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Managing the external factors that determine the innovation capabilities of SMEs. A systematic literature review and keyword co-occurrence analysis

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Abstract

Purpose – Small and medium-sized enterprises (SMEs) represent a very important part of a country's economy and depend largely on the development of their innovation capabilities to compete in the market. This study aims to research on innovation in SMEs by classifying the external factors that influence innovation capabilities and proposing a framework to support organizational learning and innovation.

Design/methodology/approach – A systematic literature review was carried out, identifying external factors that, with empirical evidence, have a positive influence on innovation capabilities of SMEs. A keyword co-occurrence analysis was also conducted to facilitate the analysis of the review.

Findings – Thirty-two articles studying external factors according to the established criteria have been identified. The identified factors were grouped into six categories, reflecting different dimensions of the external environment's relationship with innovation capability. A framework comprising 18 mechanisms for managing knowledge flows with external sources is also proposed.

Research limitations/implications – This article contributes to understanding the influence of the external environment and the organizational learning process on the development of innovation capabilities of SMEs. As a limitation, the classification and framework are conditioned by study methodology and search criteria established.

Practical implications – SME managers can use the proposed framework as a diagnostic and decision-making tool to identify the external knowledge flow mechanisms that, according to the relevant studies, have been linked to positive outcomes in the development of innovation capabilities. This is not a rigid framework. Flexible framework adaptation can be made to their specific context, resources and institutional environment.

Originality/value – This study contributes to the literature on the innovation capability of SMEs by focusing specifically on the external factors that are empirically linked to that capability. By combining a systematic literature review with a keyword co-occurrence analysis, the study provides a classification of external factors to support organizational learning in SMEs. A framework of knowledge flow mechanisms is also proposed to assist SMEs in developing their innovation capability.

Keywords Innovation capability, SMEs, External factors, Innovation management, Systematic literature review, Bibliometric analysis

Paper type Literature review



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1. Introduction

Innovation has long been viewed as a driver of economic development and entrepreneurial activity and remains central to firm performance and competitiveness (Saunila, 2020; Schumpeter, 1942, 1989). Small and medium-sized enterprises (SMEs) play a crucial role in economic growth and national competitiveness (Fu et al., 2021; Kamalrulzaman, Ahmad, Ariff, & Muda, 2021). For them, innovation is not only a source of differentiation, but also a condition for survival and sustainable growth (Jalil, Ali, & Kamarulzaman, 2022; Mendoza-Silva, 2020). SMEs face additional challenges compared to large companies, such as having fewer resources or relying more on other stakeholders to find solutions that meet customer needs in a constantly changing market (Singh, Del Giudice, Nicotra, & Fiano, 2022).

Innovation is closely linked to innovation capability (IC), understood as the potential to develop new products or services. For SMEs, IC helps overcome resource constraints and improve competitiveness and performance by enabling adaptation to changing market needs (Maldonado-Guzmán, Garza-Reyes, Pinzón-Castro, & Kumar, 2019). As IC is shaped by both internal and external determinants, identifying these factors is essential for understanding how SMEs can strengthen their innovation processes (Mendoza-Silva, 2020; Saunila, 2020). Despite their relevance, research on the determinants of IC in SMEs remains limited and fragmented, with limited consensus on the factors involved (Fu et al., 2021; Hermawati & Gunawan, 2021; Saunila, 2020; Tsakalerou, Abil, Ribiere, Lukhmanov, & Tynybayeva, 2025).

Previous studies have contributed to a better understanding of IC from various perspectives. Saunila (2020) provides a systematic review of IC in SMEs, identifying its main determinants, outcomes and research gaps, while Mendoza-Silva (2020) examines its nature and determinants at the firm level. Moreira, Navaia and Ribau (2024) focus on the dimensions of innovation capabilities, contributing to a more structured understanding of this multidimensional construct. More recently, Tsakalerou et al. (2025) review the overall determinants of SMEs' IC. However, less attention has been paid to external factors and the mechanisms that promote knowledge exchange for the development of IC.

External factors are particularly important in the context of SMEs, as interaction with external stakeholders allows them to acquire knowledge and identify opportunities for innovation despite their limited internal resources (Adam & Alofaysan, 2023; Alhassan, Bell, Andrews, Salifu, & Majeed, 2025). In dynamic environments, organizational learning, absorptive capacity and dynamic capabilities become fundamental elements for maintaining competitive advantage and performance (Pan, Essuman, Fumey, Karikari, & Boateng, 2025). It is also essential to advance research on the mechanisms that facilitate external knowledge flows in SMEs (Brunswicker & Vanhaverbeke, 2015). These flows help SMEs acquire knowledge from different sources, overcome resource constraints and promote organizational learning to develop IC (Adam & Alofaysan, 2023; Alhassan et al., 2025).

However, how SMEs access, exchange and integrate external knowledge remains insufficiently understood (Imanto & Kusumastuti, 2019; Ryu, Baek, & Yoon, 2021). Further research is needed on external knowledge flows, the strategies SMEs should adopt to manage them and the frameworks that explain their interrelationships with internal knowledge (Adam & Alofaysan, 2023; Battistella, Ferraro, & Pessot, 2023; Brunswicker & Vanhaverbeke, 2015).

Based on these gaps, the study has two objectives. The first is to identify the external factors that influence the IC of SMEs. The second is to understand the mechanisms through which SMEs exchange knowledge with external sources, promoting the acquisition of knowledge and organizational learning. The research questions (RQs) are therefore as follows:

- RQ1. What external factors determine the innovation capability of SMEs?
- RQ2. What mechanisms facilitate knowledge flows with external sources to support the development of SMEs' IC?

This article contributes to the literature by offering a focused analysis of how the external environment is associated with the IC of SMEs. Specifically, it identifies and classifies external factors empirically associated with IC through a systematic literature review (SLR) complemented by keyword co-occurrence analysis. It also proposes a framework of mechanisms through which SMEs can acquire external knowledge, promote organizational learning and support the development of IC.

The article is organized as follows. The next section presents the theoretical background, followed by the methodology. The results section reports the categories of external factors and the mechanisms facilitating external knowledge flows. The article concludes with the discussion, conclusions and limitations.

2. Theoretical background

2.1 Innovation capability

Innovation has been defined as a new or improved product or process that differs significantly from the unit's previous products or processes and has been made available to users or has been used by the unit (OECD/Eurostat, 2018). In the literature, IC is also referred to as innovation capacity, innovative capability or innovation-based capability (Saunila, 2020). IC can be considered as the potential of the company to generate innovation outputs (Neely, Filippini, Vinelli, & Hii, 2001; Saunila, 2016) and its ability to continuously transform resources and ideas into innovations, including products, processes, organizational changes or marketing (Mendoza-Silva, 2020; Zheng, Liu, & George, 2010).

