

Similarities and differences between absorptive capacity and appropriability: a bibliometric perspective

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Abstract

Purpose – This study aimed to examine the similarities and differences between the ability to analyze the environment and exploit new knowledge (absorptive capacity) and the skills to generate value from innovation (appropriation). These fields have similar origins and are sometimes confused by practitioners and academics.

Design/methodology/approach – A review was conducted based on a full-text analysis of 681 and 431 papers on appropriation and absorptive capacity, respectively, from Scopus, Science Direct and Lens, using methodologies such as text mining, backward citation analysis, modularity clustering and latent Dirichlet allocation analysis.

Findings – In business disciplines, the fields are considered different; however, in other disciplines, it was found that some authors defined them quite similarly. The citation analysis results showed that appropriation was more relevant to absorptive capacity, or vice versa. From the dimension perspective, it was found that although appropriation was considered a relevant element for absorptive capacity, the last models did not include it. Finally, it was found that studies on both topics identified the importance of appropriation and absorptive capacity for innovation performance, knowledge management and technology transfer.

Originality/value – This is one of the first studies to examine in-depth the relationship between appropriation and absorptive capacity, bridging a gap in both fields.

Keywords Absorptive capacity, Appropriation, Appropriability, Bibliometrics, Clustering analysis, Backward citation analysis

Paper type Literature review

Introduction

Cohen and Levinthal (1990) defined absorptive capacity (AC) as “the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends.” Appropriation is a concept that has some sub-definitions. Appropriation has been defined as a “firm’s ability to benefit from its resources and capabilities” (Milesi *et al.*, 2013; Teece, 1988). The appropriability regime (a sub-concept of appropriation) was defined by Teece (1986) “as the



environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation." Value appropriation (another sub-concept) is defined as "the share of exchange rent a focal firm can capture" (Gulati and Wang, 2003). Appropriation capability (another sub-concept) is known as "firms' ability to protect their novel intellectual property" (Leiponen and Byma, 2009; Reitzig and Puranam, 2009). Finally, Hurmelinna-Laukkanen and Yang (2022) introduced the concept appropriation potential, which they defined "as an innovator's potential to benefit from innovation. This potential builds on the instruments of appropriability—isolating appropriability mechanisms and complementary assets—that afford the innovator control over the innovation." They further asserted that appropriation is realized when "innovators realize benefits in the form of private and social returns in processes employing the instruments of appropriability." This study condensed these four concepts into appropriation (KA).

AC and KA are fields that have evolved together. For instance, AC seminal models include KA as an important factor that influences the AC process. AC has been recognized as a multidimensional process (Knoppen *et al.*, 2022), and some authors have defined KA as a dimension of AC (Thomas and Wood, 2014). In addition, some authors have used similar methods to measure each. For example, KA mechanisms as intellectual property have been used to measure AC (Appio *et al.*, 2019; Arbussà and Coenders, 2007; Bahl *et al.*, 2021; Barros, 2021; Malik *et al.*, 2021; Milesi *et al.*, 2013; Rey *et al.*, 2021; Spithoven and Teirlinck, 2015).

Some authors have studied the benefits of AC and KA when these are together. For instance, Cenamor *et al.* (2019) analyzed the roles that KA mechanisms and AC play in knowledge exchange and their positive impact, and Aliasghar and Haar (2021) identified the importance of KA and AC over knowledge capacity and performance. In addition, regarding KA mechanisms and AC, some authors have studied the impact of patent stock on AC (Shuwaikh and Dubocage, 2022).

Furthermore, a large body of literature has shown the significant individual benefits of AC and KA regarding relevant topics such as innovation (Lyu *et al.*, 2022; Sarsah *et al.*, 2020), entrepreneurship (Ejdemo and Örtqvist, 2020; Miller *et al.*, 2021), knowledge spillovers (Alnuaimi and George, 2015; Duan *et al.*, 2021), small and medium enterprises (Cassia *et al.*, 2020; de Zubielqui *et al.*, 2016) and green innovation (Marrucci *et al.*, 2021; Vokoun and Jílková, 2020). In addition, some authors and practitioners have defined KA quite similarly to AC or have defined KA models similar to AC (Benamar *et al.*, 2020; Carroll *et al.*, 2003).

To the best of our knowledge, there is a lack of studies analyzing the relationship between AC and KA as well as its importance in innovation and value generation. Some authors have identified this gap in the literature. For instance, Da Silva Florencio and De Oliveira (2022), in their review, encouraged research on KA and AC in technology transfer processes. Moreover, Chaparro *et al.* (2021) showed the importance of having KA in AC, specifically in start-ups.

Hurmelinna-Laukkanen *et al.* (2012) showed the relevance of studying the AC and KA relationship. In addition, regarding KA, Sun and Zhai (2018) showed the relevance of performing a deep study of KA and AC, indicating that "the discussion about the relationship of appropriability and absorptive capacity is the other hotspot in this field," and defining AC as a key element of KA considering the number of papers and citations. However, few studies have performed an in-depth comparison of AC and KA to clarify their similarities and differences and to determine whether they can be considered the same or part of the other. Therefore, we conducted a systematic review in which we deeply compared AC and KA, comparing the dimensions of each field, analyzing the literature on both areas and identifying trends in these scientific papers.

The outline of this review is as follows:

The research methodology presents the research questions, databases, queries and analysis methods. In the "findings" section, we answer specific questions formulated to

understand the differences and similarities between AC and KA. Next, we present a discussion and main conclusions of the outcomes. Finally, we present the limitations and recommendations of this study.

Research methodology

We conducted a systematic review based on a bibliometric analysis (Castaneda and Cuellar, 2021). We followed Testa *et al.*'s (2021) framework, making some adaptations considering the nature of our study. The steps developed in this study were as follows.

- (1) Establishing the review questions and protocol
- (2) Downloading full text regarding AC or KA
- (3) Identifying documents focused on AC and KA, employing inclusion and exclusion criteria
- (4) Identifying scientific papers relevant to each research question

Research questions and protocol

To establish the similarities and differences between AC and KA, we defined the following research questions:

- RQ1. What are the similarities and differences between KA and AC in terms of their definitions?
- RQ2. Do AC and KA have the same foundations?
- RQ3. Can KA be considered a dimension of AC?
- RQ4. What papers have studied KA and AC and what were their subject matters?

Downloading full text regarding AC or KA

To answer the research questions, we used two strategies. RQ1, RQ3 and RQ4 were answered based on full-text analysis, and RQ2 was answered using the citation information recovered using bibliographic information, specifically backward citation data.

