Received 14 December 2019
Revised 20 July 2020
Accepted 15 November 2020

Systematic literature review on innovation capabilities in clusters

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Abstract

Purpose – This paper aims to map literature about innovation capabilities (IC) taking into consideration industrial clusters to propose a conceptual framework that synthetizes the main factors and subfactors responsible for ICs; in addition, the paper also proposes a research agenda.

Design/methodology/approach – A systematic literature review (SLR) was performed; academic papers were analyzed qualitatively and quantitatively.

Findings – The authors provide a descriptive analysis followed by a thematic synthesis, in which we present 05 enablers and 20 critical factors (CF) of IC in clusters. The proposed framework emphasizes what needs to be done or improved to increase IC in cluster-based companies. Based on this systematic review and the framework proposed, the authors identified opportunities for future research.

Research limitations/implications – The enablers and CF identified through SLR were not validated empirically. Therefore, future studies on the current topic are required to validate the framework by investigating which factors are more relevant to cluster-based companies that intend to improve their innovative performance.

Practical implications – The present findings have important implications for the identification of the factors and subfactors that may contribute to the development of IC, which may help managers and decision-makers in recognizing which factors are the most responsible for business innovation.

Originality/value – The paper identifies enablers related to the development of IC in industrial cluster and presents a research agenda. The framework represents a guideline for companies to achieve better innovation performance.

Keywords Innovation capability, Industrial cluster, Systematic literature review

Paper type Literature review

1. Introduction

Ter Wal and Boschma (2011) argue that, to be innovative, location matters. On the one hand, literature points out that organizations tend to have better performance and opportunities when they are embedded in collaboration (Moreno & Miguelez, 2012; Whittington, Owen-Smith, & Powell, 2009). On the other hand, organizational competitiveness is based on the development of commercial networks (Pechlaner & Bachinger, 2010), especially in the context of clusters where the proximity between small and medium-sized companies

Ministério da Ciência, Tecnologia e Inovação > Conselho Nacional de Desenvolvimento Científico e Tecnológico 448893/2014–2.

Innovation & Management Review
Vol. 18 No. 2, 2021
pp. 192-220
Emerald Publishing Limited
2515-8961
DOI 10.1108/INMR-12-2019-0153

facilitates the flow of resources, information and knowledge sharing (Ucler, 2017). In essence, industrial clusters can be considered an alternative interorganizational network as they are environments driven by competition and cooperation (Strand, Wiig, Torheim, Solli-Sæther, & Nesset, 2017).

The pioneering studies on agglomerations date back to the late 19th and early 20th centuries with Marshall (1920), who was responsible for introducing the concept of industrial districts. Over the years, the terms industrial clusters and industrial districts have been treated interchangeably by some authors, like Molina Morales, Martínez Fernández, and Coll Serrano (2012). Regarding industrial clusters, Porter (1998, 2003) played an important role in the popularization of the term. He defines industrial clusters as geographic concentrations of interconnected enterprises and institutions that are part of the same industry, including government institutions, universities, associations and regulatory agencies. Altenburg and Meyer-Stamer (1999) also explain that industrial clusters have a delimited area in which firms concentrate, and emphasize the existence of a specialized profile and the exchanges (of resources, information) among firms. In addition to the geographical aspect, the idea of cognitive proximity between firms is added by Molina Morales et al. (2012), which could explain the exchange and the creation of a common knowledge base between cluster actors. Industrial clusters also have the potential to increase collaboration between companies within and between businesses and industries (Ystrom & Aspenberg, 2017).

Thus, in this paper, industrial clusters are defined as a group of companies and institutions geographically concentrated, whose relationships have as main characteristics the collaboration and exchange of resources, which implies a high cognitive proximity among actors (Molina Morales et al., 2012; Porter, 1998, 2003).

Collaboration among cluster-based companies allows accessing new or complementary resources and capabilities (Atalay, Dirlik, & Sarvan, 2017; Kalsaas, 2013; Ucler, 2017), incentives to exchange information and high-level networking (Lei & Huang, 2014), which can lead to competitive advantages. These companies also collaborate for a number of reasons, including the development of innovation (O'Dwyer, O'Malley, Murphy, & McNally, 2015). Schmitz (1992), Strand et al. (2017), O'Dwyer et al. (2015) and Ystrom and Aspenberg (2017) also emphasize the importance of collective actions and the eventual possibility of innovation (Cantner, Meder, & Ter Wal, 2010; Sammarra & Biggiero, 2008; Strand et al., 2017).

Thus, the actors in a cluster end up operating more productively, increasing access to technology and information exchange while enabling the development of innovation capabilities (IC) (Cespedes-Lorente, Antolin-Lopez, Martinez-del-Rio, & Perez-Valls, 2015; Porter, 2003; Romijn & Albu, 2002; Strand et al., 2017; Wonglimpiyarat, 2006). The term IC comes from literature on dynamic capabilities (DC) (Teece, 2017), which are the ability to renew competencies to meet the demands of the business environment, as innovative responses are needed when the pace of technological change is rapid, and the nature of competing firms and the market is difficult to identify (Teece, Pisano, & Shuen, 1997). Helfat and Peteraf (2003) also claim that capabilities can evolve and change over time. Meanwhile, Ter Wal and Boschma (2011) relate DCs to the introduction of innovations in the marketplace as change processes encapsulated in a company's routines. Thus, IC can be considered a DC. IC can be understood as the instrument needed to achieve success (Martínez-Román, Gamero, & Tamayo, 2011) by responding to the external environment in a proper manner (Akman & Yilmaz, 2008), or by putting new knowledge into productive use (Altenburg, Schmitz, & Stamm, 2008). Therefore, IC can be understood as multiple skills and competencies needed to absorb, dominate and enhance or create new existing products,

services or processes to meet market needs and generate profit (Quintana-García & Benavides-Velasco, 2005; Romijn & Albaladejo, 2002; Szeto, 2000).

Although literature on IC has been spread in the context of collaborative networks (Appio, Martini, Massa, & Testa, 2017), there are limitations in current research regarding industrial clusters. Some authors have focused on interorganizational network and the innovation process, as Dagnino, Levanti, Minà, and Picone (2015). Salim, Ab Rahman, and Abd Wahab (2019) dedicated their studies to internal capabilities and eco-innovation performance of manufacturing firms. Dagnino et al. (2015) mapped the main themes of literature on interorganizational network and innovation, without encompassing the factors that lead companies to the development of IC. Thus, literature on IC in the specific context of clusters remains scarce, especially when focusing on factors and subfactors that enable cluster-based companies to be innovative.

Regarding the above-mentioned motivations and gaps, the purpose of our paper is to map literature on IC regarding industrial clusters to propose a conceptual framework that synthetizes the main factors and subfactors responsible for the emergence of ICs in cluster-based companies. Such objective was accomplished through a systematic literature review (SLR), in which we explored papers from the ISI Web of Knowledge (Web of Science). Thereby, we outline the following specific objectives:

- to select a sample of papers that are in line with the perception of the researchers on the theme;
- to conduct a descriptive analysis of literature;
- to summarize the findings on enablers and CF; and
- to indicate topics reserved for future work.