IC should not be understood as an isolated process or activity, but as a set of capabilities sustained over time that enables companies to generate innovation outputs (Mendoza-Silva, 2020). Empirical studies on IC have typically focused on its determinants and outcomes, including competitiveness and performance (Saunila, 2020). These determinants or factors that condition the IC are both internal and external (Neely et al., 2001). Internal factors refer to firm-level aspects such as organizational culture, structure, processes, staff competence, R&D investment and resources (Albis Salas, Mora Holguin, Lucio-Arias, Sánchez, & Villarreal, 2023; Saunila, 2020). External factors refer to actors in the firm's environment, including customers, suppliers, competitors and other organizations through which SMEs can access knowledge and develop IC (Saunila, 2020).

2.2 External factors influencing innovation capability

External factors are particularly important for SMEs, as the external environment provides them with opportunities to access knowledge, identify opportunities for innovation and compensate for internal resource constraints (Albis Salas et al., 2023). In dynamic environments, firms are also more likely to innovate, as competition and market changes push them to adapt and develop new solutions (Arshad et al., 2023; Leonidou, Christodoulides, Kyrgidou, & Palihawadana, 2017).

This perspective is closely related to open innovation, which emphasizes purposively managed knowledge flows across organizational boundaries, through pecuniary and non-pecuniary mechanisms in line with the organization's business model (Chesbrough & Bogers, 2013). The concept of open innovation is also linked to the need for entrepreneurship in companies and their consequent relationship with the external environment to promote innovation (Chesbrough & Bogers, 2013; Schumpeter, 1989). Open innovation and access to

external sources of knowledge for SMEs are particularly important, as they provide complementary capabilities and facilitate faster adaptation to market demands, especially in times of crisis and uncertainty (Vasi, Sansone, & English, 2024).

2.3 External knowledge flow and organizational learning

IC is closely linked to organizational learning and knowledge acquisition, since firms need to use available knowledge and resources to develop new products and processes and improve its organizational or marketing methods (Hogan, Soutar, McColl-Kennedy, & Sweeney, 2011). External knowledge flow, understood as knowledge exchange with external sources, contributes to organizational learning and is therefore central to the development of IC (Adam & Alofaysan, 2023; Brunswicker & Vanhaverbeke, 2015; Delmas, 2002). This flow is even more important in the context of SMEs, as it provides an alternative way to access knowledge, reduce uncertainty and compensate for limitations such as lower R&D investment and fewer resources (Albis Salas et al., 2023; Battistella et al., 2023).

In addition to promoting knowledge exchange with external sources, SMEs must be able to transform that knowledge into organizational learning and thus develop innovation capabilities. This brings us to the concept of absorptive capacities, which enable organizations to learn from others and transform knowledge into new ideas, products or services through the development of their innovation capabilities (Singh et al., 2022). Absorptive capacity enables organizations to identify, assimilate and apply external knowledge, while knowledge creation processes transform that knowledge into valuable organizational outcomes (Ajmal, Islam, & Islam, 2025). In this regard, the development of IC relies on a balance between exploration and exploitation in organizational learning (Brix, 2019). External knowledge sources can therefore act as catalysts that accelerate and enrich organizational learning (Zhang & Merchant, 2020). In SMEs, this learning also occurs through external networks involving customers, suppliers and other stakeholders (Vos, Petter-Mikx, & Collou, 2025). This study contributes to this body of knowledge by categorizing factors that influence IC and proposing a framework of mechanisms that facilitate external knowledge flow.

3. Methodology

The methodology consists of an SLR, which allows previous research, gaps and opportunities in the field to be identified (Bakker, 2010; Khosravi, Newton, & Rezvani, 2019). Following Tranfield, Denyer and Smart (2003), the review was conducted in three phases: planning, execution and reporting.

3.1 Planning the review

For the search, several criteria for the selection and analysis of documents were considered. Given that this study aims to identify the external factors that influence SMEs' IC, the following criteria were applied. The review was designed to identify studies analyzing external factors that influence IC of SMEs. Following established selection criteria for literature reviews (Bakker, 2010), articles were included when they met three conditions: they analyzed one or more external factors affecting IC of SMEs; the relationship between the external factors analyzed and IC was empirically supported through surveys, questionnaires, quantitative analyses or case studies. Studies with negative, non-significant or purely theoretical relationships were excluded, and the study focused specifically on SMEs, given their distinctive characteristics compared with larger firms (Hermawati & Gunawan, 2021).

The search was conducted in Scopus and Web of Science (WOS), as we expect these databases to identify the most relevant articles on the subject under study. No restrictions were placed on the period selected, to ensure that all relevant articles have been considered. The review focused on studies reporting positive associations between external factors and IC. Therefore, factors showing negative or non-significant relationships were outside the scope of the analysis.

3.2 Execution of the literature review

The search in both databases was carried out separately and the results were cross-checked to eliminate duplicate papers. Each of the searches is described below:

- Description of Scopus search

The first filter was used to search for all articles referring to the “innovation capability” on title, abstract and keywords. For this purpose, a first search was performed by including all articles that considered the keywords: “innovation capability,” “innovation capacity,” “capacity of innovation” and “innovation capabilities.” A total of 8,473 documents were obtained with these search criteria (Criteria 1).

To limit the number of documents, the search was restricted to “articles” and those written in English. In total 5,396 articles were recovered using these new criteria (criterion 2). On the other hand, as the capacity to innovate was analyzed from a management point of view, the search was restricted to the areas of “Business, Management, and Accounting,” thus obtaining 2,300 articles (Criteria 3).

The search was then restricted to articles referring to SMEs, for which the following keywords were considered: SME, SMEs, Small and Medium Enterprise, Small and Medium-sized Enterprise. With these new limitations, 166 articles were obtained (Criteria 4):

- Search in WOS

The search was next conducted in WOS Core collection. The search was carried out considering the following keywords in “All Fields”: (“INNOVATION CAPABILITY” OR “INNOVATION CAPABILITIES” OR “INNOVATION CAPACITY” OR “CAPACITY OF INNOVATION”) AND (“SMALL AND MEDIUM-SIZE* ENTERPRISE*”) AND (“FACTORS” OR “DETERMINANTS” OR “ASPECTS”). With these keywords, 94 documents were obtained (Criteria 5).

