CLUSTER INNOVATION CAPABILITY: A SYSTEMATIC REVIEW

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ABSTRACT

Most studies on innovation capability analyze the firm level. Little efforts have been made to understand the interactions that take place in inter-organizational agglomerations and the capabilities that such arrangements retain. This study aims to develop a theoretical framework of cluster innovation capability. The academic production about innovation capability of clusters in the business field from 2005 to 2014 was analyzed and the databases consulted were: EBSCO, SCOPUS, and Web of Knowledge - 311 items were cataloged, 144 were available in full text, and among those 18 papers were selected. The cluster innovation capability was structured based on a theoretical framework through qualitative content analysis. Thus, acquisition capability, diffusing capability, and knowledge management capability are the main capabilities that constitute the cluster innovation capability.

Keywords: Innovation; Innovation Capability, Clusters, Innovation Capability of Clusters; Systematic Research.

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INTRODUCTION

Innovation is a critical factor for firms 'competitiveness (Dess, & Picken, 2000).Its undeniable relevance requires organizations to develop strategies to survive and to secure an advantage in the current scenario, marked by dynamism and hyper-competition. In this context, inter-organizational knowledge exchanges arise as an alternative to fill the firm's knowledge gaps and to help to innovate and enter to new markets.

Within that context, clusters sand out for being strongly related to the innovative potential of firms (Lai, Hsu, Lin, Chen & Lin, 2014). Several studies demonstrate that businesses belonging to geographical agglomerations tend to have a greater innovative capacity than the ones not within such arrangements (Porter, 1990, Baptista & Swann, 1998; Baptista, 2000). Due to this association of clusters and the firm's innovation, the subject has attracted the attention from scholars of management and organization fields (Pouder & John, 1996; Bell, 2005; Romanelli &Khessina, 2005; Sammarra & Biggiero, 2008; Arikan, 2009).

Although there is consensus towards the importance of innovation for the understanding of the firm's competitiveness evolution (Dodgson & Rothwell, 1994; Cassiolato & Lastres, 2000; OCDE, 2005), the reason why some of them do innovate and others do not, is still a point of discussion. In the light of such questioning, several studies support the assertion that firms have a set of capabilities to be innovative. Despite the theme on innovation capability have attracted the interest of several researchers (Guan, & Ma, 2003, Forsman, 2011; Zawislak, Alves, Gamarra, Barbieux, & Reichert, 2012; Zen & Fracasso, 2012), the literature on this matter is still incipient.

As regards cluster innovation capabilities, this gap is even greater. Thus, it appears appropriate and relevant to investigate the relationship between innovation capability and clusters in the recent literature.

Therefore, this article presents the following research objective: to develop a theoretical framework of cluster innovation capability. A systematic review was carried out seeking to reach this objective of verifying the relevance of this theme in the academy and the trends of continuity or progress on applicating the term (Borba, Hoeltgebaum & Silveira, 2011). Thus, the academic production on cluster innovation capacity in the area of business in the last ten years was analyzed.

The study contributions are: finding that few authors actually present proposals for clusters innovation capability; surveying of studies and their characteristics; listing of main approaches used and discussing the proposals presented. Finally, it introduces a theoretical framework suggesting that acquisition capability, diffusing capability, and knowledge management capability are the main capabilities that constitute the cluster innovation capability.

This paper is divided into four sections, besides this introduction. First, it presents a discussion about clusters, innovation capability, and the cluster innovation capability. Secondly, the methodological procedures, as well as the data collected, are introduced. The third section discusses the results and proposes a theoretical framework. At last, the final considerations are presented.

THEORETICAL BACKGROUND
Clusters

Clusters can be defined as geographical concentrations of interconnected industry firms that cooperate among themselves, creating competitive advantages on doing so (Porter, 1990). The pioneer study about this matter is by Alfred Marshall (1920), which brought the concept of industrial district, an agglomeration of small businesses in the same locality.

Marshall (1920) highlighted three factors that generate those businesses concentrations: availability of local supplies, qualified workforce and knowledge exchange.

The theme has grown in relevance, getting more prominence as it became noticeable

that geographic clusters were generating positive externalities (Becattini, 1990; Porter, 1990; Rocha, 2004). The central focus of researches included why the clusters exist, their main characteristics and how they could be supported by political initiatives (Isaksen, 2016). From that, it was possible to recognize a strong relation between innovation and clusters, since the firms in these agglomerations tend to be more innovative when compared to isolated ones (Marshall, 1920; Audretsch, & Feldman, 1996; Bell, 2005; Giuliani, 2010). Recent literature already associates the cluster concept to innovation (Engel, 2015).

Even after several studies, there is no consensus on the reasons why clusters are more innovative environments. Studies like those by Lawson (1999) and Maskell & Malmberg (1999) argued that what determined innovation within a cluster is its location.

However, more recent studies argue that it is not location, but the network formed in the cluster (Owen-Smith & Powell, 2004; Singh, 2005; Whittington, Owen-Smith, Powell, 2009).

Thus, it is obvious that comprehending how the knowledge transfer flowsin these networks is essential to understand how the innovation happens (Giuliani, 2005).

Last studies verified that the firms have different innovation capabilities according to their characteristics, trajectory and available resources (Tripplet al, 2015; Rufoni & Suzigan, 2012). Therefore, it is difficult to verify the reason why determined clusters and their firms are more innovative than others. That is why it is relevant and opportune to comprehend the innovation capabilities, which is next section subject.

