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KNOWLEDGE THROUGH INTERNAL AND EXTERNAL ORGANIZATIONAL NETWORKS: A PERSPECTIVE OF SOCIAL CAPITAL AND ABSORPTIVE CAPACITY

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CONHECIMENTO ATRAVÉS DE REDES ORGANIZACIONAIS INTERNAS E EXTERNAS: UMA PERSPECTIVA DO CAPITAL SOCIAL E CAPACIDADE ABSORPTIVA

KNOWLEDGE THROUGH INTERNAL AND EXTERNAL ORGANIZATIONAL NETWORKS: A PERSPECTIVE OF SOCIAL CAPITAL AND ABSORPTIVE CAPACITY

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KNOWLEDGE THROUGH INTERNAL AND EXTERNAL ORGANIZATIONAL NETWORKS: A PERSPECTIVE OF SOCIAL CAPITAL AND ABSORPTIVE CAPACITY

POR

TAINA ALVES DOS SANTOS

Tese apresentada ao Programa de Pós-Graduação em Administração - PPGA da Universidade Nove de Julho – UNINOVE, como requisito parcial para obtenção do título de Doutor em Administração, sendo a banca examinadora formada por:

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Aos meus pais e marido: Vocês foram minha motivação, inspiração e principal razão para que eu persistisse ao longo desta jornada.

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Não sabendo que era impossível, foi lá e fez.
(Jean Cocteau)

RESUMO

Alguns estudos já apontaram o trade-off entre fontes internas e externas para o desenvolvimento da capacidade absortiva das empresas, considerando que pode ser necessária atenção especial quanto à relação entre conhecimento compartilhado e amplitude de conhecimento entre os indivíduos (Ramayah et al., 2020). Embora a capacidade absortiva possa ajudar a explicar por que os relacionamentos internos e externos de uma empresa impactam o desempenho da inovação, explicações alternativas parecem possíveis considerando como essas empresas compartilham conhecimento internamente. Nesse sentido, esta dissertação preencheu três lacunas identificadas. Em primeiro lugar, a capacidade absortiva é um construto explorado e estudado através de muitas perspectivas nas últimas décadas. Embora algumas revisões bibliométricas e de literatura estejam sendo feitas desde Volberda et al. (2010), não está claro qual caminho a pesquisa está trilhando sobre esse tema. Em segundo lugar, a literatura sobre redes e conhecimento também é extensa, e não parece claro quais assuntos são mais relevantes para serem estudados neste campo de pesquisa. Em terceiro lugar, não foram encontrados estudos examinando a influência da capacidade absortiva de uma empresa e do conhecimento obtido de seus relacionamentos internos e externos no desempenho da inovação. Algumas pesquisas identificaram os efeitos dos relacionamentos externos e internos no desempenho da inovação, como Maurer et al. (2011) e Najib & Kiminami (2011), mas os fatores que levaram a esses resultados ainda não são claros. Nesse sentido, empresas com as mesmas redes de obtenção de conhecimento podem apresentar resultados de inovação diferentes, indicando que pode haver mecanismos relacionados ao fluxo de conhecimento que diferenciam essas empresas. Eu argumento que as empresas que introduzem inovações baseadas no conhecimento interno e externo apresentarão uma capacidade diferente de explorar o conhecimento devido às suas capacidades absortivas. Para explorar o papel da capacidade absortiva e das redes organizacionais internas e externas no desempenho de inovação das empresas, eu desenvolvi esta dissertação com três estudos em ordem sequencial. Metodologicamente, foi realizado um estudo bibliométrico de cocitação e pareamento no Estudo 1. Em seguida, optei por usar modelagem de tópicos para explorar o campo de redes de conhecimento e inovação no Estudo 2. Por fim, usei a abordagem PLS-SEM e a macro PROCESS no Estudo 3, usando dados coletados de startups no Brasil por meio de survey.

Palavras-chave: Capital Social; Capacidade absortiva; Compartilhamento de conhecimento; Redes Organizacionais; Desempenho de Inovação.

ABSTRACT

Some studies have already pointed out the trade-off between internal and external sources for developing firms absorptive capacity, considering that special attention may be needed regarding the relationship between shared knowledge and breadth of knowledge among individuals (Ramayah et al., 2020). While absorptive capacity can help to explain why the internal and external relationships of a firm impact innovation performance, alternative explanations seem possible considering how these firms share knowledge internally. In this sense, this dissertation filled three identified gaps. First, absorptive capacity is a construct explored and studied through many perspectives in the last decades. Although some bibliometrics and literature reviews are being done since Volberda et al. (2010), it is unclear which path research is heading on this topic. Second, the literature on networks and knowledge is also extensive, and it does not seem clear which subjects are most relevant to be studied in this field of research. Third, no studies were found examining the influence of a firm's absorptive capacity and knowledge gathered from its internal and external relationships on innovation performance. Some research identified the effects of external and internal relationships on innovation performance, such as Maurer et al. (2011) and Najib & Kiminami (2011), but the drivers that led to these outcomes are still unclear. In this sense, firms with the same networks to obtain knowledge may present different innovation results, indicating that there may be mechanisms related to the knowledge flow that differentiate these companies. I argue that firms introducing innovations based on internal and external knowledge will present a different ability to exploit knowledge because of their absorptive capacities. To explore the role of absorptive capacity and internal and external organizational networks in companies' innovation performance, I developed this dissertation with three studies in sequential order. Methodologically, a bibliometric study of cocitation and coupling was carried out in Study 1. Then, I chose to use topic modeling to explore the field of knowledge networks and innovation in Study 2. Finally, I used PLS-SEM approach and PROCESS macro in Study 3, using data collected from startups in Brazil by survey.

Keywords: Social Capital; Absorptive Capacity; Knowledge Sharing; Organizational Networks; Innovation Performance.

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SUMMARY

1 INTRODUCTION

The concept of absorptive capacity links internal knowledge building to external knowledge acquisition (Davids & Tai, 2009). Although definitions vary, the commonality among the definitions of absorptive capacity stems from the importance of knowledge to organizations (Maldonado et al., 2019). In their seminal papers, Cohen and Levinthal consider absorptive capacity as the "ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 40). Some years later, Zahra and George (2002) reconceptualized absorptive capacity as "a set of organizational routines and processes by which organizations acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability" (Zahra & George, 2002, p. 186). To summarize, this organizational capacity represents an essential part of an organization's ability to create new knowledge (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998).

Researchers have recognized the richness of the theory and assimilated the absorptive capacity concept through renewing theories, developing new conceptual models, and conducting many empirical studies (Volberda et al., 2010). For example, Zahra and George (2002) proposed two components of absorptive capacity. The first component is known as "potential absorptive capacity," which consists of the capabilities to facilitate the acquisition and assimilation of knowledge. The second component, called "realized absorptive capacity," consists of transformation and exploitation capabilities. Thus, potential absorptive capacity helps a firm identify knowledge and assimilate it, whereas realized absorptive capacity helps leverage such assimilated knowledge (Albort-Morant et al., 2018; Lane & Lubatkin, 1998; Zahra & George, 2002).

Research on absorptive capacity covers many theories, such as learning, innovation, the knowledge-based view of the firm, dynamic capabilities, and coevolutionary theories (Volberda et al., 2010). From an organizational learning lens, absorptive capacity focuses on the assimilation and valuation of learning from external sources (Lane & Lubatkin, 1998; Maldonado et al., 2019). In the knowledge-based view approach, absorptive capacity is a critical process for knowledge sharing and transfer (Maldonado et al., 2019). From the dynamic capabilities' perspective, absorptive capacity represents the organization's latent abilities to renew, augment, and adapt its core competence over time (Teece et al., 1997). In addition, many coevolutionary studies suggest that absorptive capacity enables or restricts the level and range of exploration adaptations (Cohen & Levinthal, 1990; Lewin & Volberda, 1999). Coevolution theory can integrate different levels of evolution within a unifying framework,

incorporating multiple levels of analyses and contingent effects, resulting in new insights, theories, empirical methods, or interpretations (Lewin & Volberda, 1999).

Organizations acquire knowledge from other organizations, and thus, knowledge exchange via interorganizational networks may serve as a critical antecedent of organizational innovation output (Kolloch & Reck, 2017). Some authors also defend that networks have become a central governance model that organizations use to manage innovation (Ahuja, 2000; Cap et al., 2019). These networks can create an innovation environment, increase knowledge flow, accelerate the transition of knowledge of different attributes, raise collision and integration frequency of knowledge from different sources, strengthen organization innovation capability, magnify the effect of technological innovation, and eventually increase the overall innovation level of all the participants in the network (Xu et al., 2019). Thus, networks can result in innovations occurring less commonly within individual companies, and more commonly through knowledge-creating networks integrating individuals, firms, universities, and other institutions (Hynes & Elwell, 2016).

In the literature, networks can emerge as interorganizational, innovation, or knowledge networks, and many authors adopt similar concepts with different names. For example, a knowledge network is defined as a connection among organizations searching for solutions to deal with complex critical problems and an exchange of technical knowledge within the innovation process (Alberti & Pizzurno, 2015). An interorganizational network is understood as an independent form of coordination of interaction, 'whose core is the trustworthy cooperation of autonomous, but interdependent actors, which for a limited time collaborate and therefore take into account the interests of the respective partners' (Kofler & Marcher, 2018). On the other hand, innovation networks are interorganizational networks constituted by a defined set of actors who collaborate for the sake of innovation and are governed by the interests of the network (Cap et al., 2019). In this study, I consider the nomenclature "interorganizational networks" to deal with networks between organizations for knowledge and innovation exchanges, since this is a term that clarifies the level of analysis for which this research is proposed (organizational level).

Some theories are commonly used in research on interorganizational networks. Although some authors offer different explanations for this process, they share a resource-based view of the firm as a conceptual basis for explaining why organizations participate in networking (Munoz & Lu, 2011). Networks complement the resource-based view, arguing that focusing on individual firm characteristics and capabilities can explain firm performance (Crispeels et al., 2015). Furthermore, interorganizational networks can be considered a

synonym for cooperation. These networks or other organizations might cooperate to share resources to mutual benefit, as a logical response to scarce resources and these dyads (Hynes & Elwell, 2016).

Social network theory allows us to understand the behavior of networks under two characteristics: network centrality and structural holes (Wang et al., 2019). Network centrality, represented by status power, reflects the position and hierarchical advantage of the network (Ibarra, 1993). The central organization may enjoy a high position advantage in the network. It could respond more rapidly to utilize potential resources from the network and to seize opportunities to increase its competitive advantage (Wang et al., 2019). A structural hole is formed when a node is connected to two other nodes between which there is no direct connection (Burt, 1998). Organizations with more structural holes can access more heterogeneous information and resources from different parts of the network, and are therefore more competent at identifying threats, opportunities, and high-quality potential than other organizations (Uzzi, 1996; Xu et al., 2019).

In particular, interorganizational networks as a means to grant access to knowledge may represent a critical foundation of such innovative performance (Kolloch & Reck, 2017). Interorganizational networks are increasingly recognized in the innovation management literature as 'access relationships', enabling partners to acquire non-redundant knowledge and capabilities outside their organizational and technological boundaries (Chesbrough, 2012; Cui, 2013; Zouaghi et al., 2018). The structure of these relationships inside knowledge networks will determine a firm's innovative capacity, along with how each firm makes use of its position inside them (Ahuja, 2000; Belso-Martinez & Diez-Vial, 2018; Uzzi, 1996).

Some researchers argue that knowledge beyond a firm's organizational and technological boundaries is helpful for innovation (Grant, 1996; Rodríguez et al., 2018). However, other studies suggest that internal firm conditions (e.g., experience, trust, number, and strength of ties) can be more important than external knowledge sources (Maurer et al., 2011; Ramayah et al., 2020). This might indicate that internal knowledge sources (internal networks) can also influence a firm’s innovation performance.

1.1 MAIN RESEARCH PROBLEM

This dissertation is expected to help fill some gaps related to the studied constructs and explore their links. First, absorptive capacity is a construct that has been explored and studied through many perspectives in recent decades. Although some bibliometric and literature

reviews have been performed since Volberda et al. (2010), the direction in which research is heading on this topic is still unclear. In addition, it seems crucial to understand how absorptive capacity impacts innovation literature since this theory has been studied in other outcomes (e.g., firm performance).

Second, the literature on networks and knowledge isextensive, and it does not seem clear which subjects are most relevant to be studied in this field of research. A critical factor in an organization's capability to development is balancing internal knowledge building and external knowledge acquisition (Davids & Tai, 2009). As Bapuji and Crossan (2005) argue in their study, organizations do not have much incentive to transfer knowledge to the interorganizational level because this knowledge could then be available to competitors. However, companies transfer organizational level knowledge to the interorganizational level because such transfer would legitimize it (Bapuji & Crossan, 2005). As well as the absorptive capacity construct, there are different perspectives within this field of knowledge, and it seems reasonable to identify research topics in knowledge and innovation networks.

Third, no studies were found examining the influence of a firm's absorptive capacity and knowledge gathered from its internal and external relationships on innovation performance. Knowledge generated must be channeled in specific ways to promote economic valorization, transforming invention into innovation that represents new economically valuable knowledge, often connected with new product development (Pinto et al., 2015). Some research identified the effects of external and internal relationships on innovation performance, such as Maurer et al. (2011) and Najib & Kiminami (2011), but the drivers that led to these outcomes are still unclear. In this sense, firms with the same networks to obtain knowledge may present different innovation results, indicating that there may be mechanisms related to the knowledge flow that differentiate these companies.

While absorptive capacity can help to explain why the internal and external relationships of a firm impact innovation performance, alternative explanations seem possible considering how these firms share knowledge internally. Knowledge sharing can be defined as "the process where individuals mutually exchange their knowledge and jointly create new knowledge" (Van Den Hooff & Ridder, 2004, p. 118). Previous studies argued about the relationship of knowledge sharing and absorptive capacity, such as Balle et al. (2020) and Fernandes Crespo et al. (2021), but there is still an opportunity to consider context dimensions, namely, the influence of participation in knowledge sharing networks and partnerships (Balle et al., 2020).

1.1.1 Main Research Question

Considering the literature presented, the following research question emerges: How do a firm’s absorptive capacity and the knowledge obtained by internal and external networks impact innovation performance?

1.2 OBJECTIVES

1.2.1 General

In this way, the general objective is to explore the role of absorptive capacity and internal and external organizational networks in companies' innovation performance.

1.2.2 Specifics

The following specific objectives were defined to answer the research question and the proposed general objective:

a) to understand how absorptive capacity is impacting innovation literature;

b) to identify research topics in knowledge and innovation networks; and

c) to examine the role of absorptive capacity and knowledge sharing as mechanisms that influence the relationship between interorganizational networks and innovation performance.

1.3 JUSTIFICATION

Managing innovative capacity is presented as one of the main challenges of organizational studies, due to its analytical complexity and the evolutionary nature of knowledge accumulation and refinement (Santos et al., 2018). As knowledge is a crucial resource, it is in the interest of organizations to carefully guard knowledge and refrain from sharing it with outside organizations (Bapuji & Crossan, 2005). As competition becomes more knowledge-based, a firm needs to develop a thorough understanding of its knowledge, the processes by which it converts knowledge to capabilities, and the capacity of those capabilities to meet the demands of its environment (Lane & Lubatkin, 1998).

Although social capital facilitates access to external knowledge sources, an organization absorbs it only if such knowledge complements an organization's existing knowledge (Bapuji

& Crossan, 2005; Zahra & George, 2002). The extent to which an organization can acquire and exploit this knowledge depends on several organization-specific routines and processes, referred to as "absorptive capacity" (Bapuji & Crossan, 2005). The organization's knowledge sourcing activities are also closely related to its internal knowledge building (Davids & Tai, 2009), being related to the innovative capacity approach. Without this level of self-awareness, an organization will be slow to react to the market forces that inevitably erode the combined strategic value of its set of capabilities (Lane & Lubatkin, 1998).

Networks have been closely associated with higher innovative capacity, as they give firms greater access to valuable knowledge flows that allow them to improve their products and processes (Belso-Martinez & Diez-Vial, 2018; Santos et al., 2018). In particular, because of limited internal resources, organizations usually utilize social networks to acquire external knowledge and control resources to enhance their competitive advantage (Wang et al., 2019). The more extensive the organizational network of an organization in the collaborative innovation network, the more it will access heterogeneous and diversified knowledge (Xu et al., 2019). I argue that firms that introduce innovations based on internal and external knowledge will present a different ability to exploit knowledge because of their absorptive capacities. In addition, knowledge sharing might help the firms to improve their absorptive capacity, resulting in different innovation performances and outcomes.

1.4 WORK STRUCTURE

This dissertation project will be developed through studies using a structure suggested by Da Costa et al. (2019). To explore the role of absorptive capacity and internal and external organizational networks in the innovation performance of companies, I established the proposal with three studies developed in sequential order.

The first study was dedicated to exploring the literature related to the absorptive capacity theory. This research was essential to fill the gap related to the intellectual structure that supports the studies of absorptive capacity and to discover future studies necessary in this area. Methodologically, a bibliometric study of cocitation and coupling was carried out. This study was also an essential step for me to appropriate the state of the art of this construct and develop my skills related to bibliometric techniques.

One of the factors found in study 1 was that of interorganizational knowledge networks. As this theme is extensive and has many perspectives, the focus of study 2 was to explore this literature. Furthermore, understanding which topics have already been explored and which are

currently relevant has become an important question to be answered with this study. As no previous studies were found that presented a similar focus, I chose to use topic modeling as a method to explore knowledge networks and innovation fields. This study was a necessary deliverable towards contributing to the literature and, at the same time, narrowing the theme of this dissertation proposal.

The results of Study 2 made it clear that studies continue to explore aspects of networks both internal and external to organizations. Furthermore, the prevalence of studies seeking to understand the mechanisms that lead to performance is also clear (either in terms of firm performance or innovation performance). However, no studies were found that explored the flow of knowledge from external and internal networks to innovation performance, nor the role of companies' absorptive capacity in this process. Thus, study 3 was designed to fill this gap and contribute to the literature on knowledge networks, absorptive capacity, and innovation.

Having outlined the theoretical gaps in the literature and the work structure, this dissertation project proceeds as shown in Figure 1.1. It is essential to highlight that Study 1 was presented in the 8th International Symposium on Project Management, Innovation, and Sustainability (SINGEP 2018) and published in the Iberoamerican Journal of Strategic Management (IJSM – Jun 2021 edition). Furthermore, a preliminary version of Study 2 was presented at the 45th ANPAD Annual Meeting (EnANPAD 2021), and the summarized version of Study 3 was approved for presentation at the 46th ANPAD Annual Meeting (EnANPAD 2022). However, Studies 2 and 3 are not under any journal evaluation, neither it was accepted for publication or it was published until the moment of the defense of this dissertation.

Figure 1.1. Methodological Mooring Matrix.

CENTRAL RESEARCH QUESTION How do a firm's absorptive capacity and the knowledge obtained by internal and external networks impact innovation performance?							
GENERAL OBJECTIVE To explore the role of absorptive capacity and internal and external organizational networks in companies' innovation performance.							
JUSTIFICATION OF DISTINCTION Each study seeks to meet a different objective and, therefore, utilizes methods that can help answer each of the gaps.			**JUSTIFICATION OF INTERDEPENDENCE** Studies 1 and 2 seek to deepen knowledge in a given construct according to the previous study's findings. Study 3 aims to explore, empirically, a common gap between the two previous studies.				**PUBLICATION STATUS**
Title	Research question	General objective	Sequential or simultaneous research	Single or mixed-method in the field step	Data collection procedure	Data analysis procedure	
The Evolution of Absorptive Capacity in the Scientific Literature: A Bibliometric Analysis Focused on Innovation	How does absorptive capacity impact the innovation literature?	To analyze scientific production about absorptive capacity and innovation in such a way that it is possible to identify study trends and the theoretical bases on which they are based.	Sequential	Bibliometric	Bibliometric study from the analysis of articles from the Scopus and Web of Science databases. The sample is limited only to English articles published in business and management in all available years.	Analysis was performed through bibliographic coupling, co-citation, and exploratory factor analysis.	Published in a Conference and Journal
Uncovering the Knowledge Networks in Innovation Research: A Topic Modeling Approach	What are the research topics emerging from the literature of knowledge and	To identify research topics in knowledge and innovation networks.	Sequential	Topic Modeling	Review of quantitative articles identified in Scopus, and Web of Science databases. The sample is limited only to	Analysis performed through Latent Dirichlet Allocation (LDA) and	Published in a Conference Not Published in a Journal

	innovation networks?				English articles published in business and management in all available years.	regression techniques.	
Social Capital, Knowledge Sharing, and Absorptive Capacity as Predictors of Innovation Performance: A Serial Mediation Analysis	How do a firm's absorptive capacity and knowledge sharing impact innovation performance in an interorganizational network context?	To examine the role of absorptive capacity and knowledge sharing as mechanisms that influence the relationship between interorganizational networks and innovation performance.	Sequential	Empirical	Survey with a sample collected from the experience of professionals who can share the reality of the internal and external organizational networks of Brazilian startups.	Analysis performed through the Structural Equation Modeling technique and PROCESS macro.	Submitted to a Conference Not Published in a Journal

Source: Adapted by the author from Da Costa, Ramos, and Pedron (2019).

2 STUDY 1

The Evolution of Absorptive Capacity in the Scientific Literature: A Bibliometric Analysis Focused on Innovation

Abstract

Objective of the study: This study aims to analyze scientific production about absorptive capacity and innovation in such a way as to make it possible to identify study trends and the theoretical bases on which they are based.

Methodology / Approach: We performed bibliographic coupling, co-citation, and social network analysis on a sample of 3,698 articles, considering 2,778 articles from Web of Science and 920 articles from Scopus.

Originality / Relevance: In a preliminary search, only two bibliometric works were identified that focused on absorptive capacity and innovation. However, since 2015, more than 1,500 articles have been published, with new perspectives, advancing studies on this topic.

Main results: The coupling analysis resulted in six factors showing the trends of future studies. The co-citation analysis presented three factors, representing the intellectual structure arising from the coupling analysis. The network analysis provided insight into how these studies connect. The results point to trends in future studies that can fill the research gaps on absorptive capacity and innovation. In addition, we also indicate the theoretical fronts that can be used to explore these trends. Finally, we present a model that summarizes our findings and shows how they can contribute to the advancement of research based on the seminal model of Zahra and George (2002).

Theoretical / Methodological contributions: We present a mapping of the theme that provides a clearer view of which seminal works are used to approach each theme to be explored in future studies, associating the results of the bibliometric techniques used.

Keywords: Absorptive Capacity; Innovation; Bibliometrics; Co-citation Analysis; Coupling Bibliographic.

2.1 INTRODUCTION

The absorptive capacity concept was first coined by Cohen and Levinthal (1990) and there have been significant developments in the concept and measurement ever since (Albort-Morant, Leal-Rodríguez, & De Marchi, 2018). This capacity represents an essential part of a company's ability to create new knowledge (Cohen & Levinthal, 1990) and is vital for its innovation activities (Xie, Zou & Qi, 2018). Activities related to developing new products or services in an organization are sophisticated and timeless (Limaj & Bernroider, 2017). Many previous studies have indicated that absorptive capacity contributes directly or indirectly to an organization's innovation and financial performance (Xie et al., 2018).

Other current researchers suggest developing absorptive capacity as the total dynamic capacity to improve innovation in organizations. There are, therefore, theoretical tensions which could be better understood, leading to interest in this article to provide better positioning of absorptive capacity and its potential contributions to the innovation of companies. These theoretical tensions can be explained due to the ambiguity between absorptive capacity and the dynamic capacities. If absorptive capacity is a part of what we know as dynamic capabilities, the boundaries are unclear, as are the other known dynamic capabilities, and it becomes more difficult to identify the effects and contributions of absorptive capacity to the innovation of organizations. If absorptive capacity is part of the knowledge transfer processes, such processes have been little explored in the specific literature on organizational innovation or it could be that such publications have not been properly structured for the purposes of analysis. When we examine the literature that deals with organizational routines, we find both theoretical interconnection with absorptive capacity and other constructs linked to organizational networks. The existence of extensive literature dealing with capacity in different ways, but with little exploration regarding a possible theoretical organization of the theme directly related to organizational innovation, justifies this bibliometric study.

In contrast to the abundant research on how companies absorb technological knowledge, there is little mention in the management literature about the ability of companies to absorb the knowledge needed to generate innovation (Schweisfurth & Raasch, 2018). This and other gaps need to be better identified and, for this, it is necessary to look at the intellectual structure and research trends on this theme.

The advancement in scientific productions arises from exploring knowledge from previous studies and the interaction between researchers over time. Knowing the concepts, the evolution of the theme over time, the leading scholars, and the literary production of greatest relevance can aid understanding of the existing theory. Therefore, analyzing the history of publications could help researchers to establish what has been studied on the subject and identify opportunities for future research.

In a preliminary consultation based on the Web of Science (2019), we found only two bibliometric works focused on absorptive capacity and innovation. Subsequently, Seguí-Mas, Signes-Pérez, Sarrión-Viñes, and Alegre Vidal (2016) developed a bibliometric to identify whether there was any relationship between absorptive capacity and a specific type of innovation: open innovation. Later, Rossetto, Carvalho, Bernardes, and Borini (2017) sought to present an overview of international scientific publications on absorptive capacities and innovation to map the academic contributions made between 1990 and 2015 (25 years). However, since 2015, more than 1,500 articles have been published, with new perspectives, advancing studies on this topic.

Considering the arguments presented, the following research question was proposed: How does absorptive capacity impact the innovation literature? To answer this question, the main objective of the current article was to analyze scientific production about absorptive capacity and innovation in such a way that it is possible to identify study trends and the theoretical bases on which they are based. Thus, the specific objectives were: (1) to identify relevant studies that may point to future studies related to absorptive capacity and innovation; and (2) to identify the studies that lead researchers to the intellectual structure of research on these trends.

Methodologically, a bibliometric study was developed using a sample of 3,180 articles collected from the Web of Science and Scopus databases. The coupling and co-citation analyses were then performed to derive the subfields of the study and research opportunities involving the intersection between absorptive capacity and innovation. The coupling analysis resulted in 6 factors that reflect trends for future studies, while the co-citation analysis showed, in 3 factors, the intellectual structure that underlies these trends.

The results show the trends of themes to be studied to fill gaps in the knowledge on absorptive capacity and innovation. As a differential compared to other bibliometric studies developed on this topic, we combine the results of the co-citation and coupling analysis to enable the recommendation of the intellectual structure to be used to respond to these gaps

and present network diagrams to show how these studies are connected in each analysis. Finally, we present a model that summarizes our findings and shows how they can contribute to the advancement of research based on the seminal model of Zahra and George (2002).

2.2 METHODOLOGICAL PROCEDURES

2.2.1 Method

A bibliometric method can be characterized as a series of techniques that seek to quantify the process of written communication and analyze some attributes and behaviors of published information (Okubo, 1997). As this method is a quantitative instrument that allows minimization of the subjectivity of the analyses, it was adopted to map the intellectual structure of this field. Thus, insights are also provided on the main opportunities for publication, establishing a reference for the study of trends and emerging paradigms in absorptive capacity and innovation research.

