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Recent Research Trends in Open Innovation in SMEs: A Bibliometric Literature Review

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Abstract

Open innovation (OI) has captured the attention of both academics and practitioners since its inception. However, research on OI in small and medium-sized enterprises (SMEs) has experienced rapid growth in recent years. Our research aims to scrutinize the evolution of scientific production and emerging research themes of OI in SMEs. The study employs a bibliometric analysis using the Scopus database and the ARTIREV software. The findings indicate a considerable increase in the scientific production of research on OI in SMEs, with the last five years contributing the most. Additionally, the most relevant and involved constituents of research on OI in SMEs are illuminated alongside the most productive and influential publications and authors. The study also sheds light on several divergent research themes concerning firm and innovation performance, business model innovation, OI practices, OI challenges, OI in crisis times, entrepreneurship, economic growth, and sustainable innovation. Our study provides a detailed overview of the research contexts of OI in SMEs for future research investigations.

Keywords: open innovation; small and medium-sized enterprises; SMEs; bibliometric analysis; document bibliographic coupling analysis; performance analysis

1. INTRODUCTION

Twenty years ago, the term “Open Innovation” (OI) was coined (Chesbrough 2003). The concept of OI refers to “*valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well*” (Chesbrough, 2003, p.43). The

primary purposes of OI models are to accelerate internal innovation and accumulate additional value through the market by using both outside-in and inside-out movements of knowledge and technologies between different actors (Chesbrough and Crowther 2006). After the advent of the concept, research on OI immediately began burgeoning in the innovation literature, yet primarily focused on large enterprises (e.g., Chesbrough & Crowther, 2006; Gassmann & Enkel, 2004; Henkel, 2006; Laursen & Salter, 2006; Lecocq & Demil, 2006; Lichtenthaler, 2008). Research has identified three modes of OI, including inbound (outside-in), outbound (inside-out), and coupled (Enkel, Gassmann, and Chesbrough 2009; Gassmann and Enkel 2004). This classification stresses the intentional nature of OI, comprising “*purposive inflows and outflows of knowledge to accelerate internal innovation*” (Chesbrough, 2006, p.01).

Most studies on OI have investigated the three main processes in large companies (Chesbrough and Brunswicker 2013). SMEs have received limited attention in OI research (Gassmann, Enkel, and Chesbrough 2010; Brunswicker and Vanhaverbeke 2015). However, the existing studies confirm the importance of SMEs in the open innovation landscape (Bianchi et al. 2011; Spithoven, Clarysse, and Knockaert 2011). It is widely recognized that smaller companies increasingly and extensively practice open innovation activities to overcome their “*liability of smallness*” (Gassmann, Enkel, and Chesbrough 2010; van de Vrande et al. 2009). Indeed, their limited resources impede the building and maintenance of collaborative networks (Huizingh 2011; Lee et al. 2010). Another obstacle to open innovation for SMEs is their limited capacity to absorb and exploit external knowledge and, therefore, to effectively share knowledge within open innovation projects (Hislop 2005).

This research focuses on the evolution of OI research trends in SMEs through a bibliometric analysis (BA). Our goals are to present the development of research on OI in SMEs and recent research themes in the field. Therefore, our research questions are:

1. What are the most relevant and involved constituents (authors, institutions, journals, countries, and funding parties) in the field of OI in SMEs?

2. Which publications have received the most attention in research on OI in SMEs?

3. What are the research themes on OI in SMEs that have emerged over the past five years?

The study applies performance analysis (PA) and document bibliographic coupling analysis (DBCA). PA helps to present different research constituents of the studied topic. This analysis resembles the profile of participants found in empirical research but is more analytical (Donthu et al. 2021). In contrast, DBCA is a method for science mapping working under the assumption that two publications with common references share similarities in their content (Kessler 1963; Weinberg 1974). The greater the number of common references among documents, the more likely they belong to the same research theme (Daniel, Walsh, and Mesmer-Magnus 2022). However, the method is most effective when applied within a specific timeframe (Zupic and Čater 2015) and is ideal when aiming to explore a range of research themes and their latest developments, providing a visualization of the research landscape (Donthu et al. 2021).