Innovation Capability

Within the competitive context in which the firms are inserted, they need to develop certain capabilities to stand out from competitors. Such capabilities, as well as a combination of them, can make possible to promote innovation, be it in product, process, market and management. Several authors carried out studies seeking to understand the capabilities of innovative firms (Lawson & Samson, 2001; Guan & Ma, 2003; Yam et al.

2011; Zawislak, Tello-Gamarra, Alves, Barbieux, Reichert, 2013).

Lawson e Samson (2001) define innovation capability as the firm's ability to uninterruptedly transform new ideas and knowledge in new products, new processes and systems that will benefit both the firm and the stakeholders. On the other hand, Zawislak, Tello-Gamarra, Alves, Barbieux e Reichert (2014) consider that innovation sources come from four key capabilities, which form the innovation capability, these being: technological capability, managerial capability, operational capability and transactional capability.

All firms have those capabilities, but one of them will stand out from others, which will distinguish that firm and grantit with innovation capability (Zawislak et al., 2014).

In a more general context, Yam et al. (2011) understand that there are seven capabilities that determine a company's successful performance: Research and Development capability (R&D), capability to allocate resources, learning capability, manufacturing capability, organizational capability, marketing capability and strategic planning capability. Guan and Ma (2003) had also followed this line, presenting seven key capabilities to explain a company's competitive success: learning capability, R&D capability, production capability, marketing capability; organizational capability, resources exploitation capability and strategic capability.

Analyzing the capabilities presented by those authors, it is clear that there is no consensus on the matter. Also, these studies focus on the innovation capability of the firm, and there is no understanding of innovation capability for cluster. Therefore, next section will address issues that touch on this theme.

Cluster Innovation Capability

The innovation process and how it applies to the regional economic development is an important factor to improve regional economic vitality and competitiveness (Engel, 2015). Clusters emerge as innovation mechanisms, not only for firms within these agglomerations, but also for the territory in

which they are located (Porter, 1998; Schmitz, 1999).

The positive relation between firms inside clusters and their high innovation capability has called the attention of several scholars, however, a consensus has not yet been reached as to why these firms are more innovative than isolated ones. Recent studies point out that innovation occurs in a non-homogeneous way within these interactions, due to different capabilities of firms and clusters, their sets of resources and their trajectory (Giuliani, 2007; Lai *et al.*, 2014).

In such agglomerations the innovation capability is greatly related to the absorptive capacity(Cohen & Levintal, 1990).

Absorptive capacity is the ability to recognize the value of new, external information, assimilate it, and apply it, being the ability to evaluate and use the external knowledge associated to prior acquired knowledge (Bueno & Meirelles, 2012). So, it is obviously important that extra clusters relations exist to seek distinct knowledges, spread them within the cluster and make firms absorb and use them.

Many researchers associate the clusters innovation capability to the knowledge literature (Tallman, 2004; Giuliani, 2007; Bueno & Meirelles, 2012).That happens because within these geographical agglomerations the ability of exchanging experiences and technology among the agents is a differential and crucial factor to innovate. Added to this is the need for clustered firms to organize themselves to take advantage of this knowledge and turn it into a positive return, which is greatly related to the absorptive capacity at the firm and cluster levels (Giuliani, 2007).

In sum, there is an effort to comprehend the innovative differential of clusters and it seems that innovation capability could be an approach to facilitate such comprehension. Nonetheless, the specialized literature is still fairly recent and incipient, which makes opportune to verify how the relation between cluster and innovation capability has been addressed. Seeking to answer this proposed question, a systematic review was carried out and is described in next section about methodological procedures.

METHODS

A systematic review was carried out seeking to reach the objective of this study (develop a framework of the cluster innovation capability). Systematic review is understood herein as a research based on data from literature on a specific theme (Sampaio & Mancini, 2007).

This kind of research is useful to gather information about a particular kind of study, verifying both contradictory and similar results, so that it is possible to identify themes or gaps in the literature that need evidence, guiding future studies (Linde & Willich, 2003).

Three databases were used in this research: EBSCO, SCOPUS and Web of Knowledge. These databases were chosen because they are widely used in the academic field, have great reputation among scholars of administration in both national and international circles and have the main journals of the studied area indexed in their databases. Besides, the search from the databases grants greater impartiality to the process of choosing the articles to be analyzed.

The criteria to search the articles included: only scientific articles were considered, in the period from 2005 to 2014, and which focus on cluster innovation capability. Four search strings were used in the search:(a) *Innovation Capability in Cluster*; (b) *Innovation Capability in Clusters*; (c) *Innovation Capabilities in Cluster* e (d) *Innovation Capabilities in Clusters.*

At first, the data from articles found in the three databases were tabulated, organized by publication year, title, authors, journal, country, context and the main objective of each article.

Table 1 presents the number of articles found in the three databases.