We started by identifying databases that allowed us to download full-text documents. We identified Science Direct as a data source, as it permitted the download of mostly full-text papers. Furthermore, we downloaded Scopus and Patent Lens full-text papers that could be recovered from these resources.

Our search query for AC literature was “absorptive capacity,” and that for KA literature was appropriability OR “knowledge appropriation” in titles, abstracts and keywords. We did not limit the search based on the year of publication to obtain all relevant literature to understand both topics. The subject categories were also filtered for management, accountancy and social sciences to recover only the scientific papers that were key to this investigation.

We used the PDF exportation option from Science Direct and Scopus to download full-text papers. However, Patent Lens does not allow automatic download of PDF documents; hence, we built a program based on web scraping (Open web Scaper, 2021) to recover PDFs from this database. For backward citation analysis, we used bibliographical information recovered from Scopus and Lens. We started working with 681 and 431 full-text papers on KA and AC, respectively. We used R to convert PDFs into text, especially the Tabulizer library (Leeper, 2018). This tool processes PDFs without changing the document structure. Finally, we filtered duplicated records using the string matching tool and the duplicate row filter from Knime.

Inclusion and exclusion criteria

We started by identifying scientific papers that focused on AC or KA. The strategy for this was to identify papers that had more than five key terms in the text. To identify these documents, we used the Knime R tool “R Snippet.” Furthermore, the GetCount function from the stringR package was applied to obtain relevant scientific papers for their term frequency (Datacamp, 2019). Consequently, the data set decreased to 368 and 410 for KA and AC, respectively. An example of the code used is shown in Figure 1.

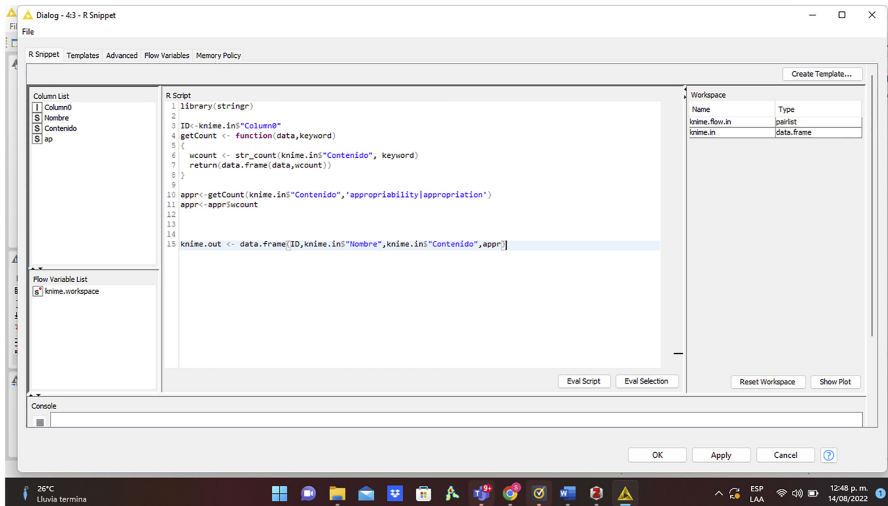


Figure 1. R code used in Knime for filtering scientific papers focused on AC and KA

Identifying scientific papers relevant to each research question

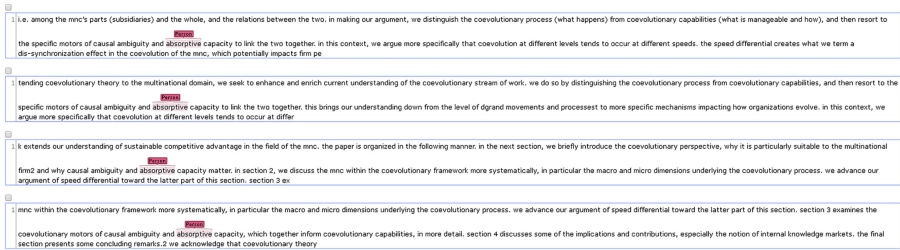
To answer RQ2, we performed a bibliometric analysis of backward citations (Castaneda and Cuellar, 2019). This analysis was performed using bibliographic information of the data set obtained in the last step of the methodology. RQ1, RQ3 and RQ4 were answered using full-text analysis. To identify the scientific papers that could help us answer these questions, we used the GetCount function of R in Knime. We split the documents using the sentence extractor node (Tursi and Silipo, 2019) and selected phrases related to our research questions. Table 1 shows the keywords used to identify relevant documents for each research question.

We manually identified and selected the scientific papers that were most relevant to each research question. To review these documents, we split the documents into sentences. To read the sentences, we used the “Tagged Document Viewer” tool from Knime. An example of this visualization is shown in Figure 2.

Research question	Keywords
RQ1	Define OR definition
RQ3	Dimension OR mechanism (only for KA) OR step
RQ3	(Acquisition OR assimilation OR transformation OR exploitation OR potential OR realized) NEAR/4 (“absorptive capacity” OR AC OR ACAP)
RQ3	“Intellectual property” OR patent OR “formal mechanism” OR “informal mechanism” OR “legal instruments” OR brand OR secrets OR trademark
RQ4	(“absorptive capacity” OR AC) NEAR/7 (appropriability OR “knowledge appropriation”)

Table 1. Query strategies to recover information regarding each research question

Figure 2.
Text revision using
Knime tool



Because of the huge volume of phrases found, bibliometric analysis – specifically cluster analysis – was the most appropriate method to analyze this volume of information and identify patterns (Castaneda and Cuellar, 2021). Semantic analysis was performed to answer RQ4. This analysis was carried out to analyze all phrases regarding both topics (AC and KA). To identify the most relevant terms, we normalized the words using different criteria. The main terms and phrases were obtained using the N-gram tool of Knime, which allowed us to obtain two-word sentences. To identify the main trends, we created a data cleansing process that merged similar terms.

Data cleansing was performed using the WinPure data cleansing tool and Tableau Desktop group creation software. Data analysis was conducted using the Knime Lda and T-sne nodes (Choo *et al.*, 2013) and the Vosviewer modularity clustering tool (van Eck and Waltman, 2010), which facilitated the identification of patterns in the data and synthesized the data set. Figure 3 shows our analysis framework.