Subsequently, only as “Document Types,” articles or reviews were considered. Furthermore, business or management or industrial engineering were also considered as “Web of Science Categories.” With these new criteria, 53 documents were obtained (Criteria 6). These articles were compared with those obtained through Scopus to eliminate duplicates.

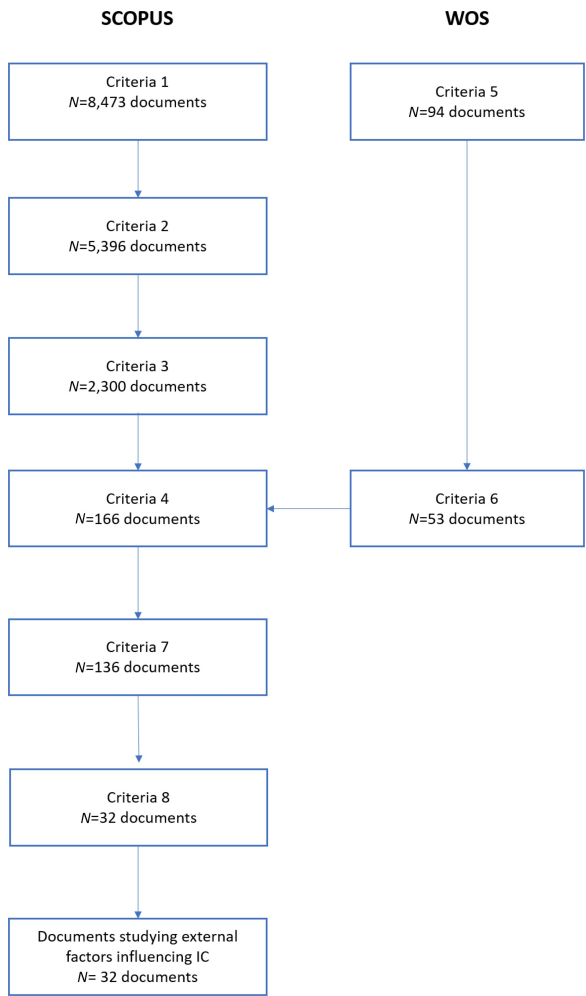
Next, the resulting articles were reviewed to identify and discard any that did not correspond to the scope of our research. Indeed, despite the application of the criteria, it is possible that not all articles correspond to studies related to IC in SMEs. To this end, we reviewed the abstracts of the papers, finally selecting 136 papers that carry out studies related to IC in SMEs. We have considered the application of this criterion as Criterion 7.

The final step consisted of reviewing the 136 documents obtained, to identify those that analyze one or more factors influencing the IC of this type of company. To this end, the considerations mentioned above were considered, namely, that the documents examine one or more external factors that influence IC; that this relationship has been empirically demonstrated; and that the study focuses on SMEs. This refers to these considerations as Criterion 8. As a result of this criterion, 32 articles were identified that analyze external factors that influence the IC of SMEs.

The strategy followed for the search is shown in [Figure 1](#).

3.3 Reporting phase

The literature review was supplemented with an analysis of keyword co-occurrence to support the classification of the identified external factors. Keyword co-occurrence analysis is a bibliometric technique that helps identify the most frequently recurring terms, their relationships and thematic clusters within a selected set of publications ([Bakker, 2010](#); [Bouyssou & Marchant, 2011](#)). As part of bibliometric network analysis, it helps reveal patterns, trends and gaps in a research field and supports evidence-based interpretation of the



Source: Author's own creation

Figure 1. Flow diagram followed for the literature review

literature (Carley, 1997; Perianes-Rodriguez, Waltman, & van Eck, 2016; Rejeb, Rejeb, Appolloni, & Seuring, 2024).

This bibliometric approach made it possible to summarize the main themes of the selected articles and group related terms into thematic clusters, providing a structured basis for analyzing and classifying the factors identified in the review (Albort-Morant, Henseler, Leal-Millán, & Cepeda-Carrión, 2017; Alsadi, Antony, Mezher, Jayaraman, & Maalouf, 2023; Krndzija & Pilav-Velic, 2022; Nedjwa, Bertrand, & Sassi Boudemagh, 2022; Ye & Ge, 2019).

The analysis was conducted using VOSviewer, a tool that allows users to create and visualize bibliometric networks (van Eck & Waltman, 2010b). The resulting co-occurrence map was used to identify recurring terms, their relationships and the clusters that support the classification of external factors (Albort-Morant et al., 2017; Rejeb et al., 2024).

Co-occurrence analysis was applied to the 32 articles selected after applying the search criteria. A minimum co-occurrence threshold of one was established to avoid excluding relevant terms. This resulted in 91 co-occurring terms, grouped into 12 clusters, as shown in the map in Figure 2. On the map, the size of the nodes reflects the frequency of the terms, the colors indicate the groups and the thickness of the links represents the strength of the relationships between the terms.

Details of the different clusters with their associated terms are shown in Table A1 in the Appendix. For each term (indicated as a label in the Table A1), its position on the map is shown, together with different indices related to the weight of the occurrence of each term. Table A1 also reports cluster overlaps, term citations and the proposed keyword-based category.

The map analysis shows that Clusters 1, 3 and 7 are associated with collaboration-related terms, including relationships, networks, alliances, intermediate organizations and open innovation. Clusters 2 and 5 are associated with technology adoption, including social media, digitization, information and communication technologies (ICTs) and enterprise resource planning.

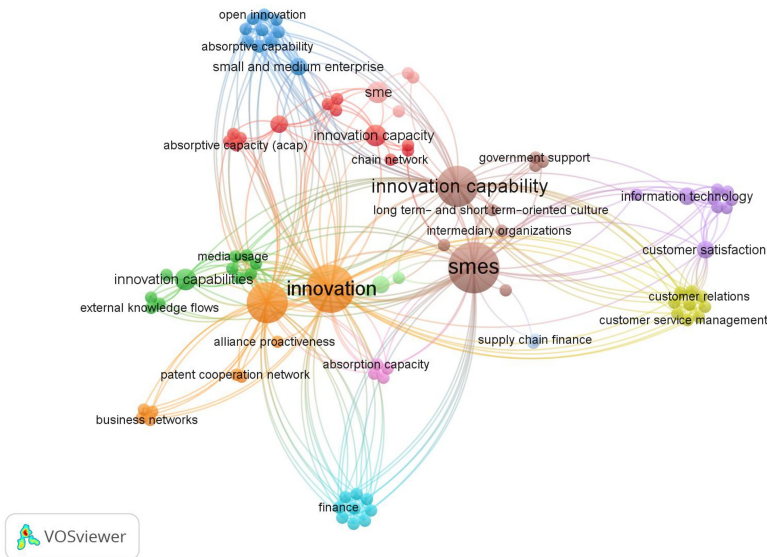


Figure 2. Co-occurrence map of the 32 final documents

Clusters 4 and 12 relate to collaboration with customers and suppliers, including customer relationship, customer relationship management (CRM), supplier integration and supply chain. Cluster 6 is associated with innovation funding and subsidies, while Cluster 8 relates to public support for innovation. Clusters 9 and 11 correspond to collaboration with universities and technology centers, respectively, whereas Cluster 10 refers to innovation management.