TABLE 1

Total of catalogued articles

Database	N° of articles found
EBSCO	106
SCOPUS	104
Web of Knowledge	166
TOTAL	376

EBSCO had 106 articles, SCOPUS had 104 articles and Web of Knowledge had 166, totalizing 376 catalogued articles. Once a same article can be indexed in all databases, the first step was to compare the articles and eliminate recidivism. From the 376 articles, 65 were eliminated for this reason, decreasing the number of articles to 311.
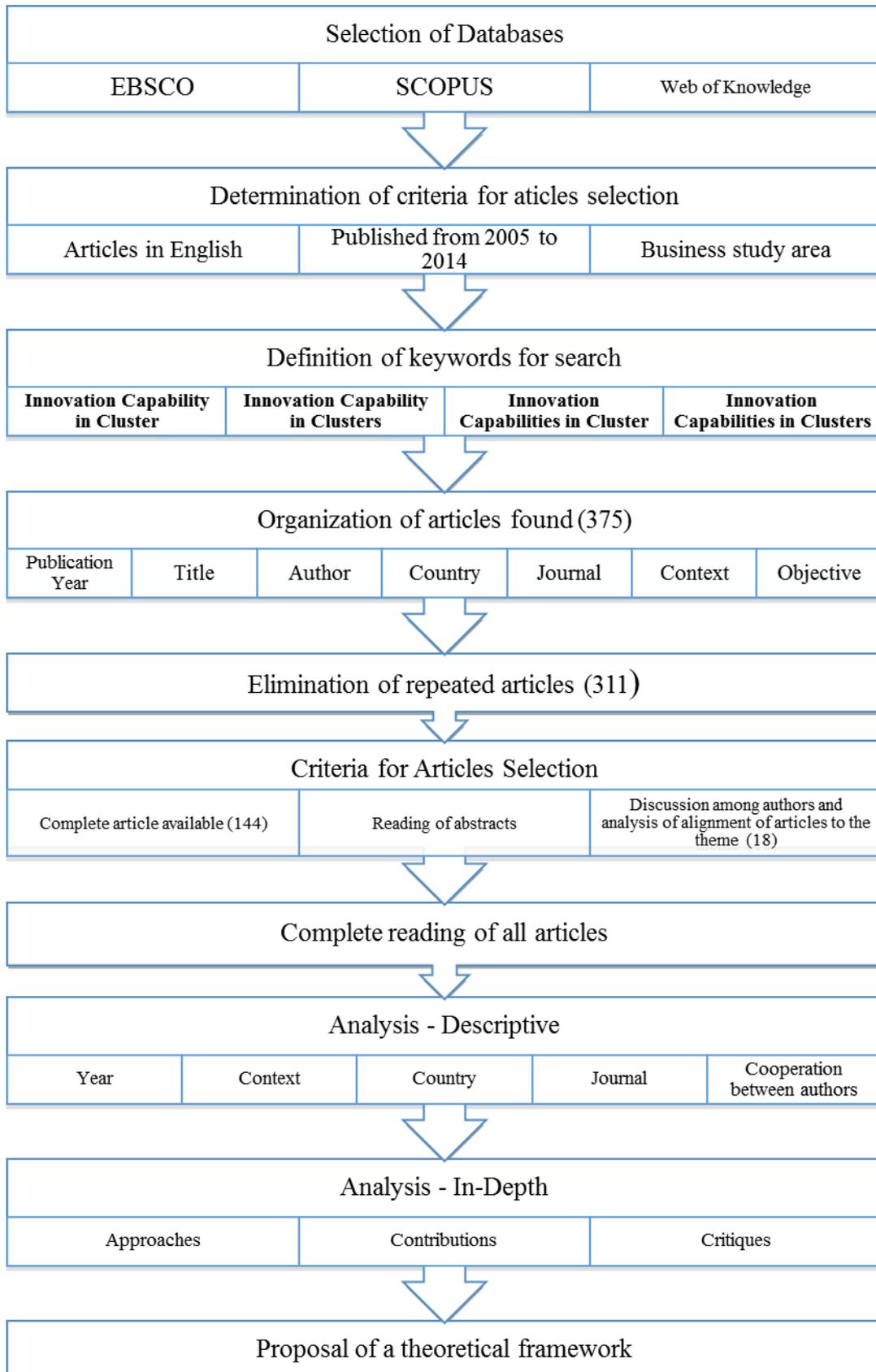
The selection mechanism of relevant articles followed three criteria. First criterion was to eliminate articles when the complete document was not available. Second criterion was that each researcher read all the abstracts of articles from one of the databases and pre-selected those which were actually relevant to the study. Third criterion was a discussion among the researchers to validate the selected articles that address the theme. So, it was possible to verify how the topic of cluster innovation capability is addressed in the literature.

After eliminating the articles without complete document, there were 144 articles to examine. From those, 18 articles that address the cluster innovation capability were selected. The selected ones were integrally scrutinized, and the data analysis was structured from them.

The analysis was organized in two stages: a descriptive step, in which issues such as year, context, country and journals are considered; and the second step is an in-depth analysis of the articles to understand which capabilities are present in the studied clusters and be able to propose a theoretical framework. Table 2 presents the research protocol used, with a step by step description of how this systematic review was performed.

Table 2
Research Protocol

Selection of Databases		
EBSCO	SCOPUS	Web of Knowledge

Determination of criteria for aticles selection		
Articles in English	Published from 2005 to 2014	Business study area

Definition of keywords for search			
Innovation Capability in Cluster	**Innovation Capability in Clusters**	**Innovation Capabilities in Cluster**	**Innovation Capabilities in Clusters**

Organization of articles found (375)						
Publication Year	Title	Author	Country	Journal	Context	Objective

Elimination of repeated articles (311)

Criteria for Articles Selection		
Complete article available (144)	Reading of abstracts	Discussion among authors and analysis of alignment of articles to the theme (18)

Complete reading of all articles

Analysis - Descriptive				
Year	Context	Country	Journal	Cooperation between authors

Analysis - In-Depth		
Approaches	Contributions	Critiques

Proposal of a theoretical framework

PRESENTATION OF DATA
Descriptive Analysis

From the systematic research of 144 articles, the study object of only 18 of them fit in the theme. Like already said, studies focused on cluster innovation capability are still incipient and with little expression within the academic field. This is clearly perceived through the small number of articles found in the three databases searched.