2.2.2 Data Collection

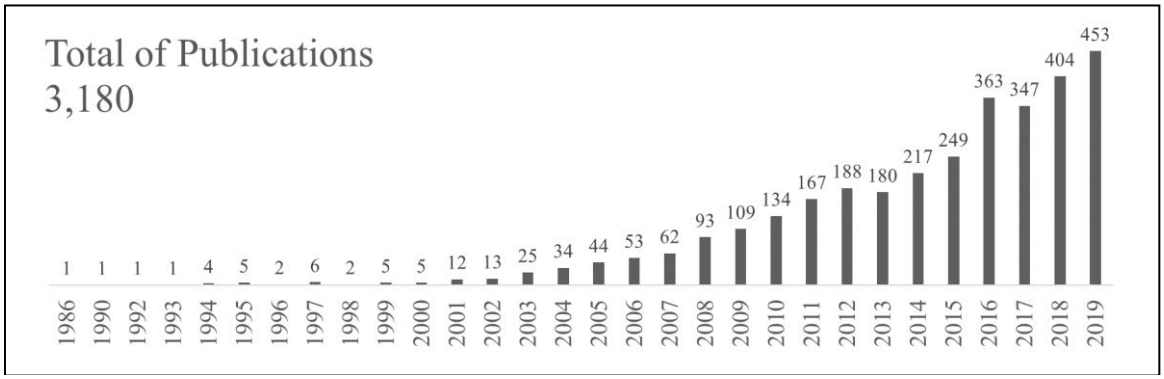
We performed searches of publications available on Web of Science and Scopus, through the terms "absorptive capacity*" AND "innovat*" (in quotation marks and with the asterisk). The period was not defined because the objective was to map all the information available in the databases until the end of 2019. The sample was delimited to consider only articles because these types of documents go through the review process blindly and in pairs. The database results were restricted to documents available in English, and published in business or management categories. A total of 2,778 articles were found in Web of Science and 920 articles in Scopus, totaling 3,698 articles found.

A total of 518 articles that did not present abstracts or references, or were duplicated in the databases were removed. Thus, the sample used for this study was composed of 3,180 articles. The protocols suggested by the Iberoamerican Journal of Strategic Management (IJSM) and Brazilian Journal of Marketing (BJM) were used to carry out this study (Quevedo-Silva, Santos, Brandão, & Vils, 2016; Serra, Cirani, & Moutinho, 2019; Serra et al., 2018).

2.2.3 Research Sample

The sample of this study consisted of 3,180 articles published in 433 journals. In general, publications on absorptive capacity and innovation increased in the period analyzed (Figure 2.1). The first study was published in 1986. Only 478 articles were published on the subject in the first 20 years (1986 to 2009), reaching a maximum of 109 articles in 2009. The period from 2010 to 2019 showed significant growth, with an average of 270 publications per year.

Figure 2.1. Evolution of scientific publications by year.



Source: Research data - Scopus and Web of Science.

The articles were published in 433 journals, and the 20 journals with the highest volume of publications accounted for approximately 45.13 percent (1,435 articles) of the scientific production analyzed. The journals that stand out for this theme are Research Policy (SJR 3,409), Technological Forecasting and Social Change (SJR 1,422), and Journal of Business Research (SJR 1,684). Table 2.1 shows the list of the main journals identified.

Table 2.1. Journals that published the most articles on Absorptive Capacity and Innovation (1986 - 2019).

#	Journal	Articles	%	% Accumulated
1	Research Policy	166	5.22%	5.22%
2	Technological Forecasting and Social Change	111	3.49%	8.71%
3	Journal of Business Research	100	3.14%	11.86%
4	Journal of Knowledge Management	91	2.86%	14.72%
5	Technology Analysis & Strategic Management	89	2.80%	17.52%
6	Strategic Management Journal	84	2.64%	20.16%
7	Technovation	83	2.61%	22.77%
8	International Journal of Technology Management	78	2.45%	25.22%
9	International Journal of Innovation Management	77	2.42%	27.64%
10	R & D Management	75	2.36%	30.00%
11	Journal of Product Innovation Management	67	2.11%	32.11%

12	Journal of Technology Transfer	65	2.04%	34.15%
13	Industry and Innovation	56	1.76%	35.91%
14	Management Decision	53	1.67%	37.58%
15	Industrial Marketing Management	48	1.51%	39.09%
16	Journal of Engineering and Technology Management	41	1.29%	40.38%
17	International Business Review	40	1.26%	41.64%
18	Asian Journal of Technology Innovation	37	1.16%	42.80%
19	Knowledge Management Research & Practice	37	1.16%	43.96%
20	Organization Science	37	1.16%	45.13%
Other 413 Scientific Journals		1,747	54.87%	100.00%

Source: Research Data – Scopus and Web of Science.

The sample also included 5,385 authors involved in the publications. However, a concentration of publications is evident, with 6 authors contributing 15 or more studies (Lichtenthaler, Li, Roper, Molina-Morales, Volberda, and Zahra). Van der Bosch, Volberda and Zahra are examples of authors who have published the most on this theme and also have studies with huge impact in the literature about absorptive capacity.

Table 2.2 presents the list of the most productive authors on this theme, considering those that presented more than 11 articles.

Table 2.3 shows the number of articles separated by citation ranges. It was observed that 227 articles (7.14% of the sample) presented more than 100 citations according to the count of the Scopus and Web of Science databases, reinforcing that the theme has been widely discussed in the literature. More than 56% of the articles presented between 0 and 10 citations, which could be a reflection of the number of articles published more recently (last 5 years). Less than 1% (20 articles) of the articles presented more than 500 citations, mainly because this includes most of the seminal works on this theme.

Table 2.2. Authors with at least 10 articles found in the analyzed sample.

Author	Articles	Author	Articles
Lichtenthaler U	25	Duysters G	12
Li J	17	George G	12
Roper S	17	Laursen K	12
Molina-Morales FX	16	Belderbos R	11
Volberda HW	15	Blind K	11
Zahra SA	15	Brettel M	11
Chen CJ	14	Kang J	11
Li Y	14	Ning LT	11
Vanhaverbeke W	14	Rothaermel FT	11
Petruzzelli AM	13	Van den Bosch FAJ	11

Source: Research Data – Scopus and Web of Science.

Table 2.3. Number of articles identified by citation ranges.

Number of Citations	Articles	%	Number of Citations	Articles	%
Above 500 citations	20	0.63%	61 - 70 citations	50	1.57%
401 - 500 citations	15	0.47%	51 - 60 citations	73	2.30%
301 - 400 citations	12	0.38%	41 - 50 citations	94	2.96%
201 - 300 citations	51	1.60%	31 - 40 citations	154	4.84%
101 - 200 citations	129	4.06%	21 - 30 citations	252	7.92%
91 - 100 citations	30	0.94%	11 - 20 citations	431	13.55%
81 - 90 citations	32	1.01%	1 - 10 citations	1315	41.35%
71 - 80 citations	42	1.32%	No citations	480	15.09%

Source: Research Data – Scopus and Web of Science.

2.2.4 Data Analysis

Among the different types of analyses that can be performed in a bibliometric study, we chose to perform coupling and co-citation analysis. Bibliographic coupling is a measure of similarity based on the frequency that two documents in the sample share at least one standard reference. In this sense, the documents in a sample are grouped according to the overlap of their bibliographies (Vogel & Güttel, 2013; Zupic & Čater, 2015). The coupling analysis allowed identification of the most commonly shared references among the authors who published about absorptive capacity and innovation. This analysis is useful for detecting trends and possible paths to a field related to publication, indicating the research front in a field (Zupic & Čater, 2015).

The analysis of co-citation is another way to analyze the citation structure and provides a glimpse of the relations between the works, representing the knowledge base in the field (Serra et al., 2018). Co-citation is defined as the frequency with which two documents are cited together in the literature (Vogel & Güttel, 2013). The analysis of co-citation and coupling differs from the analysis level: while co-citation represents a similar relationship between two cited publications, bibliographic coupling is a measure of association between two cited publications (Vogel & Güttel, 2013). While co-citation is a reliable indicator of the publication impact, bibliographic coupling measures publishing activity (Vogel & Güttel, 2013). We also present the social network analysis from the results of coupling and co-citation analysis, representing the network formations in a diagram and providing a confirmatory analysis of the cohesion index (Levine & Kurzban, 2006).

Preparation and analysis of the sample were performed using Bibexcel, SPSS, Ucinet, and Microsoft Excel as support tools. BibExcel is a toolbox that facilitates the generation of

data files from Excel for further analysis (Liu & Gui, 2016). The use of this tool was especially important to provide accurate results. This is because databases are usually extracted with problems of format and standardization of information (such as authors' names written differently and letters in higher/lower case), which can generate results and counts different from the reality of the research field studied. Bibexcel allows the researcher to identify these failures and manage the results appropriately.

2.3 RESULTS

The results generated from the methodological procedures are presented in two topics. The first topic describes the results of the bibliographic coupling analysis that sought to highlight subjects that are trends for new studies. The second topic brings the findings of the co-citation analysis, carried out based on the references of the articles found in the bibliographic coupling analysis. This latter topic contributes to the mapping of the theoretical structure that supports the trends of future studies on absorptive capacity and innovation. We also presented social network analysis on both topics, showing the link between the articles.

2.3.1 Coupling Analysis

We generated a coupling matrix with the support of Bibexcel and initially considered the standard volume of 1,001 correlated references. However, the high volume of references would make any bibliometric analysis that could respond to the research objectives impossible. Therefore, we defined two cutting criteria to focus the analysis on the most relevant articles. The first criterion used was the number of relationships between the references. After applying this criterion, all references that presented 24 or more relationships with other articles were maintained in the matrix, totaling 100 references. The second criterion of sample reduction was to exclude references from the network analysis, as suggested by Vogel and Gutel (2012). For this, we used Ucinet software to generate the network design from the matrix of 100 articles. Relationships higher than eight and the exclusion of isolated references (which were not linked to any other reference) and pedants (which connected with only one reference) were considered. Thus, the reduced version of the matrix considered 84 references.

When performing the coupling matrix analysis, we perceived that the higher the number of references shared by two documents in a sample, the higher the similarity between

them. This similarity approximates the sample items, generating a factor that can determine a path that the study field is taking. To identify these factors, we chose to perform exploratory factor analysis. The procedure recommended by Hair et al. (2009) for the performance of the exploratory factor analysis is to evaluate the KMO (above 0.5) of each item in the anti-image matrix, the general KMO (above 0.5), the exclusion of items with commonality below 0.5, the exclusion of items with a load below 0.5 in a factor, and items with crossloads (above 0.5 in more than one factor). At each exclusion, the procedure was followed from the beginning in this order of analysis, always considering the main components and the Varimax rotation method. At the end of the extractions, we observed a general KMO of 0.816. Furthermore, six factors corresponding to 60.94% of the Explained Variance were identified, above the 60% indicated by the literature (Hair et al., 2009). The internal reliability measurement of each factor (Cronbach's Alpha) was also evaluated, accepting all factors because they had values higher than 0.6. The 34 articles referring to the six factors and their crossloads are shown in Table 2.4.

The articles in **Factor 1** concern **interorganizational knowledge networks**. Some previous studies argue that a company's absorptive capacity plays a critical role in collaborative innovation and interorganizational relationships and can lead to a significant competitive advantage (Kaur & Mehta, 2016; Zhang, Zhao, Lyles, & Guo, 2015). If an organization is considered a system, knowledge is its input, and the capacity for innovation is its output (or result) (Kaur & Mehta, 2016).

The innovation literature documents that the structural positions of companies in interorganizational collaboration networks matter to innovation (Dong & Yang, 2016). These networks serve as relational exchanges with peers (competitors), customers, and suppliers, which can be a critical source of knowledge, leading to innovation (Hao & Feng, 2016). Three measures for the centrality of the knowledge network have been used to measure the impact of the network on developing new products: degree centrality, proximity centrality, and vector centrality (Dong & Yang, 2016).

Some authors argue that different types of network may perform differently by providing access to specific knowledge sets (Hao & Feng, 2016). Previous studies on innovation in interorganizational networks have focused primarily on collaboration networks based on alliance partnerships (Dong & Yang, 2016). The literature points to three types of network ties in the context of interorganizational networks: (1) purchasing ties, when companies within networks are involved in buyer and supplier relationships, (2) peer

collaboration ties, when companies build collaborative relationships with competitors, and (3) equity ties, when collaborative partners hold each other's equity interests (Hao & Feng, 2016). However, it is worth noting that knowledge networks are different from collaboration networks, as the latter are relationship-based and not knowledge-based (Dong & Yang, 2016).

Other studies highlight the importance of companies assimilating external knowledge of interorganizational networks to benefit their new product development activities (Dong & Yang, 2016; Hao & Feng, 2016; Ojo & Raman, 2016; Volberda et al., 2016). Some studies have sought to understand how companies acquire the technological foundation to quickly upgrade and move from one set of advanced products and technologies to another, focusing both on the build-up of technological capabilities and the underlying absorptive capacity of each company (Chuang & Hobday, 2013; Díez-Vial & Fernández-Olmos, 2015). However, existing studies have neglected the underlying role of individuals and the effects of individual differences on the associated dimensions of absorptive capacity (Ojo & Raman, 2016).

Factor 2 concerns the **life cycle of alliances and the influence of the upper echelon (*Chief Executive Officers* - CEO)**. Knowledge management is mainly focused on connecting people, processes, and technology to expand corporate knowledge (Gonzalez et al., 2014). The main characteristics of a sector, including its knowledge, its capabilities, its stakeholders, its interactions, and its particular institutions, form the essential elements that can help understand innovation activities in terms of their locations, and national and global dimensions (Hu & Hung, 2014; Raymond, Bergeron, Croteau, & St-Pierre, 2016). Thus, knowledge needs to be managed within the organizational structure, given the importance of this resource for maintaining competitiveness (Gonzalez et al., 2014).

Alliances are known to be short-lived, with an estimated termination rate of more than 50% within four years after formation, and many companies are involved in multiple alliances with different partners, forming portfolios of alliances (Cui, 2013). Thus, organizations must create environments that encourage and facilitate knowledge sharing, emphasizing the role of organizational structure and culture as facilitators of this process (Gonzalez et al., 2014). Some studies have adopted a portfolio perspective to examine the interdependencies between multiple alliances of a company, often observing the differences and similarities between different partner resources (Cui, 2013).

Table 2.4. Exploratory factor analysis from the coupling matrix (highlighting loads of 0.4 or higher).

Author(s), Year	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Chalmers and Balan-Vnuk (2013)	0.802	0.114	-0.149	0.135	-0.087	-0.020
Hao and Feng (2016)	0.771	0.147	-0.029	0.233	-0.047	-0.019
Zhang *et al.* (2015)	0.750	0.004	-0.049	0.268	-0.102	-0.020
Dong and Yang (2016)	0.748	0.111	0.091	-0.170	-0.082	0.033
Chuang and Hobday (2013)	0.742	0.023	-0.002	0.242	0.393	-0.081
Diez-Vial and Fernandez-Olmos (2015)	0.733	-0.053	-0.075	0.103	-0.083	0.038
Ojo and Raman (2016)	0.728	0.054	-0.015	0.387	-0.049	-0.008
Kaur and Mehta (2016)	0.674	0.040	0.151	0.148	-0.044	-0.079
Wang *et al.* (2014)	0.110	0.861	0.019	0.034	0.140	0.015
Doyle *et al.* (2014)	-0.093	0.857	0.054	-0.075	0.114	-0.078
Cui (2013)	0.275	0.772	-0.015	0.132	0.224	-0.002
Hu and Hung (2014)	-0.095	0.733	0.097	-0.153	0.051	-0.077
Dominguez Gonzalez *et al.* (2014)	0.132	0.729	0.002	0.059	0.128	-0.088
Fernandez Perez and Gutierrez Gutierrez (2013)	-0.098	0.686	0.102	-0.120	0.090	-0.111
Raymond *et al.* (2016)	0.246	0.663	0.075	-0.021	-0.045	-0.035
Ratten (2016)	-0.117	-0.020	0.792	0.022	0.018	-0.046
Lucena (2016)	-0.093	-0.032	0.739	-0.138	-0.032	-0.050
Ahlin *et al.* (2014)	-0.069	0.194	0.718	0.378	-0.039	-0.011
Datta (2016)	0.172	0.004	0.717	0.186	-0.039	-0.025
Xie *et al.* (2014)	-0.029	0.121	0.705	0.162	0.031	-0.061
Lin and Chang (2015a)	0.083	-0.051	0.689	0.318	-0.011	0.082
Pilav-Velic and Marjanovic (2016)	-0.035	0.133	0.679	0.198	0.121	0.027
Cozza and Zanfei (2016)	0.177	0.340	0.532	0.375	-0.043	0.102
Gressgard *et al.* (2014)	0.176	-0.060	0.110	0.698	-0.032	-0.001
Lin and Chang (2015b)	0.232	-0.166	0.111	0.697	-0.088	0.015
Agarwal and Wu (2015)	0.094	-0.101	0.369	0.689	-0.033	0.016
Martinez-Torres and Olmedilla (2016)	0.212	0.109	0.311	0.684	-0.106	-0.071
Spanos *et al.* (2015)	0.223	0.000	0.242	0.588	-0.088	-0.047
Huang *et al.* (2014)	-0.071	0.111	-0.036	-0.139	0.827	-0.019
Karamanos (2016)	-0.067	0.262	0.016	-0.081	0.798	-0.038
Ebers and Maurer (2014)	-0.077	0.175	0.065	-0.053	0.764	-0.119
Blind and Mangelsdorf (2016)	-0.055	-0.038	-0.128	-0.132	-0.019	0.895
Garavan *et al.* (2016)	-0.068	-0.105	-0.066	-0.062	-0.063	0.860
Lee (2016)	0.063	-0.291	0.259	0.297	-0.173	0.729
General KMO	0.816					
Eigenvalues	5.090	4.559	4.420	3.399	2.297	2.174
% Variance	14.14	12.66	12.28	9.44	6.38	6.04
% Cumulative Variance	14.14	26.80	39.08	48.52	54.90	60.94
Cronbach's Alpha Coefficient	0.89	0.88	0.85	0.79	0.77	0.81
Number of articles in each factor	8	7	8	5	3	3
Density	0.889	0.875	0.889	0.833	0.750	0.750
Cohesion	0.855	0.838	0.868	0.776	0.685	0.621

Source: Search data – Coupling matrix.

Another particularly prominent theme concerns the role of upper echelon social networks in promoting strategic flexibility and organizational learning, highlighting the importance of managers, notably CEOs, in driving strategic changes in companies (Pérez & Gutiérrez Gutiérrez, 2013). Some authors state that much of the knowledge is not explicitly codified, remaining untold, and manifesting itself as competencies and abilities of individuals (Gonzalez et al., 2014). In this context, CEO social networks act as a channel for the transmission of information, resources, and opportunities that could be leveraged to aid

companies' capacities, such as strategic flexibility and organizational learning (Pérez & Gutiérrez Gutiérrez, 2013).

Factor 3 presents the **structural aspects of alliances, ambidextrous innovation, and entrepreneur networks**. Companies are required to generate innovation streams, defined as a company's ability to simultaneously produce incremental and radical innovations, compete effectively in the short term, and survive in the long term (Lucena, 2016). While it is widely recognized that internal Research and Development (R&D) departments is a crucial source of the ability to absorb, select, and use external knowledge, severe data limitations prevent it from capturing differences between companies in this regard (Cozza & Zanfei, 2016). In this sense, R&D alliances and market-based businesses allow companies to improve the possibilities of combining different types of R&D activities in alternative modes, thus favoring that new complementarities in the production of innovation flows may emerge (Lucena, 2016).

Organizations do not have to adopt innovation but can respond to it by investing in the area of interest (Ratten, 2016). To study these issues, the mode of interaction (cooperative and contract agreements) and the geographical scope of technological alliances (international and domestic partnerships) are introduced as two new criteria for defining sources of exploration and exploitation (Lucena, 2016). Companies without structural divisibility may have difficulty finding these sources, suggesting that large companies can better achieve ambidexterity than small and medium-sized enterprises (Lin & Chang, 2015a).

By controlling internal R&D efforts, not all companies are equally likely to have access to external technology and knowledge of universities in particular (Cozza & Zanfei, 2016). For example, organizational and strategy studies have generally recognized that political ties (social connections with governments and government-affiliated agencies) influence new products (Xie, Liu, & Gao, 2014). Thus, competitive advantage is obtained through partnerships, accessing new and complementary knowledge, and exclusive resources that are not available internally (Pilav-Velić & Marjanovic, 2016).

Innovative companies often look beyond their industry in search of opportunities to diversify their knowledge related to new technologies and innovations (Datta, 2016). The theory of organizational learning explains that companies transform the value of political ties into innovative new products through organizational learning (Xie et al., 2014). In other words, companies need to extend their borders to explore innovations outside their industries

and be able to apply their technological knowledge in order to transcend the mere definition of technological knowledge (Datta, 2016).

The production of innovation flows requires companies to produce new knowledge and use existing knowledge sources (Lucena, 2016). What is currently agreed is that the most successful innovative companies invest in a breadth of accumulated knowledge and absorb information from all kinds of sources – not only internal but also all available external sources (Ahlin et al., 2014). This is due to leadership characteristics related to the idea of challenging current practices, being an essential component of the innovation process (Ratten, 2016).

Management determinants of innovation involve focusing on the personality and behavior of managers regarding how they influence innovation (Ratten, 2016). The knowledge accumulated through internal and external networks of a multinational group is generally available to the parent company and, eventually, to each subsidiary at a lower cost than through arms-length transactions and can complement the available absorptive capacity at the level of each company (Cozza & Zanfei, 2016). However, several studies on entrepreneurship address the role of networks in smaller enterprises, as this is one way that small and medium-sized entrepreneurs deal with the responsibility of knowledge creation (Ahlin et al., 2014).

Factor 4 addresses the theme of **technological diversification and new perspectives on innovation**. As suggested by the organizational learning literature, the way a company identifies and manages its technological knowledge bases will be determined by its absorptive capacity (Lin & Chang, 2015b). Unlike institutions that ultimately tend to isomorphism, individual and institutional entrepreneurs seek unique opportunities and creative business models (Agarwal & Wu, 2015). Among the diverse organizational capabilities, a company's absorptive capacity is particularly crucial for technology integration and knowledge (Lin & Chang, 2015b). In particular, the relevance of the ability to assimilate and exploit for its benefit the knowledge generated in the context of collaborative R&D has been discussed in the literature (Spanos et al., 2015), as well as the ability to exploit knowledge of resources, which is fundamental to the innovation capacities of organizations (Gressgård et al., 2014).

Technology has evolved rapidly in recent decades, and technological diversification is widely regarded as a vehicle for organizational growth (Lin & Chang, 2015b). In this scenario, the strategic behavior of companies from various sectors has been studied from

different perspectives to understand the factors that may or may not influence this evolution. For example, normative isomorphism is seen among companies influenced by informal institutions that arise externally, such as perceived subjective norms (i.e., competitors or government), or internally, from social references within the company (Agarwal & Wu, 2015). Some authors argue that public intervention is necessary to face systemic failures that block the functioning of innovation systems due to conflicting incentives between companies and public sector organizations, institutional rigidities stemming from narrow specialization, asymmetric information, and lack of networking (Spanos et al., 2015). However, these external pressures eventually lead to industry standards and best practice models, reflecting the industry's absorptive capacity (Agarwal & Wu, 2015).

As technological innovation increasingly plays a central role in the modern business environment, investigating the relationship between technological diversification and steady performance deserves more theoretical and empirical efforts, and this subject may be especially important in large companies (Lin & Chang, 2015b). Thus, new perspectives on innovation have been created, such as user/customer-based innovation, open innovation, design-oriented innovation, and employee-oriented innovation (Gressgård et al., 2014). These perspectives are different from aligning innovation with user needs (in the sense of innovation market research), which will act as an active designer in the innovation process and indirectly help reduce uncertainty about the market (Martinez-Torres & Olmedilla, 2016). On the other hand, it is also recognized that the impacts of information and communication technologies (ICT) based tools depend on individual and organizational factors. As an example, some studies suggest that the emergence of internet technologies may mitigate the role of gatekeepers (i.e., people who connect internal networks to external sources of information) in the innovation process (Gressgård et al., 2014).

Factor 5 addresses **organizational learning and business model innovation**. The literature traditionally views innovation as new products, new technologies, or alternative administration and service (Huang et al., 2014). The theory of organizational learning and the resource-based theory of strategic alliances highlight the critical link between learning through alliances and innovation (Karamanos, 2016). Previous studies on team learning focused primarily on the effects of learning behavior or learning activities; however, relatively few empirical studies are available on learning models (Huang et al., 2014).

Business model innovation is one of many innovation strategies adopted by several highly successful corporations, including Apple, Walmart, and FedEx, and small and

medium-sized enterprises (Huang et al., 2014). Some researchers have used network theories to understand how networks and knowledge structures affect the exploration and production of innovation in specific contexts (Karamanos, 2016). In general, studies on the micro-foundations of the absorptive capacity of organizations have been neglected to date. Little is known about how absorptive capacity arises from the actions and interactions of lower-level actors, such as individuals, teams, or business units (Ebers & Maurer, 2014).

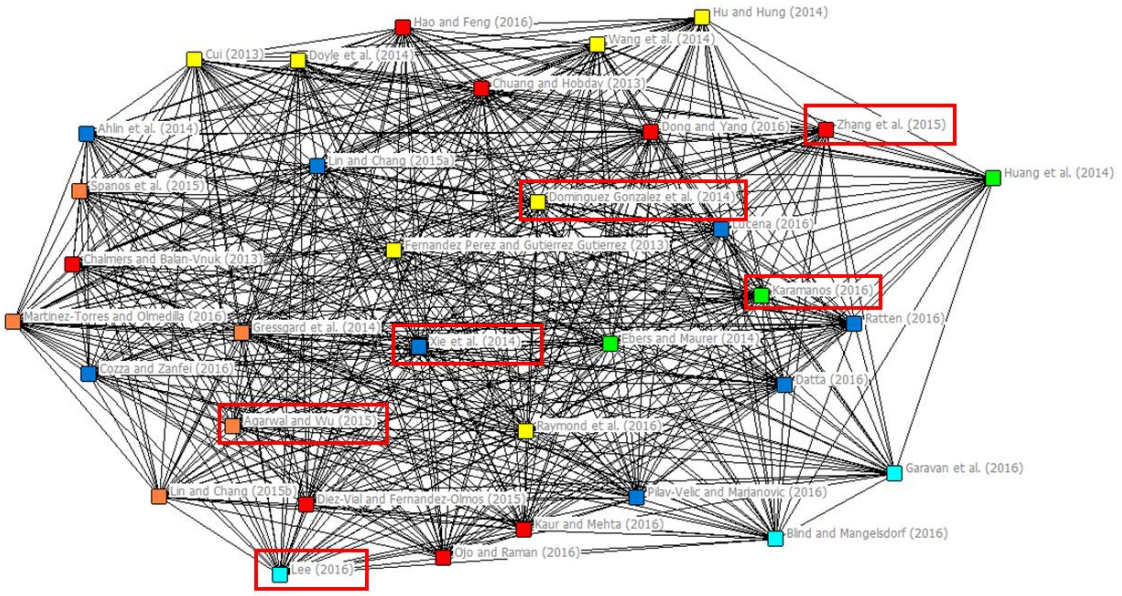
In terms of the relationship between team learning and organizational learning, team learning is considered a gateway to organizational learning, as it connects the transfer of individual learning to organizational knowledge that can then be shared by all (Huang et al., 2014). Some authors have theorized and empirically demonstrated that absorptive capacity emerges as the unintended consequence of incorporating the organization's external and internal knowledge and its relational empowerment (Ebers & Maurer, 2014). This highlights the importance of learning through external collaborations (such as strategic alliances) to produce innovation (Karamanos, 2016). Aligning multiple team learning models with organizational innovation should help create competitive advantage, and although the literature aids in the explanation of some complicated questions about organizational learning, many more studies are needed to identify specific learning models (Huang et al., 2014).