This research contributes to scientific knowledge and practical issues for some reasons. First, by systematically reviewing the literature, the paper presents an overview, research trends and opportunities for future research, allowing a greater understanding of the theme. Second, by mapping literature and proposing a conceptual framework identifying factors and subfactors concerning IC in clusters, our study is a clear advance on literature, considering the scarcity of the theme. Third, the findings may assist cluster-based firms in improving these factors resulting in innovations to deal with changes. Fourth, considering the evolution of clusters and the innovation process associated with the development and growth of the region in which they are inserted, institutions and government agents may recognize factors that are relevant to boost innovations in clusters, stimulating their development and promoting regional development.

The paper is organized as follows. Section 2 presents the research method. In Section 3, the results are approached through descriptive analyses, followed by a thematic synthesis. In Section 4, results are discussed; we present state of the art enablers and CFs responsible for the development of IC in a conceptual framework, in addition to a research agenda. In Section 5, the conclusions, limitations and contributions are drawn.

2. Research method

The SLR was the method chosen by us to perform the review. Such method is a way to identify, assess and interpret available and relevant research for a specific research question, area of study or phenomena of interest (Kitchenham, 2004). The SLR provides an overview of the primary studies that contain explicit objectives, materials and methods, and were conducted according to an explicit and replicable methodology (Greenhalgh, 1997).

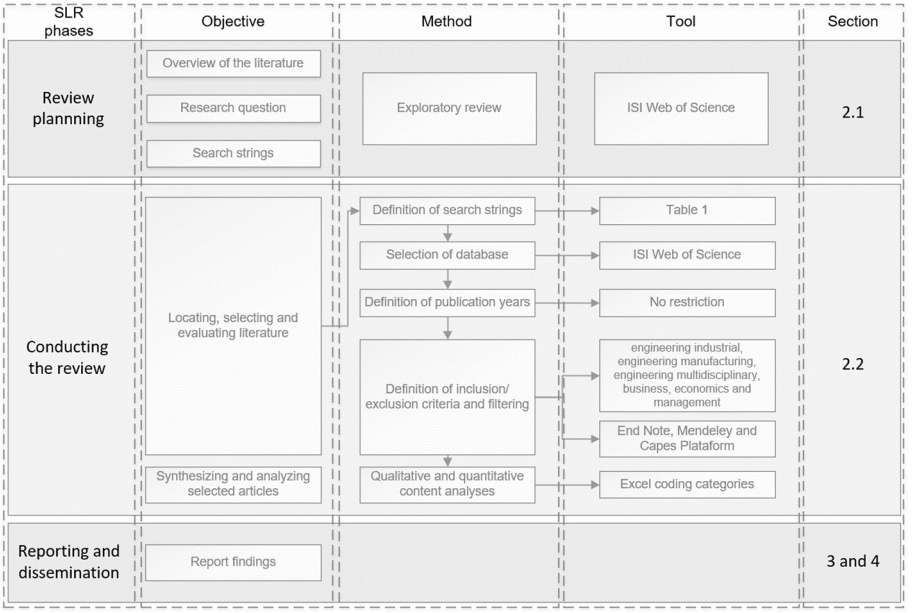
In this paper, we adopted the phases proposed by Tranfield, Denyer, and Smart (2003), summarized in Figure 1.

2.1 Review planning

To determine the most appropriate terms for the search, an exploratory and preliminary search was conducted in July 2017 in the Web of Science (WOS) database to evaluate the state of the art. WOS is considered one of the most prestigious academic literature databases in the world (Wang & Waltman, 2015). Through the exploratory research, we evaluated the relevance of the subject, delimited the area of study, and formulated the research questions and the search strings (Table 1).

2.2 Conducting the review, reporting and dissemination

Subsequently, we performed a new search in WOS considering the entire period available in the database on June 2019, using the terms presented in Table 1, which resulted in 1914 occurrences (Figure 2). We adopted, then, some filters, such as articles and reviews, WOS



Source: Based on Garza-Reyes (2015)

Figure 1.
Procedures for RSL

Connective	Search strings	Topic or title
–	resourc* or capabilit* or competenc*	Topic
AND	cluster* or "industrial district*"	Topic
AND	innovation or "new product development"	Topic

Source: Authors

Table 1.
Search strings

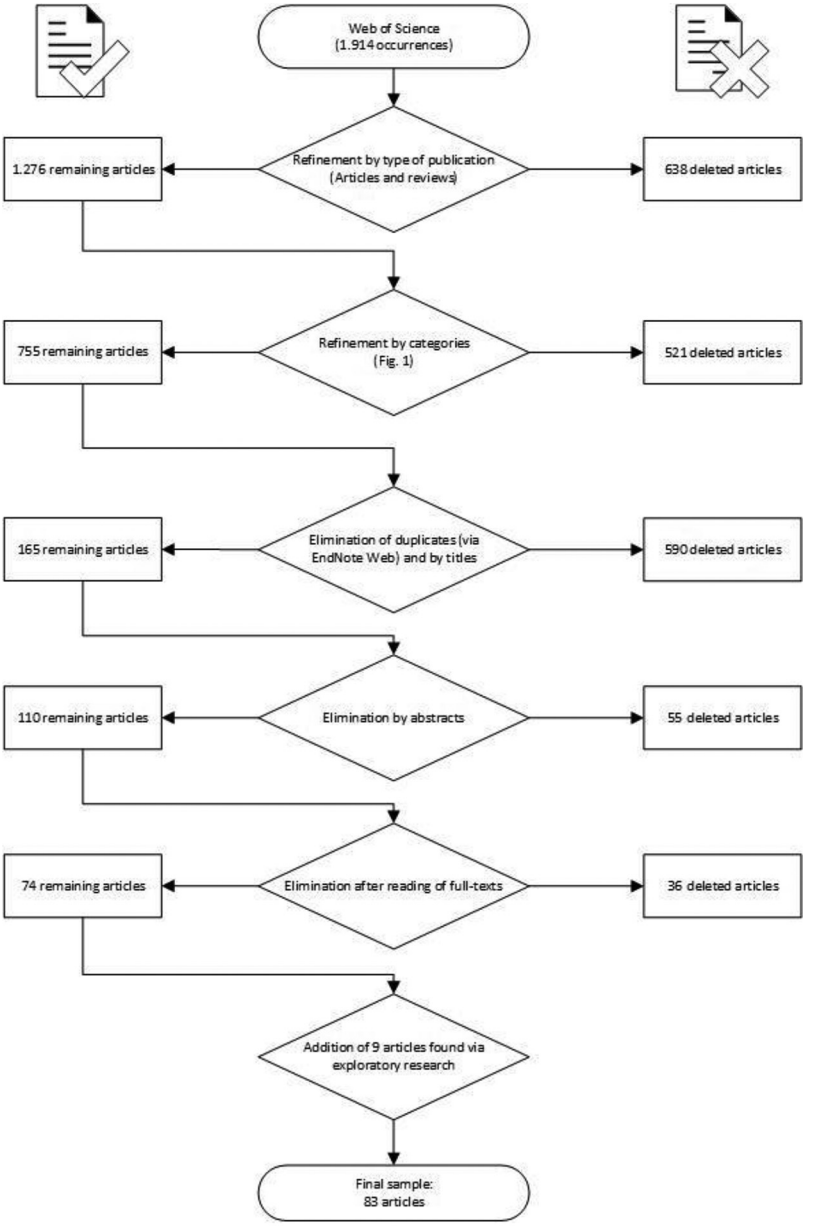


Figure 2.
Filtering procedure

Source: Authors

categories, EndNote Web and Mendeley, which resulted in 74 papers. To compose our final sample, 09 relevant papers found during the exploratory search were included, resulting in 83 papers, which are presented in Appendix. The Filtering process is presented in Figure 2. During the reading of abstracts and full papers, we excluded papers that:

- only had the pre-print version;
- did not deal with clusters or industrial districts;
- developed firm-level study and did not contribute to the study of IC;
- focused on spinoff of companies participating in clusters;
- dealt with the social aspects of relationships and networks; and
- addressed the benefits of infrastructure investments in agglomerations.