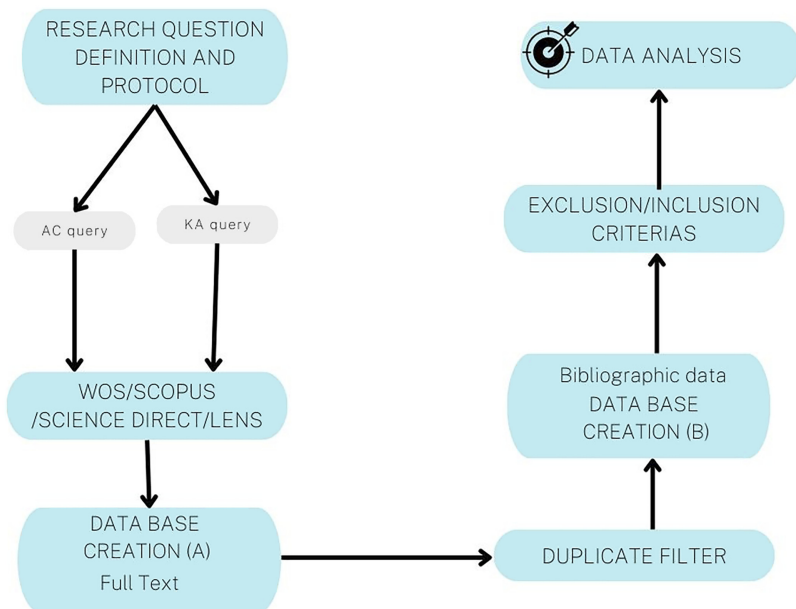


Figure 3.
Data frame used in this
research

Source(s): Inspired by Testa *et al.* (2021)

Findings

RQ1: What are the similarities and differences between KA and AC in terms of their definitions

AC is a field that emerged from management. [Cohen and Levinthal \(1990\)](#) introduced the concept of AC as the ability to exploit external knowledge and the capability to use it. They divided the AC process into four stages: knowledge acquisition, knowledge assimilation, knowledge transformation and knowledge exploitation. [Zahra and George \(2002\)](#) reconceptualized and essentially advanced the definition, dividing the process into two main steps: potential AC and realized AC. Potential AC comprises knowledge acquisition and assimilation, and realized AC comprises the transformation and exploitation stages. Potential AC is related to searching for knowledge that may be useful to a company and sharing it within the organization. Potential AC utilizes this new knowledge along with the organization's prior knowledge and exploits it via innovations, new processes or new business models. Another important contribution of the authors is that AC is a dynamic capability ([Tece et al., 1997](#)), meaning that it is a set of routines and tasks that the company learns. [Arbussa and Coenders \(2007\)](#), with an approach similar to that of [Zahra and George \(2002\)](#), divided AC into scanning the environment and the KA of the knowledge acquired. [Lane et al. \(2006\)](#) performed an extensive review of the literature, identifying the main contributions of relevant studies, and developed a model of AC. They based their investigation on a comprehensive bibliometric analysis and identified the main focus of the literature on AC. They identified papers that made a real contribution to state-of-the-art and the most important subtopics: AC innovation and organizational learning AC. Subsequently, they redefined AC as a "firm's ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning." [Lane and Lubatkin \(1998\)](#) reconceptualized AC based on strategic alliances. They developed the concept of relative AC in their research and identified different learning mechanisms. They concluded that the acquired skills were close to their capabilities for seeking new knowledge. [Jansen et al. \(2005\)](#) reexamined [Zahra and George's \(2002\)](#) potential and realized AC and analyzed the effect of organizational antecedents on them. Other authors reconceptualized the AC concept, emphasizing the recognition of the value phase, social mechanism and power relationships ([Todorova and Durisin, 2007](#)). [Tsai \(2001\)](#) studied the relationship between networks and AC. He argued that the central position in collaboration networks is better for learning and generating innovations and business performance if the units have excellent AC.

KA definitions

Regarding KA, our analysis allowed us to identify different perspectives and definitions, depending on the area. In management, there are three subcategories of appropriation: appropriation, appropriability regime and value appropriation. Appropriation has been defined as "the firm's ability to benefit from its resources and capabilities" ([Milesi et al., 2013](#); [Tece, 1988](#)). [Kamoche and Mueller \(1998\)](#), focusing on the context of human resources, found that appropriation can be split in two dimensions: retention and absorptive learning. Retention is related to preserving relevant human resources, and absorption refers to the use of expertise in the processes of the firm. They also argued that appropriation is associated with preventing the erosion of knowledge stock and the ability to transfer external employees to maintain valued expertise within the firm. [Kamoche and Maguire \(2010\)](#) defined knowledge appropriation as "the capture and absorption of rents from the utilization of knowledge." Workers principally maintain knowledge appropriation ([Law, 2013](#)). The most recent approach developed by [Hurmelinna-Laukkanen and Yang \(2022\)](#) is based on 200 key KA papers; the authors view KA as "the potential to extract value from innovation" and broadly define it as "as an innovator's potential to benefit from an innovation. This potential

builds on the instruments of appropriability—isolating appropriability mechanisms and complementary assets—that afford the innovator control over the innovation.” Regarding realized KA, they further state that “innovators realize benefits in the form of private and social returns in processes employing the instruments of appropriability.”

Another concept related to KA is the appropriability regime, defined by Teece (1986) “as the environmental factors, excluding firm and market structure, that govern an innovator’s ability to capture the profits generated by an innovation.” Arbussa and Coenders (2007) defined it as “institutional protection of the knowledge spillovers that endanger the appropriation of rent from innovation.” They also established that the most common mechanism for a good appropriability regime is intellectual property based on patents, trademarks, industrial secrets and copyrights (Cenamor *et al.*, 2019; Hurmelinna-Laukkanen, 2014). Capturing the most significant profits from innovation is called primary KA, and the creation of future innovation is called generative appropriability (Vega-Jurado *et al.*, 2008b).

Colciencias (2010), Colombia’s Ministry of Science and Technology, defines social KA as the interaction of social groups that generate knowledge as a process of comprehension and intervention in the relationship between research and development and society. In the social sciences, the term appropriation has been used in the sense of “making something your own” (Benamar *et al.*, 2020). In technology, the term is related to adopting, adapting and incorporating the product, process or model of interest (Carroll *et al.*, 2003).

From a marketing perspective, Benamar *et al.* (2020) defined the different stages in an appropriation process as symbolic appropriation, exploration, construction and stabilization. Carroll *et al.* (2003), in studying mobile technology appropriation, developed a similar perspective, defining the different appropriation stages as adoption, deeper evaluation, adaptation and integration. From both perspectives, the user’s role is not only to absorb the technology but also to transform it and generate value.