Factor 6 points to research on the **strategic development of human resources, standardization, and best knowledge sharing practices**. To date, the theory of strategic development of human resources has highlighted the primacy of human capital for organizational performance, and resource-based vision theory has been used to argue that the company's specific human capital will result in sustainable competitive advantage (Garavan et al., 2016). Companies face significant challenges, such as the need to reduce time to market, development, and manufacturing costs, or manage products with more and more technology (Lee, 2016). Through the standardization process, companies can supplement their R&D department with access to other companies' technological developments and benefit from overflows of unintended knowledge (Blind & Mangelsdorf, 2016).

The dynamic capabilities perspective helps explain how, under conditions of environmental dynamism, human resource strategic development will need to engage in continuous renewal of its capabilities if it wants to contribute to organizational performance (Garavan et al., 2016). For policymakers, standards – the results of the standardization

process – play an essential role in internalizing externalities and achieving the liberalization of international trade (Blind & Mangelsdorf, 2016). Thus, this current situation encourages the implementation of new management technologies, such as knowledge management and innovation management, to increase competitive advantages (Lee, 2016).

Figure 2.2. Network diagram showing the connections between the items in the coupling analysis.



Factor		Variable	Degree	nDegree
Factor 1		Zhang et al. (2015)	200.000	0.159
Factor 2		Dominguez Gonzalez et al. (2014)	297.000	0.237
Factor 3		Xie et al. (2014)	195.000	0.156
Factor 4		Agarwal and Wu (2015)	234.000	0.187
Factor 5		Karamanos (2016)	162.000	0.129
Factor 6		Lee (2016)	167.000	0.133

Source: Search data – Coupling matrix.

Figure 2.2 refers to the network diagram that shows the link between the authors identified at the end of the exploratory factor analysis based on the coupling matrix. The red nodes represent Factor 1 (interorganizational knowledge networks), which is central to the study by Zhang et al. (2015). The yellow nodes represent Factor 2 (life cycle of alliances and the influence of the upper echelon), which is central to the study by Dominguez Gonzalez et al. (2014). The blue nodes represent Factor 3 (structural aspects of alliances, ambidextrous innovation, and entrepreneur networks), which is central to the study by Xie et al. (2014). The orange nodes represent Factor 4 (technological diversification and new perspectives of innovation), which is central to the study by Agarwal and Wu (2015). The

green nodes represent Factor 5 (organizational learning and business model innovation), which is central to the study by Karamanos (2016). Finally, the turquoise nodes represent Factor 6 (strategic development of human resources, standardization, and best practices of knowledge sharing), which is central the study by Lee (2016).

2.3.2 Co-citation Analysis

After analyzing the six factors derived from the coupling matrix, a co-citation matrix was created with the support of Bibexcel to identify studies representing the intellectual structure of the theme studied. This matrix was made from the references of the 34 articles identified in the coupling matrix, which is a way to identify the reasons used for trends in future studies. The references cited in the 34 articles identified in the bibliographic coupling were selected to compose a new dataset. Thus, 53 references were selected because they had more than 5 citations in this dataset. From this dataset, a co-citation matrix was created for mapping the factors.

To identify the factors that represent this study's intellectual structure, we chose to perform an exploratory factor analysis with the same procedure used to analyze the coupling matrix. The procedures recommended by (Hair et al., 2009) for the performance of the exploratory factor analysis were followed, evaluating the KMO (above 0.5) of each item in the anti-image matrix, the general KMO (above 0.5), the exclusion of items with commonality below 0.5, the exclusion of items with a load below 0.5 in a factor, and items with cross loads (above 0.5 in more than one factor). At each exclusion, the procedure was followed from the beginning in this order of analysis, always considering the main components and the Varimax rotation method. At the end of the exploratory factor analysis, a general KMO of 0.918 was observed and three factors were generated from 29 articles, as shown in Table 2.5.

Table 2.5. Exploratory factor analysis from the co-citation matrix (highlighting loads of 0.4 or higher).

Author(s), Year	**Factor A**	**Factor B**	**Factor C**
Burt (1992)	0.927	-0.097	-0.046
Argote and Ingram (2000)	0.919	-0.133	-0.077
Ibarra (1993)	0.911	-0.024	-0.129
Inkpen and Tsang (2005)	0.902	-0.141	-0.050
Uzzi (1997)	0.902	-0.141	-0.050
Yli-Renko *et al.* (2001)	0.898	-0.065	0.036
Granovetter (1973)	0.890	0.060	-0.143
Tsai and Ghoshal (1998)	0.886	0.073	0.015
Hansen (1999)	0.871	0.186	-0.087
Nonaka and Takeuchi (1995)	0.844	0.101	0.231
Nahapiet and Ghoshal (1998)	0.854	0.196	0.041
Reagans and McEvily (2003)	0.821	0.199	-0.298
Lewin *et al.* (2011)	0.026	0.925	-0.031
Van Der Bosch *et al.* (1999)	0.037	0.921	0.016
Jansen *et al.* (2005)	-0.001	0.919	0.039
Cohen and Levinthal (1989)	-0.073	0.913	0.018
Volberda *et al.* (2010)	-0.009	0.891	0.109
Lane *et al.* (2006)	-0.016	0.873	0.218
Zhao and Anand (2009)	0.048	0.830	0.085
Todorova and Durisin (2007)	-0.112	0.829	0.237
Zollo and Winter (2002)	0.209	0.745	0.05
Leonard-Barton (1992)	-0.173	0.207	0.886
Levinthal and March (1993)	0.065	0.068	0.876
Trajtenberg (1990)	-0.086	-0.107	0.872
Katila and Ahuja (2002)	0.019	0.212	0.863
Hall *et al.* (2005)	-0.050	-0.073	0.856
Nelson and Winter (1982)	-0.113	-0.054	0.849
Chesbrough (2003)	-0.166	0.271	0.821
Rosenkopf and Nerkar (2001)	0.123	0.291	0.791
General KMO		0.918	
Eigenvalues	9.587	7.344	6.142
% Variance	33.06	25.32	21.18
% Cumulative Variance	33.06	58.38	79.56
Cronbach's Alpha Coefficient	0.973	0.949	0.938
Number of articles in each factor	12	9	8
Density	0.923	0.900	0.889
Cohesion	0.394	0.420	0.365

Source: Search data – Co-citation matrix.

Factor A is related to the literature on **organizational network structure and knowledge transfer**. Some authors state that the dimensions of social interaction and network bonds of social capital are associated with higher knowledge acquisition, while the dimension of relationship quality is negatively associated with the acquisition of knowledge (Yli-Renko et al., 2001). Other authors sought to understand how the dimensions of network social capital affect the transfer of knowledge among members of the network (Inkpen &

Tsang, 2005). The fundamental elements of this factor are the structural hole: a gap between two individuals with complementary resources or information (Burt, 1992). Thus, the acquisition of knowledge, in turn, is positively associated with the exploration of knowledge for competitive advantage through the development of new products, technological differentiation, and sales cost efficiency (Yli-Renko et al., 2001).

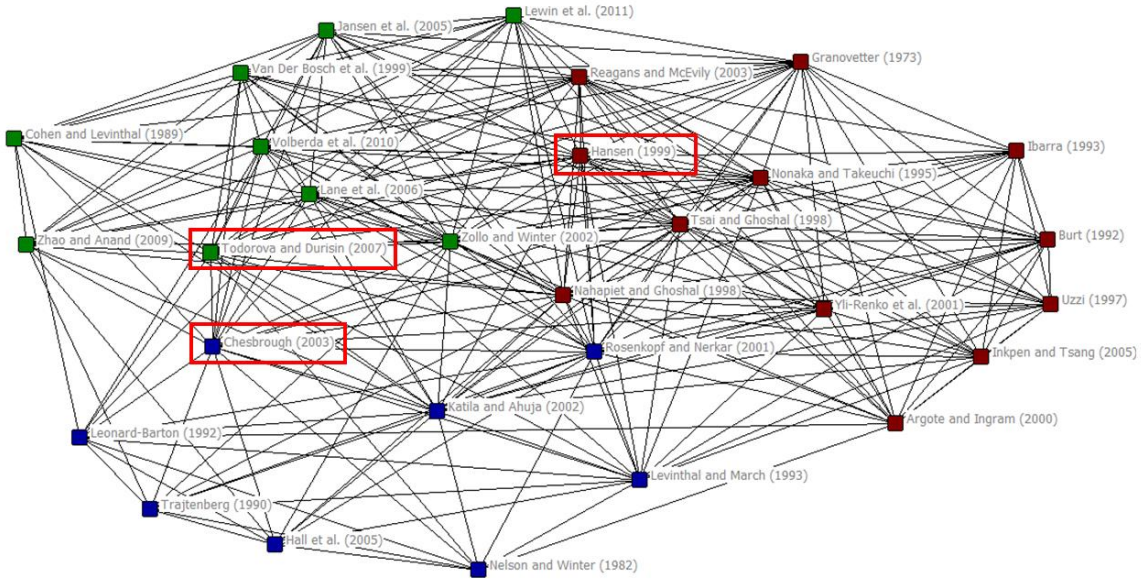
Factor B discusses the **absorptive capacity and internal and external organizational routines**. Some studies claim that the organizational mechanisms associated with coordination resources (multifunctional interfaces, participation in decision-making, and job rotation) mainly improve an organization's potential absorptive capacity (Jansen et al., 2005). The organizational mechanisms associated with socialization capacities (connectivity and socialization tactics) mainly increase the absorption capacity performed by a company (Jansen et al., 2005). Volberda et al. (2016) reviewed the underlying theories and empirical studies of absorptive capacity through bibliometry. The authors argued that realizing the potential of the concept of absorptive capacity requires more research that shows how "micro-antecedents" and "macro-antecedents" influence future results, such as competitive advantage, innovation, and firm performance. Thus, with very few exceptions, the specific organizational routines and processes that constitute the absorptive capacity remain a black box (Lewin, Massini, & Peeters, 2011).

Factor C portrays **organizational learning and technological evolution**. While core capabilities are traditionally treated as clusters of distinct technical systems, skills, and management systems, these dimensions of capabilities are deeply rooted in values, which constitute the often neglected but critical fourth dimension (Leonard-Barton, 1992). Among these capabilities, learning has to deal with the challenge of balancing competing objectives of developing new knowledge and exploring current competencies in the face of dynamic trends to emphasize one or the other. According to organizational learning research, companies position themselves in a one-dimensional search space that spans a distant local search spectrum (Katila & Gautam, 2002). In this context, many studies have seen the usefulness of patent citations as a measure of the "importance" of a company's patents, as indicated by the stock market assessment of the company's intangible knowledge stock (Hall, Jaffe, & Trajtenberg, 2005; Trajtenberg, 1990).

Figure 2.3 refers to the network diagram that shows the link between the authors identified at the end of the exploratory factor analysis based on the co-citation matrix. The dark red nodes represent Factor A (organizational network structure and knowledge

transfer), which is central to the study by Hansen (1999). The green nodes represent Factor B (absorptive capacity and internal and external organizational routines), which is central to the study by Todorova and Durisin (2007). Finally, the dark blue nodes represent Factor C (organizational learning and technological evolution), which is central to the study by Chesbrough (2003).

Figure 2.3. Network diagram showing the connections between the items in the co-citation analysis.



Factor	Variable	Degree	nDegree
Factor A	Hansen (1999)	70.000	0.278
Factor B	Todorova and Durisin (2007)	68.000	0.270
Factor C	Chesbrough (2003)	53.000	0.210

Source: Search data – Co-citation matrix.

2.4 DISCUSSIONS

By observing the intersection between the factors that make up coupling and co-citation (Figure 2.4), it is possible to deduce a relationship between them. Table 2.6 shows the normalized relations between the factors of the coupling. This process enables identification of the influence of the intellectual structure, based on the factors defined in co-citation, on forming the coupling (Serra et al., 2019).

In general, we realized that most of the factors related to trends in future studies are explored under the lens of the three factors of intellectual structure. However, there is clearly a predominance of the perspectives being used to explain these phenomena. Only factors 5

and 6 remained in only one or two factors (respectively). Although it is not one of the trends pointed out by the results of this study, new research could evaluate whether it makes use of theoretical lenses that have not yet been suggested.

Figure 2.4. Detailed relationship between the articles of coupling and co-citation analysis.

Bibliographic Coupling \ Cocitation		Factor A													Factor B										Factor C							
		Burt (1992)	Argote and Ingram (2000)	Ibarra (1993)	Inkpen and Tsang (2005)	Uzzi (1997)	Yli-Renko et al. (2001)	Granovetter (1973)	Tsai and Ghoshal (1998)	Hansen (1999)	Nonaka and Takeuchi (1995)	Nahapiet and Ghoshal (1998)	Reagans and McEvily (2003)	Lewin et al. (2011)	Van Der Bosch et al. (1999)	Jansen et al. (2005)	Cohen and Levinthal (1989)	Volberda et al. (2010)	Lane et al. (2006)	Zhao and Anand (2009)	Todorova and Durisin (2007)	Zollo and Winter (2002)	Leonard-Barton (1992)	Levinthal and March (1993)	Trajtenberg (1990)	Katila and Ahuja (2002)	Hall et al. (2005)	Nelson and Winter (1982)	Chesbrough (2003)	Rosenkopf and Nerkar (2001)
Factor 1	Chalmers and Balan-Vnuk (2013)																						●		●					
	Hao and Feng (2016)											●								●		●			●	●	●		●	
	Zhang et al. (2015b)																						●	●	●	●	●	●	●	●
	Dong and Yang (2016)																										●		●	
	Chuang and Hobday (2013)											●												●			●		●	
	Diez-Vial and Fernandez-Olmos (2015)																								●		●	●	●	●
	Ojo and Raman (2016)																						●		●	●	●		●	
	Kaur and Mehta (2016)		●																				●					●		
Factor 2	Wang et al. (2014c)	●	●	●	●	●	●	●	●	●	●	●																		
	Doyle et al. (2014)	●	●		●	●	●	●	●	●		●	●																	
	Cui (2013)	●			●	●	●	●	●	●	●													●		●				
	Hu and Hung (2014)			●				●		●			●																	
	Dominguez Gonzalez et al. (2014)	●	●	●	●	●	●	●	●	●	●	●	●																	●
	Perez and Gutierrez Gutierrez (2013)	●	●	●					●	●	●		●									●								
	Raymond et al. (2016)	●		●				●	●	●		●																		
Factor 3	Ratten (2016)												●	●	●	●	●	●	●	●	●	●								
	Lucena (2016)													●			●	●		●	●									
	Ahlin et al. (2014)										●				●	●			●											
	Datta (2016a)															●		●			●	●								
	Xie et al. (2014)									●				●	●		●	●	●	●	●									
	Lin and Chang (2015a)															●	●	●	●		●	●								
	Pilav-Velic and Marjanovic (2016)									●						●		●	●	●	●									
	Cozza and Zanfei (2016)							●	●		●	●		●	●	●		●	●		●									●
Factor 4	Gressgard et al. (2014)																				●		●						●	●
	Lin and Chang (2015b)																				●		●	●		●		●	●	●
	Agarwal and Wu (2015)													●	●	●		●	●		●								●	
	Martinez-Torres and Olmedilla (2016)						●		●		●	●						●	●							●			●	
	Spanos et al. (2015)																		●		●			●		●				●
Factor 5	Huang et al. (2014)																													
	Karamanos (2016)				●	●				●		●																		
	Ebers and Maurer (2014)																													
Factor 6	Blind and Mangelsdorf (2016)																											●		
	Garavan et al. (2016)																													
	Lee (2016)																●	●	●		●		●			●			●	

Source: Search data – Coupling and co-citation matrix.

The concept of absorptive capacity was explored, in its seminal basis, under an organizational perspective. Over time, we realized that several studies have sought to explore this topic under other levels of analysis and even from a multilevel perspective, such as, for example, Zhao and Anand (2009). Although there are still gaps that can be filled from all perspectives, we note that each of the three factors of intellectual structure points to the use of theoretical lenses to study absorptive capacity under specific levels of analysis.

It is highlighted that the majority of the studies that were based on Factor A (organizational network structure and knowledge transfer) were related to Factors 2 and 5, considering the organization as a unit of analysis or impact, as they address the life cycle of interorganizational alliances, the influence of the high echelon (CEO), organizational learning, and innovation of the business model. It was noticed that there is a tendency to use theories of networks, structural holes, and other theories that can help explain the phenomena that occur on the outside of the company. In this sense, there is a predominance of issues related to aspects of network formation and knowledge exchange that occur in the market, in the sector, in the cluster, or in the country.

Table 2.6. Summary of the association between the results of coupling and co-citation.

Association between factors	**Factor A** Organizational network structure and knowledge transfer	**Factor B** Absorptive capacity and internal and external organizational routines	**Factor C** Organizational learning and technological evolution
Factor 1 - Interorganizational knowledge networks	8.3%	5.6%	**86.1%**
Factor 2 - Life cycle of alliances and the influence of the upper echelon (CEO)	**93.5%**	1.7%	4.8%
Factor 3 – Structural aspects of alliances, ambidextrous innovation, and entrepreneur networks	14.8%	**83.3%**	1.9%
Factor 4 - Technological diversification and new perspectives of innovation	12.9%	38.7%	**48.4%**
Factor 5 - Organizational learning and business model innovation	**100.0%**	0.0%	0.0%
Factor 6 - Strategic development of human resources, standardization, and best practices of knowledge sharing	0.0%	**50.0%**	**50.0%**

Source: Search data – Coupling and co-citation matrix.

In recent years, the strategy and management literature has shown that companies invest in multiple alliances with different partners. We note that there is a tendency to better explore the aspects that involve these partnerships in order to extract better results for longer. Although there are some research fronts on this theme that try to understand what makes an alliance prone to end, such as the study of Cui (2013), it is still noticed that most studies focus on aspects related to the formation of these alliances. In general, it is clear that the different stages of the life cycle of alliances present research opportunities and their respective importance in generating results for organizations.

Decision-making related to the formation or termination of alliances may be related to the networks formed by high echelon members (CEOs and directors, for example). In addition, the relationships established between the high echelons can influence the organization's results, not only in terms of innovation but also in terms of strategic, structural, and operational levels. These relationships can be both formal and informal, and the impact of the relationships could be studied and eventually compared. In addition, different aspects could be explored in relation to the upper echelon members, such as their behavioral characteristics impacting the business (from decision making to strategies aimed at innovation that are adopted under their management).

Opportunities exist to break the frontiers of knowledge related to how these networks impact companies internally, in addition to considering the impact that networks formed by CEOs can bring to the external environment of the organization. This means that the networks established among high echelon members can have an impact both on the way the company presents itself to the market, as well as on how it is structured and how it generates results with the efforts of its teams and collaborators. Future studies could also explore the influence of these networks on workers and the influence of networks between workers.

The intellectual structure of Factor A is also being used to understand the implications of networks for organizational learning and innovation business models. The partnerships and networks formed between companies directly or through the upper echelon board should contribute to organizational learning, being considered one of the gains in collaborating or sharing knowledge externally. We understand that future studies can try to understand how and what aspects of networks can help organizations to generate more innovation and better performance. Another option would be to explore the effects of networks as a structure, since the business model can facilitate the transfer and absorption of knowledge between those involved.

Factor B (absorptive capacity and internal and external organizational routines) was related to Factors 3 and 6, dealing with topics such as the mode of interaction of companies, the geographical scope of alliances, networks of entrepreneurs, strategic development of human resources, standardization and best practices of knowledge sharing. Although Factor B also addressed themes at organizational levels, it is perceived that there are studies at the collective level. It is also noticed that there is a tendency to use small and medium-sized companies and entrepreneurs as a unit of analysis in addition to large organizations.

We observed that the study trends suggested, based on the intellectual structure of Factor B, are linked to the activities carried out by organizations or entrepreneurs to share knowledge and structural aspects that make this exchange feasible. For example, the modes of interaction, geographic scope, and ambidexterity are some characteristics analyzed in networks as strategies to generate sources of exploration and exploitation for firms. We understand that absorptive capacity and organizational routines can play an important role in generating innovative solutions and these structural aspects of networks can help companies to diversify their portfolios.

Even with technological advances, it is clear that processes and people continue to be an important part of the exchange and transformation of knowledge to reflect in the results of organizations. Therefore, standardization of processes and best practices become crucial themes for organizations to achieve their goals, which can be solving technical problems, knowledge seeking, influencing regulation, and facilitating market access. A strategic look at human capital is also evident from the use of theories that aid understanding of the importance of people to the results of organizations, such as the resource-based view and dynamic capabilities.

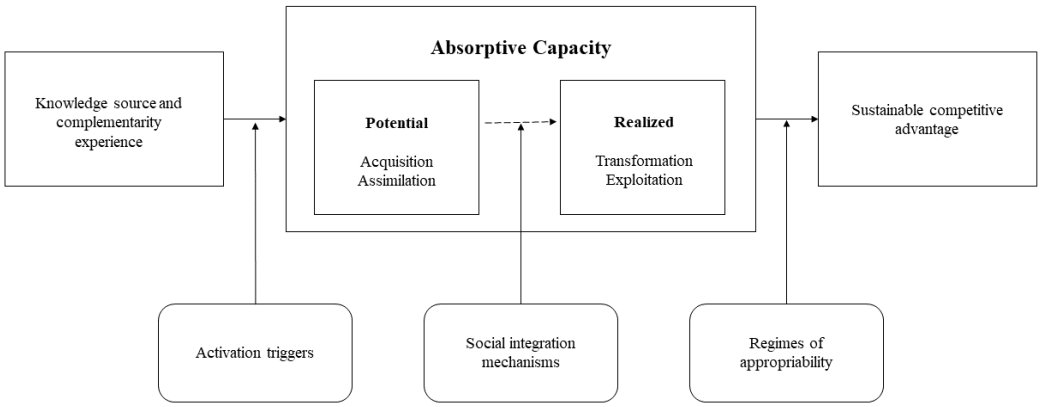
Finally, Factor C (organizational learning and technological evolution) was related to Factors 1 and 4, presenting aspects related to the types of interorganizational knowledge networks, technological diversification, and new perspectives of innovation, besides a different look at Factor 6. The intellectual structure that supports these study trends aims at understanding the impact of knowledge exchanges for the company internally. In this sense, we realize that there is a look at innovation from some specific perspectives, such as through patents, open innovation, and technology parks. For example, Zhang et al. (2015) make it clear that the relationship between open innovation and firm performance has been explored in the literature, but they also reinforce in their study that the results are controversial. Thus, there are opportunities to explore the effects of absorptive capacity in relation to these strategies for generating innovation.

The adoption of different innovation strategies means that companies have different sources of knowledge to generate new products and services for their customers. Therefore, the trends recommended by these factors reinforce the importance of processes and people so that the exchange of knowledge becomes a result. The organizational learning literature ends up being highlighted with theories that help explain this internalization of knowledge

and the use of this information so that organizations can reinvent themselves and be able to remain competitive from the internal intellectual capital.

After analyzing the association between the factors that emerged from the cocitation and pairing analyses, we realized that the results found could contribute to the development of new studies that address existing gaps based on the absorptive capacity model of Zahra and George (2002). The authors identified key dimensions of absorptive capacity, proposed the reconceptualization of this construct and also presented a model that connects the antecedents, moderators, and outcomes of absorptive capacity (Figure 2.5). We understand that the findings proposed in this bibliometric study can address the avenues needed to advance knowledge in each dimension of the model proposed by Zahra and George (2002).

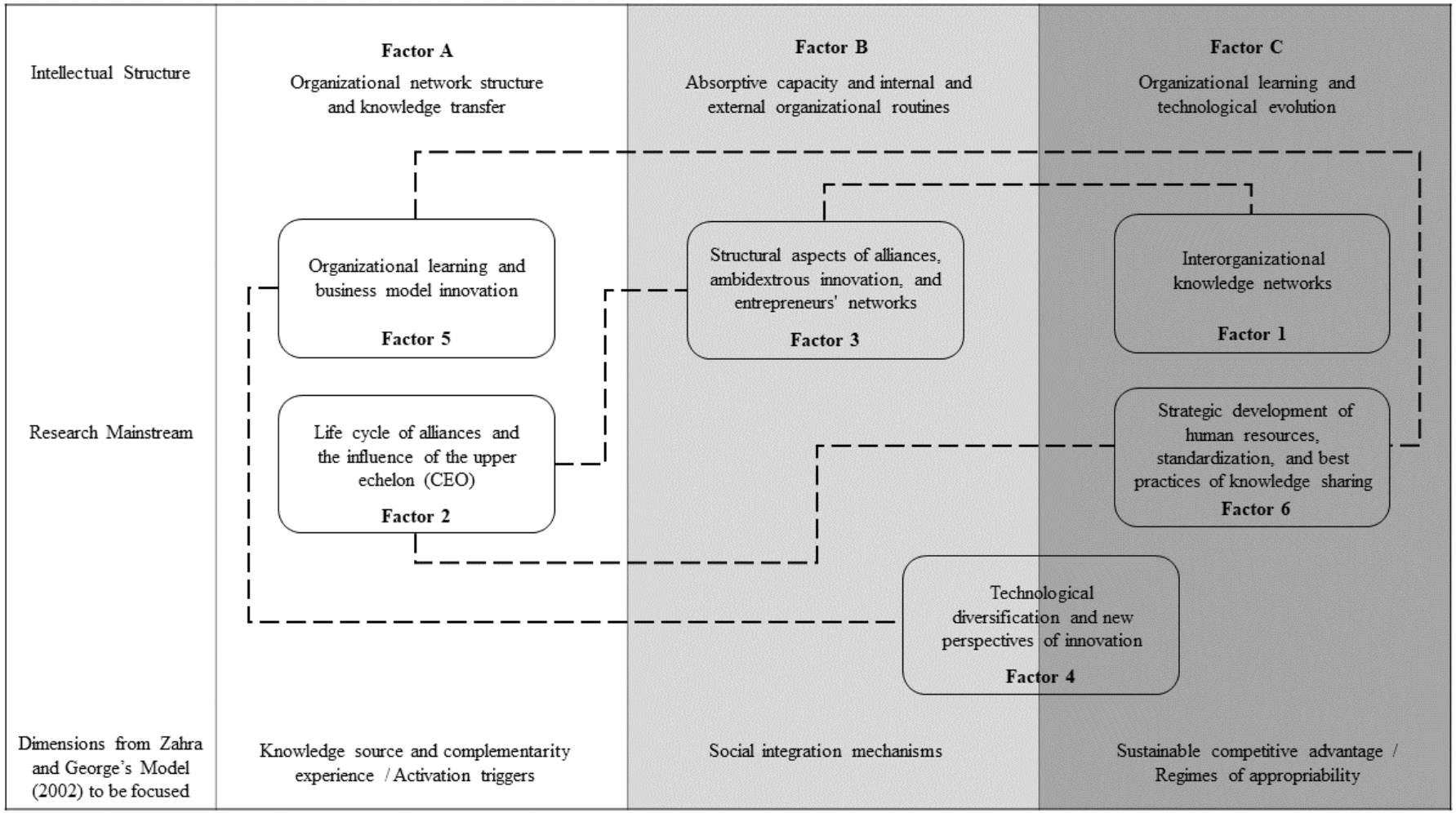
Figure 2.5. Model of absorptive capacity.