From the final sample, a content analysis was performed in two phases. This method was appropriate because it is a systematic and specialized procedure to analyze the content of documents, allowing replication (White & Marsh, 2006). First, a quantitative analysis was carried out; Microsoft Excel was used to generate descriptive statistics charts, which helps to understand the state of the art. In this step, we presented the quantitative data referring to published papers by year, main journals, scientific methods, main networks and approaches, as well as IC terms adopted by the authors.

After these steps have been carried out, a qualitative analysis was performed by reading the 83 full-texts to better understand IC in the context of cluster-based companies. This process required a careful and iterative reading conducted by the researchers (White & Marsh, 2006). We developed a thematic synthesis, in which we coded the papers to identify the following relationships: IC and geographical proximity; IC and interaction with other companies, institutions and external agents in general; definitions of IC; and factors and subfactors related to IC.

This process enabled the authors to discuss the topic:

- by proposing a conceptual framework, which relates enablers and CFs responsible for the development of IC in industrial clusters; and
- by providing an overview and propose a research agenda.

The agenda was proposed by identifying gaps and analyzing the framework and the authors' suggestions.

With the completion of these steps, as pointed by Tranfield et al. (2003), we are now ready to report and disseminate the results over the following sections.

3. Results

3.1 Descriptive analysis

Regarding the evolution of publications (Figure 3), until 2016, there is an oscillation in the number of publications on the theme, without a definite trend. However, in 2017, we found a significant increase, highlighting the pertinence of the topic. There were no temporal constraints in the systematic search; however, the first relevant publications were published in 1999, namely, Capello (1999), Lawson and Lorenz (1999), Maskell and Malmberg (1999) and Nooteboom (1999). Maskell and Malmberg (1999) is the most cited article (981 citations) according to WOS.

These four articles are related to learning in technological environments, regions or with geographical proximity. Lawson and Lorenz (1999) deal specifically with industrial clusters, establishing a relationship between clusters and collective learning. Maskell and Malmberg

(1999) argue that competitiveness is related to an organization's ability to improve its knowledge, and proximity contributes to the learning process.

Figure 4 presents journals that had at least two occurrences in the sample. The two most recurring journals, *Regional Studies* and *Technovation*, have an impact factor of 3.312 and 5.720, (2019), respectively, which highlights the high quality of the journals.

Regarding the scientific methods (Table 2 and Figure 5), we observed a predominance of the survey, followed by case study. Survey has kept stable between 1999 and 2014, and after that, we observed an increase in 2017. Documentary research, the third most common method in the sample, presented a stable frequency over the years. There are 31 qualitative articles, 46 quantitative articles and 6 qualitative-quantitative articles; thus, the quantitative approach was predominant. Of the four papers that use mathematical modeling, three adopted multicriteria decision models: Ucler (2017) (Fuzzy e Analytic Hierarchy Process – AHP), Boly, Morel, Assielou, and Camargo (2014) (Fuzzy), and Rejeb, Ben, Morel-Guimarães, Boly, and Assiélou (2008) (AHP and ELECTRE).

Concerning interorganizational networks, the most recurrent is the cluster, followed by network, industrial district and innovation system (Figure 6). The term "network" is a generic term that can encompass all types of agglomerations, including industrial clusters.

Regarding the identification of terms that refer to IC (Figure 7), the two most used ones are "innovative capability", followed by "innovation capability" itself. The term

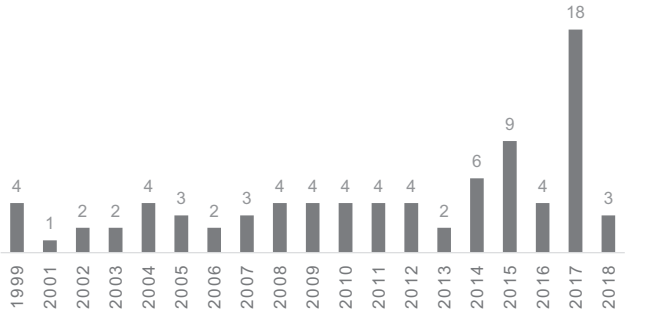


Figure 3.
Publications evolution

Source: Authors

Figure 4.
Main journals

Source: Authors

Method	Nature	Absolute frequency	Relative frequency (%)
Survey	Quanti	39	46,99
Case study	Quali	17	20,48
Documentary research	Quali	8	9,64
Mixed methods	Quali-quanti	6	7,23
Theoretical article	Quali	5	6,02
Mathematical modeling	Quanti	4	4,82
Bibliometric analysis	Quanti	2	2,41
Field research	Quali	1	1,20
Hypothesis test based on secondary data	Quanti	1	1,20
Total	–	83	100,00

Source: Authors

Table 2.
Scientific methods

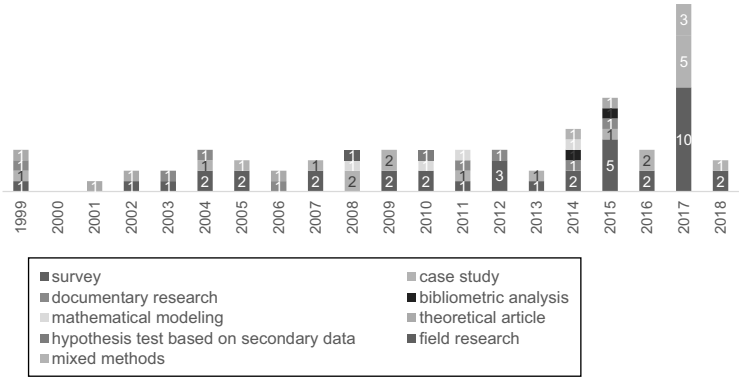


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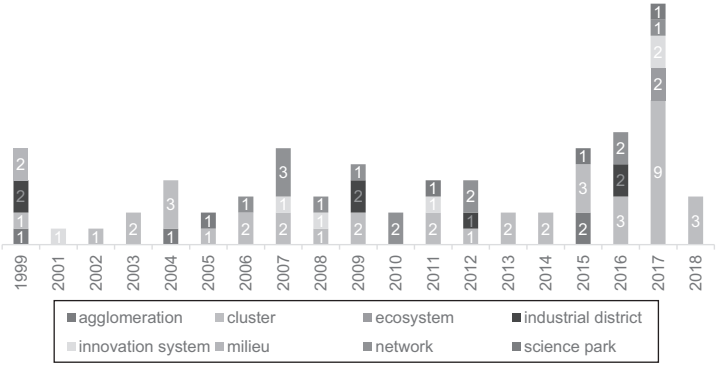
Figure 5.
Methods over the years



Source: Authors

Figure 6.
Interorganizational network

"innovation" was also included in the count, as many articles deal with capabilities and factors that lead to innovation. Besides, terms that involved technological capabilities when referring to innovation were also considered, namely, technological capability, technological IC, innovative technological capability and technological capability.