This analysis provides the basis for the categorization of external factors presented below.

4. Results

4.1 *External factors influencing innovation capability of small and medium-sized enterprises*

The SLR identified 32 articles that met the established criteria and examined external factors influencing IC of SMEs. These articles were compiled in [Table 1](#), which summarizes the factor categories derived from the review and the keyword co-occurrence analysis. [Table 1](#) reports the authors, publication year, country, sector and external factor categories analyzed in each article. The categories were defined based on the keyword co-occurrence analysis.

The results show that categories related to collaboration are the most frequently studied. Collaboration with customers and suppliers, collaboration with other organizations and collaboration with universities and R&D centers appear in 13, 12 and 9 articles, respectively. Together, they account for 34 of the 47 references to factors (72%), confirming that collaboration is the main theme. By contrast, funding and public support are less well represented, with two and three articles, respectively, while technology adoption appears in eight articles, published mainly in recent years.

Regarding the sample profile, multisectoral studies predominate, followed by those related to the manufacturing sector, suggesting a cross-sectional approach, albeit with a bias toward industrial settings. Most of the studies were published between 2020 and 2023, accounting for 19 of the 32 articles (59%), and indicating a growing interest in external factors, particularly collaboration and technology adoption. Geographically, the articles are mainly concentrated in Asia and Europe, with 17 and 12 studies, respectively.

The results also show limited integration among the different types of collaboration. Only three articles address both business and academic or research collaborations, while business collaborations predominate, with 19 articles, compared to six academic or research studies.

[Figure 3](#) summarizes the resulting categorization of external factors influencing IC of SMEs.

Based on the classification shown in [Figure 3](#), [Table 2](#) briefly describes each category of external factors, summarizes how each contributes to the development of SMEs' IC and identifies the main sources of support.

Overall, these categories highlight that the innovation capacity of SMEs depends not only on access to external resources and institutional support but also on their ability to interact with various external stakeholders. Specifically, the adoption of technology and collaboration help SMEs translate external knowledge into enhanced innovation capabilities.

4.2 *Mechanisms facilitating knowledge flows with external sources to support small and medium-sized enterprises' innovation capability*

External sources of knowledge are diverse and include not only customers and suppliers (vertical relationships) but also competitors, universities, R&D centers and other stakeholders ([Albis Salas et al., 2023](#)). The exchange of experiences, values and information with these actors creates external knowledge flows that, when continuous and transformed into useful knowledge, can support the development of SMEs' IC ([Adam & Alofaysan, 2023](#)). Identifying the mechanisms that facilitate these flows is therefore essential to understanding how SMEs acquire external knowledge and support its transformation it into

Table 1. Categories of external factors influencing innovation capabilities of SMEs

Authors	Year	Country	Multisectoral	Financing and funding	Public support to innovation	Collaboration with customers and suppliers	Collaboration with universities and R&D centers	Collaboration with other organizations	Technology adoption
Albis Salas et al., 2023	2023	Colombia	Manufacturing	*	*	*	*	*	*
He & Sun, 2023	2023	China	Multisectoral			*		*	*
Vu et al., 2022	2022	Vietnam	Multisectoral		*	*			
Edeh & Acedo, 2021	2021	Nigeria	Multisectoral	*				*	
Apa et al., 2021	2021	Italy	Multisectoral				*		
Wang, Wang, Lou and Jin, 2020	2020	China	ICT				*	*	*
Zhang & Merchant, 2020	2020	China	Multisectoral		*				
Inamoto & Kusumastuti, 2019	2019	Indonesia	Creative Industry				*		
Kim et al., 2018	2018	Korea	Manufacturing						
Egbertokun, Adeniyi & Siyanbola, 2012	2013	Nigeria	Manufacturing			*		*	
Kühne & Gellynck, 2010	2010	Europe	Food sector		*	*			
Gellynck et al., 2011	2011	Europe	Food sector		*	*			
Calabrese, 2002	2002	Italy	Automotive sector		*	*			
Song, 2023	2022	China	Multisectoral				*		
Battistella et al., 2023	2023	Italy	Multisectoral						*
Kurdve, Bird & Laage- Hellman, 2020	2020	Sweden	Multisectoral				*		
Kittilaksanawong & Ren, 2013	2013	China	Multisectoral				*		
Izushi, 2005	2005	Japan	Multisectoral				*		
Macpherson, Jones & Zhang, 2005	2005	England	Multisectoral		*				*
Singh et al., 2022	2022	United Arab Emirates	Manufacturing					*	
Lin, Chen & Chiu, 2010	2010	Taiwan	Manufacturing		*				*
Borah, Iqbal & Akhtiar, 2022	2022	China	Multisectoral						

(continued)

Table 1. Continued

Authors	Year	Country	Multisectoral	Financing and funding	Public support to innovation	Collaboration with customers and suppliers	Collaboration with universities and R&D centers	Collaboration with other organizations	Technology adoption
Adam & Alofaysan, 2023	2023	Saudi Arabia	Multisectoral			*			
Samila & Utko, 2013	2013	Finland	Multisectoral					*	
Zardini, Ceesay, Rossignoli & Mahro, 2023	2023	Italy	Food sector					*	
Mazzucchelli, Chierici, Tortora & Fontana, 2021	2021	Italy	Manufacturing				*		
Forsman & Temel, 2016	2016	Finland	Multisectoral			*		*	
Muskat et al., 2021	2021	Europe	Tourism		*			*	
Kamalulzaman et al., 2021	2021	Malaysia	Agriculture					*	
Brunswicker & Vanhaverbeke, 2015	2015	Europe	Multisectoral			*			*
Ryu et al., 2021	2021	Korea	Multisectoral						*
Ndubisi, Dayan, Yeniaras & Al-Hawari, 2020	2020	United Arab Emirates	Multisectoral			*			
Source(s): Author's own elaboration									



Figure 3. External factor categories determining innovation capabilities of SMEs
Source: Author’s own elaboration

organizational learning. Table 3 summarizes these mechanisms according to the type of external actor involved.