Source: Zahra and George (2002).

We developed a theoretical model (Figure 2.6) that can summarize the findings generated in the association of factors and to highlight the insights that emerge from these relationships. This model also expressed how our findings can contribute to the Zahra and George model. The factors related to the suggestions for future studies that came from the coupling analysis were made available in the same columns as their intellectual structures identified through the co-citation analysis. The exception is Factor 4, which presents an intellectual structure divided equally between the theoretical fronts presented in factors B and C.

Figure 2.6. Theoretical model summarizing the study's findings.



Source: Elaborated by the authors.

We realized that some subjects are related, although they appeared in different mainstream research factors and intellectual structures. These themes are connected with a dashed line, since they are insights that were not directly pointed out by the results of factor analysis. Other researchers can assess in more depth the gaps that may arise from looking at these themes from the perspective of theories, which could complement the understanding in different perspectives.

We observed that the intellectual structure presented in Factor A (organizational network structure and knowledge transfer) is connected with the **knowledge source and complementarity experience** and **activation triggers** proposed by Zahra and George (2002) as antecedents of absorptive capacity. Zahra and George (2002) suggest that external sources of knowledge can significantly influence the potential absorptive capacity of organizations. In addition, activation triggers are considered as events that can moderate the impact of knowledge sources and experience on potential absorptive capacity development (Zahra & George, 2002). In this way, it seems that the trends of future studies linked to this theoretical basis appear as ways to contribute to research gaps focused on the stages of knowledge acquisition and assimilation.

Zahra and George (2002) also suggested that **social integration mechanisms** are important to facilitate knowledge sharing and exploitation. The intellectual structure identified by means of Factor B (absorptive capacity and internal and external organizational routines) seems to propose the adequate theoretical basis to explore the research gaps that still exist in this regard. Studies carried out from the trends connected with this theoretical basis could contribute to the reduction in the gap between the potential absorptive capacity and the realized absorptive capacity.

In addition, we identified that Factor C (organizational learning and technological evolution) seems to match the proposal of Zahra and George (2002) when talking about **sustainable competitive advantage** and **regimes of appropriability**. The themes that emerged as a suggestion for future studies based on the intellectual structure of factor C may contribute to the research gaps on realized absorptive capacity. Thus, it would be possible to contribute to the literature related to the transformation and exploitation capabilities to convert knowledge into new products and services, enhancing performance and yielding a competitive advantage through a strategic look at the organization's internal intellectual capital. Furthermore, we observe that studies found in Factor C could help to explore or explain the institutional and industry dynamics that affect the firm's ability to protect and benefit from the advantages of new products or processes, phenomena called regimes of appropriability by Zahra and George (2002).

2.5 FINAL CONSIDERATIONS

Due to the increasing volume of publications involving absorptive capacity and innovation, an overview of accumulated knowledge is useful to give meaning to what is already known in the scientific field and generate a new research agenda. For this reason, we analyze the scientific production related to the absorptive capacity and innovation, presenting the trends of future studies through the coupling analysis and the recommended intellectual structure to study these themes through the co-citation analysis. We also present network diagrams to demonstrate how the studies are related.

The six factors from the coupling analysis were: interorganizational knowledge networks; the life cycle of alliances and the influence of the upper echelon (CEO); structural aspects of alliances, ambidextrous innovation, and entrepreneur networks; technological diversification and new perspectives of innovation; organizational learning and business model innovation; and strategic development of human resources, standardization and best practices of knowledge sharing. The three factors from the co-citation analysis were: organizational network structure and knowledge transfer; absorptive capacity and internal and external organizational routines; and organizational learning and technological evolution.

This article identified how absorptive capacity and organizational learning are interconnected through the literature of new perspectives of innovation and of technological diversification. Apparently, absorptive capacity is the general term that generically defines how the organization learns and organizational learning can be thought of as the various specificities that may be involved in the way the organization learns. We are arguing that literature on new perspectives on innovation could bring more specific learning concepts and would depend on developing details of the macro phases of absorptive capacity. This partial overlap between absorptive capacity and organizational learning is a possible theoretical contribution of this bibliometric study. What before could be understood as a synonym, does not seem to be sustained in light of the arguments presented herein. If we consider this view of intersection or partial overlap, we can rethink the ways of using the logic of absorptive capacity as a general concept and organizational learning as a possible evolution of the concept, due to dedicating ourselves to understanding the new perspectives of innovation, which will depend on derivations and developments of the more general concepts.

In terms of contribution to practice, by treating organizational learning as the set of theories that detail specialized or special learning processes, we have created a reduction in the level of abstraction. It would be possible, for example, to build certain frameworks with greater security and precision from the observation of an innovation phenomenon and to identify the presence or absence of learning components, which is not simple at the high level of abstraction that is absorptive capacity.

As a methodological contribution, we were able to present paths for future studies that could expand the frontiers of knowledge on what is known today about absorptive capacity, considering the combination of two bibliometrics techniques. We associated the results of these analyses and summarized the findings in the form of a theoretical model that is connected to the seminal model of absorptive capacity. The way in which we associate the results of all the analyses carried out in this study can be considered as a methodological contribution, combining the methodological procedures suggested by the protocols of Quevedo-Silva et al. (2016) and Serra et al. (2018, 2019). In addition to these contributions, we were able to indicate the themes to be explored in new research with the recommendation of an adequate theoretical basis to fill the gaps related to each part of the model proposed by Zahra and George (2002).

This study has some limitations, and there are opportunities for improvement in its development. There is also openness for future studies to complement this research with new content analyses or through conduction of an in-depth review of the publications identified in the factors of co-citation, coupling, and network analysis. The choice of databases (Scopus and Web of Science) covers a large volume of journals and articles; however, it is known that these databases do not contain one hundred percent of publications on this topic. Other researchers could make use of other databases to perform further analyses. Future studies may explore each of the factors found explicitly through systematic reviews of the literature or other methods to understand better each of the themes found.

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3 STUDY 2

Uncovering the Knowledge Networks in Innovation Research: A Topic Modeling Approach

Abstract

Over the years, research on knowledge and innovation networks has been conducted in various directions and from various perspectives. With the volume of published studies, especially in the last decade, the challenges of understanding the field as a whole have increased. The aim of this study was to identify research topics on knowledge and innovation networks using topic modeling. We derived 50 research topics by applying the Latent Dirichlet Allocation (LDA) model, which is the most popular topic modeling algorithm in scientific studies. Our sample consisted of the abstracts of 6,746 articles on networks, knowledge, and innovation, extracted from Scopus and Web of Science, and published from 1985 to 2021. From these data, we explored topic trends over the years, identifying 21 hot topics, 21 cold topics, and 8 steady topics that could help drive future studies on knowledge and innovation networks.

Keywords Knowledge; Interorganizational Networks; Innovation; Topic Modelling; Latent Dirichlet Allocation (LDA).

3.1 INTRODUCTION

The capacity to innovate has been seen in the literature as one of the competitive advantages of companies (Cefis et al., 2020; Medina-Molina et al., 2019). This capacity is a complex organizational resource with cumulative investment in various dimensions such as human capital, internal capital, and relational capital (Santos et al., 2018). Organizations that are better at searching for and integrating external and internal knowledge to create new knowledge develop advantages over other organizations (Belso-Martinez & Diez-Vial, 2018; Un & Rodríguez, 2018). In this sense, relationships and exchanges of knowledge seem to be important elements for the innovation and competitive advantage of companies.

In recent years, several studies have explored the role of knowledge networks and their relationship with innovation. For some authors, companies can accelerate capacity development and minimize their exposure to technological uncertainties by acquiring and exploiting the

knowledge developed by third parties (Grant, 1996; Lane & Lubatkin, 1998). These alliances or learning networks represent an important antecedent to innovation, because the scope of knowledge that an organization can create, process, and use is limited, and what is useful is imperfectly dispersed among organizations (Kolloch & Reck, 2017).

Especially in the innovation literature, interorganizational networks are seen as a strategy of resource saving and risk sharing, in which small and medium-sized enterprises (SMEs) often do not have sufficient financial capacity or human resources (Kofler & Marcher, 2018). However, it is observed that large companies can also use networks formed with other partners or competitors as a way to support their research, development, and innovation areas (Vicente-Oliva et al., 2015). In addition, it is clear that the relationships previously developed between the companies condition the structures of these networks and, for this reason, organizations that try to increase their ability to innovate should consider not only the type of relationships they currently have, but also how these relationships evolved (Ahuja et al., 2012; Belso-Martinez & Diez-Vial, 2018).

Although studies on the structure of the network at the organizational level have grown rapidly in the last decade, understanding of the topic remains fragmented and far from complete (Wang et al., 2019). For example, the literature on networks reports their role in promoting local development and innovation in organizations, but very few studies have evaluated the importance of networks between companies in the economic performance of organizations (Burlina, 2020). Although studies on this subject have advanced in the more than 30 years that have passed, there are still gaps that need to be explored.

It seems that research on knowledge and innovation networks has grown in various directions and from various perspectives over the years. With the volume of published studies, especially in the last decade, the challenges of understanding the field as a whole increase. Identifying latent topics and tracking their scientific evolution can be of great interest and could contribute to government, industry, and academia. In this sense, the research question that guides the current study is: what are the research topics emerging from the literature of knowledge and innovation networks?

The aim of this study was to identify research topics in knowledge and innovation networks. To achieve this goal, we used topic modeling as a method to extract latent topics from the literature. We derived 50 research topics by applying the Latent Dirichlet Allocation (LDA) model, which is the most popular topic modeling algorithm in scientific studies. Our sample consisted of the

abstracts of 6,746 articles on networks, knowledge, and innovation, extracted from Scopus and Web of Science, and published from January 1985 to December 2021. From these data, we explored topic trends over the years, identifying 21 hot topics and 21 cold topics that could help drive future studies on knowledge and innovation networks. We also found 8 other topics considered stable that may point to more recent themes in the literature.

3.2 THEORETICAL FOUNDATIONS

The combination of resources and capabilities is considered essential to the organization's ability to innovate (Davids & Tai, 2009; Un & Rodríguez, 2018). Networks have been closely associated with a greater capacity to innovate, as they provide companies with greater access to valuable knowledge flows that allow them to improve their products and processes (Belso-Martinez & Diez-Vial, 2018; Santos et al., 2018). In particular, due to limited internal resources, organizations often use social networks to acquire external knowledge and control resources to increase their competitive advantage (Wang et al., 2019). The more extensive the collaborative innovation network of an organization, the more heterogeneous and diverse the knowledge it will have access to (Xu et al., 2019).

Organizations acquire knowledge from other organizations and, therefore, the exchange of knowledge through interorganizational networks can serve as a critical antecedent of the production of organizational innovation (Kolloch & Reck, 2017). Some authors also argue that networks have become a central governance model that organizations use to manage innovation (Ahuja, 2000; Cap et al., 2019). These networks can create an environment of innovation, increase the flow of knowledge, accelerate the knowledge transition of different attributes, increase the collision and frequency of knowledge integration from different sources, strengthen the organization's capacity for innovation, expand the effect of technological innovation, and eventually increase the overall level of innovation of all network participants (Xu et al., 2019). Thus, networks can result in innovations occurring less frequently within individual companies and, more commonly, through knowledge creation networks that integrate individuals, companies, universities, and other institutions (Hynes & Elwell, 2016).

In the literature, networks can emerge as interorganizational networks, innovation networks, or knowledge networks, and many authors end up adopting similar concepts with

different names. For example, a knowledge network is defined as a connection between organizations in search of solutions to deal with complex and critical problems, in addition to the exchange of technical knowledge within the innovation process (Alberti & Pizzurno, 2015). An interorganizational network is seen as a form of interaction based on the reliable cooperation of autonomous but interdependent actors working on the goals of partners for a limited time (Kofler & Marcher, 2018). On the other hand, innovation networks are interorganizational networks consisting of a defined set of actors that collaborate for innovation and are governed by the interests of the network (Cap et al., 2019). In this study, we considered the nomenclature "networks" to deal with any exchange of knowledge for the generation of innovation, since it is a cross-sectional term that does not delimit the level of analysis used by the analyzed studies.

Some theories are commonly used in research on interorganizational networks. While some authors offer different explanations for this process, they share a resource-based company vision as a conceptual basis for explaining why organizations participate in networks (Munoz & Lu, 2011). The networks complement the resource-based vision, arguing that focusing on the individual characteristics and capabilities of the company can explain the company (Crispeels et al., 2015). In addition, interorganizational networks can be considered synonymous with cooperation. These networks or other groupings of organizations may cooperate with the sharing of resources for mutual benefit as a logical response to resource shortages (Hynes & Elwell, 2016).

Knowledge-based vision is another theory used to explain these interactions, considered a consequence of resource-based thinking (Eisenhardt & Santos, 2002). Moreover, this theory argues that the main role of the organization is as an integrator of knowledge (Crispeels et al., 2015; Grant, 1996). Organizations that can research and integrate knowledge from sources within and between countries probably have superior innovative capabilities (Leonard-Barton, 1992; Un & Rodríguez, 2018). Similar explanations can be found in the organizational learning literature, pointing out that organizations collaborate because they seek to explore and exploit new knowledge and develop the skills to use and build on such knowledge (Munoz & Lu, 2011).

From another perspective, the theory of social networks allows us to understand the behavior of networks under two characteristics: centrality of the network and structural holes (Wang et al., 2019). The centrality of the network, represented by the power of status, reflects the position and hierarchical advantage of the network (Ibarra, 1993). The central organization can enjoy a high advantage of position in the network and can respond more quickly to use potential

network resources and take advantage of opportunities to increase its competitive advantage (Wang et al., 2019). A structural hole is formed when a node is connected to two other nodes between which there is no direct connection (Burt, 1998). Organizations with more structural holes can access more heterogeneous information and resources from different parts of the network and, therefore, are more efficient in identifying threats and opportunities, and have the potential to offer better quality than other organizations (Uzzi, 1996; Xu et al., 2019).

Interorganizational networks are generally defined through different forms of business cooperation with variation in intensity, duration, and various motivations for collaboration (Kofler & Marcher, 2018). Interactions between the actors of these networks may be formal or informal. Formal relationships are generally conducted under contracts and alliances, while information relationships are based on private conversations between directors or pre-alliance relationships (Wang et al., 2019). The strength of these interorganizational networks is another characteristic that has been studied in recent decades. Granovetter (1973) argues that weak ties are more important to capture new information and resources, while strong ties need more time and attention. Weak relationships arise almost accidentally and through irregular contacts (Kofler & Marcher, 2018).

In particular, interorganizational networks as a means of granting access to knowledge can represent a critical basis for such innovative performance (Kolloch & Reck, 2017). These networks are increasingly recognized in the innovation management literature as 'access relationships' that allow partners to acquire non-redundant knowledge and capabilities that reside outside their organizational and technological limits (Chesbrough, 2012; Cui, 2013; Zouaghi et al., 2018). The structure of these relationships within knowledge networks will determine the innovative capacity of a company, along with how each company makes use of its position within them (Ahuja, 2000; Belso-Martinez & Diez-Vial, 2018; Uzzi, 1996).

In addition to the connection with interorganizational networks, the literature also points out the importance of absorptive capacity in the development of innovative capacity at the organizational level. A critical factor in the development of an organization’s capacity is the balance and interaction between the construction of internal knowledge and the acquisition of external knowledge (Davids & Tai, 2009). In many cases, organizations do not have much incentive to transfer knowledge to the interorganizational level, as this knowledge could then be available to competitors (Bapuji & Crossan, 2005). However, companies transfer knowledge from

the organizational level to the interorganizational level as this transfer is a way to legitimize and validate shared knowledge (Bapuji & Crossan, 2005).

In general, it is perceived that there are different perspectives and theories used to explore the phenomenon of knowledge networks to generate innovation. Some studies are bibliometric and all were published in recent years, but these publications bring a specific view within the theme, such as open innovation (Gao et al., 2020; Randhawa et al., 2016), and do not cover the entire period in which there are publications (Agostini et al., 2020; Dagnino et al., 2015). Therefore, we argue that it is necessary to explore the literature of knowledge networks and innovation to promote an overview of the issues contained in this field and, from this, break with the frontiers of knowledge through the identification of opportunities for future studies.

3.3 METHODOLOGICAL PROCEDURE

This section explains the methods and procedures adopted to identify research topics in knowledge and innovation networks. First, we briefly explore the method used in the study, after which we detail the methodological procedure, composed of four steps: (1) data analysis and sample definition, (2) LDA modeling, (3) textual preprocessing, and (4) trend identification.

3.3.1 Method

In recent years, there has been a significant increase in the volume of scientific content available in databases on various subjects. In parallel, we noticed the emergence of different methods of text analysis, starting from both qualitative and quantitative approaches. In addition, there are an increasing number of open source tools for text analysis (e.g. R and Python), although these tools are not easily leveraged by researchers, who probably have limited programming knowledge (Banks et al., 2018). In general, there is interest from the scientific community in discovering ways of analyzing the literature to summarize what has already been discovered on a given theme and indicate gaps that still need to be explored.

Topic modeling has attracted significant attention and can be successfully used in various text mining activities (Lee & Kang, 2018). Topic modeling algorithms are a set of machine learning methods for discovering hidden thematic structures in large document collections (DiMaggio et

al., 2013). These algorithms assume that (1) each document is a mixture of topics and (2) each topic has its own probability distribution over words (Blei et al., 2010; Lee & Kang, 2018). Thus, the analysis of the texts is carried out from the co-occurrence between words to determine the emerging topics. This method increases the interpretability of topics and the identification of outliers.

Topic templates allow researchers to code collections of text too large to be coded manually (DiMaggio et al., 2013). In addition, they do not require any prior labeling of the documents; the topics emerge from the analysis of the original texts (Lee & Kang, 2018). These topic templates can also serve the purpose of retrieving information, as documents are scored based on their similarity to the topic (probability) and therefore can be classified to identify the most representative documents (Banks et al., 2018). With topic models, researchers can discover new patterns in their text data and analyze much larger collections than would be possible manually (DiMaggio et al., 2013).

To obtain latent topics from the literature on knowledge and innovation networks, we used a probabilistic method of topic modeling known as Latent Dirichlet Allocation (LDA). LDA is a topic modeling algorithm widely adopted in academic studies, proposed by Blei et al. (2003). This Bayesian learning algorithm extracts "topics" from the text based on the co-occurrence of words (Toubia et al., 2019). The basic assumption of LDA is that each document is a mixture of topics, where each topic is a distribution in words. Each word that appears in the document can be attributed to one of the topics with some probability, and the meaning of the word may change with the association of other words within the document (Jeong et al., 2019).

3.3.2 Data Collection and Sample Definition

The first step of the methodological procedure was data collection and definition of the sample to be used in the study. We used the Scopus and Web of Science databases to search for publications related to the research theme. The searches were performed from the keywords "knowledge" AND "innovat*" AND "network*". We chose to delimit the sample to consider only English publications of the article type, because these publications have gone through blinded peer review processes. In addition, only articles published in the areas of business and management

were kept in the sample. At the end of the searches, we found 8,030 articles, 2,849 articles in Scopus and 5,181 in the Web of Science.

We extracted the metadata related to these searches and created a database with the main information of these articles (authors, title, journal, year, and abstract). Some of the journals that publish on this theme are indexed in the two databases and, therefore, the databases contain duplicate articles. In addition, some of the articles did not have a summary section, essential information for analysis through LDA. We excluded 1,265 articles from the sample due to duplication and 19 articles that did not present an abstract. No criteria were used to delimit the sample per year, since the dynamics of publications over time are also a target of interest in this study.

The final sample was composed of a list of 6,746 articles. We noted that around 37% of the sample was published in a list of 20 journals in different fields, such as marketing, innovation, sustainability, entrepreneurship, management, and business (Table 3.1). As the abstract summarizes the general idea of the study, we chose to use only the abstract to represent the document to be analyzed by the LDA algorithm.

Table 3.1. List of the top 20 main journals found in the sample.

	Journal	Number of Articles (%)
1.	Research Policy	331 (4.91%)
2.	Technological Forecasting and Social Change	267 (3.96%)
3.	Journal of Knowledge Management	182 (2.70%)
4.	Technology Analysis & Strategic Management	173 (2.56%)
5.	Technovation	154 (2.28%)
6.	Journal of Business Research	146 (2.16%)
7.	Industrial Marketing Management	140 (2.08%)
8.	Industry and Innovation	131 (1.94%)
9.	International Journal of Technology Management	127 (1.88%)
10.	R & D Management	98 (1.45%)
11.	Journal of Technology Transfer	94 (1.39%)
12.	Journal of Business & Industrial Marketing	93 (1.38%)
13.	Entrepreneurship and Regional Development	86 (1.27%)
14.	Organization Science	83 (1.23%)
15.	Management Decision	82 (1.22%)
16.	Journal of Product Innovation Management	78 (1.16%)
17.	Strategic Management Journal	78 (1.16%)

18. European Journal of Innovation Management	77	(1.14%)
19. International Journal of Innovation Management	70	(1.04%)
20. IEEE Transactions on Engineering Management	66	(0.98%)
Other 786 Journals	4,190	(62.11%)

3.3.3 Textual Preprocessing

Once abstracts of the articles have been collected, some preprocessing is required before conducting LDA inference. We used the R package tm (text mining) to prepare the content. First, we standardized the form of writing of some words that often appear in the literature as synonyms. For example, words such as "organizational" and "organisational" were standardized as "organizational". In addition, we removed the numbers, punctuations, blanks, and symbols for each document.

All the words are required to be lowercase. Next, we removed the words that are used to make the sentences grammatically correct (such as articles and prepositions), but that do not convey meaning to the subject when presented alone. These words are known as stop words and there is a list of pre-established words in the R tm package. It is also acceptable to use user-defined stop words for analytical purposes (Lee & Kang, 2018). Therefore, we created a list of the words that appear generally in the articles, such as "study", "paper", and "discuss", and removed these words from the text corpus.

After the removal of the words, the text corpus was lemmatized, seeking to reduce the total number of words available for analysis without losing information. Stemming finds the lemma (or expression) that preserves both the meaning and information of the part of speech that was originally used in the text (Lee & Kang, 2018). Other studies use derivation (or stemming) as a technique to more significantly reduce the size of the text corpus, but there is a risk of losing meaning and interpretation by displaying only the root of the words. For example, the words “innovative”, “innovation”, and “innovations” would become “innovat” when we use the derivation technique; in lemmatization, we would have “innovative”, “innovation”, and “innovation”. As the interpretation of the words contained in the topic is an important step in this study, we chose to use lemmatization.

Finally, the document-term matrix (DTM) was generated from the text corpus. The DTM is an array in which rows are each document in the sample, columns are each single word in the

sample, and cells are the number of times each word occurs (Storopoli, 2019). This matrix was used as data entry in the inference of the LDA.

3.3.4 LDA Modeling

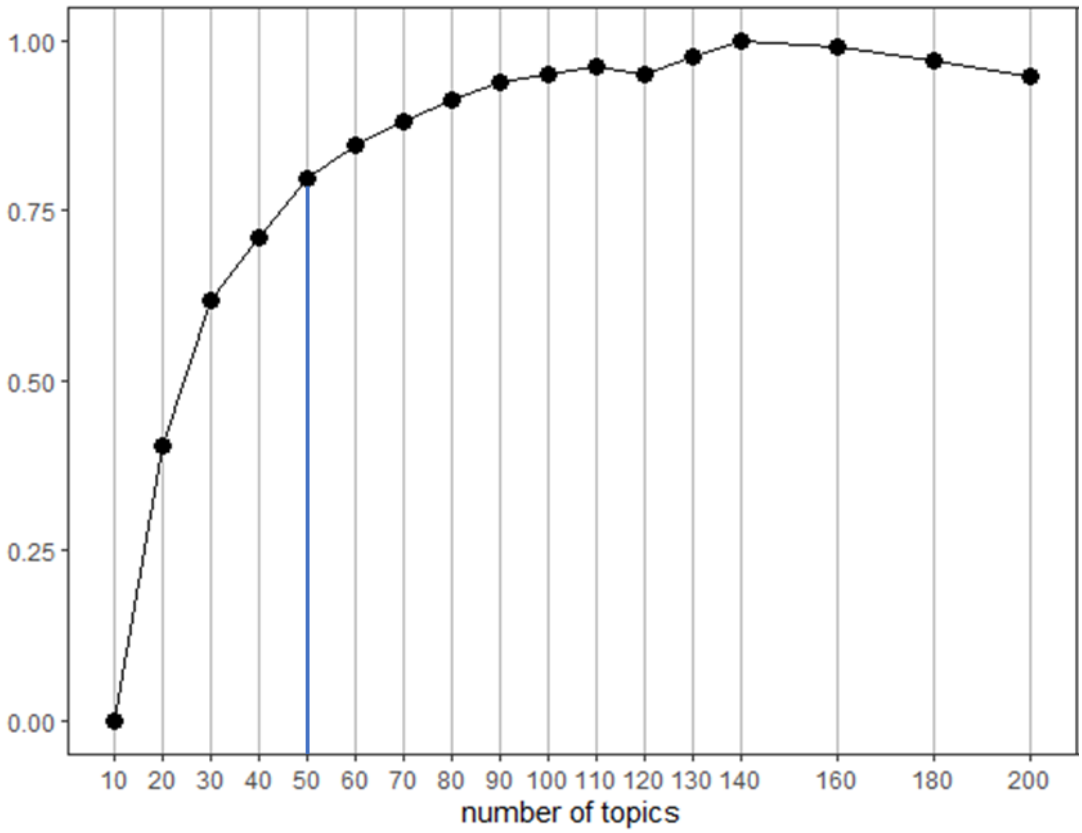
The third step was to perform the modeling of the LDA, at which time we decided the parameters and number of topics (K) to analyze the data sample. It was perceived that there is no consensus on how to define the parameters for the realization of LDA. Therefore, we tried to define the parameters for topic modeling based on the recommendations and good practices adopted by other studies that used the same method. Table 3.2 summarizes the parameters used in this stage.

Table 3.2. Parameters for LDA inference.

Component	Parameter
Sample size	6,746 abstracts
Number of topics K)	50, estimated with Griffiths and Steyvers (2004) metric
Inference algorithm	Collapsed Gibbs sampling
Gibbs sampling interaction	1,000
Dirichlet parameter α	50/K, being optimized each 10 iterations
Dirichlet parameter β	0.1 (default value)

The first parameter defined was the number of topics in the sample, performed from the R package LDATuning (Nikita, 2016). This package allows the use of the metric proposed by Griffiths and Steyvers (2004), which suggests the ideal number of topics for LDA based on a Markov Chain Monte Carlo algorithm. This suggestion is made from the selection of Bayesian models and the calculation of a posterior probability estimate, varying the topic values through running Markov chains (Figure 3.1). The highest value found is considered an indication of the number of topics able to summarize and explain the general corpus. Although the algorithm presented 100 topics as the best result to explain the data sample, we decided to go with 50 topics, since the model does not improve significantly enough after this amount to justify the analysis of a larger amount of content. In addition, we noticed that the greater the number of topics, the more difficult it becomes to interpret the data within the context of the literature studied.

Figure 3.1. LDA tuning results.