Our analysis shows that some KA definitions are analogous to those of AC. For instance, Carroll *et al.* (2003) presented an approach with similar stages to an AC process, where the different levels could be analogous to AC dimensions in this order: adoption with acquisition, deeper evaluation with assimilation, adaptation with transformation and integration with exploitation. Kamoche and Mueller’s (1998) retention process could be analogous to acquisition and absorptive learning in the assimilation step in AC. Vega-Jurado *et al.*’s (2008b) generative appropriability stage is analogous to the transformation stage or “making something your own” (Benamar *et al.*, 2020). Benamar *et al.* (2020) defined appropriation as “making something your own”; when this happens, it is necessary to absorb the knowledge and exploit it.

The difference between KA and AC is evident in the literature, in which AC obtains and transforms knowledge from the environment. KA is a firm’s ability to obtain value from innovation.

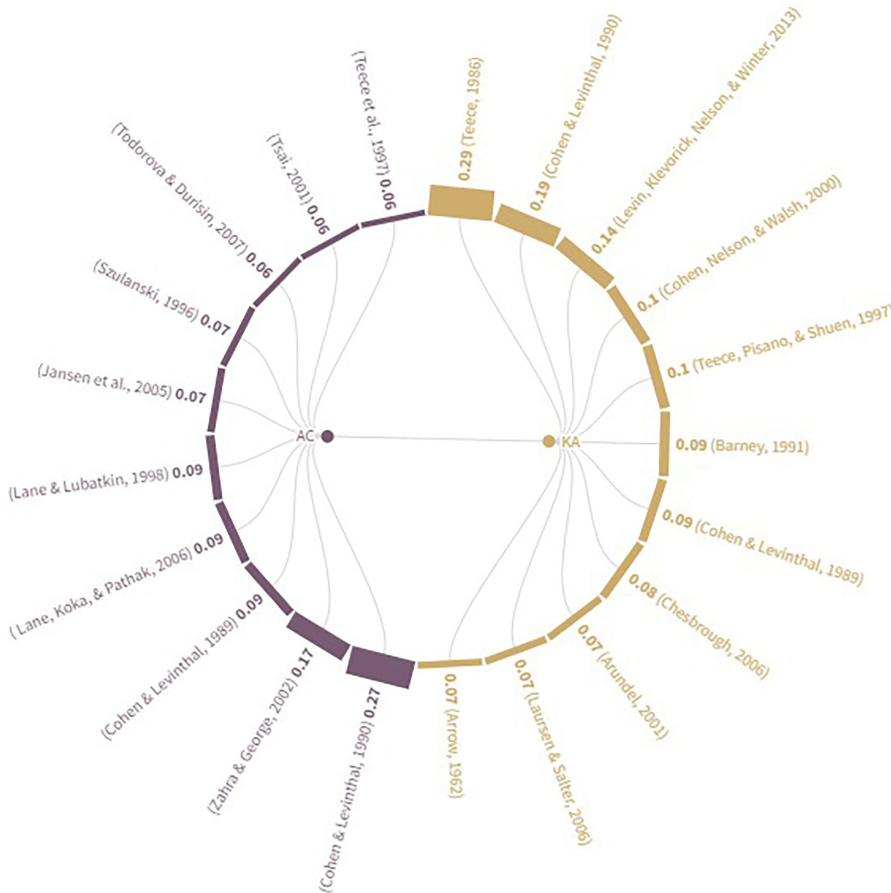
RQ2: Backward citation analysis

RQ2 seeks to determine whether the foundations of AC and KA are the same. To answer this question, we conducted a backward citation analysis for each topic individually. A comparison was made to identify similarities and differences in their genesis.

Figure 4 shows the scientific literature considered relevant to the authors of the core scientific papers. Cohen and Levinthal’s (1990) paper was the most popular reference by backward citations for AC authors, with Cohen and Levinthal (1989) being the third most cited. In the KA context, Cohen and Levinthal’s (1990) paper was the second most referenced, and their (1989) paper was the seventh. These papers establish the concept of AC as “the ability of a firm to recognize the new external information, assimilate it and apply it to commercial ends.” This research demonstrates the nature of AC as a process with different stages. These investigations also propose the appropriability regime “as a moderator of the antecedent of AC” (Todorova and Durisin, 2007). Cohen and Levinthal (1990) empirically found that KA is negative for AC. When there is an industry with low KA, absorptive AC is more accessible.

Zahra and George' (2002) paper was the second most crucial on AC by backward citations, and the 54th for KA (none in the backward core citations). They transform and reconstruct AC and view it as a dynamic capability or set of routines and processes. Routines are organizational activities that facilitate work via resources and organizational skills, and managerial processes are social interactions (Todorova and Durisin, 2007). Zahra and George (2002) proposed two stages: potential AC and realized AC. They established an appropriability regime as an element that regulates AC and the outcomes of sustainable competitive advantage. They defined the appropriability regime as "the institutional and industry dynamics that affect the firm's ability to protect the advantages of (and benefit from) new products or processes." They also discussed another relevant concept, knowledge spillover or loss of control over the innovations generated in the firms, which occurs when the investment in AC is low. Additionally, they found that when an appropriability regime exists, it helps to generate knowledge appropriation based on intellectual property rights.

Lane et al's (2006) paper was the fourth most relevant backward citation for AC core literature, but it was irrelevant to KA literature. They conducted an extensive review of the



Note(s): The numbers show the relevance of each against the sum of the total number of backward citations of the ten most relevant citations

Figure 4. Main backward citations in the absorptive capacity and knowledge appropriation fields

literature, defined the papers' main contributions and developed a model of AC. They based their research on comprehensive bibliometric analysis. They identified literature that focuses on AC. They found papers that made a real contribution to the state-of-the-art and most important subtopics, such as organizational learning, AC, innovation and AC. Subsequently, they redefined AC as a "firm's ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning." This research only mentions knowledge appropriation relating to the conclusions of [Cohen and Levinthal \(1989\)](#).

[Lane and Lubatkin's \(1998\)](#) paper was the fifth most relevant paper on AC, and the second for KA, while [Lane et al.'s \(2006\)](#) paper was the sixth. [Lane and Lubatkin \(1998, 2006\)](#) analyzed appropriability based on [Cohen and Levinthal \(1989\)](#). They reconceptualized AC based on strategic alliances and developed the concept of relative AC by identifying different learning mechanisms. They concluded that the skills required to acquire new knowledge were close to their capabilities.