The volume of publications of studies focused on cluster innovation capability increased from 2010, representing 13 of the 18 articles. Figure 1 presents the distribution of articles from 2005 to 2014.
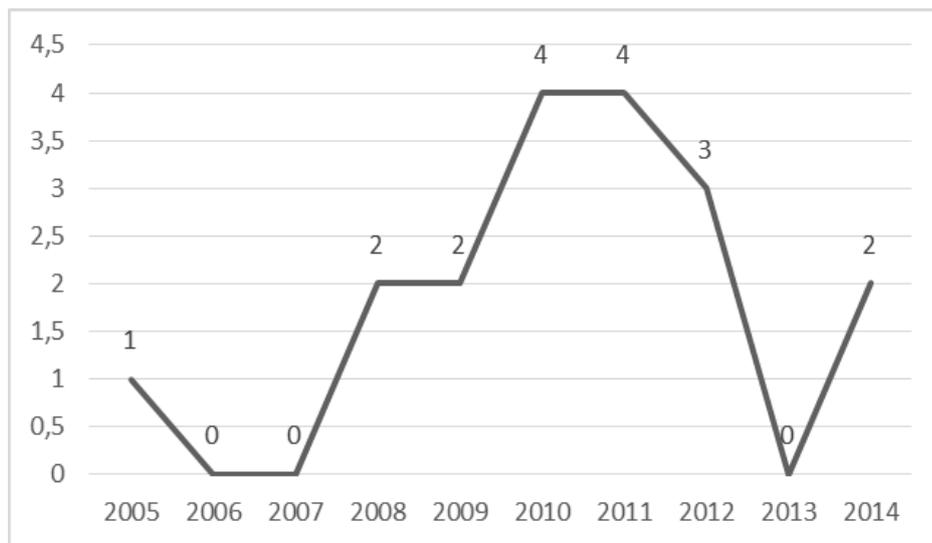

Figure1. Distribution of articles per year.

The greater concentration is in years 2010, 2011 and 2012, representing 12 articles. An abrupt decrease happened right after that, in 2013 (no production in the period) and there was a recovery of published studies in 2014.

These studies were carried out in several countries, including either developing countries such as Brazil and India, or developed countries, such as United States and Ireland. Countries focused in the researches are in three continents: Asia, America and Europe.

The American and Asian continents had more records, both with eight studies. Taiwan was the country with greater incidence of studies (three).

The articles were published in 16 different journals. The only journal with two articles published was International Journal of Innovation Management. The themes innovation and management are prominent in the lists of relevant subjects of these journals.

Several economic sectors were addressed in these articles. Among them were biotechnology, leather industry, mining, and others.

The sectors or areas that have been most prominent in these articles were the science parks, with three studies, and the software industry and the high technology sector, with two studies each.

Regarding cooperation between researchers from different universities located in different countries, seven articles presented this type of relationship. It is believed that cooperation between researchers from different institutions is important for the development of studies in the academic field. Table 3 presents this relation.

Table 3
Cooperation between researchers

Year	Title	Country of the study	Universities
2008	The role of venture capital firms in Silicon Valley's complex innovation network	United States	Ceram Business School (France); Stanford University (United States); Northwestern University (United States)
2010	From blind spots to hotspots: How knowledge services clusters develop and attract foreign investment	Brazil, Argentina and Mexico	University of Massachusetts (United States) Universidad de Navarra (Spain); Duke University (United States)
2010	Gatekeepers, knowledge brokers and inter-firm knowledge transfer in Beijing's Zhongguancun science park	China	University of Sussex (England); Cranfield University (England)
11	On How Firms Located in an Industrial District Profit from Knowledge Spillovers: Adoption of an Organic Structure and Innovation Capabilities	Lithuania	Universidad Jaime I (Spain); Universidade de Valência (Spain)
2012	High technology in emerging markets Building biotechnology clusters, capabilities and competitiveness in India	India	Willamette University (United States); Indian Institute of Management Lucknow (India)
2014	The effects of industry cluster knowledge management on innovation performance	Taiwan	Feng Chia University (Taiwan); University of Kaohsiung (Taiwan); Asia University (Japan)
2014	Capability accumulation, innovation, and technology diffusion: Lessons from a Base of the Pyramid cluster	Brazil	University of Winnipeg (Canada); Instituto Federal Fluminense (Brazil)

As shown, in the article *"The role of venture capital firms in Silicon Valley's complex innovation network"* there have been cooperation between researchers from three distinct Universities, two of them from the United States and the other researcher from France. Another interesting study was *"From blind spots to hotspots: How knowledge services clusters develop and attract foreign investment"*, which focused on Brazil, Argentina and Mexico, but involved researchers from Universities in the United States and Spain.

Other example of cooperation is in the article *"Capability accumulation, innovation, and technology diffusion: Lessons from a Base of the Pyramid cluster"*, carried out in Brazil involving cooperation between Canadian and Brazilian researchers.