The second parameter was the inference algorithm. The inference algorithm tries to collect samples from the posterior to approximate it with an empirical distribution (Blei et al., 2010). Generally, two inference algorithms can be employed: Variational Expectation Maximization (VEM) or Gibbs sampling (Gibbs). Mohammad Zubir et al. (2018) compared the results of the two algorithms and the results show that Gibbs, like the inference algorithm, provides a better prediction about the optimal number of topic data compared to VEM. In this sense, we chose to use Gibbs as the inference algorithm of this study.

The other parameters were defined according to the recommendation of Griffiths and Steyvers (2004). We used $\alpha = 50/K$ as the posterior value for topics about documents, and $\beta = 0.1$ as values for words about topics. Finally, the LDA was conducted by the FitLdaModel function in the TextmineR package (Jones, 2019) with 1,000 iterations, optimizing the value of α every 10 iterations of Gibbs.

3.3.5 Trend Identification

The fourth stage performed in this study was the identification of trends based on the topics generated in the LDA. Identifying hot and cold topics can be an attractive application of this type of model, providing statistical measures related to the prevalence of these subjects in the sample. This identification can be useful to present the most relevant subjects to be explored in future studies.

Generally, each scientific article addresses more than one subject in its content. While other methods of grouping or sample reduction can force the assignment of a document to a single subject, LDA allows the document to be assigned to all topics related to it, with their respective proportions. From the LDA results, we extracted the list of documents with their respective proportions assigned to each of the 50 topics, generating an array of documents per topic.

The identification of trends in this study was a post hoc analysis, for which we used linear regression as a tool to identify topics that increased or decreased in popularity over the period from 1985 to 2021. Specifically, we used the year index as the input variable and the aspect ratio values assigned to the documents per topic as the response variable, following the recommendation of Griffiths and Steyvers (2004). The topics with regression coefficients presented as positive (negative) at a level of statistical significance of 0.05 were determined as hot (cold) topics. Thus, we consider hot topics as those that have shown, statistically, an increase in popularity over the years, while cold topics reflect the issues that have shown a decrease in popularity.

Once the topic trends were identified, we proceeded to read the first 10 abstracts of the articles that had the highest correlation with each topic (totaling 500 abstracts analyzed). We chose this quantity because it was the number of articles sufficient to reach theoretical saturation and translate the common subject of these articles of each topic. From this analysis, we proposed an overview of the literature based on the similarity between the sample's topics.

3.4 RESULTS

The 50 topics drawn from the studies of knowledge and innovation networks are shown in Table 3.3, with the ten most frequent and relevant words. We defined the names (or labels) of these topics based on the interpretation of these words and the abstracts of the main articles related to

each topic. The topics were numbered in descending order of proportions throughout the collection of articles, that is, we considered the percentage of participation of each topic within the sample to compose the ranking by proportion. In addition, we considered the number of articles in which each topic was identified, also generating a ranking.

The difference between attributions by proportion and by number of articles is clearly noted in Table 3.3. There are some differences in topic classifications between the two types of attributions. For example, [T14] the Actor's role in innovation networks ranks fourteenth in terms of sample proportion, while this topic ranks twenty-fifth in the number of articles ranking. This may indicate that this subject is a topic that is being explored in many studies, but its position in the ranking related to the volume of articles is impacted as research on this topic ends up covering other topics as well. For Lee and Kang (2018), it is likely that analyzing only the volume of articles published on each theme prevents the capture of the real distributions of the older articles. For this reason, we employ the proportions as a common sharing measure to identify hot and cold topics using linear regression, as suggested by Griffiths and Steyvers (2004).

Table 3.3. Topics of innovation and knowledge networks.

Topic		Frequent words	Share Rank			
			Proportion (%)		Number of articles	
T1	Firm performance through knowledge networks	performance, relationship, impact, influence, positive, moderate, sample, hypo, investigate, affect	4.098	(1)	1,809	(1)
T2	Research design and network approach focused on empirical contribution	research, design, limit, practical, value, limitation, interview, publish, analyze, provide	3.538	(2)	1,398	(2)
T3	Network analysis in systematic literature reviews	research, literature, field, future, review, identify, area, current, contribution, researcher	3.390	(3)	1,159	(5)
T4	Practices to acquire and transfer knowledge	knowledge, share, transfer, flow, acquisition, base, exchange, tacit, acquire, intensive	3.155	(4)	1,209	(4)
T5	Alliances portfolio diversity influencing firm's absorptive capacity	firm, alliance, capacity, absorptive, benefit, partner, portfolio, interfirm, base, focal	2.900	(5)	1,216	(3)
T6	Network's structures and characteristics	network, tie, structure, position, centrality, strong, strength, structural, embed, weak	2.715	(6)	1,037	(7)
T7	Network influence in innovation processes	innovation, process, exploratory, innovate, activity, exploitative, link, explore, promote, focus	2.605	(7)	1,058	(6)
T8	Value co-creation networks	value, creation, framework, create, literature, perspective, develop, conceptual, understand, offer	2.450	(8)	656	(10)
T9	Knowledge network as learning strategy in complex systems	system, change, complex, term, dynamic, agent, transformation, long, environment, concept	2.376	(9)	713	(8)
T10	Theoretical and methodological models of networks	model, use, propose, technique, apply, term, tool, information, feature, evaluation	2.357	(10)	591	(15)
T11	Regional innovation and the role of public support	policy, development, public, regional, economic, government, support, region, sector, private	2.144	(11)	677	(9)
T12	Patents as a technological development spillover and inventors' network	technology, technological, patent, inventor, invention, citation, period, mobility, license, analyze	2.125	(12)	647	(11)

T13	R&D internationalization and the knowledge diffusion between local and subsidiary firms	international, subsidiary, global, local, foreign, embeddedness, multinational, country, internationalization, corporation	2.094	(13)	631	(14)
T14	Actor's role in innovation networks	role, actor, interaction, play, different, important, specific, exchange, context, focus	2.082	(14)	439	(25)
T15	Networks as a source of competitive advantage for small and medium-sized enterprises	smes, market, enterprise, small, competitive, size, advantage, medium, strategy, large	2.079	(15)	642	(13)
T16	Stakeholder engagement to address sustainability issues	challenge, stakeholder, face, sustainable, goal, build, require, action, involve, address	2.066	(16)	534	(18)
T17	Design practices and collaborative product development processes	process, product, development, develop, design, involve, market, lead, mean, exist	2.063	(17)	521	(19)
T18	Strategic management of networks and knowledge	management, strategy, strategic, manager, manage, managerial, process, practice, asset, factor	2.016	(18)	505	(21)
T19	Geographic scope of knowledge spillovers	cluster, industrial, proximity, regional, local, region, geographical, spillover, geographic, locate	2.004	(19)	644	(12)
T20	Knowledge diffusion and technology transfer focused on digital consumer behavior	information, technology, communication, user, diffusion, platform, digital, adoption, consumer, internet	1.976	(20)	543	(17)
T21	Organizational unit networks configuration and their knowledge processing	unit, outcome, across, benefit, individual, diverse, argue, large, likely, prior	1.976	(21)	420	(26)
T22	Institutional logic in global innovational networks	country, economy, institutional, global, national, develop, emerge, institution, sector, economic	1.925	(22)	499	(22)
T23	Social network brokerage and individual factor’s behavior	factor, individual, influence, behavior, perceive, level, characteristic, important, perception, motivation	1.910	(23)	452	(23)
T24	Knowledge networks through the lens of social capital theory	social, capital, human, medium, dimension, relational, structural, cognitive, intellectual, impact	1.910	(24)	513	(20)
T25	Entrepreneurial universities and science parks spin-offs	university, research, science, academic, scientific, park, spin, institution, institute, scientist	1.904	(25)	564	(16)
T26	Capabilities and knowledge networks' role in business innovation model	business, model, company, market, develop, environment, create, element, focus, order	1.855	(26)	396	(28)

T27	Relationship between internal and external knowledge networks	external, open, source, internal, knowledge, search, strategy, openness, depth, breadth	1.793	(27)	452	(24)
T28	Organizational characteristics and ideation networks	different, type, idea, innovative, radical, generation, relation, individual, incremental, generate	1.772	(28)	342	(38)
T29	Organizational structures and employees' role in learning networks	organization, work, employee, organizational, organize, productivity, professional, worker, structure, self	1.733	(29)	404	(27)
T30	Rationalized logic and actor-centric ecosystems	practice, ecosystem, explore, perspective, emerge, understand, address, logic, good, offer	1.715	(30)	369	(32)
T31	Levels of organizational configurations in innovation networks and high-tech industry	level, high, tech, increase, degree, intensity, manufacture, output, low, potential	1.708	(31)	321	(40)
T32	Customer centric innovation and service organizations	service, customer, company, provider, operation, intensive, manufacture, involvement, solution, client	1.692	(32)	388	(30)
T33	Dynamic capabilities and buyer-supplier relationships	capability, supplier, dynamic, integration, base, develop, buyer, outsource, relational, resource	1.665	(33)	394	(29)
T34	Collaborative innovation networks and smart cities	decision, make, city, intermediary, energy, smart, support, plan, infrastructure, framework	1.660	(34)	355	(35)
T35	Startups and investment networks towards innovation	venture, start, growth, success, entrepreneur, experience, incubator, investment, woman, startup	1.637	(35)	342	(39)
T36	Networking across boundary spanning activities	activity, boundary, right, reserve, space, across, focus, ation, span, take	1.625	(36)	263	(45)
T37	Knowledge transfer network and industrial development history	industry, sector, biotechnology, industrial, lead, pharmaceutical, standard, manufacture, innovative, importance	1.624	(37)	320	(41)
T38	Online innovation communities and members behaviors through social network perspective	community, member, group, online, participation, software, good, family, support, participant	1.624	(38)	346	(37)
T39	Transformational leadership and organizational learning processes in innovation	learn, organizational, leadership, culture, organization, leader, interactive, mechanism, structure, japanese	1.616	(39)	353	(36)
T40	Strategies to manage quality, cost, and risk in knowledge flows and innovation processes	quality, cost, increase, risk, control, production, reduce, time, uncertainty, scope	1.589	(40)	277	(44)

T41	Teams and project organizations as sources for creativity and innovation	project, team, creative, creativity, diversity, construction, member, task, work, conflict	1.576	(41)	363	(33)
T42	R&D partnerships and collaborative network across industries and sectors for innovation	collaboration, partner, collaborative, partnership, collaborate, joint, benefit, research, increase, facilitate	1.566	(42)	370	(31)
T43	Education and professional development focused on innovation and industry's needs	education, skill, experience, exploration, competence, exploitation, competency, professional, student, train	1.549	(43)	280	(43)
T44	Entrepreneurial opportunity identification and development through social networks	entrepreneurial, entrepreneurship, opportunity, entrepreneur, orientation, role, develop, support, environment, play	1.496	(44)	356	(34)
T45	Supply network stability in dynamic environments	chain, supply, problem, efficiency, trade, improve, food, production, logistic, solve	1.490	(45)	291	(42)
T46	Evolution of innovation processes based on collaborative networks	stage, time, phase, early, evolution, life, cycle, dynamic, late, vertical	1.485	(46)	251	(46)
T47	Governance mechanism in the innovation and knowledge network	mechanism, governance, trust, power, configuration, mode, relational, coordination, contract, interfirm	1.476	(47)	244	(47)
T48	Collaborative networks with the triple helix actors	resource, access, helix, human, constraint, base, triple, financial, niche, facilitate	1.446	(48)	242	(48)
T49	Interorganizational cooperation and regional networks	interorganizational, cooperation, informal, core, inter, china, formal, structure, cooperative, competition	1.427	(49)	237	(49)
T50	Social networks in healthcare	healthcare, health, work, world, medical, clinical, care, hospital, patient, people	1.322	(50)	223	(50)

Linear regression was used to analyze the distribution of articles by topic over the years, identifying 21 hot topics, 21 cold topics, and 8 steady topics. These topics are presented in Table 3.4 with their respective regression coefficients in descending order, representing a popularity ranking.

Table 3.4 Hot, cold and steady topics in networks of knowledge and innovation.

No.	Topic		Coefficient
(a) Hot Topics			
1	T1	Firm performance through knowledge networks	0.1560
2	T2	Research design and network approach focused on empirical contribution	0.1380
3	T23	Social network brokerage and individual factor behavior	0.0659
4	T7	Network influence in innovation processes	0.0548
5	T44	Entrepreneurial opportunity identification and development through social networks	0.0530
6	T10	Theoretical and methodological models of networks	0.0489
7	T3	Network analysis in systematic literature reviews	0.0379
8	T24	Knowledge networks through the lens of social capital theory	0.0359
9	T8	Value co-creation networks	0.0359
10	T30	Rationalized logic and actor-centric ecosystems	0.0359
11	T27	Relationship between internal and external knowledge networks	0.0333
12	T34	Collaborative innovation networks and smart cities	0.0314
13	T42	R&D partnerships and collaborative network across industries and sectors for innovation	0.0311
14	T45	Supply network stability in dynamic environments	0.0305
15	T15	Networks as a source of competitive advantage for small and medium-sized enterprises	0.0304
16	T49	Interorganizational cooperation and regional networks	0.0285
17	T35	Startups and investment networks towards innovation	0.0246
18	T43	Education and professional development focused on innovation and industry’s needs	0.0211
19	T48	Collaborative networks with the triple helix actors	0.0160
20	T46	Evolution of innovation processes based on collaborative networks	0.0049
21	T38	Online innovation communities and members behaviors through social network perspective	0.0026

(b) Cold Topics

1	T32	Customer centric innovation and service organizations	-0.0024
2	T33	Dynamic capabilities and buyer-supplier relationships	-0.0034
3	T26	Capabilities and knowledge networks' role in business innovation model	-0.0081
4	T47	Governance mechanism in the innovation and knowledge network	-0.0097
5	T41	Teams and project organizations as sources for creativity and innovation	-0.0130
6	T22	Institutional logic in global innovational networks	-0.0153
7	T36	Networking across boundary spanning activities	-0.0198
8	T28	Organizational characteristics and ideation networks	-0.0215
9	T6	Network structures and characteristics	-0.0277
10	T5	Alliances portfolio diversity influencing firm’s absorptive capacity	-0.0331
11	T19	Geographic scope of knowledge spillovers	-0.0433
12	T25	Entrepreneurial universities and science parks spin-offs	-0.0449
13	T40	Strategies to manage quality, cost, and risk in knowledge flows and innovation processes	-0.0456
14	T11	Regional innovation and the role of public support	-0.0514
15	T4	Practices to acquire and transfer knowledge	-0.0521
16	T29	Organizational structures and employees’ role in learning networks	-0.0583
17	T39	Transformational leadership and organizational learning processes in innovation	-0.0606
18	T37	Knowledge transfer network and industrial development history	-0.0910
19	T18	Strategic management of networks and knowledge	-0.0974
20	T17	Design practices and collaborative product development processes	-0.1420
21	T9	Knowledge network as learning strategy in complex systems	-0.1570

(c) Steady Topics

1	T16	Stakeholder engagement to address sustainability issues	0.0137
2	T14	Actor's role in innovation networks	0.0036
3	T21	Organizational unit networks configuration and their knowledge processing	0.0030
4	T13	R&D internationalization and the knowledge diffusion between local and subsidiary firms	0.0028

5	T31	Levels of organizational configurations in innovation networks and high-tech industry	-0.0020
6	T12	Patents as a technological development spillover and inventors' network	-0.0123
7	T20	Knowledge diffusion and technology transfer focused on digital consumer behavior	-0.0182
8	T50	Social networks in healthcare	-0.2900

3.5 DISCUSSIONS

After reading the 10 most representative abstracts of each of the 50 topics, we identified that some topics presented similarity and may reflect, in general, some of the evolution of the research in this field. We understand that there is a trend in studies that use an individual level analysis unit that may in some way impact the performance of the organization or innovation. This individual level appears in the topics of both the size of the companies and the concern for the individual. In addition, the issues that are on the rise seem to be related to practical issues and problems of organizations or environments. The similarity between the topics generated some perspectives that are presented in sequence.

3.5.1 Networking outcomes

This perspective is related to the expected results from knowledge and innovation networks. We observed that the literature seems to demonstrate increasing interest in studying topics from the field of networks related to the performance of firms and co-creation of value, reflected in the hot topics T1 and T8. Although the topic of patents seems to have been explored over the years, its reflection through topic T12 emerged as a study trend that remained stable.

In T1 (Firm performance through knowledge networks), we observed that the literature was explored under different facets to understand how company performance is affected by networks to generate competitive advantages. In many studies, we observed that innovation performance (and possible variables that may affect it) appears as an antecedent of firm performance. In other studies, innovation performance seems to be used as a way of looking at firm performance. In

addition, there is some interest in what can be considered as an antecedent of innovation performance.

In T8 (Value co-creation networks), we observed that the studies address how knowledge networks contribute to the creation of value by the companies involved. We also observed that the business model and the characteristics of the environment in which the company is located are also factors that can influence the value creation processes. Part of the studies used the dominant service logic dominant theory and cost and transaction theory as lenses for these phenomena.

In T12 (Patents as a technological development spillover and inventors' network), we observed the presence of studies that started from the analysis of patents to understand the behavior of technological development in certain regions or industries. Patents were widely used to understand the flow of knowledge between inventors and how their mobility could influence the generation of inventions (often brought in as knowledge spillovers). In some studies, we identified the collaborative approach between industry and university, as well as the role of government, being mapped through patents. Most of the studies started with secondary data from patent databases, making use of quantitative techniques or network analysis to explore the topic.

3.5.2 Methodological aspects

This perspective reflects the findings regarding the methodological aspects of the analyzed articles, considering that in all abstracts there is a brief explanation of the methods used in the research. Topics T2, T3, and T10 emerged as hot topics and reflect the way networks have been used, increasingly, to translate both the literature in this field and to propose models and solutions that bring contributions to practice. As they contain similar terms, some topics ended up being divided into two groups, one more focused on the theoretical aspect and the other focused on the methodological aspect.

In T2 (Research design and network approach focused on empirical contribution), we identified two different themes. The first theme is related to research design, emphasizing research techniques and methods as a way to contribute with empirical studies in knowledge networks. The second theme is related to the use of the network approach as a theoretical lens or research design to analyze the phenomena, mostly dealing with value creation and the use of knowledge by companies (most of them in the tourism sector). In T3 (Network analysis in systematic literature

reviews), we observed that there is a predominance of literature review studies, performed mostly through bibliometric techniques.

In T10 (Theoretical and methodological models of networks), we identified the presentation of two different groups of papers. The first group brought studies that proposed theoretical models as an attempt to translate and understand the dynamics of networks between companies. The second group sought to present models, techniques, frameworks, and other solutions for the use of network analysis. In general, both groups present proposals for models that can bring contributions to network studies, whether in terms of method or theory.

3.5.3 Theoretical aspects

In this perspective, we brought the topics that had, explicitly, the mention of theoretical lenses for the analysis of phenomena. We identified that the theories that emerge from the strategy line appear through the cold topics T5 (Absorptive capacity), T22 (Institutional logic), and T33 (Dynamic capabilities). Hot topics reflect the use of social capital theory (T24) and theories that serve as a lens for cognitive aspects (T30). It should be noted that these were not the only theories used in the surveys that were part of the sample. Some studies used a resource based view and service-dominant logic, for example. However, not all theories emerged as the main theme or as evidence to the point of assuming a leading role in the topics analyzed.

In T5 (Alliances portfolio diversity influencing firm's absorptive capacity), we identified studies that explored strategies for managing alliance portfolio diversity and partnerships between companies, mainly for the development of new products or technologies. Most of these partnerships are presented as ways to support the R&D departments of these companies, mostly large companies. Other studies argue that the way the diversity of these portfolios is managed makes a difference in the firm's absorptive capacity and, consequently, in their innovation performance.

In T22 (Institutional logic in global innovation networks), we identified studies that sought to analyze the innovation networks formed between different countries from the perspective of institutional logic. For Dudukalov et al. (2016), global innovation networks play an important role in the development of the modern global economy because they stimulate international cooperation in the innovation sphere, the translation of knowledge in the global economic system, and general

scientific and technological development and production development. Other authors, such as Genin et al. (2021), used institutional theory as a lens to explain how the different institutional aspects, networking characteristics, and the environment where they are inserted affect innovation results.

In T33 (Dynamic capabilities and buyer-supplier relationships), we identify how companies involved in buyer-supplier networks behave and benefit from the exchange of knowledge in innovation development processes. In some studies, there is the presence not only of the buyer and supplier actors, but also a role of the consumer contributing to these innovation processes. The argument used by some authors is related to the fact that these relationships help companies to develop or access the necessary capabilities to acquire a competitive advantage.

In T24 (Knowledge networks through the lens of social capital theory), we identified studies that used social capital theory as a lens to analyze knowledge networks. Part of the studies focus on the external perspective of organizations, exploring how the three dimensions of social capital (cognitive, relational, and structural) affect or are affected in interorganizational relationships. Other studies explore the same dimensions in the internal relationships of organizations in creative processes, focusing mainly on aspects related to trust.

In T30 (Rationalized logic and actor-centric ecosystems), we identified studies focused on the cognitive aspects of knowledge processing, often treated as translation logics or rationalized logic. These logics were constantly presented through metaphors or philosophical expressions as a way of translating the dynamics of ecosystems centered on different actors.

3.5.4 Practical contributions

In this perspective, we present the topics that addressed a theme directly linked to contributions to practice. We noticed that the topic becomes hotter as the contribution to the field becomes more specific or tangible. In addition, older themes or themes already extensively explored in the literature appeared as cold topics (T4, T9, and T37). Hot topics. on the other hand, focused on the clear contributions of the relationship between internal and external networks (T27), and collaboration networks focused on innovation and smart cities (T34). Issues focused on sustainability, customer behavior, knowledge diffusion, technology transfer, and stakeholder

engagement appeared in topics T16 and T20, which remained stable over the years in this perspective.

In T4 (Practices to acquire and transfer knowledge), the analyzed studies point to several examples of practices to enable the transfer or sharing of knowledge. These practices, include the use of social platforms, such as intranets, to encourage interaction between employees and companies, both externally or internally.

In T9 (Knowledge network as learning strategy in complex systems), we noted the presentation of studies that evaluated the knowledge networks formed between companies from different perspectives to understand how the exchange of knowledge occurs in complex systems. Some of the studies use actor-based approaches or co-evolutionary perspectives to understand the dynamics and interactions between those involved in a network. Apparently, this theme addresses the network as a strategic source of knowledge for companies to remain competitive. In addition, we observed the existence of studies bringing virtual platforms and environments as a way to promote interaction between network actors in complex systems, enabling greater reach between companies (for example, when accessing companies from other industries and ecosystems).

In T16 (Stakeholder engagement to address sustainability issues), we identified studies that addressed the use of networks as a way of bringing companies together to address sustainable problems, such as climate change. In T20 (Knowledge diffusion and technology transfer focused on digital consumer behavior), we observed the existence of studies focused on the use of platforms and other digital channels classified as information and telecommunication technologies (ICT) in the innovation development processes focused on the consumer behavior of users.

In T27 (Relationship between internal and external knowledge networks), we identified studies that explore the relationship between internal and external networks under different aspects and their respective effects on the results. These studies reinforce that the use of external networks as a source of knowledge is a strategy for solving company innovation problems. Although external networks play an important role in innovation outcomes, some important studies argue that internal networks play a role in that process. Studies started from the analysis of R&D studies or indicators, reflecting the networks between these large companies as objects of analysis.

In T34 (Collaborative innovation networks and smart cities), we identified studies that addressed the use of collaborative innovation networks to develop solutions for smart cities, often with a sustainable focus. We noticed that most of the solutions benefited cities in several aspects,

but there is a predominance of studies that focused on solutions aimed at mobility, transport, and logistics. According to Leminen et al. (2017), cities can benefit from innovation networks by simultaneously exploiting multiple platforms such as living labs for innovation.

In T37 (Knowledge transfer network and industrial development history), we identified studies that brought historical contexts as a way of presenting the scenario of specific sectors of the industry and used innovation networks as an argument or strategy for the industrial development in question. Parsons and Rose (2005), for example, explored both the legacy and the ways in which the networks of innovation functioned as the UK outdoor trade expanded. In another study, Bergquist and Söderholm (2011) argued that an examination of the innovation-system approach used to further the industry's environmental goals reveals that the knowledge and technology development underpinning the project depended on a network of diverse actors.

3.5.5 Structural network aspects

Regarding the structural aspects of the networks, we noticed that there was a predominance of cold topics related to the descriptive characteristics of the networks (T6 and T19). Themes related to the configurations of the organizations, as well as the roles of the actors in the networks, presented themselves as stable (T14, T21, and T31). Networking at the regional level emerged as the only hot topic linked to this perspective (T49).

In T6 (Network structures and characteristics), we identified studies that explore the influence of different structures and characteristics of a firm’s relationships (e.g. size, quality, proximity, stability, and spatial aspects) on innovation generation and performance.

In T14 (Actor's role in innovation networks), we identified studies that address the role of different actors in innovation networks. Despite being part of a network with different actors (e.g. other companies, universities, government, and suppliers), having access to knowledge and resources is not enough for the company to succeed in its objectives related to generating innovation. Authors like Van de Ven (2005) argue that the role of the actor in this network and how knowledge and available resources are used has an influence on these results. For these authors, the actors do not play impartial roles; instead, they are active participants who become embroiled in diverse, partisan, and embedded issues of innovation development (Van de Ven, 2005).

In T19 (Geographic Scope of Knowledge Spillovers), we find studies based on the perspective of networks in terms of geographical structure. In this sense, issues such as distance or proximity between network companies were some of the aspects analyzed in these studies. We observed that the terms agglomeration and cluster were frequently used to analyze social behavior between companies at regional or global levels through a geographic view for the creation and use of knowledge directed to innovation.

In T21 (Organizational unit networks configuration and their knowledge processing), we identified studies that deal with the networks formed by companies and their different business units. The studies argue that the configuration of these networks of organizational units (e.g. distance, similarity, concentration, and dispersion) or idiosyncratic characteristics contained in these businesses (e.g. centralized versus decentralized R&D, specialist or generalist professionals) can influence how knowledge is processed and the expected results, whether they are focused on creativity, innovation performance, or company performance.

In T31 (Levels of organizational configurations in innovation networks and high-tech industry), we observed the approach of different levels of organizational configurations in the midst of networks. Part of these organizational configurations emerged as high and low levels of competences, entrepreneurial micro and macro level influences, higher education investment, and intellectual capital levels. We also noticed that most of the studies are related to the high-tech industry. In T49 (Interorganizational cooperation and regional networks), we identified studies dealing with cooperation between organizations and innovation networks formed at the regional level.

3.5.6 Strategic management level

In this perspective, we brought the topics that addressed themes related to the level of strategic management. We note that, as with the practical contribution perspective, there is heightened interest in studying topics that are more specific and tangible. Topics that addressed more general issues, such as the role of public support (T11), strategic management of networks (T18), capabilities (T26), strategies to manage quality, cost, and risk (T40), and governance mechanism (T47), were identified as cold topics. The hot topics that emerged brought up topics such as R&D partnerships and collaborative network across industries and sectors for innovation

(T42), supply network stability in dynamic environments (T45), and collaborative networks with the triple helix actors (T48). Topics such as R&D internationalization, the knowledge diffusion between local and subsidiary firms (T13), and social networks in healthcare (T50) have remained stable over the years.

In T11 (Regional innovation and the role of public support), we found studies that dealt with the development of innovation at a regional level and how the characteristics of the region influence the generation of innovation by companies inserted in this environment. Part of the studies focused on the role of public policies, government collaboration, and other types of public support to foster innovation at the regional level. For this, the networks were used as a way to understand the dynamics of these regions and how the government could support (or not) the innovation processes. In T13 (R&D internationalization and the knowledge diffusion between local and subsidiary firms), we identified studies focused on the R&D internationalization strategies of multinational companies and how knowledge is disseminated between local companies and their subsidiaries located in other countries.