[Todorova and Durisin's \(2007\)](#) paper is another relevant paper on AC. They reconceptualized the AC concept, emphasizing the recognition of the value phase and the acquisition, assimilation, transformation and exploitation phases. They defined three critical items as contingent factors: the social mechanism (social relationships or networks with the environment), power relationships (relationships between players in an ecosystem) and KA. Their model defines KA as relevant before recognizing the value and after the exploitation phase (i.e. in the first and last stages of AC).

[Jansen et al.'s \(2005\)](#) paper is relevant in the AC literature, but KA was not among the first twenty most popular backward citations. They considered [Zahra and George's \(2002\)](#) potential and absorptive capacities and analyzed the effect of organizational antecedents on AC. However, this study did not introduce KA.

[Tsai \(2001\)](#) provided another relevant backward citation. He defined AC as the capacity to respond to new knowledge. He examined the relationship between networks and AC and argued that the central position in collaboration networks is better for learning and generating innovation and business performance. In this study, knowledge appropriation and similarities were not examined. [Figure 4](#) shows the backward citations in the AC and KA fields.

On the other hand, we identified KA relevant backward citations. As discussed earlier, some scientific investigations have been conducted on AC and KA. The seminal authors [Cohen and Levinthal \(1989, 1990\)](#) were among the backward citations more relevant to appropriability authors.

Other backward citations are not relevant to AC but have been KA's building blocks or essential references. [Teece's \(1986\)](#) paper is one of the seminal papers on KA in management. He analyzed some business cases that show that an innovator company does not always exploit and generate profits from innovation. In some cases, these profits come from followers. He subsequently recognized three critical elements for capturing the market: the appropriability regime, dominant design and complementary assets. Following up, he defined the appropriability regime as "the environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation." The technological field and legal mechanisms of protection influence the appropriability regime. The relevance of technology-related knowledge (tacit or explicit) and the role of intellectual property were also examined in this investigation. He defined two critical dimensions of appropriability: legal instruments related to intellectual property and the nature of the technology associated with the type of development (product or process) and the type of knowledge. Subsequently, he defined three types of KA. Tight KA occurs when an innovation can be protected against intellectual property. Even when the technology is not ready for the market and the IP is not strong, the innovator can generate

complementary assets for marketing. Related to weak KA, the author refers to industries that require a long period of development.

[Tece \(1986\)](#) defined three types of players: innovators, imitators and owners of co-specialized assets. Regarded as players, he showed why large firms have more opportunities of launching innovation than small firms, emphasizing the co-specialized assets that facilitate appropriability. The relevance of industry structure in appropriability was also demonstrated in this study. In addition, he recognized that the maturity level of an industry is also relevant; this is not the same for generating profits in an emergent industry where everybody is looking to develop a dominant design for a mature industry where scale economies are essential.

[Winter and Nelson \(1982\)](#) began with a relevant dichotomy. Patents give the owner a monopoly but are also pertinent to diffuse innovations to benefit customers. They defined the following KA methods: patents, secrecy, lead time and learning curve advantages. Learning methods were also analyzed to identify the most relevant license agreements, reverse engineering and independent R&D. Finally, they explored the cost and time required for imitation and the costs of duplicating innovations (typical and significant). One of the main conclusions of this study is that a patent system improves the appropriability of innovation returns. Lead time is also a key factor. Other mechanisms such as secrecy, the learning curve and sales and services can provide additional protection. They also demonstrated that patents are not the best strategy for appropriation. The industry's KA levels are also an essential factor in this analysis, showing a strong correlation among them. This study did not discuss AC because the concept did not yet exist.

From a similar perspective, [Cohen et al. \(2000\)](#), based on 1478 R&D labs, analyzed the relevance of different KA mechanisms and found that lead time and secrecy are the primary mechanisms used by manufacturing industries. To protect product innovation, they found that firms have increased confidentiality; therefore, patents are not only used for KA but also for commercialization, marketing and preventing rivals from patenting similar inventions.

[Tece et al.'s \(1997\)](#) seminal paper on dynamic capabilities was the fifth most crucial backward citation in the KA field and the tenth most crucial backward citation in the AC field. This study focuses on one of the most critical building blocks in management. Regarding KA, the authors discuss its relationship with imitation and indicate that a robust KA regime avoids replication, and vice versa.

[Barney \(1991\)](#) is another research paper that has been significantly cited in the KA literature. Barney analyzed the relationship between firm resources and sustainable competitive advantage. Another relevant document related to backward citation analysis was published by [Chesbrough \(2006\)](#). His book provides examples of open innovation. Using the case of the IBM open innovation model, he analyzes a business case, the critical aspects of open innovation and the role that patents play in business models. Some IBM open innovation strategies make their patent information available to improve knowledge flows and access to their patents, and to create new databases such as Delphion. They also use mechanisms such as cross-licensing to share and exchange technology. [Arundel \(2001\)](#) is another relevant KA article. He explored the relevance of patents versus secrecy for appropriation and found that companies prefer to use secrecy as an appropriation tool.

[Laurson and Salter \(2006\)](#) were the authors of another relevant backward citation paper. They analyzed companies' strategies by searching for new ideas and technologies in innovation. New sources and actors appear as options to find innovative ideas. [Arrow \(1962\)](#) is another relevant KA study that focuses on invention, which is defined as a knowledge product. Arrow established the factors that influence investment in inventions. He viewed information as a commodity, and an invention as a data product. Thus, information is an appropriate commodity for inventors. Some problems related to the appropriation of inventions are the complexity of the system and lack of incentives. In addition, he recognized

that a relevant issue of investment in inventions is that appropriation is time-limited. This study also discusses the relevance of information as innovation input.

Regarding [RQ2](#), our backward analysis shows that KA is a concept that has an older foundation; it has been included as a relevant factor in seminal publications on AC. Although it is not considered a dimension of AC, the influence of KA as a negative factor or positive element of AC has been discussed by the principal authors. However, seminal researchers originally focused on KA's role in innovation and the primary mechanism for generating KA. We can conclude that AC has partially influenced the foundations of appropriability.