Having presented data on some characteristics of the selected articles, the approaches used in the studies will be presented.

Main approaches

The approaches used in the analyzed studies are strongly related to knowledge, its absorption and exploration so that its correct use results in innovations. The following approaches were used in the analyzed articles: knowledge management, innovation networking, open innovation, innovation system, innovation capability, technological capacity, absorptive capacity, innovation measurement and resource-based view.

Knowledge Management was used as a theoretical basis in some articles because it plays an important role to a firm's innovative performance, which depends on the comprehension about the organizational information flows. That is also because innovation is related to the commercial applications of knowledge, as well as its application and exchange to generate organizational value (Porter, 1990). Besides, knowledge management makes possible to

predict uncertainties (Carrillo & Gaimon, 2004; Nonaka & Takeuchi, 1995). Thus, knowledge and innovation management are directly related to the network in which the organization is inserted, and can become stronger by knowledge sharing, creation of bridges between all those involved so that information can flow in the network (Ramirez & Dickenson, 2010). Significant positive impact can occur as a result of knowledge management concerning innovation performance either in a firm or in a cluster (Lai *et al.,* 2014).

As for **innovation networking**, the importance of open innovation for knowledge and experiences exchange between those involved was emphasized (Chesbrough, 2012). In the clusters case, geographical proximity allows a knowledge exchange relation and creation of alliances and partnerships (Wu, Gu & Zhang, 2008). Networking capability is considered as a fundamental element for the development of production, investments and, consequently, for the innovation capability of a firm or cluster, as it contributes to the refinement and improvement of the firm's abilities to enjoy and exploit all the benefits of its network (Lai, *et al*., 2014).

The topic **open innovation**, related to the networking capability, was also addressed as a theoretical basis. This approach argues that for an improvement process in a firm's innovative performance, it is essential to use the network of all agents with which it is possible to work, that is, buyers, suppliers, universities and research institutes (Chesbrough, 2012). This theory was used to explore the relationship between the cluster players in the innovation process.

The **innovation systems** were also used as a theoretical framework. The proximity of the involved agents in an innovation system, which can transcend geographical borders, helps on knowledge transfer, effectiveness and on costs of technological transfer. Besides that, public policies play a fundamental role for the effectiveness of innovation systems, once the system can be encouraged and strengthened by infrastructure such as education and scientific and technological institutions (Giuliani, 2005).However, the benefits of an innovation system can be perceived by firms if they have

research and development capability(R&D) and absorptive capacity, being able to transform the knowledge that flows between the available channels within the cluster into something tangible, if they are able to innovate(Cohen & Levinthal, 1989).

The companies benefit with this, especially small ones, because they learn from each other. The concept of interactive learning arises in this context and deals with the process of acquiring knowledge through collaboration with other agents of the system (Lundvall, 1992).The clusters literature also addresses the spillovers, which are catalysts of technical and specialized knowledge, both the creation and the dissemination. The exploration and the creation of knowledge value are facilitated through the spillovers (Montalvo, 2011).

Innovation capabilities are also recurring points in the articles, defined as abilities to develop new products, apply technological processes in these new products, develop and adopt new processes and respond to competitors' activities. So, it is an important organizational asset (Adler &Shenbar, 1990; Guan & Ma, 2003). Other subject addressed under the topic about capabilities is innovation **technological capabilities**, which are related to the capacity to acquire technological knowledges and exploit them, creating new technologies, developing new products and processes (Lall, 1993; Kim, 1999; Cho & Lee, 2003). Four elements compose the technological capability: production capacity, investment capacity, innovation capacity and networking capacity (Amsden & Hikino, 1994).

Absorptive capacity was also addressed. It is understood as the ability of a firm to perceive value in the available knowledge, acquire it, assimilate it and transform it, applying it for commercial purposes (Cohen & Levinthal, 1990; Todorova & Durisin, 2007).The capacity to absorb knowledge, both from the people who are part of the organizational environment and from the organization, depends on the knowledge base already acquired, that is, it is a cumulative capacity built up through experiences and the knowledge accumulated from them. Moreover, it is not only the firm's ability to retain knowledge, but the ability to

exploit acquired knowledge that matters (Cohen & Levinthall, 1990).

The **technology diffusion** approach was also used, referring to how innovation flows through the members of an innovation system. As in the case of absorptive capacity, diffusion is also related to the way organizations, when interacting to each other, interpret and manipulate technologies. So, it is a successful process in the case of clusters for adoption of new technologies. The role assumed by agents of change, that help in the promotion and diffusion of new technologies, is highlighted in this context (Silvestre & Silva-Neto, 2014).

Innovation measurement was another theoretical framework used in the articles. The innovation measurement is essential for the innovation and competitive strategy of the firm and so that the knowledge generated in the process is not lost (Alijani, 2009).