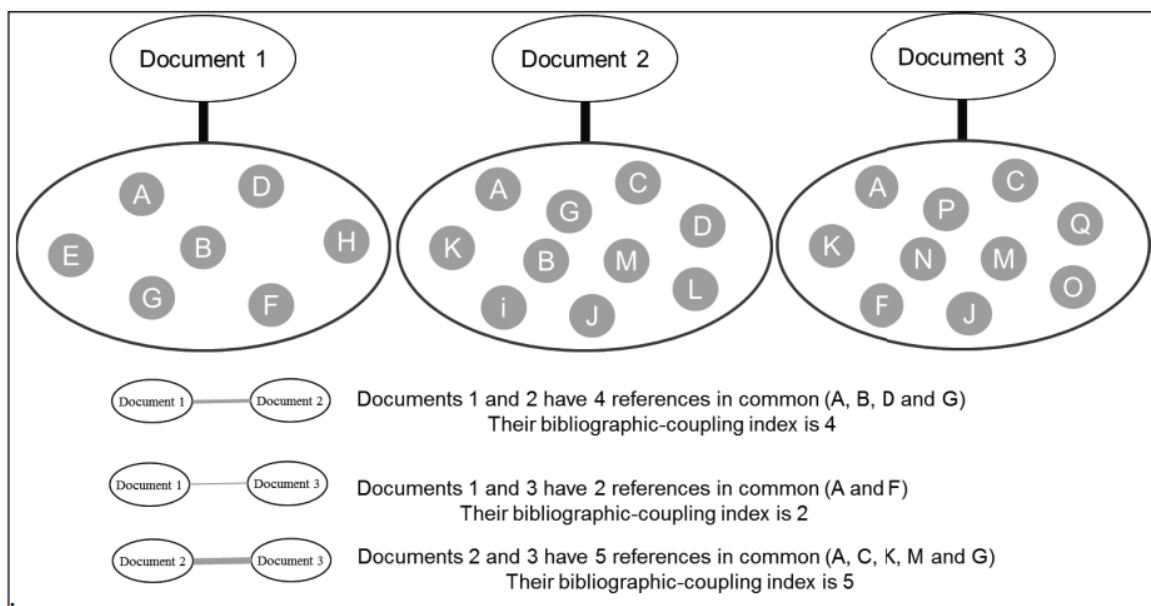


Figure 1. Bibliographic coupling of documents – Adopted from Walsh & Renaud (2017)

The following sections of the study include details on methodology, research findings, discussion, conclusion, and finally, contributions of the study.

2. METHODOLOGY

Bibliometric analysis involves quantitatively examining bibliographic materials (Broadus 1987). It has become a widely employed and rigorous way for researchers to handle substantial amounts of scientific data and generate significant research impact (Donthu et al. 2021). It employs mathematical and statistical techniques to increase researchers' objectivity when classifying publications in a given field (Borgman and Furner 2002). BA, therefore, helps unravel the accumulated scientific knowledge of a specific field whilst illuminating current research themes (Donthu et al. 2021).

As shown in Figure 2, the research follows a total of 6 steps:

The first step is to select essential keywords to extract related publications within the field. The keywords were “open innovation” and “small and medium-sized enterprise*” (including “SME*” and other related expressions).

The second step involves the use of software. To ensure an effective and efficient bibliometric literature review, the research used ARTIREV software (**ART**ificial **I**ntelligence and Literature **RE**view) – *an automated and integrated bibliometric-based artefact developed, designed, and tested/evaluated with direct input from end users* (Walsh et al. 2022).

In **the third step**, database extraction occurred in ARTIREV in December 2023 using advanced search functions and Boolean operators. To ensure accuracy, various search filtering criteria were applied (see Figure 2).

