrough, H., Radziwon, A., Vanhaverbeke, W. & West, J. (Eds.), The Oxford Handbook of Open Innovation. Oxford University Press. Chapter 8.

Rodríguez, M., Doloreux, D., & Shearmur, R. (2017). Variety in external knowledge sourcing and innovation novelty: Evidence from the KIBS sector in Spain. Technovation, 68, 35–43. https://doi.org/10.1016/j.technovation.2017.06.003.

Saeed, A., Riaz, H., Baloch, M.S. (2022) Does big data utilization improve firm legitimacy? Technological Forecasting and Social Change, Vol. 82. DOI: https://doi.org/10.1016/j.techfore.2022.121847.

Salih, A., AL-Sharayah, J & Abou-Moghli, A. (2024). Unlocking the potential of big data through open innovation on strategic foresight: An empirical analysis.*International Journal of Data and Network Science, 8*(1), 329-336.

Seclen-Luna, J.P., Álvarez-Salazar, J., Cancino, C., & Schmitt, V.G.H. (2024). The Effects of Innovations on Peruvian Company's Sales: The Mediating Role of KIBS. Technovation, 129, 102877. https://doi.org/10.1016/j.technovation.2023.102877

Sharda, R., Delen, D. and Turban, E. (2018) *Business Intelligence, Analytics, and Data Science: A Managerial Perspective.* Pearson, New York.

Tracy, S. J. (2010). Qualitative Quality: Eight "Big-Tent" Criteria for Excellent Qualitative Research. *Qualitative Inquiry, 16*(10), 837-851. https://doi.org/10.1177/1077800410383121

Trott, P., & Hartmann, D. (2009). Why "open innovation" is old wine in new bottles. *International Journal of Innovation Management, 13*(4), 715–736.

Tsai, F. S., Cabrilo, S., Chou, H. H., Hu, F., & Tang, A. D. (2022). Open innovation and SME performance: The roles of reverse knowledge sharing and stakeholder relationships. *Journal of Business Research, 148*, 433-443.

Urbinati, A., Bogers, M.L., Chiesa, V., & Frattini, F.F. (2019). Creating and capturing value from Big Data: A multiple-case study analysis of provider companies. *Technovation*, Vol.84-85. DOI: https://doi.org/10.1016/j.technovation.2018.07.004.

Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423-437.https://doi.org/10.1016/j.technovation.2008.10.001

Vanhaverbeke, W., Vermeersch, I., & Zutter, S.D. (2012). Open innovation in SMEs: How can small companies and start-ups benefit from open innovation strategies? Available in:https://innovationmanagement.se/wp-content/uploads/2012/05/open-innovation-in-smes.pdf.

Vanhaverbeke, W. (2017). *Managing open innovation in SMEs.* Cambridge University Press.

Vanhaverbeke, W., Frattini, F., Roijakkers, N., & Usman, M. (Eds.). (2018). *Researching open innovation in SMEs*. World Scientific.

Zhou W. (2024). Dilemma and coping strategies of news communication based on artificial intelligence and big data. *Heliyon, 10*(3):e25398. https://doi.org/10.1016/j.heliyon.2024.e25398.

Wang, M., Wang, Y., Mardani, A. (2023). Empirical analysis of the influencing factors of knowledge sharing in industrial technology innovation strategic alliances. *Journal of Business Research, 157*, 113635.

Yin, R. (2018). *Case Study Research and Applications: Design and Methods.* Sixth Edition. Sage Publications.

Biographies

Ana Clara Cândido. Ana Clara Cândido is Adjunct Professor at the Department of Information Science at the Federal University of Santa Catarina - Brazil. She has a PhD in Technology Assessment from the Faculty of Science and Technology of Universidade Nova de Lisboa. She has a degree in Economic Sciences from the Regional University of Blumenau and a Master's degree in Economics and Innovation Management from the University of Porto-Portugal.Her research interests include open innovation, information management, technology assessment and big data.

ORCID: https://orcid.org/0000-0003-1897-3946

CRediT Statement: Conceptualization; Writing – original draft; Formal analysis; Writing – review and editing

Jean Pierre Seclen-Luna. Jean Pierre Seclen-Luna is researcher and full-time professor at the Department of Management Sciences (DMS) of the Pontifical Catholic University of Peru (PUCP). He has PhD in Economics from the University of the Basque Country (Spain). He is currently Academic Coordinator of Research at the DMS; Coordinator of the Research Group in Innovation Management; Editor in 360 Journal of Management Sciences and Member of the Advisory Board of the Basque Journal of Economics. His research activity is focused on issues such as innovation management, servitization and KIBS.

ORCID: https://orcid.org/0000-0003-1683-0570

CRediT Statement: Conceptualization; Methodology; Writing – review and editing

Cristina Sousa. Cristina Sousa is Associate Professor at ISCTE/IUL. She has a Master's degree in Economics and Management of Science and Technology and a PhD in Economics, both from ISEG/UTL. Her research interests include innovation, creation and circulation of knowledge and entrepreneurship. Currently, her research is focused on networks, on entrepreneurship in knowledge-intensive sectors and on the transition to a sustainable energy system. The results of her research were object of publication in academic journal and books and were presented in several national and international conferences and workshops.

ORCID: https://orcid.org/0000-0002-8051-3943

CRediT Statement: Conceptualization; Writing – original draft