In total, 18 mechanisms have been identified that enable SMEs to acquire information, expertise and external resources through various forms of collaboration. In general, these mechanisms act as channels through which external knowledge flows can be assimilated and transformed into useful knowledge, thereby contributing to the development of SMEs’ IC. Figure 4 summarizes these mechanisms according to the type of collaboration involved.

The 18 mechanisms can also be classified according to two complementary criteria. Table 4 groups them by nature, distinguishing between operational and organizational practices, technological tools and relational forms. Table 5 classifies them according to their function in the organizational learning process, including the generation and acquisition of knowledge, the transfer and application of knowledge, the protection and exploitation of innovation and the creation of networks and the expansion of knowledge.

Although some mechanisms may fit into more than one category, both classifications help clarify how external knowledge flows support organizational learning and the development of IC.

5. Discussion

The study addresses the limited understanding of external factors influencing SMEs’ IC and the insufficient analysis of the mechanisms through which SMEs acquire and use external knowledge. In response to RQ1, the SLR and keyword co-occurrence analysis enabled the

Table 2. Categories of external factors influencing SMEs' innovation capability

Category	Description	Contribution to SME innovation capability	Key references
Financing and funding	Access to external financial resources, such as loans, venture capital, credit lines, grants and subsidies, to support innovation activities	External financing helps SMEs overcome internal resource constraints and allocate resources to R&D and innovation projects. This is particularly relevant for SMEs in the manufacturing sector, where technological innovation often requires higher levels of investment	Albis Salas et al., 2023; Edelh and Acedo, 2021
Public support	Public policies, programs and institutional services that support SME innovation, including subsidies, innovation grants, technology transfer services and intermediary support	Public support reduces the costs, risks and uncertainty associated with innovation. Beyond financial support, public institutions can also facilitate access to technology, expertise and research organizations through technology transfer and advisory services	Albis Salas et al., 2023; Battistella et al., 2023; Hwang and Oh, 2023; Muskat et al., 2021
Technology adoption	Acquisition and use of technologies that support communication, information exchange and value creation, including ICT, digital platforms, social media, big data, artificial intelligence, mobile technologies and the internet of things	The adoption of technology facilitates knowledge sharing with external stakeholders and enhances the agility and effectiveness of collaboration. Furthermore, it helps SMEs identify customer needs, improve communication, and transform business models, contributing to the development of IC	Alam, 2011; Borah et al., 2022; Fang, Huang, and Li, 2013; Macpherson et al., 2005; Ryu et al., 2021
Collaboration with customers and suppliers	Vertical collaboration with customers and suppliers through feedback, joint initiatives, information sharing, supply chain integration and customer relationship management practices	Collaboration with customers and suppliers enables SMEs to better understand market needs, gain access to operational and market insights and increase the likelihood that their innovations will be accepted by the market. Supply chain integration also encourages joint participation in innovation-related activities	Albis Salas et al., 2023; Egbetokun et al., 2012; Izushi, 2005; Kühne and Gellynck, 2010; Song, 2023; Vu et al., 2022

(continued)

Table 2. Continued

Category	Description	Contribution to SME innovation capability	Key references
Collaboration with universities and R&D centers	Cooperation with universities, research centers and technology institutions through research projects, training programs, technology transfer, collaboration on patents and technical support	This type of collaboration enables SMEs to access specialized knowledge, technological expertise and research capabilities that they often lack internally. It also fosters organizational learning and accelerates the development of innovation capabilities at a lower cost than fully in-house R&D	Albis Salas et al., 2023 ; Kittilaksanawong and Ren, 2013 ; Kurdve et al., 2020 ; Song, 2023
Collaboration with other organizations	Relationships with external stakeholders other than customers, suppliers, universities and R&D centers, including other companies, competitors, consultants, intermediaries, business networks and strategic alliances	Collaboration with other organizations enables SMEs to expand their knowledge and encourage joint initiatives that strengthen their capacity for innovation. It also helps reduce uncertainty and risk in innovation projects	Battistella et al., 2023 ; Forsman and Temel, 2016 ; Kamalulzaman et al., 2021 ; Mazzucchi et al., 2021 ; Saunila and Ukko, 2013 ; Wang et al., 2020

Table 3. Mechanisms facilitating external knowledge flows in SMEs

External source	Knowledge-flow mechanisms	Role in external knowledge flow	Key references
Customers and suppliers	Digital platforms; supply chain management; R&D collaboration between supply-chain members; organizational infrastructures and communication channels; CRM practices; use of ICT	These mechanisms create stable channels for exchanging market, operational and technical information with customers and suppliers, while helping to reduce organizational barriers to disruptive innovation. They enable SMEs to identify customer needs, leverage supplier expertise and access supply chain information. They also help transform this information into useful insights for improving products and processes	Adam and Alofaysan, 2023; Calabrese, 2002; He and Sun, 2023; Lin et al., 2010; Macpherson et al., 2005; Ndubisi et al., 2020; Vu et al., 2022
Universities and R&D centers	Collaboration via support programs; creation of a technology company; collaborative R&D projects; patent cooperation networks; training programs; technology transfer services.	Through project collaboration, training, technology transfer, and cooperation on patents, SMEs can gain access to specialized knowledge and external technological resources that are difficult to develop in-house. In this way, these mechanisms help SMEs assimilate scientific and technological knowledge through organizational learning and apply it to innovation activities	Albis Salas et al., 2023; Battistella et al., 2023; Izushi, 2005; Kittilaksanawong and Ren, 2013; Kurdve et al., 2020; Rossoni et al., 2024
Other organizations	Business networks; knowledge exchange with R&D teams; benchmarking operations against competitors; technology transfer agreements; cooperation through patents; strategic alliances	These mechanisms expand SMEs' access to external knowledge beyond vertical and academic relationships. Business networks, strategic alliances, benchmarking and R&D team exchanges help SMEs share resources, compare practices and reduce the risks of innovation, while technology transfer agreements and patent cooperation promote the application and protection of external knowledge	Battistella et al., 2023; Forsman and Temel, 2016; Kamalulzaman et al., 2021; Mazzuchelli et al., 2021; Saunila and Ukko, 2013; Wang et al., 2020; Zardini et al., 2023