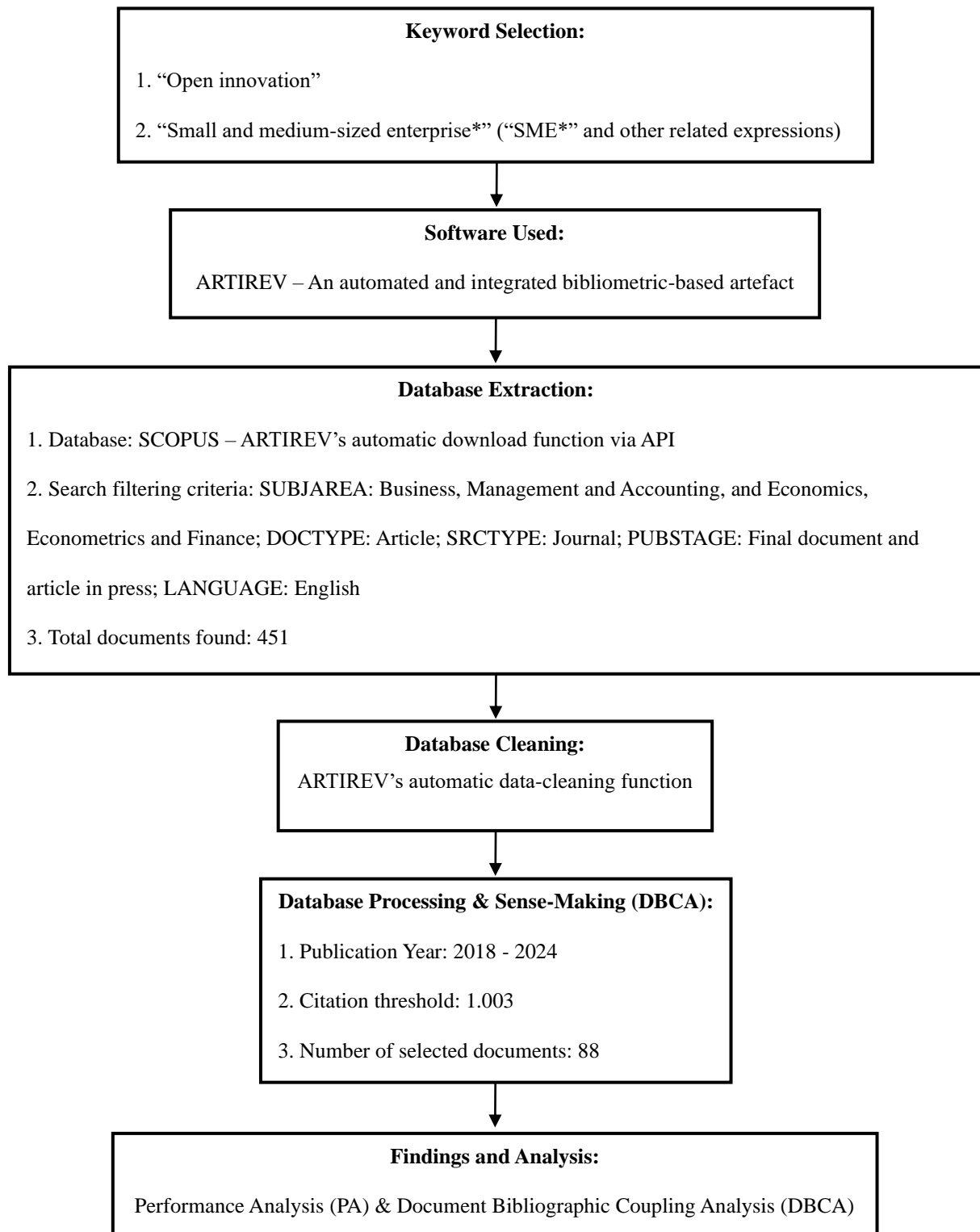


Figure 2. Research methodology structure

The established search query for database extraction was:

TITLE-ABS-KEY ((("open innovation") AND ("SME" OR "small and medium-sized enterprise*" OR "small and medium enterprise*" OR "small or medium enterprise*" OR*

"small and medium-sized business" OR "small and medium business*" OR "small or medium business*" OR "small and medium-sized firm*" OR "small and medium firm*" OR "small or medium firm*" OR "small-sized enterprise*" OR "medium-sized enterprise*" OR "small-sized business*" OR "medium-sized business*" OR "small-sized firm*" OR "medium-sized firm*" OR "small enterprise*" OR "medium enterprise" OR "small business*" OR "medium business" OR "small firm*" OR "medium firm*")) AND SUBJAREA (busi OR econ) AND DOCTYPE (ar) AND SRCTYPE (j) AND PUBSTAGE (aip OR final) AND LANGUAGE (english)*

A total of 451 documents were obtained and downloaded in ARTIREV.