RQ3: AC dimensions

To answer [RQ3](#), regarding whether KA can be considered a dimension of AC, we identified scientific papers focusing on the AC and KA dimensions. AC researchers have clearly defined the different phases of this process. These phases include the acquisition, assimilation, transformation and exploitation phases. The **acquisition phase** seeks to localize, identify and acquire external knowledge ([Jiménez-Barrionuevo et al., 2011](#)). The **assimilation** phase aims to analyze, classify, process, interpret and internalize relevant knowledge ([Cohen and Levinthal, 1990](#); [Jiménez-Barrionuevo et al., 2011](#)). [Zahra and George \(2002\)](#) call these two phases *potential AC*.

In the **transformation** phase, organizations transfer and combine previous expertise with new knowledge. In this phase, knowledge is added, eliminated, interpreted or blended in new or different ways ([Jansen et al., 2005](#); [Jimenez-Barrionuevo et al., 2011](#)). Finally, in the **exploitation phase**, new knowledge is incorporated and transformed into a firm's operations. This capability allows the company to enhance the creation and improvement of products, processes, services, new organizational forms and derivatives ([Jansen et al., 2005](#); [Jiménez-Barrionuevo et al., 2011](#)). These two phases are labeled by [Zahra and George \(2002\)](#) as *realized AC*.

Another group of authors divided AC into *no codified knowledge* or *tacit* and *codified knowledge as explicit* ([Scaringella et al., 2017](#)). Another classification is based on the internal and external routines of knowledge absorption ([Lewin et al., 2011](#)) or external and internal knowledge capacity ([Figueiredo and Cohen, 2019](#)).

[Figure 5](#) summarizes the different terms that authors have used to define the various dimensions of AC and whether they study appropriability in their research.

KA dimensions

[Teece \(1986\)](#) defined different dimensions of the appropriability regime. He established two types of crucial dimensions: (1) legal instruments that refer to intellectual property mechanisms used to protect knowledge, such as patents, trademarks and trade secrets, and (2) KA based on the nature of technology, that is, as a product, process, tacit or codified. The literature does not show significant changes in these dimensions. For example, in Argentina, [Milesi et al. \(2013\)](#) measured KA based on patents, brands, secrecy and two new dimensions not mentioned in [Teece \(1986\)](#). These are first-mover strategies and the participation and control of distribution networks. Moreover, [Colombelli et al. \(2020\)](#) used a similar approach and aggregated other indicators such as lead time and complementary assets, including commercial and production. Other authors have used similar methods based on intellectual property to measure KA ([Arbussa and Coenders, 2007](#); [Barros, 2021](#)).

[Benedicto et al. \(2014\)](#) and [Rubira-García et al. \(2018\)](#) classified the dimensions in the direct (intellectual property) and indirect appropriation mechanisms as networks, partnerships, business incubators, spin-offs and university-industry collaborations. [Torres de Oliveira et al. \(2021\)](#) used the traditional IP mechanism and other new indicators such as product complexity, process design, employee contracts, lead time advantage, complementary manufacturing, marketing and service capabilities as knowledge appropriation dimensions.

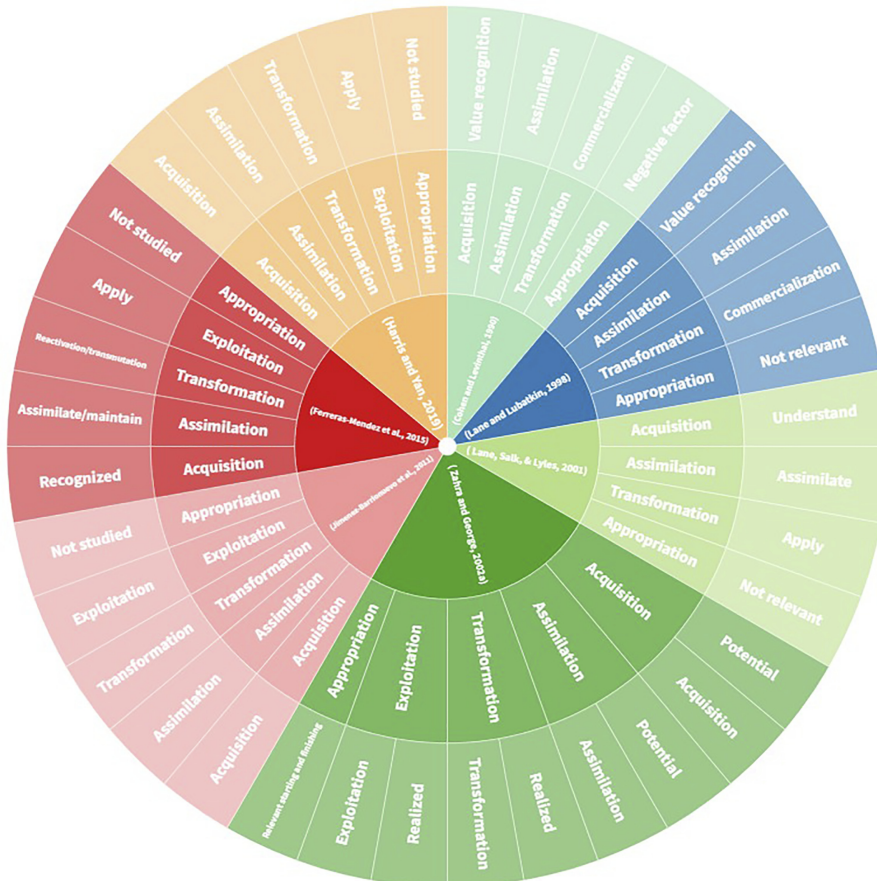


Figure 5. Absorptive capacity dimensions

Note(s): The AC dimensions are shown in the following circle graph

Regarding RQ3, seminal studies have considered appropriability as a relevant element in the first and last stages of AC. However, more recent trends in the literature do not show appropriability as a dimension of AC, or vice versa; therefore, we do not consider KA as a dimension of AC or vice-versa.