To study ICs different approaches have been adopted (Figure 8). Knowledge and learning theories are predominant since IC research has focused on the importance of knowledge as a resource or capability that leads to the development of innovations (Britton, 2004; Cantner et al., 2010; Cappellin, 2003; Díez-Vial & Fernández-Olmos, 2015; Ganesan, Malter, & Rindfleisch, 2005; Larty, Jack, & Lockett, 2017; Lawson & Lorenz, 1999; Maskell & Malmberg, 1999; Pechlaner & Bachinger, 2010; Presutti, Boari, & Majocchi, 2011). Theories related to innovation, IC, and networks in general, are also prevalent.

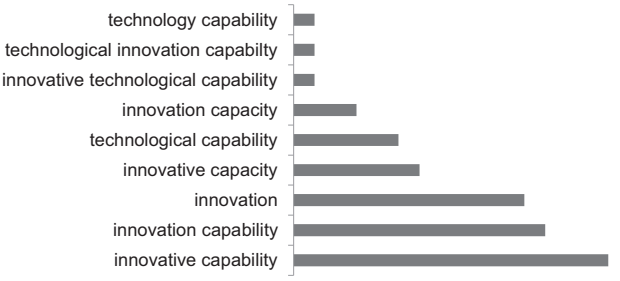


Figure 7.
Innovation capability terms

Source: Authors

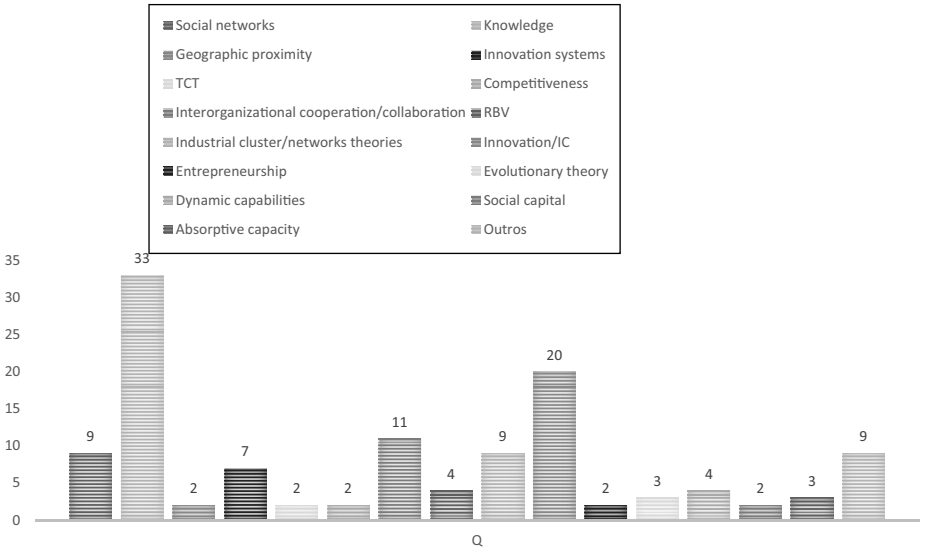


Figure 8.
Main approaches

Source: Authors

3.2 Thematic syntheses

During the analyses, we found some evidences regarding geographical proximity and interaction with other companies and external agents, which emphasizes their importance for the innovation process in industrial clusters (Tables 3 and 4).

Authors	Arguments
Capello (1999)	*Innovation activities* depend greatly on the cultural proximity with the workforce
Brown and Duguid (2002)	The local character is important for *innovation* due to the development of social networks, highlighting the case of Silicon Valley
De Bruijn (2004)	Emphasizes the role of regional factors and geographical proximity, arguing that the latter is a catalyst for *innovation*
Díez-Vial and Fernández-Olmos (2015)	Proximity allows companies access to services and support to market their products, thus obtaining better performance than companies that work in isolation, regarding *innovation* issues
Giuliani (2013)	Companies that operate with geographical proximity achieve better performance in *innovation*
Ganesan et al. (2005)	Emphasizes the importance of informal and face-to-face communication, and suggests that almost all the benefits (including *innovation*) of geographic proximity depend on relationships with strong ties
Grillitsch et al. (2015)	Brings the concepts of cognitive, technological, organizational, social, cultural and institutional proximity. According to the authors, the geographical proximity allows these other types of proximity and this context leads to *innovation*
Larty et al. (2017)	The geographical agglomeration of firms offers greater opportunity for knowledge exchange, leading to an increase in *innovation* in the region
Silvestre and Dalcol (2009)	At least three elements determine the relationship between *geographic proximity and innovation:* industry patterns in which the agglomeration is embedded, local dynamics (support institutions and policies), and the role of the firm in the cluster value chain

Source: Authors

Table 3. Innovation and geographical proximity

Authors	Arguments
Antolin-Lopez et al. (2015)	Interorganizational cooperation can improve the *innovation* performance of cooperating companies Interorganizational collaboration is a mechanism for knowledge exchange among firms. Knowledge gained through other organizations can be used for the company's *innovative* activities
Huggins, Johnston, and Thompson (2012)	Companies do not *innovate* in isolation, but through a set of interactions with external agents
Jang et al. (2017)	In addition to the internal factors of the company, the external environment and the collaboration network influence *innovation*
Petruzzelli et al. (2009)	Individual agents are rarely able to *innovate* independently. *Innovation* is linked to the creation of new technological knowledge, which, in turn, demands the combination of internal and ex ternal learning processes, through interaction, for example

Source: Authors

Table 4. Innovation and interaction with other companies and external agents

Industrial clusters provide both geographical proximity and interaction, and stimulate not only individual innovation but also collaborative innovation, bringing new possibilities, either related to technological aspects, operations or logistics, making them more propitious to new technologies and services. The logic behind collaborative innovation is determined by the resources and capabilities that companies need to access or develop through collaboration, in addition to their own organizational characteristics (Antolin-Lopez, Martinez-del-Rio, Cespedes-Lorente, & Perez-Valls, 2015). Grillitsch and Nilsson (2015) also point out that innovation relies on the internal capabilities of companies and access to external elements, which is precisely the situation provided by industrial clusters.

These characteristics may help cluster-based companies in achieving strategic benefits by developing and strengthening their innovation-driven capabilities as a mean of obtaining quick responses to change (Christopherson & Clark, 2007). Therefore, capabilities are important determinants of innovation activity (O'Gorman & Kautonen, 2004). The concept of IC related to industrial clusters are presented in Table 5.

Literature also indicates that the collaborative environment in clusters increases the access to technology, boosting IC (Antolin-Lopez et al., 2015; Porter, 2003; Strand et al., 2017; Wonglimpiyarat, 2006). Thus, we found possible to identify several factors that lead or influence IC in clusters (see Table 6; the numbers represent the authors listed in the Appendix). This table also presents the innovation term used in each article. The terms with the greatest corroboration in literature are geographical proximity, absorptive capacity and knowledge exchange, with five, three and three occurrences, respectively. This does not mean that within the entire sample, these and other terms were not used in different articles. This concerns the factors considered necessary for IC, in the context of these papers. Further explanation is presented in Section 5.

4. Proposal of the framework

From the thematic synthesis, we identify enablers and CFs (referred to as factors and subfactors) that affect the entire IC as well as innovation performance in clusters-based companies (Figure 9). The factors were extracted from Table 6 and were grouped into five categories, according to the similarity among themes: network collaboration, knowledge creation and transfer, technology development, market influence and proximity (Table 7).