The fourth step, therefore, is database cleaning, which was supported by the automatic data-cleaning function of ARTIREV, thus requiring no manual decision-making (Walsh et al. 2022).

After cleaning the database, **the fifth step** involves processing and sense-making using the ARTIREV software. In DBCA processing, default parameters were retained. Therefore, 88 documents cited at least 1.003 times the average from the last five years were deemed most significant. Subsequently, a science map was created from these 88 retained documents in the sense-making stage, also without any changes to default parameters.

The final step features two distinct analyses: (1) performance analysis encompassing the number of publications/citations by year, authors, affiliations, journals, countries, and sponsoring parties, and (2) document bibliographic coupling analysis enabling visualization of clusters that represent recent research themes in the field (Walsh et al. 2022).

3. FINDINGS

3.1. Performance Analysis

Evolution of the number of publications/citations on OI in SMEs

Since the study aimed to identify all publications that covered the research topic, there were no time restrictions. This resulted in identifying 451 articles in the Scopus database focusing on OI in SMEs from 2007 to 2024. These articles received 17,395 citations, with the ones published in 2017 gaining the most. Figure 3 illustrates a steady increase in publication trends, particularly with a notable surge in the last five years (2019-2023), contributing 59.42% to the overall production.

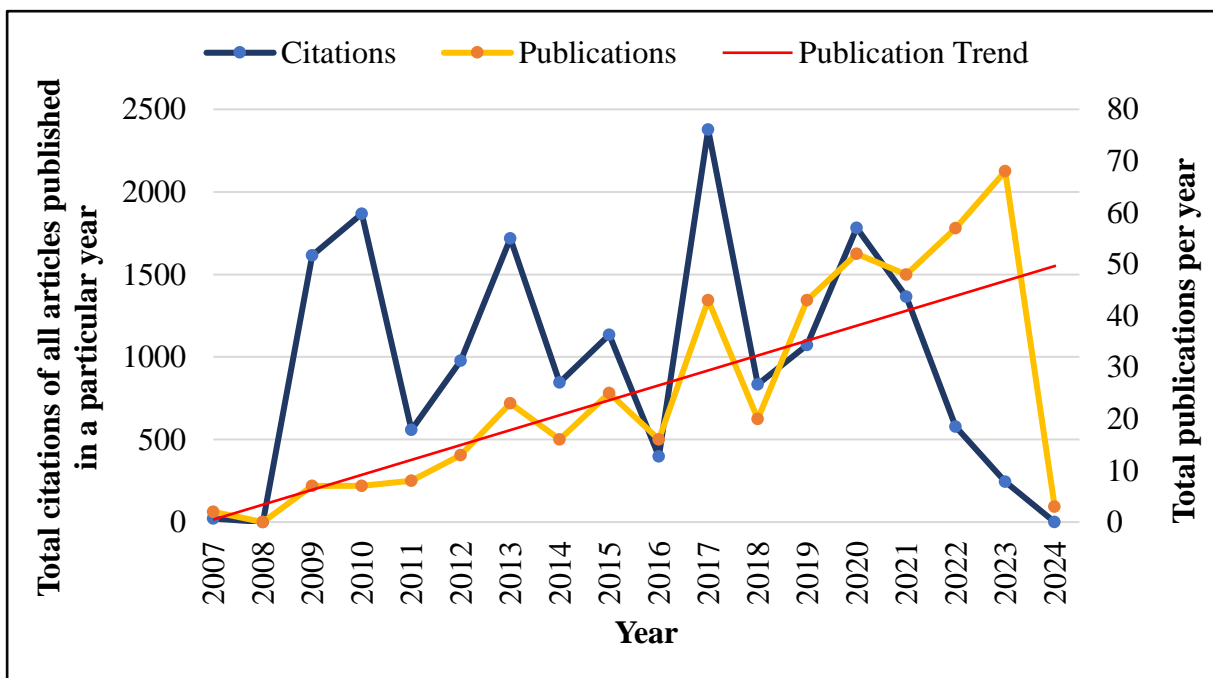


Figure 3. Evolution of scientific production of OI in SMEs

Most cited articles

Rank	Authors	Title	Year	Journal	Citations
1	van de Vrande et al.	Open innovation in SMEs: Trends, motives and management challenges	2009	Technovation	1509
2	Lee et al.	Open innovation in SMEs-An intermediated network model	2010	Research Policy	1010
3	Parida, Westerberg, and Frishammar	Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance	2012	Journal of Small Business Management	582
4	Brunswick and Vanhaverbeke	Open Innovation in Small and Medium-Sized Enterprises (SMEs): External Knowledge Sourcing Strategies and Internal Organizational Facilitators	2015	Journal of Small Business Management	498
5	Spithoven, Vanhaverbeke, and Roijackers	Open innovation practices in SMEs and large enterprises	2013	Small Business Economics	431
6	Spithoven, Clarysse, and Knockaert	Building absorptive capacity to organise inbound open innovation in traditional industries	2010	Technovation	333
7	Scuotto et al.	Shifting intra- and inter-organizational innovation processes towards digital business: An empirical analysis of SMEs	2017	Creativity and Innovation Management	274
8	Spithoven, Clarysse, and Knockaert	Building absorptive capacity to organise inbound open innovation in traditional industries	2011	Technovation	274