In T18 (Strategic management of networks and knowledge), we identified studies that dealt with practices and techniques for strategic knowledge management and networks among companies for innovation generation. Some studies have brought the context of product development through R&D departments. Other studies have sought to understand how networks and knowledge management can be managed at a strategic level to reach competitive advantage. In T26 (Capabilities and knowledge networks' role in business innovation model), we identified studies focused on the use of knowledge networks as a strategy for accessing and developing the capabilities necessary for the (re)configuration of the business innovation model.

In T40 (Strategies to manage quality, cost, and risk in knowledge flows and innovation processes), we identified studies that sought to explore strategies to manage the cost, quality, and risks involved in innovation processes and knowledge flows. Authors such as Gupta et al. (2009) state that having knowledge networks external to the organization is a strategy to reduce the obstacles encountered throughout the innovation processes. On the other hand, other researchers bring the challenges of managing issues such as the high costs involved in these networks (since they often arise from the outsourcing of part of the process), risks of diffusion of strategic knowledge, and the impact on the quality of the products. The studies seem to try to balance mainly

the aspects of quality, cost, and risk so that companies can have the maximum advantage in the results without losing the dynamism of innovation and its positioning in the market.

In T42 (R&D partnerships and collaborative network across industries and sectors for innovation), we identified studies on partnerships formed between research and development departments as a strategy to accelerate and improve the product development process. In addition, we also found studies focused on interpersonal relationships generating collaborative networks to influence organizations' creative domains. Other studies have also addressed the behavior behind collaborative work in terms of authorship, exploring for example the impact of collaborator's quality and creativity on the outcomes (i.e. patents).

In T45 (Supply network stability in dynamic environments), we identified studies dealing with problems, solutions and strategies to help supply chain management remain stable and adapt quickly to the dynamics of the environment. Part of the studies brought up situations that forced companies to adapt, such as regulatory changes and the COVID-19 epidemic. Other studies used technology and pro-environmental activities as an argument for networks to make companies more efficient and sustainable, achieving their goals in an innovative way.

In T47 (Governance mechanism in the innovation and knowledge network), we identified studies that deal with governance mechanisms used by companies in knowledge and innovation networks. Although the literature deals more closely with the beneficial side of collaborative networks, studies on this topic bring up the concerns behind information protection and other mechanisms related to trust and social interaction between firms. In T48 (Collaborative networks with the triple helix actors), we identified studies dealing with networks formed with government, university, and industry. In T50 (Social networks in healthcare), we identified studies related to the use of social networks as a theoretical lens or method to explore problems related to the health sector.

3.5.7 Individual and collective level

Regarding the individual and collective levels, we found topics with research focused on exploring the role, characteristics, and behavior of individuals, leadership, and teams in networks. However, we noticed that while topics dealing with the individual level (such as community

members and staff) presented themselves as hot topics (T23, T29, T38, and T43). The themes focused on leadership and teams appeared as cold topics (T39 and T41).

In T23 (Social network brokerage and individual factor behavior), the studies seek to investigate how the characteristics and behavior of the individual factor affect the performance of innovation, as well as its interaction in the network. Research on social networks and innovation emphasizes that individuals spanning structural holes and crossing institutional boundaries have more opportunities for knowledge recombination and innovation involvement (Llopis et al., 2021). Occupying a brokerage network position provides the focal actor with structural opportunities to access non-redundant information and knowledge, which may result in enhanced innovative behavior (Nedkovski & Guerci, 2021). The identified studies seek to investigate how the characteristics and behavior of the individual factor affect the performance of innovation, as well as its interaction in the network.

In T29 (Organizational structures and employees' role in learning networks), we identified studies related to the influence of organizational structure and the role of employees in generating learning through knowledge and innovation networks. Some studies have focused on company assets, from hierarchical organization (e.g. traditional versus cellular) to the use of corporate social networks to encourage the exchange of knowledge. Other studies focused on the role of employees and how different employee profiles act in innovation-oriented learning processes.

In T38 (Online innovation communities and their members' behaviors through social network perspective), we identified studies that used the concept of communities of practice as a way to transfer knowledge among its members and generate innovative results. Due to the context of the digital economy, most studies deal with online or virtual communities and bring, in particular, the scenario of communities formed around open-source software projects. The behavior of the members of these communities, position of the members in the network, the role and formation of leaders in this environment, and the use of online communities as a form of spanning boundaries were other subjects addressed by studies on this topic.

In T39 (Transformational leadership and organizational learning processes in innovation), we found studies that addressed the different mechanisms involved in organizational learning processes towards innovation and how transformational leadership influences these processes. To de Weerd-Nederhof et al. (2002), learning is an essential part of innovation, including the need to internalize and disseminate information and to reduce the duplication of research activities, both

technological and organizational. According to García-Morales et al. (2008), organizations with greater organizational learning generate a network of learning that will make it easier for them to learn what they need to know and to innovate, enabling the organization to maintain its competitive position as a technological center. In some of the analyzed papers, aspects of transformational leadership were explored as a potential influence on these learning processes.

In T41 (Knowledge network influence on team diversity and team creativity), we identified studies related to the networks formed between teams and project organizations as sources of creativity and innovation for companies. According to Kratzer et al. (2010), since the creative product development task requires the teams to combine and integrate input from multiple other teams, the team's structure of interaction is an important determinant of their creativity. In addition, some studies present elements about the influence of team diversity on their creativity. For example, Bodla et al. (2018) explored conditions that leverage the positive and restrain the negative effects of team diversity on team knowledge sharing, which leads to team creativity.

In T43 (Education and professional development focused on innovation and industry's needs), we observed that the studies deal with the proposal or case studies of educational solutions for professional development, with a focus on the needs of industries. For example, Zaccarin and Silvestri (2011) state that universities play an important role in equipping students with suitable skills for developing research and innovation to identify the demand of firms in the sector. Hero, on the other hand, argues that universities play an important role in collaborating with industry, but the projects proposed by these institutions need to benefit student learning, not only the organizations looking for innovations.

3.5.8 Innovation processes

In this perspective, we brought the topics directly linked to innovation processes. We observed that issues related to propositions of practices, activities, and models (often bringing case studies) presented themselves as cold topics (T17, T28, T32, and T36). The topics related to the specific search for the influence of networks on innovation processes (T7) and the evolution of innovation processes from collaborative networks (T46) were presented as hot topics.

In T7 (Network influence in innovation processes), we identified studies focusing on activities related to innovation processes and how knowledge and collaboration networks can affect

their results. Studies often address different types of innovation, stages of the innovative process, and how networks affect the exploration and exploitation of knowledge.

In T17 (Design practices and collaborative product development processes), we identified two complementary groups of articles. The first group included studies focused on the product development process being supported by the networks formed between companies, suppliers, and other actors. In the second group, there are studies that bring different techniques and approaches to the design of new products.

In T28 (Organizational characteristics and ideation networks), we identified studies related to ideation networks as part of innovation processes and how the characteristics of organizations influence these processes. In addition, we observed that part of the studies mention the use of platforms based on web or social media as tools for the exchange of knowledge between collaborators and other actors in the network, becoming the environment where the ideation process (or part of it) takes place.

In T32 (Customer centric innovation and service organizations), we identified studies focused on customer-centric solutions development practices and processes. Due to the degree of customization as a way of adding value to what is being delivered to the customer, these solutions appear in the studies as an innovation. We observed that these solutions are mostly delivered in the form of services, and not necessarily in the form of a tangible product. In this sense, the topic also addresses how organizations providing these services can better understand customer behavior, both for the development of new innovative solutions (services) and for the configuration of their business management strategies.

In T36 (Networking across boundary spanning activities), we identified studies focused on boundary spanning activities to promote interactions at the intra-organizational level in such a way that it can benefit companies' innovation processes. For Huo (2021), for example, knowledge search spanning organizational boundaries is believed to be essential to innovation but is often technologically, geographically, and socially bounded in the inter-firm co-innovation processes. Furthermore, given that spanning any type of boundary may lead to both decreased learning and increased creativity, its influence on co-innovation success remains unclear (Huo, 2021). In T46 (Evolution of innovation processes based on collaborative networks), we identified studies that deal with the evolution of innovation processes and the life cycles of collaboration networks between actors for the development of new solutions.

3.5.9 Size of the firm

In this perspective, we identified aspects related to the size of companies as an unexpected result of the analysis of the topics. Although most of the studies analyze the networks between large companies and institutions such as government and universities, the literature seems to be directed to explore phenomena of smaller companies. We found topics related to small and medium enterprises (T15) and startups (T35). These findings may point to aspects of the networks that work differently for these companies, as they have different challenges compared to multinationals.

In T15 (Networks as a source of competitive advantage for small and medium-sized enterprises), we identified studies that addressed how small and medium-sized companies benefit from networks to gain competitive advantage. Part of the studies argue that networks are strategic for companies of this size because they have different challenges in comparison with large companies and because this is a way to allow them entry into different markets. In addition, other studies argue that networks help small and medium-sized companies to fill their gaps (considering that they are companies with limited resources), especially in terms of coopetition, as they benefit from networks both to cooperate and to compete with other companies.

In T35 (Startups and Investment Networks for Innovation), we identified articles related to the influence of investment networks on startup innovation outcomes. As an investment network, we noticed the presentation of different actors such as universities, venture capital, crowdfunding, and incubators. While some studies argue that these investment networks are useful for providing physical spaces and funds, other studies suggest that entrepreneurs may prefer, for example, incubator collaboration because of business and network knowledge. Although most studies are presented at the organizational level, we observed the existence of studies that explored the characteristics of founders or investors as something that can also influence the innovation results of these startups.

3.5.10 Entrepreneurship

Another unexpected finding was reported in this perspective, which brought up topics related to entrepreneurship. We noticed that themes related to universities and technology parks as

environments that foster entrepreneurship were presented as cold topics (T25). On the other hand, studies that seek to understand how to identify and develop business opportunities through networks emerged as a hot topic for future research (T44).

In T25 (Entrepreneurial universities and science parks spin-offs), we identified studies focused on knowledge networks involving universities and technology parks for technological development. Universities, as providers of knowledge and technology, have a key role in society based on knowledge (Marques et al., 2019). Science parks have been crucial elements of innovation systems both in developed and developing countries because of their role in bridging the gap between academia and business through knowledge spill-overs and spin-offs (Fikirkoca & Saritas, 2012). In this sense, access to academic knowledge and expertise by businesses located on site is a key principle of Science Parks (Lindelof & Lofsten, 2005). Some studies suggest that companies that form networks with universities and technology parks benefit both in terms of technological development and in aspects related to entrepreneurship. Hansson et al. (2005), for example, argue that the new role of science parks may be to cater for the development of the social capital necessary for enabling and facilitating entrepreneurship in networks. Other studies used academic entrepreneurship literature to show how universities can supply support for the development of firm competencies, either directly or indirectly (Rasmussen & Wright, 2015).

In T44 (Entrepreneurial opportunity identification and development through social networks), we identified studies that explored how the characteristics of entrepreneurs and the networks in which they are inserted influence business identification and development. Part of the studies analyzed these networks between entrepreneurs in a broad way, dealing with the characteristics of the entrepreneurial ecosystem and physical spaces (such as coworking spaces). Shu 2018, for example, argues that social networking is increasingly important to entrepreneurs because it can help them to recognize valuable opportunities. In this sense, some other studies were identified dealing with the alertness, personality traits, and interaction mechanisms among entrepreneurs, that precede the identification of a business opportunity. Others argue that these same traits are valid for driving businesses to success.

3.6 FINAL CONSIDERATIONS

We identified 50 topics from studies on knowledge networks and innovation, applying the method of modeling topics in a text corpus containing more than five thousand articles published in the period from January 1985 to December 2021. Among the findings, we identified 21 hot topics, 21 cold topics, and 8 steady topics that may support the direction of future studies.

The results seem to point to studies that seek to explain the phenomena within the context of innovation and knowledge networks in more detail. We noticed that many studies that appear as cold topics addressed issues at a macro level or in a generic way. Matters related to practical problems and clear results were presented as hot topics. The clearest contribution among the topics is precisely the hottest topic: T1 - Firm performance through knowledge networks. This is perhaps the topic that sums up the interest behind all the other topics found in topic modeling. In addition, the interest in studying networks in smaller companies was also a finding that deserves further investigation in future studies, as well as the convergence with the field of entrepreneurship.

Although an attempt has been made to converge the themes, there are opportunities for improvements to be implemented. One possible improvement is an in-depth discussion of the hot and cold topics found and the presentation of propositions that better guide researchers in future studies. Furthermore, research into topics that have not been identified as hot (cold) may suggest recent topics that do not yet have a sufficient volume of publications. In this sense, an analysis of these emerging topics could also bring contributions to research on this topic. Another limitation of this study is the fact that the literature on internal networks and external networks was not disassociated. A complete mapping of all theories used as a lens for both different types of networks was also not provided. Future studies can explore these opportunities and provide further insights for researchers in this field.

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4 STUDY 3

Social Capital, Knowledge Sharing, and Absorptive Capacity as Predictors of Innovation Performance: A Serial Mediation Analysis

Abstract

This paper aims to examine the role of absorptive capacity and knowledge sharing as mechanisms that influence the relationship between interorganizational networks and innovation performance. The partial least squares structural equation modeling approach was applied with data collected from startups in Brazil by survey questionnaire. A total of 162 observations were used to test the hypothesis using both SmartPLS and PROCESS macro. Although the direct influence of knowledge sharing on the innovation performance of startups was not identified, the results point to a mechanism (represented by serial mediation) where knowledge sharing has a positive impact on the absorptive capacity, which in turn influences the company's innovation performance. This study contributes to the expansion of knowledge related to the mechanisms of knowledge flow for the generation of innovation, considering internal and external relationships as sources of knowledge. In addition, we also considered the role of companies' absorptive capacity in this mechanism. We argue that firms that introduce innovations, based on internal and external knowledge, will present a different level of the ability to exploit knowledge because of their absorptive capacities. In addition, knowledge sharing might help the firms to improve their absorptive capacity.

Keywords: Innovation performance; Absorptive capacity; Social capital; Knowledge sharing; Interorganizational networks

4.1 INTRODUCTION

It is already known that a company's ability to keep pace with technological progress and continually innovate is vital to its survival and growth (Cao et al., 2021). However, as the innovation paradigm has changed from being discovery-based to more central learning-based, the way in which knowledge processes are managed within and between firms has emerged as a major theme in recent research (Ramayah et al., 2020). Increasingly, the capacity to apply knowledge to

the innovation process is a critical source of competitive advantage because it plays a critical role in the firm's ability to generate innovations through the transfer and integration of knowledge (Rodríguez et al., 2018).

The knowledge generated must be channeled in specific ways to promote its economic valorization, transforming invention into innovation that is new economically useful knowledge, often connected with new product development (Pinto et al., 2015). Some research has identified effects of external and internal relationships in innovation performance (e.g. Maurer et al., 2011, and Najib & Kiminami, 2011), but the drivers that lead to this outcome are still not clear. In this sense, firms that have the same interorganizational networks to obtain knowledge may present different innovation results, indicating that there may be mechanisms related to the process of absorption and sharing of knowledge that differentiate these companies.

Absorptive capacity can be defined as a dynamic capability that allows companies to acquire and assimilate external knowledge, which must be internally transformed and exploited in order to create competitive advantages (Zahra & George, 2002). Some studies have already pointed out the trade-off between internal and external sources for the development of firms' absorptive capacity, considering that special attention may be needed regarding the relationship between shared knowledge and breadth of knowledge among individuals (Ramayah et al., 2020).

While absorptive capacity can help to explain why a firm’s internal and external relationships impact innovation performance, alternative explanations seem possible considering how these firms are sharing knowledge internally. Knowledge sharing can be defined as “the process where individuals mutually exchange their knowledge and jointly create new knowledge” (Van Den Hooff & Ridder, 2004, p. 118). Although previous studies deliberated the relationship of knowledge sharing and absorptive capacity, such as Balle et al. (2020) and Fernandes Crespo et al. (2021), there is still an opportunity to consider context dimensions, namely, the influence of participation in knowledge sharing networks and partnerships (Balle et al., 2020).

In this sense, social capital theory can be used as a perspective to better understand interorganizational networks. These external organizational networks are conduits that can allow the companies to leverage valuable information, capabilities, knowledge, and other resources possessed by their partners, and further conceptualize the advantage bestowed by internal organizational networks to be a network resource (Liu & Yang, 2019). Social capital provides paths to search for heterogeneous knowledge across firms’ borders, while the knowledge gained can

promote their absorptive capacity and enhance their innovation performance (Lyu et al., 2022). No other studies were found that analyze this knowledge flow through the serial mediation effect of knowledge sharing and absorptive capacity between social capital and innovation performance.

Considering the arguments presented, the aim of the current study is to answer the following question: How do a firm's absorptive capacity and knowledge sharing impact innovation performance in the interorganizational network context? This paper aims to examine the role of absorptive capacity and knowledge sharing as mechanisms that influence the relationship between interorganizational networks and innovation performance. Specifically, the purpose of this paper is twofold; first, to examine the influence of external organizational relationship aspects on innovation performance, and second, to explore the effect of absorptive capacity and knowledge sharing as drivers that lead to different innovation outcomes through serial mediation.

We argue that firms that present better innovation performance, based on internal and external knowledge, demonstrate a different level of ability to exploit knowledge because of their absorptive capacities. In addition, knowledge sharing might help firms to improve their absorptive capacity, resulting in different innovation performances and outcomes. Methodologically, the PLS–SEM approach was applied, with data collected from startups in Brazil using a survey questionnaire. The hypothesis was tested using both SmartPLS and PROCESS macro.

The paper's structure will be presented as follows. The next section of the paper focuses on the theoretical aspects and development of research hypotheses. Section 3 provides a description of the methodological procedures adopted. Sections 4 and 5 address, respectively, the results and discussions from the statistical testing of the hypotheses in a sample of Brazilian startups. The final section presents the implications to theory and practice, in addition to some conclusions and suggestions for future studies.

4.2 THEORETICAL BACKGROUND

In this section, the background and theoretical model that guide the study are presented, based on social capital, absorptive capacity, knowledge sharing, and their relationship with innovation performance.

4.2.1 External Networks toward Innovation Performance

Since being introduced by Coleman (1988), social capital has permeated to firm level (Burt, 1992) and it has been generally acknowledged that a firm establishes diverse interorganizational ties in the course of its activities (Koka & Prescott, 2002). These external organizational networks are a part of social capital for two reasons. First, interorganizational relationships can be seen as conduits of information and generate opportunities for the companies involved; and second, these relationships form a pattern of obligations and expectations that can be advantageous to the companies within the network (Burt, 1992; Koka & Prescott, 2002; Zou et al., 2019). However, it is beneficial to define social capital on the basis of behavior, considering that learning consists of a social component that renders it subject to social capital behaviors (Hughes et al., 2014).

Conceptually, social capital explains the interaction of firms and stakeholders in their social networks considering their context, and provides platforms for the flow of information and knowledge (Lyu et al., 2022). These interactions between firms not only expand the possibilities of access to resources, but also contribute to the expansion of learning capabilities, which can become an advantage for the firm, by improving its ability to use knowledge to develop innovations (Dyer & Singh, 1998; Pucci et al., 2020). Thus, social capital represents the ability of actors to secure benefits by virtue of membership in social networks or other social structures (Solano et al., 2020). However, it is not clear how these relations involving social capital and knowledge work together. Despite there being many empirical models relating social capital and absorptive capacity, these studies are normally interested in testing one or two relations to confirm, or not, a unidirectional hypothesis, without reaching more clarity about how the complete model works, especially comparing different flow possibilities and using verification of serial mediating effects.

Previous research suggested through social capital theory that social networks underlie learning processes used by firms to search for and use new knowledge (Pucci et al., 2020). Unlike human capital, social capital is not contained within individual employees, but includes the value of all the relationships established by firm members inside and outside the organization (Nahapiet & Ghoshal, 1998). These benefits include privileged access to knowledge and information, preferential opportunities, reputation, influence, and enhanced understanding of network norms (Inkpen & Tsang, 2005; Solano et al., 2020). As a result, a learning network stimulates innovation performance, namely new idea generation, creativity, effectiveness in the development of new

processes and products and patenting (Pucci et al., 2020). Hence, if this is true, we argue that it is relevant to more deeply study the role of social capital in the innovation performance, understanding the difference between a direct relation or indirect relation, for instance.

Social capital is a multi-dimensional construct, largely known by three dimensions: structural, relational, and cognitive. The structural dimension reflects networking behaviors that structure the relationships an actor develops, as it refers to the general pattern of connections generated by personal and commercial relationships in terms of density, centrality, connectivity, hierarchy, and network configuration (Ahuja, 2000; Bapuji & Crossan, 2005; Lefebvre et al., 2016; Nahapiet & Ghoshal, 1998; Uzzi, 1996). The relational dimension captures the kind of relations actors have with each other for generating knowledge by leveraging relational assets in the course of company activities, as it refers to assets created and leveraged through relationships based on respect, friendship, trust, norms, sanctions, obligations, and expectations (Bapuji & Crossan, 2005; Coleman, 1988; Nahapiet & Ghoshal, 1998). The cognitive dimension refers to shared representation, interpretations, vision, and systems of meaning among parties, including collective narratives with shared language, codes, and vocabulary (Bapuji & Crossan, 2005; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 2009; Uzzi, 1996).

4.2.2 Absorptive Capacity

In their seminal papers, Cohen and Levinthal consider the absorptive capacity as the "ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 40). More recently, Zahra and George (2002) reconceptualized absorptive capacity as a set of organizational routines and processes by which companies acquire and assimilate knowledge (potential absorptive capacity), and also transform and exploit this knowledge (realized absorptive capacity) to produce a dynamic organizational capability. In general, this organizational capacity represents an essential part of an organization's ability to create new knowledge (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998).

Although definitions vary, the commonality among the definitions of absorptive capacity stems from the importance of knowledge to organizations (Maldonado et al., 2019). According to Cohen and Levinthal (1990), absorptive capacity is fundamental and might increase the user's internal resources to identify, value, assimilate, and exploit external sources of knowledge (Saiz et

al., 2018). Absorptive capacity is proposed as a critical type of dynamic capability that enables a firm to conduct a set of organizational routines by which the firm acquires, assimilates, transforms, and exploits external knowledge, information, and other material resources (Liu & Yang, 2019). Thus, knowledge sources (intra and interorganizational networks) can be important, since firms need to have a high level of accumulated prior knowledge in order to evaluate and exploit new external knowledge (Cohen & Levinthal, 1989).

Firms engaging in collaborations at more basic levels of knowledge need high levels of investment in learning and absorptive capacity to benefit from this venture (de Moraes Silva et al., 2018). A firm's interfirm networks work like a reservoir of external resources, and a firm can exploit network ties as conduits for reaching externally tacit information, knowledge, material resources, and endorsements of allies (Liu & Yang, 2019). Prior studies have shown, from a qualitative point of view, how internal relationships can positively impact performance in knowledge-intensive contexts (Ortiz et al., 2021). Furthermore, some opportunities for research emerge to better explore how a company's absorptive capacity might affect these networks toward innovation.

4.2.3 Knowledge Sharing

External knowledge is not the sole factor on which comprehension of individual innovativeness is based: the structure of knowledge sharing interactions within a company is equally significant (Giudice & Maggioni, 2014). Knowledge sharing is the process of exchanging tacit knowledge through social and collaborative processes (Ali et al., 2018; Nonaka, 1994). It can also be seen as a conveyance activity in which individuals or groups in an organization transmit or diffuse knowledge to other organizational members (Lee et al., 2020).

Other definitions make clear the relevance of knowledge sharing in an organizational environment. Some authors argue that knowledge sharing is a culture of social interaction that involves sharing staff knowledge, work-related thinking, information, solutions, experience, and skills with each other or across departments or organizations (Usmanova et al., 2020). As a result of making available task related information and know-how, coworkers can be supported in a collaborative environment to solve problems, and generate new ideas (Singh et al., 2021).

Knowledge sharing practices are vital for mobilizing the "flow" of knowledge within an organization, which is an essential precursor to knowledge creation and overall organizational learning (Ali et al., 2018). When sharing knowledge, the participating units influence each other's knowledge, facilitating the joint creation of new knowledge (Balle et al., 2020). Knowledge sharing among employees within an organization is critical for developing knowledge specific to the domain of the organization (Bhatti et al., 2021). Thus, it makes sense to argue that knowledge sharing can be an important piece in the mechanism to acquire, assimilate, transform, and exploit knowledge in the form of competitive advantage.

4.2.4 Conceptual Model and Hypothesis

Several authors have stated that the internal and external sources of information and cooperation are complementary and not substitutes (Moura et al., 2020). However, the processes and mechanisms that can make these sources become innovation are still being explored in the literature.

Prior studies argued that the greater the interaction with external knowledge sources, the larger the experiential learning accumulated by an organization in dealing with outside information (Cohen & Levinthal, 1989; Zahra & George, 2002). Other authors indicate that external sourcing of knowledge is associated with business service improvements and new service introductions (Rodríguez et al., 2018), and innovation success (Ben Arfi & Hikkerova, 2021). This might occur because companies with superior social capital can obtain heterogeneous knowledge by establishing tight connections or reaching a consensus with cooperative subjects, stimulating companies to innovation and enhancing their innovation performance (Lyu et al., 2022).

On one hand, it is expected that we could find a direct relation between social capital and innovation performance, however, we also intend to analyze beyond the statistical results. We want to explain if these relations are more intense than others described in the reviewed literature. Considering the three dimensions of social capital (structural, relational, and cognitive) and the concepts involved in this dimension, we could expect a different impact of each dimension on the innovation performance. For instance, the structure of the network (Social Capital, structural dimension) consists of metrics of the resultant firm network in terms of centrality, density, and connectivity, so, it is not clear that different network anatomies can impact on the innovation

performance in direct terms. In this research, we intend to test the complete construct, so we need to declare the first hypothesis as the reference for subsequent comparisons. Thus:

H1 – Social capital positively influences innovation performance.

As argued by Cohen and Levinthal (1990), the capacity to gain and utilize external knowledge is a very significant element in the innovative process. Indeed, the inclusion of knowledge from outside the firm has been found to improve the innovative performance of firms (Ahuja, 2000). Considering that new knowledge is fundamental to innovation, it is necessary that the company has the ability to absorb and transform this knowledge into innovation (Fernandes Crespo et al., 2021). Several studies have shown and highlighted the importance and key role of absorptive capacity in innovation (Cohen & Levinthal, 1990; Ortiz et al., 2021; Solano et al., 2020; Zahra & George, 2002; Zou et al., 2019). Thus, the next hypothesis is:

H2 – Absorptive capacity positively influences innovation performance.

Some authors argued that knowledge sharing behaviors result in positive organizational outcomes, such as innovation performance (Muhammed & Zaim, 2020; Singh et al., 2021). A possible explanation might come from the fact that innovation performance is essentially contingent upon tacit knowledge, so knowledge sharing is the foremost indispensable factor for innovation performance (Nonaka, 1994). Previous research with multinational firms showed that knowledge-sharing activities across the subsidiaries of these firms (Chatterjee et al., 2021), as well as interdepartmentally (Singh et al., 2021) are important for product and process innovation. However, no studies were found that explored this same relationship with small companies, such as startups. Thus:

H3 – Knowledge sharing positively influences innovation performance.