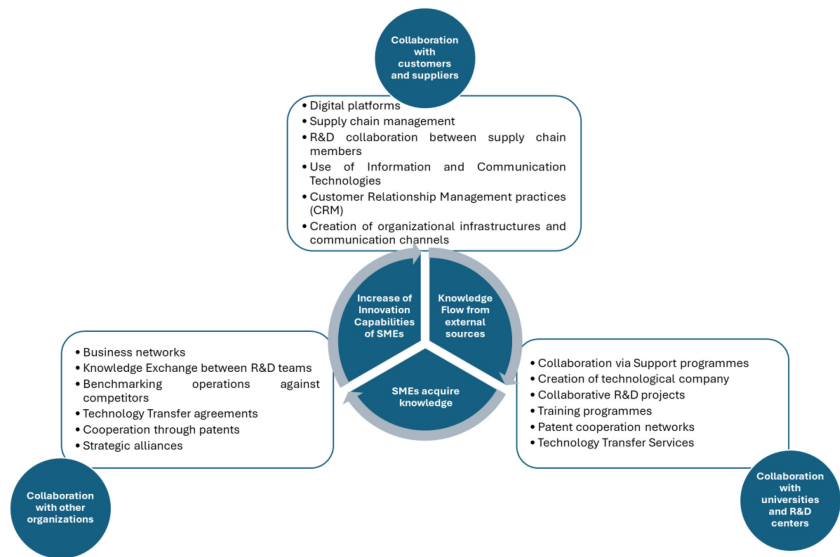


Figure 4. How SMEs can acquire knowledge and support the development of innovation capability
Source: Author’s own elaboration

Table 4. Mechanisms for organizational learning according to their nature

Type	Mechanism
Operational and organizational practices	Benchmarking operations against competitors, training programs, supply chain, R&D collaboration between supply chain members, creation of technological company, knowledge exchange between R&D teams, creation of organizational infrastructures and communication channels
Technological tools	Digital platforms, use of ICT technologies, CRM practices
Relational forms (formal and informal relationships)	Strategic alliances, business networks, support programs collaboration, patent cooperation networks (universities and R&D centers), technology transfer agreements with other organizations, collaborative R&D projects, technology transfer services, cooperation through patents (other organizations)

classification of external factors into several categories. Unlike previous studies that tend to examine external factors in isolation, this classification offers an integrated view of how the external environment supports SMEs’ IC.

The results show significant synergies between the category of technology adoption and the three types of collaboration categories. Specifically, factor analysis reveals that the creation of digital platforms, ICT and the use of social media greatly facilitate collaboration with the external environment, making these collaborations more effective.

Public support also creates synergies with other categories. It is closely linked to financing and funding through grants and other financial instruments. It also fosters innovation through technology transfer, consulting and links with research centers and universities. In this way, public support helps reduce the costs and uncertainty associated

Table 5. Mechanisms for organizational learning according to their purpose in the organizational learning process

Type	Mechanism
Knowledge generation and acquisition	Training programs, knowledge exchange between R&D teams, benchmarking operations against competitors, collaborative R&D projects, R&D collaboration between supply chain members
Knowledge transfer and application	Digital platforms, use of ICT technologies, CRM practices, technology transfer services, technology transfer agreements, creation of technological company, creation of organizational infrastructures and communication channels
Innovation protection and exploitation	Patent cooperation networks (universities and R&D centers), cooperation through patents (other organizations)
Networks creation and knowledge expansion	Business networks, strategic alliances, supply chain, collaboration via support programs

with innovation in SMEs (Albis Salas et al., 2023). This classification also opens avenues for comparative research on how the relevance of external factors varies across sectors, regions and institutional contexts.

In response to RQ2, the study proposes a framework of mechanisms that facilitate external knowledge flows. This framework contributes to innovation management and offers practical guidance for SMEs. Classifying mechanisms according to their nature (operational or organizational, technological tools and relational forms) allows managers to select the most appropriate actions for developing innovation capabilities based on their resources and context at any given time.

Likewise, classifying mechanisms according to their purpose in the organizational learning process helps to understand how each mechanism contributes, from different perspectives, to strengthening organizational learning. In this way, SME managers can better adapt their strategies to develop innovation capabilities.

Among the different mechanisms identified, the use of ICT is particularly relevant because it can enhance other knowledge-flow mechanisms. It strengthens mechanisms related to collaboration with customers and suppliers, such as supply chain management, CRM and communication channels. Similarly, digital tools can enhance knowledge-flow mechanisms with universities, R&D centers and other organizations, including collaborative projects, strategic alliances and business networks. Social media also strengthens interaction with customers, suppliers and other stakeholders, supporting joint innovation activities (Fang, Qalati, Ostic, Shah, & Mirani, 2022).

The proposed framework can also be interpreted from the perspective of collective learning within the organization. Recent conceptual studies suggest that absorptive capacity can emerge at the team level as collective intelligence, supported by relational and technological dimensions (Narazaki, Popadiuk, & Rodrigues, 2025). This reinforces the idea that mechanisms such as digital platforms, collaborative projects and business networks not only transfer knowledge but also shape collective capabilities for innovation.

The predominance of collaboration-related studies confirms the importance of interorganizational collaboration in sustaining knowledge flows and supporting SMEs' IC (Muskat, Hörtnagl, Peters, & Zehrer, 2021). This interest has increased significantly in recent years, confirming the growing importance of SMEs' collaboration strategies with external sources for innovation, a need that has possibly been accentuated after the pandemic and is also likely associated with the increase in technology and digitalization.

Conversely, public funding and public support are the most under-researched categories. This highlights the need for research studies focusing on both categories, given their importance, particularly the public sector, in developing the innovation capabilities of SMEs (Battistella et al., 2023).

The results also show a decoupling between academic/research and business collaborations, as very few studies – only 9% integrate both approaches. This may lead to fragmented analyses of how knowledge is transferred and exploited, since both types of collaboration often coexist in innovation processes (Rossoni, de Vasconcellos, & de Castilho Rossoni, 2024). It may also limit the design of innovation policies and programs that require an integrated view of university–business and interorganizational collaboration (Ates, Paton, Bititci, & Kemal Konyalıoğlu, 2025). The integrated study from both perspectives provide a better understanding of how both systems interact, identify synergies between them and accelerate the generation of applicable knowledge and the cycle time required for innovation. Future research should therefore adopt integrated approaches to analyze the mechanisms of collaboration between universities and businesses, as well as interorganizational collaboration within SMEs.