The **resource-based view** (RBV) was an approach also used. Such a view takes into account that each firm has its specific

After reviewing the main theories addressed in the studies, it is possible to analyze the construction of the knowledge about clusters innovation capability throughout the analyzed period. Concerning contributions, it was possible to perceive several aspects about firms and clusters regarding innovation and how it occurs. The more complete the resources of an industrial cluster are, the greater the vertical sharing of resources is and, consequently, the creation of knowledge, its acquisition, its storage and its diffusion. The acquisition of resources and information through industrial clusters offers companies a more frequent interaction of knowledge exchange with various agents such as government, universities and companies. This may result in innovation and better organizational performance, as these firms can easily acquire resources that they would not be able to achieve if they were outside a cluster. As a result, reducing costs through infrastructure, knowledge and shared methods is also a benefit due to being part of an agglomeration of companies. In addition, knowledge management plays a key role in fostering innovation as well as measuring innovation (Lai, *et al.,* 2014)

capabilities and resources, which are built rather than simply acquired. In his seminal paper, Barney (1991) states that each firm has unique competitive advantage resources, such as human, organizational, financial, and physical (Ahn, Hajela & Akbar, 2012).Thus, knowledge flowing with no barriers within a district is not symmetrically distributed, what explains the competitive advantage of some companies and their permanence in an advantageous position compared to others. It is an approach with a look inside the firm, the internal resources and their characteristics (Penrose, 1959; Cohen & Levinthal, 1990; Malmberg & Maskell, 2002).

After highlighting the theories and approaches explored in the selected articles, next section presents the contributions brought by the articles, critiques and divergences of concepts. Finally, the cluster innovation capability framework is proposed.

DISCUSSION OF RESULTS
Contributions and Criticisms

Clusters are important sources of attraction and retention of talent, which enrich the information and knowledge exchange network. Firms in clusters may have competitive advantages and better innovative performance, mainly when there is a relation with scientific parks and universities, which are important sources of knowledge (Lai, *et al.,* 2014; Manning, Ricart, Rique & Lewin, 2010).

With respect to network management and organization capabilities, cultural issues such as language and customs of other countries are very important to access opportunities through international partners as well as knowledge exchange (Manning, *et al.,* 2010).

Venture capital firms in clusters, for example, expand the range of access possibilities for firms, including in their network access to agents such as large companies and laboratories, fundamental players to the competitive advantage of firms, through the diffusion of knowledge, and to the cluster robustness (Ferrary & Granovetter, 2009).In addition, it is necessary that the whole network of the cluster assists in the exchange of knowledge for learning (Wu, Gu & Zhang, 2008). However, support mechanisms should not focus only on large firms, but especially on small ones, which have

greater difficulties in absorbing and assimilating knowledge (Forsman, 2009).

It shall be noted that the technologies adopted by only one or some firms within the cluster do not assist in the development and exchange of internal knowledge if there is no diffusion of these restricted technologies. Quite the opposite, this could contribute to the exclusion of those who remain at the margin (Silvestre & Silva-Neto, 2014).As far as knowledge diffusion is concerned, spillovers have a very important function (Gachino, 2010).

However, the diffusion process can be flawed by several factors, such as the existence of additional barriers, for example, high level of informality and financial pressures, as well as the awareness level of support organizations in relation to diffusion processes, promoted policies and their consistency (Hervas-Oliver & Albors-Garribos, 2009).

Clusters are of fundamental importance in developing countries, as they help to foster the productive base, generate value for their regions and attract talent (Wu, Gu & Zhang, 2008). Thus, it is important that governments can understand the knowledge dynamics of clusters so that they can create more conscious and effective policies (Manning, *et al.*, 2010; Montalvo, 2011) through a development strategy, considering factors such as local attractiveness and incentive laws (Alijani, 2009).An approach encompassing both the industrial and regional spheres and scientific and technological policies would assist in building and solidifying capabilities (Ryan & Giblin, 2012).

For Ryan and Giblin (2012), policies are very focused on the development of distinct industrial sectors and are insufficient to ensure future growth. In addition, government plays an important role in providing critical infrastructure for talent generation and renewal, through universities and schools, for example (Ahn, Hajela & Akbar, 2012). That is because the ability to absorb and generate value through the knowledge that a cluster has is related to the capacities of the people who make up the cluster.

According to Huang, Yu and Seetoo (2012), small companies can get more benefits for being part of clusters than large enterprises.

This is because although firm size has a positive relationship with innovative performance, small firms can improve their innovative performance when located in industrial parks or spontaneous clusters.

So, it is noticeable that despite the capacities of large companies, the small ones can benefit much more by being in clusters, precisely by the available access, which in part is already possessed by the large ones even outside clusters.

Finally, without efforts to sustain organizational capabilities, the competitive advantage of a cluster will not be achieved (Alijani, 2009). So, managerial and strategic analysis has a positive impact on innovative performance, especially when the company is aware of its capabilities.

Approaches such as RBV help in this organizational awareness, since it also works all internal aspects of the firm (Tsai & Tsai, 2010; Hervas-Oliver & Albors-Garrigos, 2009).

Studying the considerations made by the authors in the articles, it is noticeable that the works analyzed in this 10-years period work the innovation much more focused on firms within clusters, neglecting the external factors that contribute to make the clusters more innovative, which is the main focus of this work.

It was clear that the literature on clusters innovation capabilities is still incipient, being necessary more studies on which capabilities and approaches make certain clusters more innovative. One theory that could be well applied in this study focus could be the RBV, because it analyzes competitive advantage, a clue to understand why some clusters are more innovative than others.

Another aspect that arose from the articles is confusion of concepts, mainly between innovation process and innovation capabilities. Even the concept of innovation capability is not clear yet; there is no consensus.

The studies of innovation in clustered firms address, mainly, knowledge management in the firm and absorptive capacity that is innovation acquisition and diffusion, in clusters.