To innovate and compete in a dynamic environment, firms need social capital within their boundaries as a mechanism for the circulation, transfer, and modification of knowledge (Duodu & Rowlinson, 2020). A firm’s intellectual resources (such as social capital), are recognized as an

antecedent of absorptive capacity because these resources enable firms to identify new knowledge in the environment, assimilate it into their boundaries, and combine it with existing knowledge for the generation of new processes, products, and services (W. M. Cohen & Levinthal, 1990; Zahra & George, 2002). Some authors consider social capital as a mechanism for the accumulation, maintenance, and circulation of knowledge, serving to enable the transfer and modification of such knowledge along the different stages of the absorptive process (Duodu & Rowlinson, 2020). On the other hand, absorptive capacity deals with external sources of knowledge that are especially relevant to companies because the exposure of individuals to new knowledge can increase their chance of absorbing it (Fernandes Crespo et al., 2021). In this sense, the next hypothesis is:

H4 – Social capital positively influences absorptive capacity.

Knowledge sharing is important to the collaborative and innovative improvement process of the organization (Lee et al., 2020). While knowledge sharing can be seen as a process, absorptive capacity may be viewed as an organizational competency that enables it to identify, acquire, and leverage relevant knowledge to support the attainment of organizational objectives (Ali et al., 2018). Previous literature shows that knowledge sharing influences absorptive capacity, playing the role of antecedent and explaining part of a company's absorptive capacity (Fernandes Crespo et al., 2021). In this sense, knowledge-sharing practices develop absorptive capacity by creating an enabling environment for knowledge transfer, and developing knowledge stock to the company (Ali et al., 2018). Hence, we formulated the following hypothesis:

H5 – Knowledge sharing positively influences absorptive capacity.

Social capital theory also suggests that knowledge exchange occurs when people have access to others for sharing knowledge, rendering them able to anticipate the value of sharing and motivating them to share their knowledge (Muhammed & Zaim, 2020). Knowledge sharing enables employees to mutually learn new knowledge and expertise from external sources for solving new process problems and for obtaining organizational performance breakthroughs (Lee et al., 2020). Moreover, social capital influences the intrinsic and extrinsic motivations of coworkers to engage in knowledge sharing behaviors (Singh et al., 2021). So it makes sense to argue that:

H6 – Social capital positively influences knowledge sharing.

Firms may also need to develop their absorptive capability to take advantage of knowledge sources to enhance innovation and performance (Duodu & Rowlinson, 2020). As knowledge sources, interorganizational networks provide opportunities to a firm's members to acquire new knowledge, but its impact on organizational performance might depend on the way this knowledge is assimilated and used by the firm (Ortiz et al., 2021). Furthermore, previous research reveals that absorptive capacity plays a mediating effect on the relationship between social capital and firm innovation (Lyu et al., 2022) in other contexts. Thus:

H7 – Absorptive capacity significantly mediates between social capital and innovation performance.

Social capital facilitates knowledge sharing, organizational performance, and innovation (Lefebvre et al., 2016; Singh et al., 2021). The network of social relationships possesses the power to facilitate employee access to critical strategic resources, which ensures that individual employees have relevant information and knowledge to identify organizational problems and develop innovative solutions (Nahapiet & Ghoshal, 1998; Singh et al., 2021). Some authors argue that knowledge sharing among employees within an organization is critical for developing knowledge specific to the domain of the organization (Bhatti et al., 2021). In this sense, knowledge sharing might have an important role in the knowledge flow from social capital to innovation performance. For this reason, the next hypothesis is:

H8 – Knowledge sharing significantly mediates between social capital and innovation performance.

Knowledge and capabilities are considered particularly important resources when determining the degree of inter-firm collaboration (Dyer & Singh, 1998). However, while the sharing of knowledge implies that knowledge resources held by other parties are accessed or mobilized, this is not a sufficient condition for changed performance outcomes (Maurer et al.,

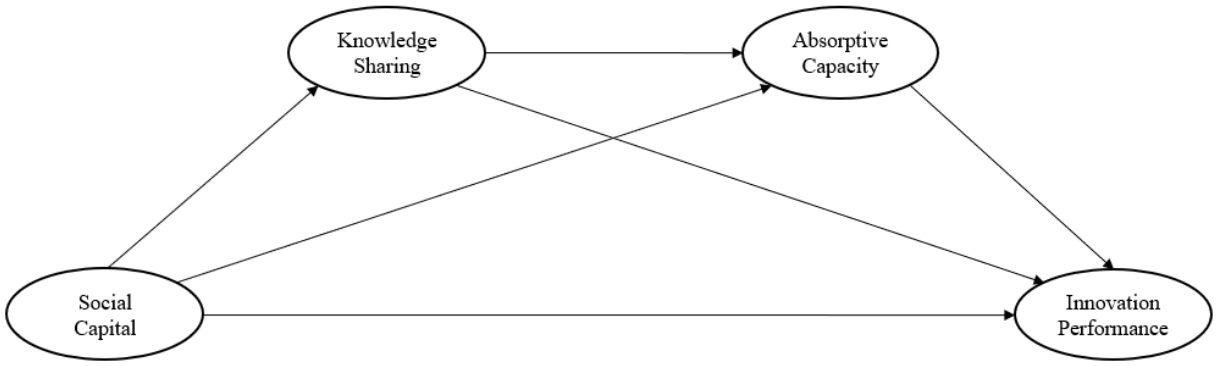
2011). The literature indicates that mechanisms of social integration play an important role in a company's process of external knowledge and the development of absorptive capacity (Ben Arfi & Hikkerova, 2021; Ebers & Maurer, 2014; Zahra & George, 2002).

Recently, Ali et al. (2018) examined the impact of knowledge governance, knowledge sharing, and absorptive capacity on project performance in the context of project-based organizations. The authors found that knowledge governance and knowledge sharing are important antecedents for improving the project's absorptive capacity, which in turn significantly improves project performance. However, the serial effect (double mediation) of knowledge sharing and absorptive capacity was not tested. In addition, their purpose was focused on project performance, opening opportunities to explore the other perspectives of a firm's performance (e.g. business performance and innovation performance). Furthermore, Ali et al. (2018) used social capital theory as a lens to evaluate internal social capital. In this sense, there is the opportunity to advance the literature by analyzing the influence of the external social capital construct. Thus:

H9 – Knowledge sharing, and absorptive capacity operate as a serial mediation between social capital and innovation performance.

Based on the theoretical background above, we proposed the conceptual model that was tested by empirical data (Figure 4.1).

Figure 4.1. Conceptual model.



Note: Only latent variables are presented in this figure.

4.3 METHODOLOGICAL PROCEDURES

This study adopted a quantitative method in which data are collected through a survey. For data collection, we focused on Brazilian startups. The main reason for this was because startups usually have limited resources so they might need support from other organizations in order to get off the ground, to start growing their business, and to solidify their position in the market (Ahmed et al., 2021). In this sense, internal and external knowledge seems to be crucial to fill the resource gaps and achieve the organizational goals.

PLS-SEM is considered a highly robust modeling approach, which is applied in two steps. First, it adopts a threefold approach to ensure the appropriateness of the measurement model,including an assessment of reliability, validity (convergent and discriminant), and model fitness. In sequence, the started model is analyzed to test the hypothesized relationship. Finally, the overall strength and predicted relevance of the model is checked by analyzing the coefficient of determination (R square), blindfolding (Q square), and PLS Predict (Q square predict).

4.3.1 Measures

The instrument for data collection was composed of scales which have previously been used and validated in other studies (see Table 4.1 for the list of items). Measures for the variables of the study included the following: (1) Inter-organizational networks following social capital perspective according to Martínez-Cañas et al. (2012) and Ortiz García Navas et al. (2019); (2) Knowledge Sharing according to Casimir et al., (2012); (3) Innovation Performance according to Al-Jinini et al. (2019); and (4) Absorptive Capacity based on Flatten et al. (2011). In addition, control variables were included in the final instrument. At the end, we proceeded with a reverse translation procedure (English-Brazilian Portuguese-English) to provide the survey in Brazilian Portuguese following the recommendations of Brislin (1986).

Table 4.1. Scales used to construct's measurement.

Construct	Dimension	Reference	Item	
Social Capital	Cognitive	Martínez-Cañas et al. (2012)	SC-1	We share common beliefs for motives, goals, and objectives.
			SC-2	We use a similar language and easily understand other's specific terms.
			SC-3	We make joint decisions to develop and start to use new shared technologies.
	Relational	Martínez-Cañas et al. (2012)	SC-4	We believe that there will not exist opportunistic behavior.
			SC-5	There is trustworthiness for sharing ideas, sentiments, and specific goals with contacts.
			SC-6	Our firm knows and accepts other firms' mission and principles.
	Structural	Ortiz et al. (2018)		My firm usually…
			SC-7	Acquires knowledge from our inter-organizational contacts' network
			SC-8	Personally meets contacts who acquire external knowledge
			SC-9	Maintains narrow interrelationships with contacts who acquire external knowledge
			SC-10	Maintains frequent interrelationships with contacts who acquire external knowledge
			SC-11	(In general) Has contacts who acquire knowledge from among themselves
Knowledge Sharing		Casimir et al. (2012)	KS-1	I willingly share the information I have with colleagues within my department
			KS-2	I voluntarily share my skills with colleagues within my department
			KS-3	When I have learnt something new, I see to it that colleagues outside my department can learn it as well
			KS-4	I willingly share the information I have with colleagues outside my department.
			KS-5	I voluntarily share my skills with colleagues outside my department
Innovation Performance		Al-Jinini et al. (2019)	IP-1	Our company introduces modifications to its existing product or services.
			IP-2	Our company constantly develops new products or services.
			IP-3	The companies' new products and services are often perceived as novel by customers.
			IP-4	In new products and service introductions our company is often first-to-market.
			IP-5	In comparison with the company's competitors, our company has introduced more innovative products and services during the past years.
			IP-6	The company's work processes are constantly updated.
			IP-7	Our company emphasizes on the development of new ways to provide its services.
			IP-8	Our company constantly uses up-to-date technology to enhance products and services.

Absorptive Capacity	Acquisition	Flatten et al. (2011)		Please specify to what extent your company uses external resources to obtain information (e.g., personal networks, consultants, seminars, internet, database, professional journals, academic publications, market research, regulations, and laws concerning environment/technique/health/security):
			AC-1	The search for relevant information concerning our industry is every-day business in our company.
			AC-2	Our management motivates the employees to use information sources within our industry.
			AC-3	Our management expects that the employees deal with information beyond our industry.
	Assimilation	Flatten et al. (2011)		Please rate to what extent the following statements fit the communication structure in your company:
			AC-4	In our company ideas and concepts are communicated cross-departmental.
			AC-5	Our management emphasizes cross-departmental support to solve problems.
			AC-6	In our company there is a quick information flow, e.g., if a business unit obtains important information it communicates this information promptly to all other business units or departments.
			AC-7	Our management demands periodical cross-departmental meetings to interchange new developments, problems, and achievements.
	Transformation	Flatten et al. (2011)		Please specify to what extent the following statements fit the knowledge processing in your company:
			AC-8	Our employees have the ability to structure and to use collected knowledge.
			AC-9	Our employees are used to absorb new knowledge as well as to prepare it for further purposes and to make it available.
			AC-10	Our employees successfully link existing knowledge with new insights.
			AC-11	Our employees are able to apply new knowledge in their practical work.
	Exploitation	Flatten et al. (2011)		Please specify to what extent the following statements fit the commercial exploitation of new knowledge in your company (NB: Please think about all company divisions such as R&D, production, marketing, and accounting):
			AC-12	Our management supports the development of prototypes.
			AC-13	Our company regularly reconsiders technologies and adapts them accordant to new knowledge.
			AC-14	Our company has the ability to work more effective by adopting new technologies.

4.3.2 Data Collection

The data were collected over a period of 3 months between October and December 2021 through an online survey. The online survey was developed using Question Pro, an online survey platform, and was subject to an initial pilot test using a convenience sample of 6 respondents. After making final improvements, the online survey was distributed via LinkedIn, Facebook, and email to professionals from Brazilian startups. A final sample of 162 completed responses was considered for this study. To analyze our research model, Partial Least Squares (PLS) path modeling was performed in SmartPLS 3.0 software.

The research sample included 120 men (74.07%) and 42 women (25.93%). The majority of respondents were between 26-40 years old, in the percentage ratio of 56.79%. A total of 47 respondents had an undergraduate degree, and another 53 had a specialization or MBA, that together totaled 61.72% of the sample. A total of 109 respondents (67.28%) held the position of Manager or a role in an upper echelon position (such as Director, Vice President, President, Owner, or Founder). Approximately half of the sample was characterized by respondents working in startups with up to 20 employees (82 companies, 50.62%). It was also observed that most of the startups from the sample had been operating for up to 8 years (129 companies, 79.63%).

4.3.3 Sample size

Despite falling within the 100–200 case range considered sufficient for PLS-SEM analysis (Chin, 2010), a priori and post-hoc power analyses were performed using the G*Power tool to determine the adequacy of the sample size (Faul et al., 2009). Using the minimum values suggested by Cohen (1988) and Hair Jr. et al. (2017) (an effect size convention of 0.15, a statistical power of 80%, and six predictors considering that the innovation performance construct has the largest number of predictors), the a priori G* Power calculation indicated that a sample size of 98 would be necessary for this study. In addition, the post-hoc G* Power calculation for an effect size convention of 0.15, a sample size of 162, and six predictors indicated that the statistical power achieved using the study's sample size was 0.97. This statistical power is above Cohen's (1988) recommendations, thus justifying the adequacy of our sample size.

4.4 RESULTS

Data analysis was conducted in three parts. The first part focused on establishing the reliability and validity of the data. The second part involved testing the hypotheses. Finally, the third part brings an explanation related to the explanatory and predictive power of the model. The following sections explain these steps in detail.

4.4.1 Reliability and validity

Reliability of the measures was established by evaluating values of Cronbach's alpha (CA), composite reliability (CR), and average variance extracted (AVE) (see Table 4.2). During this process, it was necessary to remove 6 items from the model for having loads lower than what it is recommended in the literature: IP-1 to IP-5, related to innovation performance construct; and STR-1, related to the structural dimension from social capital construct. After this, it was observed that all CA values were well above 0.7, except by relational dimension (.664). Considering the recommendations of Bido and Da Silva (2019), it was decided to keep the 3 items from the relational dimension in the model so as not to harm the content validity. Moreover, all CR values were well above 0.8; thus, it was considered that the current model is acceptable, establishing the reliability of the measures (Hair Jr. et al., 2017).

To establish the convergent validity of the model, Hair Jr. et al. (2017) suggested that the AVE for each construct must be above the minimum threshold of 0.5. Table 4.2 shows that the AVE values are above the required threshold of 0.5 (Fornell & Larcker, 1981; Hair Jr. et al., 2017). Furthermore, the factor loadings of each item kept in the model (reported in Table 4.3) were adequate to establish convergent validity (Hair Jr. et al., 2017).

Discriminant validity of the model was assessed by comparing the square root of AVE and inter-construct correlations (Fornell & Larcker, 1981). To establish discriminant validity, the square root of AVE must be greater than all inter-construct correlations. According to the information provided in Table 4.2, the results are adequate to the Fornell–Larcker criterion (Fornell & Larcker, 1981) for both first and second order variables. Thus, the scales display adequate reliability and validity indices, and we can thus proceed to evaluating the hypotheses.

Table 4.2. Correlation matrix between latent variables (n = 162).

(a) Latent Variables (First order)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Acquisition	**0.814**								
2. Assimilation	0.679	**0.840**							
3. Transformation	0.637	0.635	**0.861**						
4. Exploitation	0.534	0.546	0.577	**0.809**					
5. Cognitive	0.461	0.582	0.531	0.392	**0.830**				
6. Relational	0.472	0.550	0.544	0.359	0.522	**0.775**			
7. Structural	0.531	0.475	0.389	0.409	0.374	0.400	**0.836**		
8. Knowledge Sharing	0.260	0.354	0.395	0.419	0.323	0.315	0.278	**0.830**	
9. Innovation Performance	0.569	0.496	0.495	0.512	0.569	0.529	0.404	0.304	**0.812**
Cronbach's Alpha	0.744	0.860	0.884	0.733	0.780	0.664	0.850	0.886	0.740
rho_A	0.756	0.864	0.894	0.740	0.827	0.677	0.857	0.888	0.741
Composite Reliability (CR)	0.854	0.905	0.920	0.850	0.869	0.818	0.894	0.917	0.852
Average Variance Extracted (AVE)	0.662	0.705	0.742	0.654	0.689	0.601	0.629	0.688	0.659

(b) Latent Variables (Structural model)	**1**	**2**	**3**	**4**
1. Absorptive Capacity	**0.860**			
3. Social Capital	0.725	**0.781**		
4. Knowledge Sharing	0.426	0.278	**0.830**	
5. Innovation Performance	0.608	0.627	0.304	**0.812**
Cronbach's Alpha	0.919	0.846	0.886	0.740
rho_A	0.924	0.854	0.888	0.741
Composite Reliability (CR)	0.931	0.877	0.917	0.852
Average Variance Extracted (AVE)	0.739	0.610	0.688	0.659

Note: The diagonal values are the square root of the AVE; All correlations are significant at 1%; Absorptive Capacity and Social Capital are second-order variables.

Table 4.3. Factor loadings of indicators (first-order crossloading) (n = 162).

Variables	Acquisition	Assimilation	Transformation	Exploitation	Cognitive	Relational	Structural	Knowledge Sharing	Innovation Performance
ACQ-1	**0.758**	0.522	0.420	0.430	0.375	0.272	0.382	0.225	0.425
ACQ-2	**0.859**	0.616	0.616	0.426	0.422	0.503	0.480	0.238	0.488
ACQ-3	**0.821**	0.512	0.500	0.453	0.324	0.356	0.429	0.171	0.475
ASS-1	0.586	**0.887**	0.599	0.454	0.561	0.472	0.413	0.329	0.420
ASS-2	0.538	**0.840**	0.513	0.447	0.410	0.517	0.438	0.380	0.413
ASS-3	0.602	**0.858**	0.567	0.547	0.469	0.474	0.384	0.260	0.442
ASS-4	0.553	**0.769**	0.440	0.377	0.517	0.379	0.361	0.216	0.389
TRA-1	0.581	0.618	**0.896**	0.505	0.506	0.495	0.373	0.406	0.501
TRA-2	0.614	0.593	**0.899**	0.526	0.462	0.453	0.365	0.353	0.437
TRA-3	0.568	0.577	**0.851**	0.512	0.518	0.439	0.362	0.267	0.432
TRA-4	0.406	0.362	**0.795**	0.440	0.318	0.498	0.218	0.337	0.314
EXP-1	0.356	0.419	0.478	**0.730**	0.248	0.260	0.309	0.398	0.299
EXP-2	0.449	0.461	0.464	**0.841**	0.391	0.297	0.272	0.301	0.459
EXP-3	0.484	0.445	0.462	**0.850**	0.307	0.311	0.409	0.325	0.472
COG-1	0.447	0.534	0.512	0.372	**0.879**	0.413	0.373	0.294	0.480
COG-2	0.191	0.294	0.261	0.227	**0.737**	0.282	0.199	0.149	0.312
COG-3	0.442	0.558	0.489	0.348	**0.866**	0.555	0.323	0.321	0.573
REL-1	0.324	0.476	0.424	0.280	0.435	**0.779**	0.271	0.286	0.351
REL-2	0.444	0.446	0.476	0.263	0.432	**0.852**	0.315	0.232	0.469
REL-3	0.323	0.351	0.358	0.298	0.343	**0.687**	0.316	0.216	0.408
STR-2	0.428	0.413	0.396	0.343	0.393	0.331	**0.830**	0.295	0.394
STR-3	0.455	0.412	0.294	0.348	0.282	0.339	**0.896**	0.265	0.291
STR-4	0.363	0.234	0.229	0.263	0.192	0.235	**0.810**	0.109	0.260
STR-5	0.504	0.478	0.349	0.389	0.342	0.360	**0.803**	0.225	0.377
KS-1	0.197	0.261	0.387	0.292	0.280	0.355	0.238	**0.770**	0.224
KS-2	0.199	0.227	0.269	0.348	0.234	0.264	0.253	**0.853**	0.310
KS-3	0.242	0.332	0.356	0.384	0.332	0.142	0.265	**0.838**	0.296
KS-4	0.207	0.307	0.284	0.288	0.239	0.321	0.209	**0.830**	0.203
KS-5	0.228	0.334	0.332	0.415	0.245	0.236	0.186	**0.854**	0.226
IP-6	0.480	0.413	0.435	0.301	0.484	0.440	0.328	0.228	**0.810**
IP-7	0.476	0.447	0.379	0.407	0.506	0.416	0.359	0.219	**0.853**
IP-8	0.430	0.345	0.392	0.540	0.392	0.432	0.295	0.294	**0.769**

4.4.2 The Explanatory and Predictive Power of the Model

The value of the coefficient of determination (R square) can be defined as a common measure used to evaluate a structural model, representing the combined effects of all independent variables on the dependent variables. In other words, R square is calculated to determine the explanatory power of the research framework, representing the coefficient of how well the values fit compared to the original values. Some authors argue that the standardized value of R square is 10% (Falk & Miller, 1992). The adjusted R square is also a measure used to evaluate the adequacy of the model's explanation but adjusted for the number of terms in a model.

It is important to highlight that the value of R square only assesses the explanatory power of a model, not being an indicator capable of predicting the values of new cases not included in the estimation process. Researchers agree that assessing the out-of-sample predictive power of a model involves estimating the model in a training (analysis) sample and evaluating its predictive performance on data other than the training sample (Shmueli et al., 2016). Another metric frequently used to assess the predictive quality of the model is the Q square value from the blindfolding procedure (Chin, 1998). Blindfolding omits single data points from the sample, replacing them with, for example, average values to estimate the PLS path model. Table 4.4 presents the R square, R square adjusted, and Q square values related to the constructs explored in this study. Thus, it can be considered that the values presented are adequate with what is practiced in the literature.

Table 4.4. R square, R square adjusted, and Q square values.

Latent Variables	R Square	R Square Adjusted	Q^2
Absorptive Capacity	0.547	0.542	0.260
Knowledge Sharing	0.148	0.143	0.095
Innovation Performance	0.444	0.434	0.270

As the Q square value is not based on validation samples but on single omitted and imputed data points, this metric is a combination of in-sample and out-of-sample prediction, without clearly indicating whether the model has a good explanatory fit or exhibits predictive power (Shmueli et al., 2019). Contrary to the standard structural model evaluation metrics such as the R square and Q square, Shmueli et al. (2019) suggest PLS Predict, a technique that offers a means of assessing a

model's out-of-sample predictive power (i.e. a model's accuracy when predicting the outcome value of new cases). In addition, the authors suggest a calculation procedure for predictive relevance of the research model specifically designed for PLS-SEM prediction-oriented studies (see Shmueli et al., 2019 for a detailed explanation of the technique).

After evaluating the R square, R square adjusted, and Q square values, we proceeded with the PLS Predict analysis as recommended by Shmueli et al., 2019. We performed the PLS Predict test using the default settings (10 repetitions and 10 folds), to asses the PLS-SEM Q square predict value for all indicators of the model and their respective prediction statistics. In addition, MAE (Mean Absolute Error) and RMSE (Root Mean Squared Error) are reported to discuss the prediction error distribution of the analysis, as well as the difference between these two metrics.

Examining the prediction error distribution not only offers guidance regarding the choice of the best prediction statistic (i.e. MAE in the case of highly non-symmetric errors, and RMSE in other cases), but also provides evidence of systematic biases (Shmueli et al., 2019). The MAE measures the average absolute differences between the predictions and the actual observations, with all the individual differences having equal weight. The RMSE is the square root of the average of the squared differences between the predictions and the actual observations. Both metrics depend on the scaling of the manifested variables. As the RMSE squares the errors before averaging, the statistic assigns a greater weight to larger errors, which makes it particularly useful when large errors are undesirable and generally the preferred "default" (Shmueli et al., 2019).

Table 4.5 considers the values of the Q square predict based on the predictions of the PLS-SEM (which considers the entire structural model) and based on the predictions of the linear regression (LM) model. The predictive power of the PLS path model should be at least equal to that of the LM, with larger improvements demonstrating increasing predictive power (Danks & Ray, 2018). We focus our analysis on the model's key target construct innovation performance, but also report the prediction statistics of all the other endogenous construct indicators.

To interpret the results, it is necessary to check if the Q square predict is higher than 0 to confirm predictive relevance and then observe the prediction error distribution for the construct items. If the PLS-LM of fewer or minority items is smaller, it identifies a low predictive power; if the PLS-LM of all items is higher it refers to no predictive power; and if the value of PLS-LM of all items is lower, it refers to a greater or higher predictive power (Shmueli et al., 2019). Considering that the results in Table 4.5 present a Q square predict > 0, and PLS-SEM values are

higher than LM values for all innovation performance indicators, we observed that this model has high predictive power. Moreover, this study recognizes that the Q square of innovation performance is 0.270, absorptive capacity is 0.260, and knowledge sharing is 0.095, which is higher than zero, and demonstrates greater predictive power at the construct level.

Table 4.5. PLS-Predict.