Authors	Concepts
Altenburg et al. (2008)	The creation of new knowledge put into productive use
Quintana-García and Benavides-Velasco (2005)	The ability to shape and manage multiple competences, such as technology skills, production management and marketing. It can be defined as a dynamic capability as it integrates, adapts and reconfigures capabilities and competences to create profitable products and services
Romijn and Albu (2002)	The skills and knowledge required to effectively absorb, master and improve existing technologies, and to create new ones
Wonglimpiyarat (2010)	Ability to make major improvements and modifications to existing technologies, and create new ones

Source: Authors

Table 5.
IC definitions

Table 6.
Factors and sub-factors related to IC

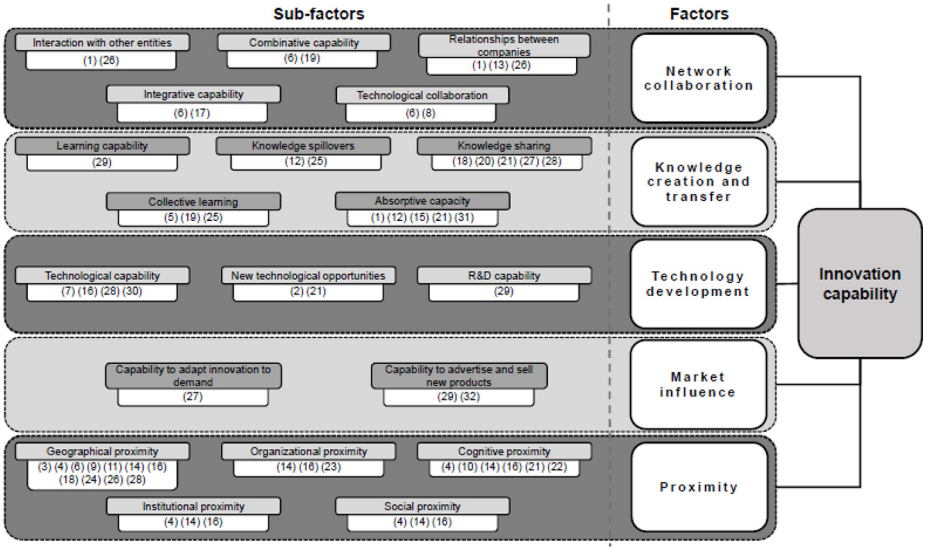
Factors	Sub-factors	Related to	Author
Collective learning	Trust/organizational proximity	IC	11
			41
		Innovation	60
Learning capabilities		Technological IC	69
Density and quality of relationships		IC	2
High density and strength of ties		Innovation	26
			12
Integrative capabilities	Widely diversified knowledge of technologies		
	Firm-specific knowledge development and exploitation	IC	35
Interaction with suppliers, customers, public agencies, associations, foundations			62
Network cooperation		Capacity for innovation	16
Relationships between enterprises and institutions		IC	2
Technological collaboration	Learning routines and incentives to reveal their own tacit knowledge	Innovation	12
Combinative capability	Mobility of skilled personnel on the local labor market	IC	41
	Co-operation among producers		
Combinatory capabilities	Diversified knowledge of technologies	Innovation	12
Absorptive capacity		IC	2
			25
	Knowledge acquisition	Innovation	74
In-house knowledge capability	Knowledge of each individual	Innovation	34
	Homogeneity/diversity of experience and knowledge of staff		
	Communication processes		
	Role of gatekeepers		
	Expectations and ambitions		
Knowledge exchange		IC	42
	Trust	Innovation	50
	Cultural proximity		
Knowledge sharing			40
Managerial knowledge exchange		IC	63
Market knowledge exchange			

(*continued*)

Table 6.

Factors	Sub-factors	Related to	Author
Spillovers		Innovation	25
Technological knowledge exchange		IC	60
Market capability	Transform new technological knowledge into marketable products, to combine and mutually adapt technological knowledge		63
Marketing capability		Technological IC	69
			80
Cognitive proximity		Innovation	70
Cultural proximity		IC	22
Geographic proximity	Collective learning processes		11
			21
		Innovation	70
			40
	Trust and cognitive identification	Innovation	59
		IC	67
	Competitiveness, information exchange, collaboration	Innovation	72
			70
Institutional proximity			
Organizational proximity		IC	22
Physical proximity	Local transfer of information	Innovation	5
			12
			70
Social proximity			
Capabilities in emerging technologies		Capability for innovation	71
New technology opportunities		IC	3
R&D capabilities		Technological IC	69
Technology capability		IC	13
Technological competences		Innovativeness	34
Manufacturing capabilities		Technological IC	69
Organizational capabilities			
Resource capabilities			
Skilled labour force		Innovative capacity	16
Strategic capability		Technological IC	69

Source: Authors



[1] Altenburg, Schmitz, and Stamm (2008); [2] Alvarez, Marin, and Fonfria (2009); [3] Atalay, Dirlik, and Sarvan (2017); [4] Boschma (2005); [5] Capello (1999); [6] Cappellin (2003); [7] Cavalheiro and Brandão (2017); [8] Christopherson and Clark (2007); [9] Dalcin, Balestrin, and Teixeira (2017); [10] Dangelico, Garavelli, and Petruzzelli (2010); [11] De Bruijn (2004); [12] Diez-Vial and Fernandez-Olmos (2015); [13] Elche, García-Villaverde, and Martínez-Pérez (2018); [14] Fontes and Sousa (2016); [15] Grillitsch and Nilsson (2015); [16] Grillitsch, Todtling, and Hoglinger (2015); [17] Herstad and Ebersberger (2014); [18] Larty, Jack, and Lockett (2017); [19] Lawson and Lorenz (1999); [20] Molina-Morales, Martinez-Fernandez, and Coll-Serrano (2012); [21] Nooteboom (1999); [22] Petruzzelli, Albino, and Carbonara (2009); [23] Pietrobelli and Rabellotti (2011); [24] Presutti, Boari, and Majocchi (2011); [25] Quintana-García and Benavides-Velasco (2005); [26] Romijn and Albu (2002); [27] Sammarra and Biggiero (2008); [28] Silvestre and Dalcol (2009); [29] Strand et al. (2017); [30] Toivanen (2014); [31] Van Geenhuizen (2008); [32] Yam et al. (2004).

Figure 9.
Conceptual framework

Source: Authors

The enablers are too complex but represent an initial attempt to understand the complexity involving IC in industrial clusters and their relationships. Some of the CFs need to be stimulated by supporting institutions (such as institutional proximity and interaction), while the very proximity between companies may facilitate others. Besides, the conceptual framework emphasizes what needs to be done or improved to increase innovativeness. At this point we present some more details about each type of IC.

4.1 Network collaboration

Collaborative relationships produce information sharing and promote rapid and flexible response to changing and expanding markets, thus promoting IC (Christopherson & Clark, 2007). It also has a strong social character, as it is accomplished through social relations. Firms collaborate to obtain technological and market information, and such interactions can provide important resources for IC (Romijn & Albu, 2002). IC also depends on the density and quality of collaborative relationships, either among companies or between companies and supporting institutions (Altenburg et al., 2008; Elche, García-Villaverde, & Martínez-Pérez, 2018). Integrative capability is essential as it enables companies to develop and exploit their resources, which is in line with the concept of collaboration (Herstad & Ebersberger, 2014).