The role assumed by the government was studied with focus on regional level of each country or region. The importance of the

economic growth was discussed using the cluster as a strategy. However, few suggestions on how to enhance and encourage clusters were listed.

Also, there was no evolution in the concept of innovation capability along these ten years. Some studies analyzed some capabilities alone, such as technologic and absorptive capability, or issues as R&D, but few really contributed to the concept consolidation and identification of capabilities that encompass the clusters innovation capability. Also, few models were presented.

Most studies were more focused on the case studies than on proposing models about the factors that involve innovation capability. Thus, based on the theoretical contributions listed and related critiques, this article presents a cluster innovation capability framework.

Framework

Few of the authors presented a framework of cluster innovation capability in the analyzed articles. Therefore, this study presents the frameworks found in the literature and develops a framework that synthetizes them.

Sivestre and Neto (2014) argue that the cluster innovation capability is divided into two capabilities: technologic development capability and technologic diffusion capability. The following aspects are listed in the technologic development capability: promotion of new technologies by support organizations; the process that emphasizes the organizational capabilities; the importance of the social capital and social network; the adoption rates among the firms involved; the number of firms using the technology in the cluster.

Under technologic diffusion capability, the authors point as important elements: the interaction between firms and support organizations; the process that emphasizes technological capability; the importance of infrastructure for the development of technology.

In the same sense, Damanpour and Wischnevsky (2006) divide cluster innovation into two similar phases: innovation generation and adoption. Generation is separate from adoption at a point in which the diffusion

process of innovation among potential adopters begins.

Adoption is a problem-solving process consisting of initiation and implementation phases. The process of innovation development can be described as random and emergent, in nature characterized by variation, research, experimentation and discovery, whereas adoption is a planned process based on a sequential progression characterized by selection, refinement, choice and execution.

Broadening this view, Wu, Gu and Zhang (2008) bring cycles with four capabilities: acquisition, assimilation, internal diffusion and improvement and synergy. The authors further argue that companies go through three specific phases, transactional and fluid, and that the country in which the cluster is located also influences the innovation capability.

Forsman (2009), which also advocates four dimensions of innovation capability, presents different elements from the others. For the author, clusters have entrepreneurial capability, network capability, internal knowledge capability and managerial capability. Entrepreneurial capability consists of skills to identify opportunities, willpower (connection to strategy), risk-bias, abilities to crystallize goals, and skills to balance them with resources (Forsman, 2009).

Network capability refers to relationship orientation, receptivity to learning across the network, skills and intentions to internalize skills and ability of partners to build and maintain trust between partners (Hamel, 1991).

The internal knowledge capability strengthens the ability to modify and adapt external knowledge and facilitates its transformation into combinations with new knowledge. Finally, managerial capability consists of management and leadership skills, including project and change management skills (Forsman, 2009).

At last, Lai *et al.* (2014) bring a new vision, since they divide the cluster innovation capability into three: cluster capability, knowledge management and innovation performance.

Under cluster capability, the authors list the clusters resources and their relationships. Knowledge management is divided into

knowledge creation, acquisition, diffusion and storage. And innovation performance encompasses market performance and product performance. In addition, each capability has several sub-items that helped the authors to measure their research.

Based on these models it is possible to perceive that many capabilities presented are similar between the approaches. In addition, some authors bring capabilities that span multiple condensed abilities in one or for similar purposes. Thus, this work sought, from this survey, to establish the main capabilities present in the cluster that constitute its innovation capability. From these capabilities and the proposals extracted from the studies, a framework of cluster innovation capability was conceived, as seen in Figure 2.
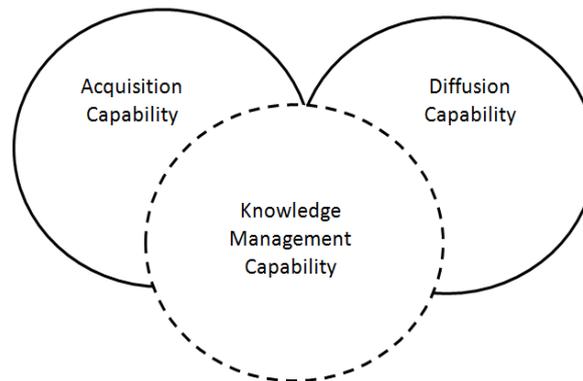
Figure1. Cluster Innovation Capability Framework

Table 4 presents, from what was discussed in the selected articles, the cluster capabilities that constitute its innovation capability. These capabilities were organized into three main groups: acquisition capability, diffusion capability and knowledge management capability.

Table 4

Clusters Innovation Capability

Capabilities	Description
Acquisition Capability	Technological Capability
	Technological Development
	Generation of Innovation
	Entrepreneurial Capability
Diffusion Capability	Absorptive Capacity
	Technological Diffusion
	Internal Diffusion
	Network Capability
	Capability to Access Talent
	Capability to Access Market
	Transactional Capability
Knowledge Management Capability	Innovation Adoption
	Assimilation
	Improvement
	Sinergy
	Internal Knowledge

Managerial Capability
Learning during interactions of the technologic process
Interaction, collaboration and learning Capability
Capability to explore acquired knowledge

The capture and development of knowledge and technologies have been well addressed by the models and presented as essential for the innovation capability. Thus, the acquisition capability would encompass these abilities, and could be related to the technological development (Silvestre & Silva-Neto, 2014), the generation of innovation (Damapour & Wischnevsky, 2006) and entrepreneurial capability (Forsman, 2009).