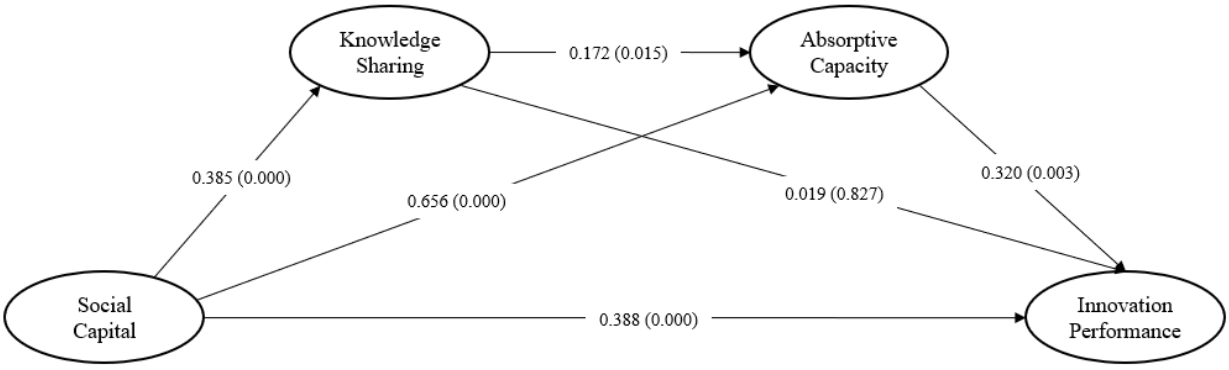
	PLS			**LM**			**PLS-LM**		
	RMSE	**MAE**	**Q^2_predict**	**RMSE**	**MAE**	**Q^2_predict**	**RMSE**	**MAE**	**Q^2_predict**
ACQ-1	0.986	0.726	0.186	1.025	0.751	0.120	-0.039	-0.025	0.066
ACQ-2	1.116	0.826	0.336	1.149	0.846	0.296	-0.033	-0.020	0.040
ACQ-3	1.189	0.920	0.213	1.244	0.964	0.138	-0.055	-0.044	0.075
ASS-1	1.150	0.888	0.353	1.170	0.906	0.330	-0.020	-0.018	0.023
ASS-2	1.163	0.852	0.313	1.206	0.889	0.261	-0.043	-0.037	0.052
ASS-3	1.336	1.023	0.292	1.384	1.035	0.240	-0.048	-0.012	0.052
ASS-4	1.366	1.046	0.266	1.337	1.002	0.296	0.029	0.044	-0.030
TRA-1	1.051	0.789	0.308	1.103	0.815	0.237	-0.052	-0.026	0.071
TRA-2	0.998	0.758	0.269	1.042	0.811	0.202	-0.044	-0.053	0.067
TRA-3	1.074	0.822	0.290	1.145	0.869	0.192	-0.071	-0.047	0.098
TRA-4	0.957	0.736	0.159	0.951	0.726	0.168	0.006	0.010	-0.009
EXP-1	1.228	0.891	0.105	1.288	0.919	0.016	-0.060	-0.028	0.089
EXP-2	0.925	0.721	0.149	0.966	0.758	0.072	-0.041	-0.037	0.077
EXP-3	0.943	0.741	0.187	1.004	0.783	0.078	-0.061	-0.042	0.109
KS-1	0.754	0.558	0.111	0.810	0.565	-0.026	-0.056	-0.007	0.137
KS-2	0.613	0.494	0.086	0.645	0.514	-0.013	-0.032	-0.020	0.099
KS-3	0.810	0.606	0.090	0.847	0.629	0.007	-0.037	-0.023	0.083
KS-4	0.815	0.615	0.092	0.855	0.651	0.002	-0.040	-0.036	0.090
KS-5	0.907	0.672	0.064	0.973	0.709	-0.077	-0.066	-0.037	0.141
IP-6	1.210	0.945	0.257	1.234	0.971	0.227	-0.024	-0.026	0.030
IP-7	1.057	0.749	0.273	1.121	0.790	0.182	-0.064	-0.041	0.091
IP-8	1.134	0.873	0.201	1.175	0.920	0.144	-0.041	-0.047	0.057

Caption: PLS = Partial Least Squares, LM = Linear regression Model, RMSE = Root Mean Squared Error, MAE = Mean Absolute Error

4.4.3 Hypothesis Tests

After checking the reliability and validity measures, the hypotheses tests were conducted using bootstrapping with 5,000 resamples (Chin, 1998) on SmartPLS 3.0 to ensure that the significance values could be ascertained using PLS-SEM. According to Preacher et al. (2007), bootstrap tests are nonparametric simulations, and are an efficient and reliable approach to evaluate the indirect effects for mediation and moderation models. The main characteristic of this test is that it does not depend on the normality assumption, as it is also suitable for smaller sample sizes (Hair Jr. et al., 2017; Pardo & Román, 2013). Figure 4.2 shows the path coefficients and significance level of the endogenous variable.

Figure 4.2. Results of PLS-SEM.



The results of the structural model hypotheses testing (direct effects) are presented in Table 4.6. The results show that social capital (0.388, $p<0.05$) and absorptive capacity (0.320, $p<0.05$) have a direct positive effect on innovation performance, confirming hypotheses 1 and 2. However, the direct effect of knowledge sharing on innovation performance was not significant, which causes hypothesis 3 to be rejected (0.019, $p>0.05$). Furthermore, the results make it clear that social capital (0.656, $p<0.05$) and knowledge sharing (0.172, $p<0.05$) influence the absorptive capacity of the studied startups, supporting hypotheses 4 and 5. Finally, social capital had a significant direct effect on knowledge sharing (0.385, $p<0.05$), demonstrating acceptance of hypothesis 6.

Table 4.6. Structural model results (n = 162).

Hypothesis	Paths	Coefficient	t-value	p-value	Standard Error	BCI LL	BCI UL	f^2	VIF	Decision
H1 (+)	SC -> IP	0.388	4.467	0.000	0.087	0.220	0.557	0.128	2.125	Supported
H2 (+)	AC -> IP	0.320	2.953	0.003	0.108	0.108	0.528	0.083	2.209	Supported
H3 (+)	KS -> IP	0.019	0.219	0.827	0.087	-0.136	0.195	0.001	1.239	Not Supported
H4 (+)	SC -> AC	0.656	11.209	0.000	0.059	0.534	0.765	0.810	1.174	Supported
H5 (+)	KS -> AC	0.172	2.431	0.015	0.071	0.037	0.313	0.056	1.174	Supported
H6 (+)	SC -> KS	0.385	6.283	0.000	0.061	0.266	0.508	0.174	1.000	Supported

Caption: f^2 = Cohen effect size (1988), VIF = Variance Inflation Factor, BCI LL = Bias-Corrected Confidence Interval Low Limit, BCI UL = Bias-Corrected Confidence Interval Upper Limit.

Legend: SC = Social Capital, AC = Absorptive Capacity, KS = Knowledge Sharing, IP = Innovation Performance

4.4.4 Mediating Analysis

The mediating effect was analyzed using PROCESS macro (Model 6) with 5000 bias corrected bootstraps (Hayes & Scharkow, 2013). Recent studies discussed the use of SmartPLS and PROCESS macro (see Hair, 2019). Unlike the protocol recommended for this type of analysis in SmartPLS (Carrión et al., 2017; Hair Jr. et al., 2017), the calculations necessary for the analysis of complex effects of models such as mediation are performed automatically by the PROCESS macro algorithm. In addition, this approach allows the examination of the indirect effect simultaneously through up to four parallel mediators and provides pairwise comparisons between the proposed indirect effects (Hayes & Scharkow, 2013). For these reasons, it was decided to proceed using Hayes and Scharkow's protocol for PROCESS macro to evaluate the mediating tests, as well as providing the results calculated through the SmartPLS' protocol as recommended by Carrión et al. (2017). We present the results by the two protocols in order to contribute to the methodological practices related to this type of analysis and to the debate related to the use of these two tools.

The results of the mediating hypotheses testing (indirect effects) provided by PROCESS macro are presented in Table 4.7. Previous research showed that the use of a bias-corrected bootstrap confidence interval is the best approach for identification of mediation effects (Hayes & Scharkow, 2013). Thus, the bias-corrected bootstrap confidence interval was calculated considering the confidence interval in the lower level of 5% and the upper level of 95%.

Table 4.7. Mediating analysis results (Hayes and Scharkow's PROCESS macro).

Paths	Effect	SE	BCI LL	BCI UL
Model 1: SC -> KS -> IP	0.007	0.033	-0.051	0.080
Model 2: SC -> AC -> IP	0.210	0.074	0.103	0.381
Model 3: SC -> KS -> AC -> IP	0.021	0.012	0.003	0.048
Total indirect effect	0.239	0.070	0.103	0.379
Contrasts:				
Model 1 versus Model 2	-0.203	0.094	-0.387	-0.021
Model 1 versus Model 3	-0.014	0.037	-0.082	0.064
Model 2 versus Model 3	0.189	0.072	0.061	0.338
R squared	0.393			

Caption: SE = Standard Error, BCI LL = Bias-Corrected Confidence Interval Low Limit, BCI UL = Bias-Corrected Confidence Interval Upper Limit.
Legend: SC = Social Capital, AC = Absorptive Capacity, KS = Knowledge Sharing, IP = Innovation Performance

The result indicates that the indirect effect of social capital on innovation performance with the presence of absorptive capacity as a mediator is significant at p<.05, where the lower level confidence level (BCI LL) is 0.103, and the upper level confidence level (BCI LL) is 0.381. This result supports model 1 presented in hypothesis 8. However, no significant effect of knowledge sharing was found in the relationship of social capital and innovation performance (Effect 0.007, SE = 0.074, 95% BCI [-0.051, 0.080]). In this sense, model 2 presented in hypothesis 7 was not supported.

The results also sustained the serial mediating effect (Effect = 0.021, SE = 0.012, 95% CI [0.003, 0.048]), supporting model 3 presented in hypothesis 9. In the sequence, pairwise comparisons were conducted among the three indirect effects to test whether they exerted equal impacts on the association between knowledge sharing and absorptive capacity (see Table 7). The results indicated that the indirect effect of social capital on innovation performance through absorptive capacity was significantly greater than the indirect effect through knowledge sharing (Effect = 0.210, SE = 0.074, 95% CI [0.103, 0.381]), which was greater than the serial mediating effect.

Results calculated through the SmartPLS protocol are presented in Table 4.8. Models 1 to 3 presented the same effect and significance level when evaluated by both protocols. Model 1 did not achieve a significant level and did not support hypothesis 7. Models 2 and 3 are statistically significant and supported hypotheses 8 and 9.

Table 4.8. Mediating analysis results (SmartPLS' protocol).

Paths	Original (O)	Mean (M)	Bias (O - M)	CI LL	CI UL	BCI LL	BCI UL	VAF
Model 1: SC -> KS -> IP	0.007	0.010	-0.002	-0.042	0.070	-0.044	0.068	1.85%
Model 2: SC -> AC -> IP	0.210	0.208	0.002	0.086	0.337	0.088	0.339	35.11%
Model 3: SC -> KS -> AC -> IP	0.021	0.021	0.000	0.005	0.043	0.005	0.043	5.18%
Total indirect effect	0.238	0.361	-0.123	0.120	0.359	-0.003	0.236	38.06%
Contrasts:								
Model 1 versus Model 2	-0.203	-0.199	-0.004	-0.128	-0.267	-0.132	-0.271	
Model 1 versus Model 3	-0.014	-0.012	-0.002	-0.047	0.027	-0.049	0.025	
Model 2 versus Model 3	0.189	0.187	0.002	0.081	0.294	0.083	0.296	

Caption: SE = Standard Error, BCI LL = Bias-Corrected Confidence Interval Low Limit, BCI UL = Bias-Corrected Confidence Interval Upper Limit.
Legend: SC = Social Capital, AC = Absorptive Capacity, KS = Knowledge Sharing, IP = Innovation Performance

Although the effect of knowledge sharing as a mediating variable in the relationship between social capital and innovation performance has not been confirmed, models 4 and 5 were tested to complement the analysis and reinforce that knowledge sharing has an effect through a firm's absorptive capacity. Model 4 was developed to test the relationship between social capital and absorptive capacity considering knowledge sharing as a mediator. Model 5 intended to test the effect of absorptive capacity as a mediator between knowledge sharing and innovation performance. The results from the Hayes' Process macro are presented in Table 4.9, and the SmartPLS protocol results for these same models are reported in Table 4.10.

Table 4.9. Results regarding models 4 and 5 (Hayes and Scharkow's PROCESS macro).

Paths	Effect	SE	BCI LL	BCI UL
Model 4: SC -> KS -> AC	0.066	0.029	0.015	0.132
Model 5: KS -> AC -> IP	0.248	0.050	0.156	0.354

Table 4.10. Results regarding models 4 and 5 (SmartPLS' protocol).

Paths	Original (O)	Mean (M)	Bias (O - M)	CI LL	CI UL	BCI LL	BCI UL	VAF
Model 4: SC -> KS -> AC	0.066	0.067	-0.001	0.022	0.122	0.021	0.120	14.58%
Model 5: KS -> AC -> IP	0.055	0.055	0.000	0.013	0.109	0.013	0.109	12.42%

4.5 DISCUSSIONS

This paper aims to examine the role of absorptive capacity and knowledge sharing mechanisms that influence the relationship between interorganizational networks and innovation performance. To this end, a sample of 162 observations collected from startup professionals was analyzed using structural equation modeling (PLS-SEM). The hypothesis tests were performed using both SmartPLS and the PROCESS macro.

The results validate some findings discussed in the literature in recent years. For example, the results confirm that social capital has a positive effect on knowledge sharing, absorptive capacity, and innovation performance. The direct effect of absorptive capacity on innovation performance was also observed. Previous studies explored the role of absorptive capacity as a

mediator in the relationship between social capital and innovation performance. Recent research has begun to discuss the role of knowledge sharing in relation to absorptive capacity. All these relationships were examined in the current study and corroborate the findings discussed in the literature.

The conceptual model proposed in this study seeks to contribute to the proposed mechanism (or flow) of knowledge through networks that are internal and external to organizations (in this case, startups). Our results demonstrate that social capital and knowledge sharing can be considered as lenses for knowledge sources that function as antecedents of absorptive capacity, corroborating and contributing with Zahra and George's model. Although some authors argue that knowledge sharing can generate better innovation performance, the results show that this does not occur directly. Social capital and knowledge sharing play an important role in the flow of organizational knowledge, as they act as antecedents of absorptive capacity, influencing innovation performance in a causal way, as demonstrated in hypothesis 9 through serial mediation.

4.6 FINAL CONSIDERATIONS

This study sought to contribute to the theoretical gap related to the mechanisms (or flow) of knowledge at the organizational level. Therefore, the objective of the study was to examine the role of absorptive capacity and knowledge sharing in the mechanisms that influence the relationship between interorganizational networks and innovation performance. A survey was carried out and the data were analyzed using the PLS-SEM and PROCESS macro. The results show that social capital and knowledge sharing act as antecedents of absorptive capacity to influence the innovation performance of companies. In addition, there is a flow of knowledge through external networks (analyzed through the lens of social capital) and internal networks (analyzed from the perspective of knowledge sharing) that impact innovation performance through absorptive capacity. This relationship was analyzed through serial mediation, showing that this mechanism works in a causal way.

The current study has limitations and opportunities for future research. First, the data were collected from startup professionals from Brazil only. Other studies can explore the proposed model based on the reality of other countries. Second, this study explored the conceptual model only at the construct level. Other researchers can analyze the model from the level of the dimensions of social capital and absorptive capacity. In addition, it was observed that the effects

of knowledge sharing were relatively smaller in relation to the effects found in the other constructs. Future studies can explore how knowledge sharing affects, in particular, the different dimensions of absorptive capacity, contributing to recent discussions on this topic.

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5 FINAL CONSIDERATIONS

The main research question defined for this dissertation was: How do a firm's absorptive capacity and the knowledge obtained by internal and external networks impact innovation performance? To answer this question, I developed three sequential studies; two literature review studies (a bibliometric study and a topic modeling study) and an empirical study (survey study). The summary of results, contributions, limitations, and proposals for future studies related to each study are presented in the Contribution Matrix of Mooring (Figure 5.1).

At the end of the three studies, I conclude that external networks (social capital) positively impact the innovation performance of companies. Absorptive capacity plays a mediating role, being responsible for part of the effect identified between social capital and innovation performance. Although internal networks (knowledge sharing) did not have a significant effect on innovation performance, I identified their influence on absorptive capacity. I have shown (through the results of study 3 tested through serial mediation) that when knowledge acquired from external networks is shared within the company, there is a positive effect on absorptive capacity which, in turn, influences innovation performance. This mechanism answers the main research question of this dissertation.

From the three studies that make up this dissertation, as well as opportunities for future studies, some reflections emerge. Figure 5.2 is an attempt to make these reflections tangible, in addition to the paths that can continue to contribute to the literature on absorptive capacity based on the conceptual model of Zahra and George (2002). It should be noted that these reflections are insights, and it is valid to carry out a further investigation into the state of the art of each theme to find out what has already been studied by other researchers in this sense.

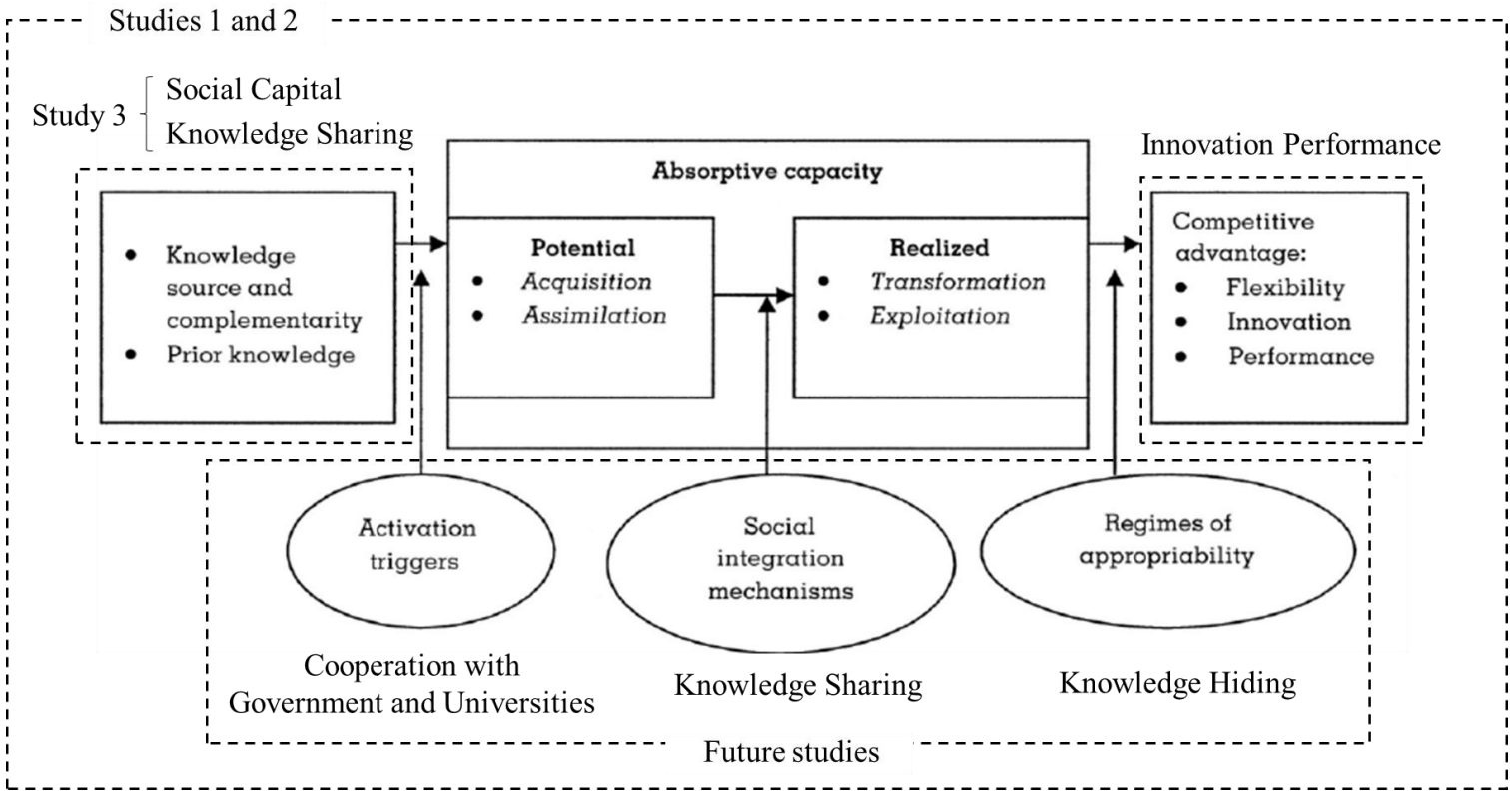
Figure 5.1. Contribution Matrix of Mooring

CENTRAL RESEARCH QUESTION How do firms' absorptive capacity and the knowledge obtained by internal and external networks impact innovation performance?				
GENERAL OBJECTIVE To explore the role of absorptive capacity and internal and external organizational networks in companies' innovation performance.				
PARTICULAR CONCLUSION At the end of the three studies, I conclude that external networks (social capital) positively impact the innovation performance of companies. Absorptive capacity plays a mediating role, being responsible for part of the effect identified between social capital and innovation performance. Although internal networks (knowledge sharing) did not have a significant effect on innovation performance, I identified their influence on absorptive capacity. I have shown (through the results of study 3 tested through serial mediation) that when knowledge acquired from external networks is shared within the company, there is a positive effect on absorptive capacity which, in turn, influences innovation performance.				
	Summary of results	Contributions to the advancement of knowledge	Limitations	Proposal for future studies
Study 1	The coupling analysis resulted in six factors showing the trends of future studies. The co-citation analysis presented three factors, representing the intellectual structure arising from the coupling analysis.	The results point to trends in future studies that can fill the research gaps on absorptive capacity and innovation. In addition, we also indicate the theoretical fronts that can be used to explore these trends. Finally, we present a model that summarizes our findings and shows how they can contribute to the advancement of research based on the seminal model of Zahra and George (2002).	The choice of databases (Scopus and Web of Science) covers a large volume of journals and articles; however, it is known that these databases do not contain one hundred percent of publications on this topic. Other researchers could make use of other databases to perform further analyses.	There is openness for future studies to complement this results with new content analyses or through conduction of an in-depth review of the publications identified in the factors of co-citation, coupling, and network analysis. Also, other researchers may explore each of the factors found explicitly through systematic reviews of the literature or other methods to understand better each of the themes found.
Study 2	It was explored topic trends over the years, identifying 21 hot topics, 21 cold topics, and 8 steady topics that could help drive future studies on knowledge and innovation networks.	The results seem to point to studies that seek to explain the phenomena within the context of innovation and knowledge networks in more detail. We noticed that many studies that appear as cold topics addressed issues at a macro level or in a generic way. Matters related to practical problems and clear results were presented as hot topics.	There are opportunities to realize an in-depth discussion of the hot and cold topics found and the presentation of propositions that better guide researchers in future studies. Another limitation of this study is the fact that the literature on internal networks and external networks was not disassociated. A complete mapping of all theories used as a lens for both different types of networks was also not provided.	Future studies can explore these opportunities from the limitations to realize an in-depth discussion of the trend topics, and provide propositions to provide further insights for researchers in this field. Also, mapping the theories and disassociate intenal (external) networks might be other studies opportunities.

Study 3	Although the direct influence of knowledge sharing on the innovation performance of startups was not identified, the results point to a mechanism (represented by serial mediation) where knowledge sharing has a positive impact on the absorptive capacity, which in turn influences the company's innovation performance.	This study contributes to the expansion of knowledge related to the mechanisms of knowledge flow for the generation of innovation, considering internal and external relationships as sources of knowledge. In addition, we also considered the role of companies' absorptive capacity in this mechanism.	The data were collected from startup professionals from Brazil only. Also, this study explored the conceptual model only at the construct level. In the results, it was observed that the effects of knowledge sharing were relatively smaller in relation to the effects found in the other constructs, but no answer was found for that in the construct level.	Other researchers can explore the proposed model based on the reality of other countriesand analyze the model from the level of the dimensions of social capital and absorptive capacity. Future studies can explore how knowledge sharing affects, in particular, the different dimensions of absorptive capacity, contributing to recent discussions on this topic.
INTEGRATING CONCLUSION The three studies contribute to the conceptual model of absorptive capacity proposed by Zahra and George. Possibilities for future studies emerged from the results of these studies, suggesting other lenses and perspectives for understanding the knowledge mechanism for generating innovation in companies.				

Source: Adapted by the author from Da Costa, Ramos, and Pedron (2019).

Figure 5.2. Dissertation's contributions to the absorptive capacity model from Zahra and George (2002) and suggestions for future studies



Source: The author, based on Zahra and George (2002) and dissertation's results.

The first reflection is related to how the studies contribute to the literature on absorptive capacity. At the end of study 1, I indicate how the results contribute to the conceptual model of absorptive capacity proposed by Zahra and George (2002). However, the other two studies also seem to contribute to the literature to explore this same seminal model.

In general, studies 1 and 2 contribute as literature reviews, suggesting themes and theoretical lenses that can help to expand knowledge about absorptive capacity (both the model as a whole and specific parts of the model). Although the factors and research topics found in these studies can point out some directions, more in-depth study is needed to explore the research gaps in each identified subject. Studies of a meta-analytic nature could be an alternative to aid mapping of the state of the art of the subject to be studied and, thus, present more clearly what has not yet been explored.

As explained earlier, study 1 presents factors related to opportunities for future studies based on the field of absorptive capacity and, for the purposes of this dissertation, I chose to continue with the first factor: interorganizational knowledge networks. From this factor, I developed study 2, focused on knowledge networks and innovation. Study 2 provides 50 topics that, in addition to contributing to the theoretical framework of Study 3, also provide a range of research paths. When comparing the results of these two theoretical studies, we observed that there are some issues that converge. For example, both studies presented themes related to the development of human resources, structural aspects of alliances and networks formed by entrepreneurs. Thus, I understand that these studies provide relevant directions in their respective fields, as well as which, the intersection between their results can generate insights that, if combined, can fill gaps in both themes in the literature.

Perhaps because of its empirical nature, study 3 seems to contribute to the absorptive capacity model in a more specific and explicit way. By using social capital as a proxy to analyze external networks and knowledge sharing as internal networks to organizations, it is possible to see these constructs as the antecedents to the absorptive capacity of the Zahra and George model, specifically as a lens for knowledge sources. The seminal model presents a competitive advantage as an outcome of absorptive capacity, being able to present itself in terms of flexibility, innovation, and performance. In this sense, the dependent variable used in study 3 was innovation performance. Thus, the empirical study proposal of this dissertation not only responds to a gap in the literature, but also brings new perspectives that complement the knowledge based on the study.

The second reflection that emerges from this dissertation is directly connected to study 3. Although it met the objective and answered the main research question, study 3 presented analyses only at the construct level. Social capital and absorptive capacity are multidimensional constructs and, in this sense, it makes sense to think that each dimension can have different effects on the proposed conceptual model. Future studies can explore this same model proposed in study 3 at the dimension level.

The possibility of finding a difference in effects at the dimensional level is even stronger when we analyze the effect of knowledge sharing on absorptive capacity, a construct that had a relatively smaller effect than social capital. A possible answer to this is that knowledge sharing may not impact all dimensions of absorptive capacity and, therefore, the effect at the construct level is reduced. If this is true, it is also worth rethinking the role of knowledge sharing in the current model. Rather than being seen as an activation trigger, perhaps knowledge sharing plays a role as a social integrator mechanism. In this new position, knowledge sharing would be responsible for influencing the relationship between potential absorptive capacity and realized absorptive capacity. Thus, it is possible that knowledge sharing is an important element to transform and exploit knowledge previously acquired and assimilated from external sources (inter-organizational networks).

Another important issue regarding the knowledge sharing construct is the choice of scale for measurement. In study 3, I used a scale that considers knowledge sharing as a one-dimensional construct. However, there are other validated scales in the literature that consider knowledge sharing as a bi-dimensional construct. Future studies can make use of these dimensions to better understand how this mechanism between internal and external networks affects absorptive capacity and innovation performance.

The third reflection is related to the way networks are treated in the absorptive capacity literature. Among the studies analyzed during the development of this dissertation, as well as from the results of studies 1 and 2, it is clear that the literature refers to networks mostly as a strategy that benefits those involved by filling resource gaps and promoting a flow of knowledge. However, there are opportunities to further explore the mechanisms for these companies to protect knowledge during their innovation processes. Zahra and George refer to these mechanisms as appropriability regimes. Some studies can be found on this topic, suggesting patents as a possible solution for large companies. However, what are the appropriability regimes that can be adopted by small and medium-sized companies? And which of these practices would work for startups? It is possible that the knowledge hiding construct

could help to answer these questions, but an in-depth study of the literature in this regard is necessary to identify whether, in fact, there is theoretical support for this.

A final reflection refers to other elements that can complement the understanding related to the mechanism found at the end of this dissertation. One of these elements is the triple helix, that is, the integration between universities, industry, and government. The results of study 3 present a mechanism without considering possible cooperation that the sample startups may have with universities and government. This cooperation could be considered as a activation trigger, as suggested on Zahra and George's model. Therefore, analysis of the mechanism in panels can be a relevant proposal for future studies to explore whether there are different effects for startups that have this type of support. Another possible element that can be explored is the comparison between the scenarios of developed and developing countries.

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