RQ4: Link between KA and AC

To better understand the link between KA and AC, we analyzed scientific papers that have examined both KA and AC. Two methodologies were used for the analysis. The first was the Vosviewer modular-based clustering methodology. This methodology defines groups based on the strength of the relationship between nodes, in this case keywords (Apriliyanti and Alon, 2017; Tibaná-Herrera et al., 2018). The second methodology was the latent Dirichlet allocation (LDA) probabilistic methodology. This methodology defines the probability that a paper can be part of a topic or cluster, and also, for each cluster, this methodology recognizes the most representative terms (Choo et al., 2013; Kherwa and Bansal, 2018). We used the T-sne dimension reduction methodology to simplify the interpretation of LDA analysis (Choo et al., 2013). In Vosviewer, we identified five main thematic clusters,

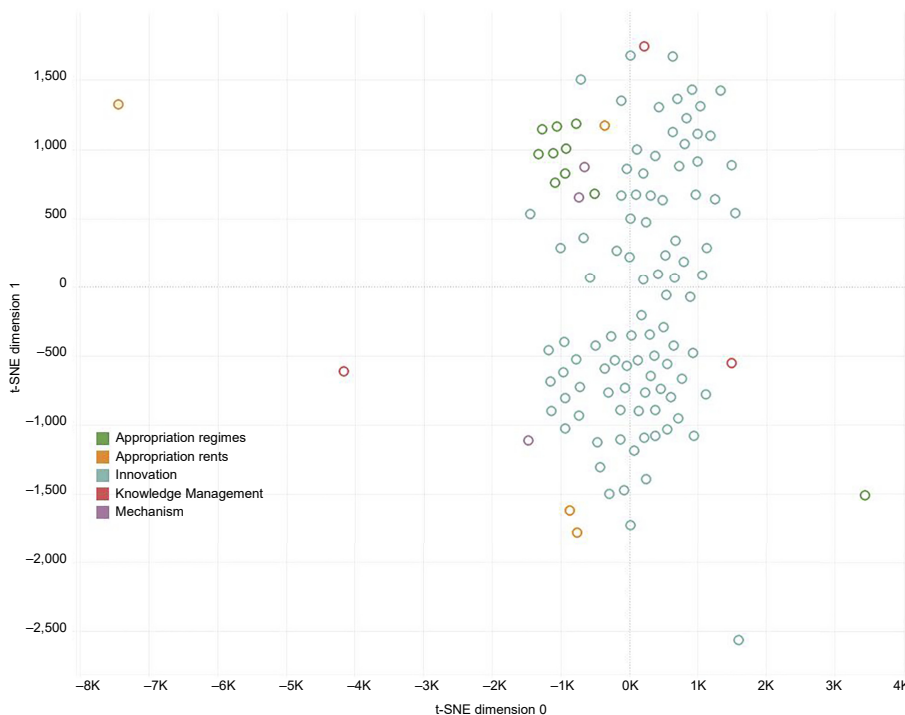


Figure 7.
LDA key topics in the
KA and AC literature

Bahl *et al.* (2021) analyzed the link between KA capability, internationalization and innovation, and found that KA weakens the link between these two topics. Synergistic effects between AC and KA were identified in this study, demonstrating the relevance of the exploration and exploitation of knowledge.

Additionally, AC and KA are strongly related to innovation processes as positive or negative triggers. The topic “Innovation” aims to deepen knowledge in this area.

Giant magnetoresistance is an important innovation that has revolutionized the world. This is the basic technology for hard drives. Dedrick and Kraemer (2015) examined the history of this technology and showed that AC has contributed significantly to exploiting this technology in the United States and Japan. They also found that the limited returns on investment to the first innovators are due to a bad appropriability regime over the technologies.

Value appropriation is a key topic identified in our Vosviewer analysis and is placed in the innovation cluster. Cepeda-Carrion *et al.* (2016) analyzed the link between AC and value in the banking industry. They also examined the role of knowledge application. They found that banks had mainly focused on realized AC to obtain value appropriation in the industry. They referred to value appropriation as “the development of a set of capabilities to extract benefits that stem from value creation” or the retention of value in organizations, which they argued is more important than avoiding imitation from competitors.

Kokshagina *et al.* (2017), from an open innovation viewpoint, recognized the relevance of AC for KA and implementation processes in ecosystems and organizations. They proposed a new type of open innovation to stimulate AC. Hervas-Oliver *et al.* (2011) identified a correlation between technological opportunities, KA conditions and innovation performance

by observing the differences between intensive R&D industries and non-intensive R&D organizations. Firms with more internal resources can develop AC correctly and obtain relevant information from the environment. [Escribano et al. \(2009\)](#) showed that AC is important for managing external knowledge flows to stimulate innovation outcomes. They found that AC was an important source of competitive advantage in environments with turbulent knowledge. They analyzed the degree of turbulence and level of legal appropriability and found that solid legal appropriability facilitates external knowledge flows. [Vega-Jurado et al. \(2008a\)](#) analyzed the external and internal factors that affect product innovation and novelty. They found that a company's technological competency is a key factor in product innovation. They also found that environments with more appropriability conditions are better for innovation performance. Furthermore, they examined the indirect effect of increasing AC, which affects a firm's capability to exploit external knowledge.

Another relevant topic is knowledge management. [O'Dwyer and O'Flynn \(2005\)](#) analyzed the importance of knowledge value in alliance governance, mainly in knowledge exchange, and the critical role of AC and organizational learning in these relationships. They studied knowledge appropriation in networks and the coordination of these communities. The mutual relationship between AC and KA was analyzed in detail in this research. They recognized that it is harder to perform KA when knowledge is tacit. However, when knowledge is explicit, it is easier to appropriate it, which can result in better governance.

[Hurmelinna-Laukkanen et al. \(2012\)](#) examined the relevance of improving AC, KA and network stability in orchestration. They found that AC and KA were enhanced when the networks were stable. Therefore, intellectual property plays an important role in this governance because it is the channel that generates knowledge transfer and protects knowledge inside the network.

The final topic we explored was KA mechanisms. [Spithoven and Teirlinck \(2015\)](#) examined R&D outsourcing based on four elements: internal capabilities, AC, formal and informal KA mechanisms and network resources. One of the main conclusions of this study is that informal mechanisms, such as complexity design, are better at generating a competitive advantage than formal mechanisms, such as patents, which are harder to protect. The study found that stronger use of the KA mechanism stimulates R&D outsourcing.

[Hurmelinna-Laukkanen and Olander \(2014\)](#) recognized the lack of information about AC and KA. To evaluate KA, the authors used formal and informal mechanisms. They found that KA positively affects firms' innovation performance. They also argued that the appropriability regime significantly affects controlling innovations when competitors have AC.

Concerning [RQ4](#), we found that AC and KA are strongly linked to innovation performance and each subfield of KA, such as value appropriation and the appropriability regime.