With predisposition to innovate and search for external knowledge, it is possible to bring the necessary inputs to generate changes in the clusters and, thus, to make it more competitive.

In addition, it is not enough for a firm to acquire knowledge and technologies, without transmitting and involving the other firms in the cluster, thus, diffusion capability is necessary. Diffusion capability is strongly related to technological diffusion (Silvestre & Silva-Neto, 2014), internal diffusion (Wu, Gu & Zhang, 2008) and network capability (Forsman, 2009). This exchange is only possible through collaboration between firms, which allows access to new markets and external technologies, accelerating the product to market and the exchange of complementary skills (Ryan & Giblin, 2012).

Finally, besides the acquisition and diffusion capability, the importance of the knowledge and its management in the clusters was emphasized, since a change can only be considered innovation when results value generation. In this way, knowledge management capability would encompass the capabilities to innovation adoption (Damapour & Wischnevsky, 2006), assimilation, improvement and synergy (Wu, Gu & Zhang, 2008), internal knowledge and management (Forsman, 2009),and knowledge management (Lai *et al*., 2014).

Therefore, this capability supports the cluster in relation to the other capabilities, being the ability to manage what is acquired and transmitted.

FINAL CONSIDERATIONS

This study aimed to develop a theoretical framework of cluster innovation capability. A systematic review was carried out using the literature about a specific theme as the data source (Sampaio & Mancini, 2007). Three databases were used in the research: EBSCO, SCOPUS and Web of Knowledge, since they are databases widely used in the academic scope. Within the three databases, 376 articles were found, of which 65 were eliminated because they were repeated in the databases, reducing the number of articles to 311. Of this total, after being filtered, 18 articles were really suitable to be analyzed and used in this study.

Based on the analyzes, cluster innovation capability is a subject that, although relevant, is still incipient in the literature. Few authors actually proposed models of cluster innovation capability. That is why this work sought, from the models found and the literature studied, to propose a theoretical framework that adds to the others.

Several capabilities presented are similar among the several approaches. Furthermore, some capabilities listed by some authors encompass various abilities condensed into one or have similar purposes. So, a framework was developed based on three main capabilities: acquisition capability, diffusion capability and knowledge management capability.

Acquisition capability refers to the capture and development of knowledge and technologies and may be a capability related to technological development (Silvestre & Silva-Neto, 2014), innovation generation (Damapour & Wischnevsky, 2006), and entrepreneurial capability (Forsman, 2009). Through predisposition to innovate and search for external knowledge, clusters can become more competitive.

But it is not enough to acquire knowledge and technologies, if there is not a diffusion between firms, then, the importance of

diffusion capability is emphasized. This capability is related to technological diffusion (Silvestre & Silva-Neto, 2014), internal diffusion (Wu, Gu and Zhang, 2008) and network capability (Forsman, 2009). This exchange is only possible through collaboration between firms and the consequent exchange of complementary competences (Ryan & Giblin, 2012).

Finally, the third and final capability would be knowledge management capability, since the importance of knowledge and its management in the clusters was rather emphasized in the works. This capability would include innovation adoption capability (Damapour & Wischnevsky, 2006), assimilation, improvement and synergy (Wu, Gu and Zhang, 2008), internal knowledge and management (Forsman, 2009) and knowledge management (Lai *et al*. 2014). Therefore, this capability supports the cluster in relation to the other capabilities, being the ability to manage what is acquired and transmitted.

This study brings three contributions to the literature on clusters and innovation capability. As the first and main contribution, there is the proposed theoretical framework that allows to understand the cluster innovation capability, which is still an incipient subject in the literature, especially concerning clusters. The second contribution is the study of innovation capability and cluster and the discussion about the approaches used to explain this phenomenon. With this information it is possible to identify how the theme is behaving and to understand the contributions and the critiques emerging from the subject.

As a third contribution, there is a series of insights that have been raised in the literature to better understand the relationship between clusters and innovation. Among them, one that deserves emphasisis that public policies cannot be neglected. A better understanding about the factors that lead to the success of a cluster should be observed by the decision makers so that the policies adopted are the most correct to foster the development of agglomerations. In addition, another very important government role is to provide adequate infrastructure so that clusters can grow and the renewal and emergence of talents that make up the clusters

can continue. This is important because the cluster ability to absorb and generate knowledge is related to the capacity of the people who compose it.

In addition, clusters are of fundamental importance in developing countries, since they help to foster the productive base, generate value for their regions and attract talent (Wu, Gu & Zhang, 2008). According to Huang, Yu and Seetoo (2012), small firms can get more benefits for being in clusters than large enterprises. As far as knowledge diffusion is concerned, spillovers have a very important function (Gachino, 2010).

The present study also brings managerial contributions since it seeks to guide cluster managers to understand and maximize the agglomeration's innovation capability. Also, it seeks to assist public managers in the development of public policies for regional development. It is worth mentioning that the limitation of the study was the exclusively theoretical basis with secondary data collected only from three databases. Furthermore, due to the emergence of the thematic, the proposed framework is still an initial discussion, not feasible to being generalized, but rather, used as a basis for future studies.

In this sense, new research may deepen the use of this theoretical framework in empirical works. Initially, exploratory work and comparative studies between developed and developing countries are recommended. Based on these qualitative studies, it would be possible to propose a measuring scale of cluster innovation capability to carry out a research of confirmatory nature.

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