Additionally, the concentration of multisectoral studies (18 articles) and manufacturing sector (six articles) suggest that research focused mainly on contexts where innovation and collaboration processes are more visible. By contrast, sectors such as agriculture, tourism and service companies remain underexplored, opening opportunities for future research on how external factors influence SMEs' IC across different sectoral contexts.

Finally, the mechanisms identified also open avenues for future research into how these mechanisms interact with internal capabilities, such as the internal learning culture or teams' absorptive capacity. Recent studies on the learning culture of SMEs, collective intelligence and ambidextrous innovation suggest that the effectiveness of external knowledge acquisition may depend on internal factors such as learning routines, team-level absorptive capacity and organizational culture (AlSaied & Alkhoraif, 2024; Narazaki et al., 2025; Vos et al., 2025).

6. Limitations

Several limitations should be acknowledged. One limitation relates to the applicability of the model to companies in different sectors. In this regard, the impact according to sector type has not been analyzed, as it may vary depending on the sector to which the company belongs. However, given that most of the studies analyzed consider companies from different sectors, the impact of this aspect is limited.

Another limitation concerns the search terms used in the systematic review. Although the selected terms are commonly used in the IC literature, terminology in this field is not fully standardized. Related expressions such as “innovative capacity,” “innovation potential” or similar concepts could have helped identify additional studies using different terminology to analyze similar phenomena. This limitation may have influenced the resulting sample of articles and, consequently, the external factors identified and the proposed framework. Future reviews could expand the search strategy to include these adjacent constructs and examine whether additional factors, mechanisms or alternative classifications emerge.

On the other hand, this review focused on studies describing positive empirical relationships between external factors and IC, excluding negative or empirically unproven relationships; this implies that the proposed framework does not capture all possible factors, enabling conditions or potential adverse effects in external knowledge relationships.

Finally, regarding the proposed category classification and the resulting framework, although they are based on the soundness of the bibliometric analysis, this does not preclude the possibility of proposing other classifications and frameworks using a different approach.

7. Conclusion

This study explores the influence of the external environment on the IC of SMEs. Based on the research's objectives and the SLR, 32 articles were identified that met the established criteria. In addition, keyword co-occurrence analysis enabled these factors to be classified into six categories: financing and funding; public support; technology adoption; collaboration with customers and suppliers; collaboration with universities and R&D centers; and collaboration with other organizations. This classification contributes to understanding how the external environment influences IC of SMEs and how different external factors interact. The results highlight the amplifying effect of technology adoption and the importance of public support in reducing the risks and costs associated with SME innovation. This contributes to the literature by classifying and analyzing external factors by category rather than in isolation, supported by keyword co-occurrence analysis.

The study also highlights the need for future research adopting an integrated view of collaboration in SMEs. This may improve understanding of the factors involved in SME innovation processes and the conditions under which external collaboration supports IC. In addition, the analysis of the three collaboration categories identified 18 mechanisms that facilitate knowledge flows with external sources.

These mechanisms are presented in a framework and have been classified according to several criteria. The proposed framework and classification of mechanisms contribute to understanding organizational learning processes and provide SME managers with guidance for managing innovation within their companies.

The proposed framework may also help SMEs structure knowledge exchange with external sources and strengthen organizational learning processes, thereby supporting their innovation efforts. Furthermore, since these mechanisms are based on previous studies showing positive empirical associations with innovation capabilities, they offer managers a set of options to guide their innovation efforts, although their effectiveness depends on sectoral, organizational and institutional conditions. In this sense, the framework should not be interpreted as a prescriptive model that guarantees innovation outcomes but rather as a synthesis of the mechanisms that previous studies have linked to positive effects in the field of innovation.

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Table A1. Cluster classification and categories (1)

N	Label	x	y	Cluster	Category	weight<1Links>	Weight<total link strength>	weight<Occurrences>	Score<avg. citations>	Score<avg. norm. citations>
38	Innovation capacity	-0.079	0.4026	1	Collaboration with organizations	11	12	3	28	10,227
3	Absorptive capacity	-0.42	0.4446	1		12	12	2	49.5	1,289
4	Absorptive capacity (acap)	-0.5722	0.3726	1		5	5	1	35	0.5676
8	Chain network	-0.0275	0.3184	1		2	2	1	7	0.0576
9	Chain relationship quality	0.0349	0.3719	1	Different chain relationship directions	3	3	1	13	1
16	Different chain relationship	0.0348	0.352	1		3	3	1	13	1
24	Formal and informal collaboration	-0.2222	0.4957	1	Formal and informal collaboration	7	7	1	64	20,105
26	government	-0.5981	0.3868	1		5	5	1	35	0.5676
29	Industry collaboration	-0.2512	0.5168	1		7	7	1	64	20,105
68	Small- and medium-sized enterprise stakeholder pressure	-0.5586	0.3978	1		5	5	1	35	0.5676
70	Small- and medium-sized enterprises (SMEs) stakeholder pressure	-0.5842	0.4121	1	University-industry collaboration	5	5	1	35	0.5676
91	University-industry collaboration	-0.2182	0.536	1		7	7	1	64	20,105
36	Innovation capabilities	-0.7522	-0.1044	2	Technology adoption	14	16	3	4,63,333	0.8408
17	Digital leadership	-0.5859	-0.0634	2		10	10	1	133	21,568
19	External knowledge flows	-0.8746	-0.2011	2		5	5	1	2	0.24
47	Knowledge	-0.8743	-0.1681	2		5	5	1	2	0.24
54	Media usage	-0.5774	-0.0222	2	Small- and medium-sized enterprises (SMEs)	10	10	1	133	21,568
69	Small- and medium-sized enterprises (SMEs)	-0.8454	-0.1884	2		5	5	1	2	0.24
75	Social media	-0.5357	-0.017	2	Social media usage	10	10	1	133	21,568
76	Social media usage	-0.5619	-0.0981	2		10	10	1	133	21,568
77	Social medium usage	-0.5046	-0.0458	2		10	10	1	133	21,568
78	Social networking (online)	-0.522	-0.0837	2		10	10	1	133	21,568
79	Strategic alliance	-0.8185	-0.0866	2	Collaboration with organizations	1	1	1	4	0.1257
62	Small and medium enterprise	-0.3504	0.6475	3		18	19	2	41.5	21,452
2	Absorptive capability	-0.4921	0.7211	3		12	12	1	19	2.28
43	Intermediary organizations	-0.4829	0.7771	3		12	12	1	19	2.28
44	Intermediary organization	-0.4243	0.7721	3	Open innovation capabilities	12	12	1	19	2.28
56	Open innovation	-0.4731	0.8307	3		12	12	1	19	2.28
57	Open innovation capabilities	-0.5156	0.8183	3		12	12	1	19	2.28
58	Open innovation capability	-0.5398	0.7815	3		12	12	1	19	2.28
71	Small-and-medium enterprise	-0.451	0.7369	3	Technology transfer service	12	12	1	19	2.28
87	Technology transfer service	-0.5315	0.7391	3		12	12	1	19	2.28
88	Technology transfer services	-0.4328	0.8145	3		12	12	1	19	2.28