For technological collaboration, firms need learning routines to reveal their own tacit knowledge (Christopherson & Clark, 2007); thus, companies would be able to integrate external knowledge into the company's knowledge base. Combinative capability is the ability to combine and recombine resources flexibly and can be achieved through the mobility of

Table 7.
Factors and sub-factors related to IC

Factors	Synthesis	Sub-factors	Authors
Network collaboration	Collaboration with various actors can provide important resources for building IC	Relationships between companies	Altenburg *et al.* (2008), Cappellin (2003); Christopherson and Clark (2007), Elche *et al.* (2018); Herstad and Ebersberger (2014), Lawson and Lorenz (1999); Romijn and Albu (2002)
		Integrative capability	
		Interaction with other entities	
		Technological collaboration	
		Combinative capability	
Knowledge creation and transfer	The knowledge transit among actors is directly influenced by the capability to share, absorb and pass it on	Absorptive capacity	Díez-Vial and Fernández-Olmos (2015); Grillitsch *et al.* (2015), Larty *et al.* (2017); Lawson and Lorenz (1999), Molina Morales *et al.* (2012); Nooteboom (1999); Quintana-García and Benavides-Velasco (2005); Sammarra and Biggiero (2008), Strand *et al.* (2017); Van Geenhuizen (2008)
		Knowledge sharing	
		Knowledge spillovers	
		Knowledge spillovers	
		Learning capability	
Technology development	Technologies are important sources of innovation and increase the IC	New technological opportunities	Álvarez *et al.* (2009); Cavalheiro *et al.* (2017), Strand *et al.* (2017); Toivanen (2014)
		Technological capability	
		R&D capability	
Market influence	The existence of innovations depends on the demand and acceptance of the innovative product or process	Capability to adapt innovation to demand	Sammarra and Biggiero (2008), Strand *et al.* (2017); Yam *et al.* (2004)
		Capability to advertise and sell new products	

(*continued*)

Table 7.

Factors	Synthesis	Sub-factors	Authors
Proximity	Determining characteristic for the formation of innovative collaborative networks. It includes geographical, cognitive, organizational, social and institutional proximity	Geographical proximity	Atalay *et al.* (2017) ; Álvarez *et al.* (2009); Boschma (2005), Cappellin (2003); De Bruijn (2004), Fontes and Sousa (2016); Grillitsch *et al.* (2015); Quintana-García and Benavides-Velasco (2005); Nooteboom (1999), Petruzzelli *et al.* (2009); Pietrobelli and Rabellotti (2011); Presutti *et al.*, 2011); Silvestre and Dalcol (2009)
		Cognitive proximity Organizational proximity Social proximity Institutional proximity	

Source: Authors

personnel through the local market, or by establishing relations of cooperation (Lawson & Lorenz, 1999). It assumes a vast and diverse knowledge in technology (Cappellin, 2003).

4.2 Knowledge creation and transfer

The way knowledge transits among industrial cluster actors is directly influenced by the ability to create, share and transfer knowledge. Thus, absorptive capacity [ability to identify, seek, acquire and use knowledge (Cohen & Levinthal, 1990)] concerns the effective absorption and application of knowledge in general (Ter Wal & Boschma, 2011). It drives the interactions among companies in a cluster, whose main source are similar or related competencies (Chandrashekar & Hillemane, 2018; Grillitsch & Nilsson, 2015). Knowledge sharing is also relevant and depends on the existence of social networks among companies (Larty et al., 2017). The authors investigated the existence of knowledge sharing mediators, whose role would be to encourage the creation of new networking opportunities, to facilitate new collaborations and to promote knowledge exchange.

Knowledge spillovers can be considered one of the main reasons behind the creation of clusters and also an essential element for innovation performance (Quintana-García & Benavides-Velasco, 2005). Spillovers are a consequence of more convenient access to research, ideas and experiences from research centers, as well as from socially related suppliers, customers or companies, acquired informally due to social interaction and geographical proximity (Díez-Vial & Fernández-Olmos, 2015; Quintana-García & Benavides-Velasco, 2005). Thus, the position of a company within an industrial cluster and its access to local spillovers increases the attractiveness of the company to potential partners (Quintana-García & Benavides-Velasco, 2005).

Collective learning is another enabler for IC and relates to the social aspect (Capello, 1999). Therefore, collective learning can be defined as a cumulative social process of knowledge based on a set of shared rules and procedures that allow individuals to coordinate their actions when solving problems (Capello, 1999). Quintana-García and Benavides-Velasco (2005) also argue that the collective learning process is motivated by networks of specialized partners who share complementary resources. It is intrinsic to the innovative environment (Capello, 1999).

4.3 Technology development

The arrival of new technological opportunities justify the contribution of networks to firms' ICs (Álvarez, Marin, & Fonfría, 2009). The combination among technologies are important sources of innovation (Nooteboom, 1999) and technological capabilities increase IC (Grillitsch, Tödtling, & Höglinger, 2015). Technological capability is the set of resources, skills, knowledge and experiences incorporated by workers and by the organizational system (Cavalheiro, Brandão, & Brandao, 2017). The participation in clusters facilitates the accumulation of technological capability (Silvestre & Dalcol, 2009).

R&D capabilities are defined according to the following aspects (Strand et al., 2017): need for sufficient investment in the development of new products; efficient communication between R&D activities and other departments; application of customer feedback in the development of technology; end-user satisfaction; and elaboration of explicit purposes and plans for research projects.

4.4 Market influence

To influence the market, cluster-based companies need to transform new technological know-how into salable products. Companies need to combine and adapt technological know-how to this end (Sammarra & Biggiero, 2008). We call it "capability to adapt innovation to

demand". The "capability to advertise and sell new products" is based on the definition of Yam, Guan, Pun, and Tang (2004) of marketing capability. According to the authors, this capability concerns the ability of a company to advertise and sell products based on consumer needs, the competitive environment, costs and benefits and acceptance of innovation. The crucial point is that market influence is a determinant of IC because the existence of innovations depends on the demand and acceptance of the innovative product, service or process by the market.

4.5 Proximity

Although proximity initially seems to refer only to geographic distance, it has other meanings when approaching IC in industrial clusters. According to Boschma (2005), the French School of Proximity Dynamics contributed to literature on innovation when it proposed that proximity encompasses several different dimensions, namely, geographical, organizational and institutional. Boschma (2005) also added two other dimensions: social and cognitive proximities.

Geographical proximity is an important enabler for IC in clusters. Companies that are geographically close and often from the same or related sectors are motivated to establish external relationships to access new information and create knowledge (Álvarez et al., 2009; Silvestre & Dalcol, 2009). This happens because the area in which the companies are geographically concentrated facilitates a greater exchange of information through formal and informal communication processes; despite the provision of advanced technological tools, information is tacit and better transmitted when agents are close (Grillitsch et al., 2015; Quintana-García & Benavides-Velasco, 2005).

In turn, organizational proximity is defined as the extent to which actors share the same space of relationships in an organizational system, whether within or among organizations (Boschma, 2005). It facilitates interaction because it allows an understanding of the rules, hierarchies and codes of behavior of a determined organization (Fontes & Sousa, 2016), enabling the development of IC.