Discussion

AC and KA are key elements of innovation performance ([Hurmelinna-Laukkanen et al., 2012](#)). The objective of this study was to analyze the similarities and differences between AC and KA and how they have been studied in the literature. The academic community has identified the necessity of studying the relationship between AC and KA in depth. Systematic reviews have identified the need to study these topics together ([Chaparro et al., 2021](#); [Da Silva Florencio and De Oliveira, 2022](#); [Hurmelinna-Laukkanen et al., 2012](#); [Sun and Zhai, 2018](#)). Our research addresses this gap in the literature by comparing the origins of AC and KA based on backward citations, comparing AC and KA definitions and identifying the links between AC and KA based on the literature. Our findings show that the AC building block literature typically includes KA as a key element ([Cohen and Levinthal, 1990](#); [Zahra and George, 2002](#)), while regarding KA, [Cohen and Levinthal's \(1989, 1990\)](#) AC building blocks are also key backward

citations. In addition, although the seminal authors (Cohen and Levinthal, 1990; Todorova and Durisin, 2003, 2007; Zahra and George, 2002) included KA as a key element in their models, the last models do not include KA as a dimension of AC (Harris and Yan, 2019; Marrucci *et al.*, 2021), with some exceptions such as Thomas and Wood (2014). These analyses suggest that KA cannot be considered an AC dimension and vice versa, but both should be considered key elements (Da Silva Florencio and De Oliveira, 2022). Notwithstanding, although there are similarities in some specific definitions, both concepts have clear differences.

Studies that have examined both topics have focused on the impact of AC and KA on value generation, mainly in innovation performance (Dedrick and Kraemer, 2015), the link of AC and KA with knowledge transfer and management (O'Dwyer and O'Flynn, 2005) and the link between AC and KA mechanisms (Spithoven and Teirlinck, 2015), but not the theoretical relationship between the two. Our results show that AC and KA are key elements with similar origins and have evolved together.

Regarding RQ1, in management, there is a clear difference between AC as a process for acquiring, assimilating, transforming and exploiting knowledge, and KA as the generation of value and rents from innovation. However, the KA concept has not been developed solely in the field of management, and some authors have proposed definitions that are similar to AC (Benamar *et al.*, 2020; Carroll *et al.*, 2003; Kamoche and Mueller, 1998).

RQ2 concerns whether AC and KA have similar foundations. In the literature, we did not find any other studies that compared the backward citations of AC and KA. Nevertheless, some bibliometric studies have identified the seminal papers of KA using methods such as co-citations and have recognized the majority of building blocks that we recognized in our study (Arrow, 1962; Teece, 1986; Winter and Nelson, 1982), which validates our results. Our investigation showed that KA always plays a key role in the main building block of AC (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Zahra and George, 2002). However, our findings show that the key literature on AC (Cohen and Levinthal, 1989, 1990) has also been among the most cited references in the KA literature. Our findings corroborate those of Sun and Zhai (2018), who recognized AC as a "citation bust node" of KA. Our findings further show that the foundations of both topics are strongly related, and for a large set of authors, they have the same foundations.

Regarding RQ3, many authors have used the KA mechanism for measuring AC dimensions and AC when it has been considered a nondimensional process (Cuéllar *et al.*, 2022). For instance, KA mechanisms, specifically patents, have been used to measure AC (Appio *et al.*, 2019; Bishop *et al.*, 2011; Deeds, 2001; Dushnitsky and Lenox, 2005; Kim and Inkpen, 2005; Malik *et al.*, 2020, 2021; Ramani *et al.*, 2008; Rothaermel and Thursby, 2005; Ruth *et al.*, 2013; Shin and Jalajas, 2010; Srivastava *et al.*, 2015; vom Stein *et al.*, 2015; Wagner, 2011). The state-of-the-art subtopics show the importance of KA as a proxy for AC dimensions.

Our analysis shows that KA is considered a key element of AC in the seminal models of AC, but not as an AC dimension (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Zahra and George, 2002). The last AC model typically does not have KA as an AC dimension. These outcomes suggest that this trend is not included as a dimension (Ferrerás-Méndez *et al.*, 2015; Harris and Yan, 2019). Although some authors have included KA as a dimension (Thomas and Wood, 2014), this is not common in the literature.

Regarding RQ4, clearly, the investigation of AC and KA has been a hot topic in the literature, as Sun and Zhai (2018) recognized in their study. Our analysis addresses a gap in the literature on AC and KA, showing that studies have focused on the effects of AC and KA and their mechanisms on innovation and technology transfer. Our analysis corroborates the lack of studies on the relationship between AC and KA as indicated in the literature (Chaparro *et al.*, 2021; Da Silva Florencio and De Oliveira, 2022; Hurmelinna-Laukkanen *et al.*, 2012; Sun and Zhai, 2018).

Conclusions

This study clearly and concisely shows the differences and similarities between AC and KA. Both fields have similar foundations based on a deep and extensive analysis of their origins. There are similarities in some definitions of KA and AC, but both concepts are different in the management sciences. KA is not considered an AC dimension; however, KA is a key element of AC, and vice versa. Both fields are crucial to innovation, knowledge management and technology transfer. This study addresses a gap in the literature by deeply analyzing both fields and conducting a rigorous comparison of these fields and the importance of both in strategic topics in innovation and knowledge management.

This study employs a new approach for conducting systematic reviews based on web scraping, robot process automation, machine learning methodologies and bibliometrics. This methodology has not been common in other systematic reviews. One of the advantages of this approach is that we can more easily identify relevant papers based on full-text analysis. Furthermore, we found more papers relevant to our analysis using this approach than using the title, abstract and keywords approach, showing the robustness of our method.

Some limitations of our research include the lack of availability of full text in the databases we used. This type of analysis is challenging, and access to full-text documents depends on the agreement between libraries. Another limitation concerns the database used in this study. Other databases, such as Proquest or Web of Science, could be useful for future studies.

Our analysis has created an opportunity for future research. Therefore, more studies are needed to analyze the influence of AC on KA, and vice versa. Specifically, more research needs to be conducted to analyze the macro and micro levels. For instance, researchers could study the influence of AC and KA on innovation in a country, or they could compare two similar countries with different innovation performances, such as Chile and Colombia. Scientific papers such as those by [Dedrick and Kraemer \(2015\)](#) are needed to understand why the production of innovations is limited in some countries. However, to understand the link between these two fields from other perspectives, a convergence and divergence analysis could provide another perspective on the benefits of these topics in different management areas ([Hacklin et al., 2021](#)).

We suggest that policymakers should generate policies that improve AC and KA to improve innovation performance and technology transfer in emerging economies with weak innovation ecosystems.

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