(continued)

Table A1. Continued

N	Label	x	y	Cluster	Category	weight<Links>	Weight<total link strength>	weight<Occurrences>	Score<avg. citations>	Score<avg. norm. citations>
12	Customer relations	1,071	-0.1623	4	Collaboration with customers and suppliers	11	11	1	236	19,424
13	Customer relationship management	10,279	-0.1932	4		11	11	1	236	19,424
15	Customer service management	10,207	-0.2446	4		11	11	1	236	19,424
33	Information sharing	0,986	-0.2236	4		11	11	1	236	19,424
41	Innovation programs	10,821	-0.2007	4	Technology adoption	11	11	1	236	19,424
52	Long-term partnerships	10,348	-0.1436	4		11	11	1	236	19,424
53	Managers	0,9948	-0.1497	4		11	11	1	236	19,424
80	Supplier integration	0,9749	-0.1848	4		11	11	1	236	19,424
81	Supplier management	1,06	-0.2346	4	Technology adoption	11	11	1	236	19,424
14	Customer satisfaction	1,088	-0.0001	5		19	19	2	128.5	14,485
34	Information technology	10,231	0.1889	5		10	11	2	30	10,898
18	Enterprise resource planning	11,257	0.1526	5		8	8	1	21	0,9545
31	Information and communication technologies (ICTs)	11,773	0.1777	5		8	8	1	21	0,9545
40	Innovation networks	11,596	0.1495	5		8	8	1	21	0,9545
48	Knowledge sharing	0,8416	0.1976	5		3	3	1	39	12,251
65	Small and medium-sized enterprise (SME)	11,617	0.207	5		8	8	1	21	0,9545
84	Supply chains	11,284	0.2135	5		8	8	1	21	0,9545
89	Telecommunication networks	11,137	0.1834	5		8	8	1	21	0,9545

Table A2. Cluster classification and categories (2)

N	Label	x	y	Cluster	Category	weight<Links>	Weight<total link strength>	weight<Occurrences>	Score<avg. citations>	Score<avg. norm. citations>
20	Finance	-0.2099	-0.9061	6	Financial and funding public support	11	11	1	30	0.9424
21	Financial constraints	-0.1605	-0.964	6		11	11	1	30	0.9424
22	Financial support	-0.1205	-0.9534	6		11	11	1	30	0.9424
23	Financial system	-0.0987	-0.9184	6		11	11	1	30	0.9424
25	Governance approach	-0.1884	-0.871	6		11	11	1	30	0.9424
60	Public support	-0.1109	-0.8791	6		11	11	1	30	0.9424
61	Public supports	-0.1976	-0.9454	6		11	11	1	30	0.9424
72	Smaller firms	-0.1546	-0.9122	6		11	11	1	30	0.9424
85	Supports	-0.148	-0.8607	6		11	11	1	30	0.9424
35	Innovation	-0.2399	-0.1361	7	Collaboration with organizations	63	84	15	46.8	11.689
64	Small and medium-sized enterprise	-0.4641	-0.1862	7		50	62	11	301.818	10.251
5	Alliance proactiveness	-0.4266	-0.3235	7		2	2	1	35	10.995
6	Business networks	-0.8772	-0.5992	7		5	5	1	4	1
7	Business service	-0.8702	-0.5699	7		5	5	1	4	1
10	Collaboration	-0.8997	-0.5616	7		5	5	1	4	1
32	Information and communication technology	-0.5535	-0.4473	7		3	3	1	18	0.4472
59	Patent cooperation network	-0.5733	-0.4403	7		3	3	1	18	0.4472
67	Small firms	-0.9066	-0.5907	7		5	5	1	4	1
74	SMEs	0.2643	-0.0607	8	Government support	47	62	17	31	0.9179
37	Innovation capability	0.2062	0.2267	8		44	57	11	5.80,909	1.313
27	Government support	0.4838	0.3267	8		4	4	1	50	12.422
28	Industry associations	0.1611	0.0177	8		3	3	1	11	1
42	Institutions	0.4837	0.2985	8		4	4	1	50	12.422
45	Intermediary organizations	0.3655	0.0696	8		2	2	1	10	0.3226
46	Joint innovation capabilities	0.3775	-0.1404	8		1	1	1	73	18.137
49	Learning capability	0.5077	0.3123	8		4	4	1	50	12.422
51	Long-term- and short-term-oriented culture	0.3298	0.1432	8		2	2	1	19	0.5969
1	Absorption capacity	-0.075	-0.404	9	Collaboration with universities	6	6	1	20	0.4969
11	Collaborative innovation	-0.0407	-0.4159	9		6	6	1	20	0.4969
30	Industry-university collaboration	-0.0538	-0.4489	9		6	6	1	20	0.4969
90	University collaborations	-0.0879	-0.4369	9		6	6	1	20	0.4969
73	SME	-0.071	0.5555	10	Innovation management (internal factor)	11	13	3	41	13.626
39	Innovation management	0.002	0.4911	10		3	3	1	52	16.774
50	Learning orientation	0.0354	0.6236	10		3	3	1	7	1

(continued)

Table A2. Continued

N	Label	x	y	Cluster	Category	weight<Links>	Weight<total link strength>	weight<Occurrences>	Score<avg. citations>	Score<avg. norm. citations>
55	Networking capability	0.0507	0.6102	10		3	3	1	7	1
66	Small and medium-sized enterprises	-0.0612	-0.1236	11	Collaboration with technology centers	6	6	2	43	10,227
63	Small and medium-sized enterprise	0.0027	-0.0971	11		4	4	1	63	1
86	Technology centers	-0.1054	-0.1426	11		2	2	1	23	10,455
82	Supply chain finance	0.484	-0.3141	12	Supply chain	2	2	1	17	0.2757
83	Supply chain management	0.477	-0.3261	12	(customers and suppliers)	2	2	1	17	0.2757

Note(s): Although financing/funding and public support are closely related in the co-occurrence analysis, they were treated as separate analytical categories because public support also includes non-financial mechanisms, such as technology transfer or advisory services