Social proximity is defined in terms of social relations among agents at the micro-level. It involves trust based on friendship, affinity and experience. Relationships of trust facilitate the exchange of tacit knowledge and minimize the risk of opportunistic behavior (Boschma, 2005), reinforcing the development of IC in industrial clusters. Concerning cognitive proximity, it relates to the existence of understanding, a common knowledge base and expertise among agents (Nooteboom, 1999; Petruzzelli, Albino, & Carbonara, 2009), enabling ICs. Sufficient and mutual cognitive proximity and trust (which implies dispensing complex, detailed, costly, restrictive contracts while containing spillover risks) are achieved based on shared norms and values, family bond or friendship or shared routines (Nooteboom, 1999).

Institutional proximity is related to the institutional structure at the macro level. It refers to actors who share the same institutional rules as a set of cultural habits and values (Boschma, 2005). The lack of institutional proximity is detrimental to collective action and innovation due to weak formal institutions and lack of social cohesion and collective values (Boschma, 2005).

Proximity, in any of its dimensions, does not promote innovation if it is either excessive or scarce. The ideal would be an intermediary proximity, which Boschma (2005) denominates "loose coupling", aiming to protect organizational, social and institutional autonomy within and among organizations, maintain flexibility and satisfactory control.

5. Research agenda

Based on SLR and the framework proposed herein, we identified some opportunities for future research. Therefore, we categorized these opportunities into four distinct issues: innovation, geographical context and country, scientific methods and network type (Figure 10). The numbers within Figure 10 represent the sample articles listed in the Appendix. If there is no number placed next to the research topic, the opportunity for further studies comes from the analysis and synthesis, and from the proposed conceptual framework. It is interesting to highlight that some opportunities identified during the analysis were the same as those proposed by the authors' sample. The opportunities below can be addressed by adopting different approaches, especially those less applied to our sample (TCT, RBV, evolutionary theory, social capital theory, among others - see Figure 8). Interestingly, common theories addressing interorganizational issues were not applied, such as relational theory and extended RBV; themes that need further investigation.

5.1 Innovation

Factors related to IC. Further research on the factors and subfactors that enable IC are needed. We suggest figuring out the evolution of these factors to better understand how the phenomenon of IC in clusters-based companies is evolving. To relate IC to firm performance to investigate the relationship between them is also opportune. Future studies should also target the evaluation of cluster-based companies' IC index by applying different methods, such as multicriteria tools.

Innovation network. Further investigations are needed to elucidate how the relational features of regions operate similarly or differently according to alternative measures of innovation performance. It is also worth investigating the contribution of different (local, global) knowledge networks to innovation intensity and business performance.

Innovation capabilities. This subject was central in our research and many research opportunities may stem from it. We suggest that two important theories could be adopted and applied to analyze the IC in cluster-based companies: coevolutionary and institutional theory. The first one could be applied to analyze the coevolution of suppliers and customers regarding IC in cluster-based companies. The second could verify the influence of

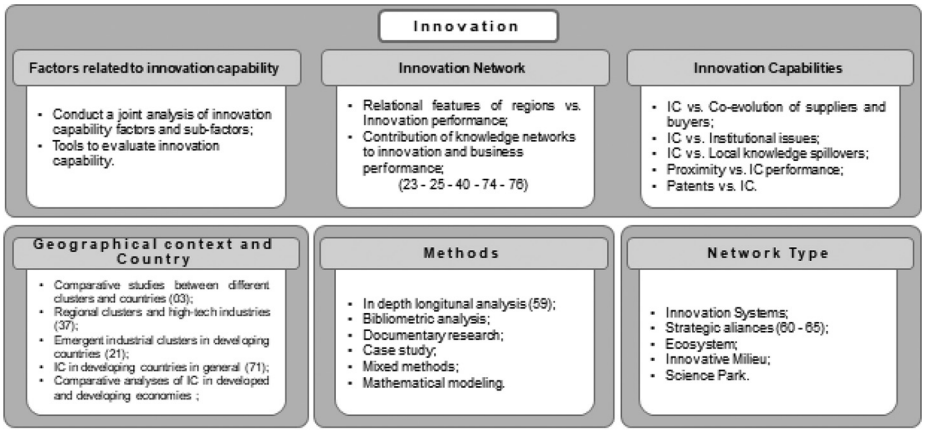


Figure 10.
Research agenda

Source: Authors

institutional factors in the development of IC. Other issues that need further investigation are related to knowledge spillovers and geographical proximity and its impact on IC performance in industrial clusters. Additional work on the relationship between patents and IC performance would also be an emergent topic.

5.2 Geographical context and country

Further research could carry out more in-depth comparative analyses between IC and influential factors and subfactors across industries and countries (Álvarez et al., 2009), emergent and developed countries (Dalcin, Balestrin, & Teixeira, 2017), or between high tech clusters and regional ones (Jang, Kim, & von Zedtwitz, 2017). Comparative discussions between results obtained from studies carried out in different geography contexts (Álvarez et al., 2009) could bring new insights into the subject, especially regarding the enablers and CFs responsible for IC's development.

5.3 Methods

Further work needs to be done to explore literature according to different theoretical approaches and bibliometric analysis. Mixed methods should also be applied in this context. An example would be the development of a quantitative tool used to evaluate the IC index by adopting focus group and mathematical modeling. Even though case studies are the second most frequent research method, we recommend that further research should focus on it, especially in the context of comparative analyses and longitudinal studies, as recommended by Presutti et al. (2011).

5.4 Network type

During the review process, the SLR revealed the need to further investigate other business arrangements, as the relationships developed by companies in these arrangements can also contribute to developing or improving the organizations' IC, regardless of the low representativity of geographical proximity.

6. Conclusions

Studies exploring ICs in the context of industrial clusters are new and remain at early stages. Thus, recognizing the importance of these capabilities as well as the enablers and CFs responsible for the development of such ICs in cluster-based-companies, faster technological progress are changing market needs and increasing the pressure for innovation. In this context, this paper developed an SLR by presenting an overview on the subject as well as proposing a conceptual framework that relates enablers and CFs for the development of IC in cluster-based companies, generating an initial architecture that supports the research topic. Subsequently, based on the results and the framework, we propose paths for future research.

This paper presents relevant contributions. For example, even though literature presented some attempts to analyze ICs in the industrial cluster, the investigation was restricted to geographic proximity and knowledge sharing interactions (Allen, Gloor, Fronzetti Colladon, Woerner, & Raz, 2016), or on practices of innovation management (Boly et al., 2014). Differently, our paper proposed a theoretical framework (Figure 9) showing 04 factors and 20 enablers related to IC in cluster-based companies. Besides, IC has been studied over the years by many authors, but no survey so far has mapped and organized research on the theme through an extensive analysis of literature. In this sense, the framework proposed herein allows for a better understanding and operationalization of

these complex constructs. In managerial terms, the framework is relevant because it clarifies, which factors and subfactors contribute to the development of innovation capabilities, helping managers and decision-makers recognize which factors are responsible and relevant to business innovation. Besides, the results showed that, by working together in industrial clusters, companies might achieve innovation capabilities.

The second contribution is related to the descriptive and thematic analyses. The descriptive analysis allowed a broad understanding of how academics have addressed the subject over the years. Thus, it was possible to identify the evolution of research on the subject through the analysis of important journals, scientific methods applied, main networks studied and IC terms adopted by the authors. Through the thematic synthesis, we presented some evidences related to innovation and geographical proximity; innovation and interaction with other companies, institutions and external agents in general; the main definitions of IC; and factors and enablers related to IC. Thus, this information may be interesting for scholars and practitioners willing to investigate the topic and to contribute to both academic and business spheres.

The third contribution is related to the research agenda, developed through the identification of gaps during the synthesizing process, an in-depth analysis of the conceptual framework and the authors' suggestions for future research. The agenda was proposed considering the following main topics (Figure 10): innovation, geographical context and countries, research methods and network type. The agenda is essential because it indicates some emerging themes and promising areas for future research on IC in industrial clusters, stimulating additional investigation on the topic.

Finally, despite the recent SLR of Dagnino et al. (2015) on interorganizational networks and innovation through the development of a bibliometric study and proposition of a research agenda, the authors did not focus on IC from a thematic synthesis perspective, neither proposed a conceptual framework. In addition, we followed the authors' suggestion for future studies to provide broader reviews on different types of networks (in our case, industrial cluster) to identify enablers for the development of IC; our study, therefore, is a clear advance on current literature.

We aware that our research may have some limitations. The first is the search strings adopted; the second concerns the selection criteria of articles encompassing IC in an industrial cluster; and the third relates to the database adopted. Thus, future research can broaden the scope by selecting other search strings, criteria of exclusion and inclusion, as well as a different database(s). The enablers and CFs identified through SLR were not validated through empirical research. Therefore, further research may validate the framework by investigating which one is most important for cluster-based companies to improve innovative performance. Nevertheless, some subfactors have close interrelations among one another, which requires further explanation.

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Appendix

No.	Authors	Approaches
1	Allen et al. (2016)	Social network; knowledge sharing; geographic proximity
2	Altenburg et al. (2008)	Innovation systems
3	Álvarez et al. (2009)	Transaction costs; competitiveness
4	Antolin-Lopez et al. (2015)	Interorganizational cooperation
5	Atalay et al. (2017)	knowledge management; cluster and social network theory
6	Best (2015)	Darwin's evolutionary principles
7	Boly et al. (2014)	Dynamic capabilities
8	Britton (2004)	Knowledge management; absorptive capacity
9	Brown and Duguid (2002)	Social network
10	Cantner et al. (2010)	Regional Innovation Systems; social network; knowledge exchange; collaboration
11	Capello (1999)	Collective learning; knowledge transfer
12	Cappellin (2003)	Knowledge management
13	Cavalheiro et al. (2017)	Industrial clusters
14	Chandrashekar and Subrahmanya (2017)	Industrial district; Industrial cluster; Innovation performance
15	Chandrashekar and Hillemane (2018)	Absorptive capacity
16	Christopherson and Clark (2007)	Co-location; innovation
17	Claver-Cortés, Marco-Lajara, and García-Lillo (2017)	Dynamic capabilities; absorptive capacity
18	Cooke (2001)	Regional innovation systems
19	Crespo, Suire, and Vicente (2014)	Networks theories
20	Dagnino et al. (2015)	Interorganizational network
21	Dalcin et al. (2017)	Resource-based view (RBV)
22	Dangelico, Garavelli, and Petruzzelli (2010)	Agglomerations; knowledge transfer
23	De Bruijn (2004)	Clustering of firms
24	De Marchi and Grandinetti (2016)	Regional Innovation Systems
25	Díez-Vial and Fernández-Olmos (2015)	Knowledge spillovers
26	Elche et al. (2018)	Innovation and inter-organizational relationships; Firm innovation
27	Expósito-Langa, Tomás-Miquel, Bratucu, and Barbulescu (2018)	Cluster knowledge network; clustered firm's innovation
28	Feldman (2014)	Entrepreneurship
29	Fleming, King, and Juda (2007)	Collaboration networks
30	Fontes and Sousa (2016)	Social and knowledge network; economic geography; entrepreneurship
31	Ganesan et al. (2005)	Organizational learning; knowledge management
32	Giuliani (2013)	Interorganizational networks
33	Grillitsch and Nilsson (2015)	Knowledge spillovers
34	Grillitsch et al. (2015)	Knowledge management; knowledge sourcing
35	Herstad and Ebersberger (2014)	Interorganizational network
36	Huggins et al. (2012)	Knowledge management
37	Jang et al. (2017)	Knowledge externalities; proximity and clustering of firms
38	Kalsaas (2013)	Innovation; collaboration
39	Lai and Shyu (2005)	Porter's model for innovation
40	Larty et al. (2017)	RBV
41	Lawson and Lorenz (1999)	Firm capabilities; competitive advantage; organizational learning;

(*continued*)

Table A1. Authors of the SLR

No.	Authors	Approaches
42	Lei and Huang (2014)	Social network
43	Liu, Ying, and Wu (2017)	Institutional theory; knowledge-based view
44	Marco-Lajara, Zaragoza-Sáez, Claver-Cortés, and Ubeda-García (2016)	Knowledge-based theory; industrial district theory
45	Martínez-Pérez and Beauchesne (2017)	Social capital; social networks
46	Maskell and Malmberg (1999)	Knowledge creation; learning; RBV
47	Molina Morales et al. (2012)	Social capital; social networks
48	Montoro-Sánchez, Ortiz-de-Urbina-Criado, and Mora-Valentín (2011)	Knowledge spillovers
49	Moreno and Miguelez (2012)	Knowledge
50	Nooteboom (1999)	Economic evolution; cognitive science; RBV; TCT
51	Novelli, Schmitz, and Spencer (2006)	Cluster; networks
52	O'Gorman and Kautonen (2004)	Knowledge
53	O'Dwyer et al. (2015)	Cluster
54	Ozer and Zhang (2015)	Knowledge theories; innovation (exploitative x exploratory)
55	Pechlaner and Bachinger (2010)	Knowledge
56	Petruzzelli et al. (2009)	Knowledge management and acquisition
57	Pietrobelli and Rabellotti (2011)	Global value chain; innovation systems; knowledge management
58	Porter (2003)	Regional economic development; regional economies; economic performance of regions
59	Presutti et al. (2011)	Knowledge management; knowledge-based
60	Quintana-García and Benavides-Velasco (2005)	Dynamic capabilities; knowledge spillover
61	Rejeb et al. (2008)	Innovation theory
62	Romijn and Albu (2002)	IC
63	Sammarra and Biggiero (2008)	Knowledge
64	Saunila (2017)	Innovation theory
65	Schilling and Phelps (2007)	Clustering of firms
66	Schütz (2017)	Innovation systems
67	Silvestre and Dalcol (2009)	Custer theory; innovation systems
68	Spigel (2017)	Agglomerations
69	Strand et al. (2017)	Innovation capabilities
70	Ter Wal and Boschma (2011)	Cluster theory; evolutionary theory; industrial dynamics; network theory
71	Toivanen (2014)	Innovation theory
72	Ucler (2017)	Collaboration and innovation
73	Valkokari, Seppänen, Mäntylä, and Jylhä-Ollila (2017)	Innovation
74	Van Geenhuizen (2008)	Knowledge
75	Wannenmacher and Antoine (2016)	Knowledge management; tacit knowledge
76	Whittington et al. (2009)	Knowledge
77	Wonglimpiyarat (2006)	Porter's model for innovation; venture capital
78	Wonglimpiyarat (2010)	Porter's model for innovation
79	Xue (2017)	knowledge sharing, knowledge network, innovation in cluster
80	Yam et al. (2004)	IC
81	Yoon and Jeong (2015)	Cooperation
82	Yström and Aspenberg (2017)	Innovation
83	Zukauskaite (2012)	Knowledge economy; innovation networks

Table A1.