9	Popa, Soto-Acosta, and Martinez-Conesa	Antecedents, moderators, and outcomes of innovation climate and open innovation: An empirical study in SMEs	2017	Technological Forecasting and Social Change	259
10	Scuotto et al.	Knowledge-driven preferences in informal inbound open innovation modes. An explorative view on small to medium enterprises	2017	Journal of Knowledge Management	255

Table 1. Most cited articles

Table 1 lists the most-cited articles on OI in SMEs, representing 31.20% of total citations. All of them are published in high-ranked journals and have been cited over 250 times in Scopus. The leading article is the publication of van de Vrande et al. (2009), published in *Technovation* (1509 citations). The authors indicate that SMEs in the Netherlands, especially

medium-sized firms, are increasingly involved in OI and tend to be more heavily engaged than their smaller counterparts. The purposes and motivations for Dutch SMEs to practice OI are associated with market-related motives to catch up with their competitors or address customer demands. The second article is from Lee et al. (2010), published in *Research Policy* (1010 citations). The authors report Korean SMEs' success in adopting OI through an intermediated network, indicating that effective networking facilitates SMEs' innovation capabilities. The third article (500 citations) published in *Journal of Small Business Management* belongs to Parida, Westerberg, and Frishammar (2012). The authors examine 252 high-tech SMEs in Sweden to demonstrate that divergent inbound OI practices contribute positively to distinct innovation outcomes in SMEs.

Most productive authors

In Figure 4, *Alberto Di Minin* and *Gabriele Santoro* lead with nine scientific publications each. However, *Santoro* has obtained more citations (708) than *Di Minin* (443). Although they have not collaborated on articles, their research converges on various topics. These include Big Data for OI (Del Vecchio et al. 2018; Scuotto, Santoro, et al. 2017), OI driving digital transformation (Crupi et al. 2020; Jabeen et al. 2022), external knowledge sourcing (Del Sarto et al. 2023; Santoro et al. 2018; 2021), OI propensity (Marullo, Martelli, and Di Minin 2021; Santoro, Quaglia, et al. 2020), and OI practices (Costa et al. 2023; Marullo, Di Minin, et al. 2020; Marullo, Minin, et al. 2020; Santoro 2017; Santoro, Ferraris, and Winteler 2019). As mentioned earlier, *Wim Vanhaverbeke* has the most-cited article, and this author's studies (8) have also received the highest number of citations (2635) on the research topic. His articles concentrate on strategic topics such as challenges and advantages of OI practices in SMEs (Livieratos et al. 2022; Spithoven, Vanhaverbeke, and Roijackers 2013; van de Vrande et al. 2009), entrepreneurship (Usman, Vanhaverbeke, and Roijackers 2023; Usman and

Vanhaverbeke 2017), stakeholder engagement (Grama-Vigouroux et al. 2020), external knowledge sources (Brunswicker and Vanhaverbeke 2015), and business model innovation (Albats, Podmetina, and Vanhaverbeke 2021).

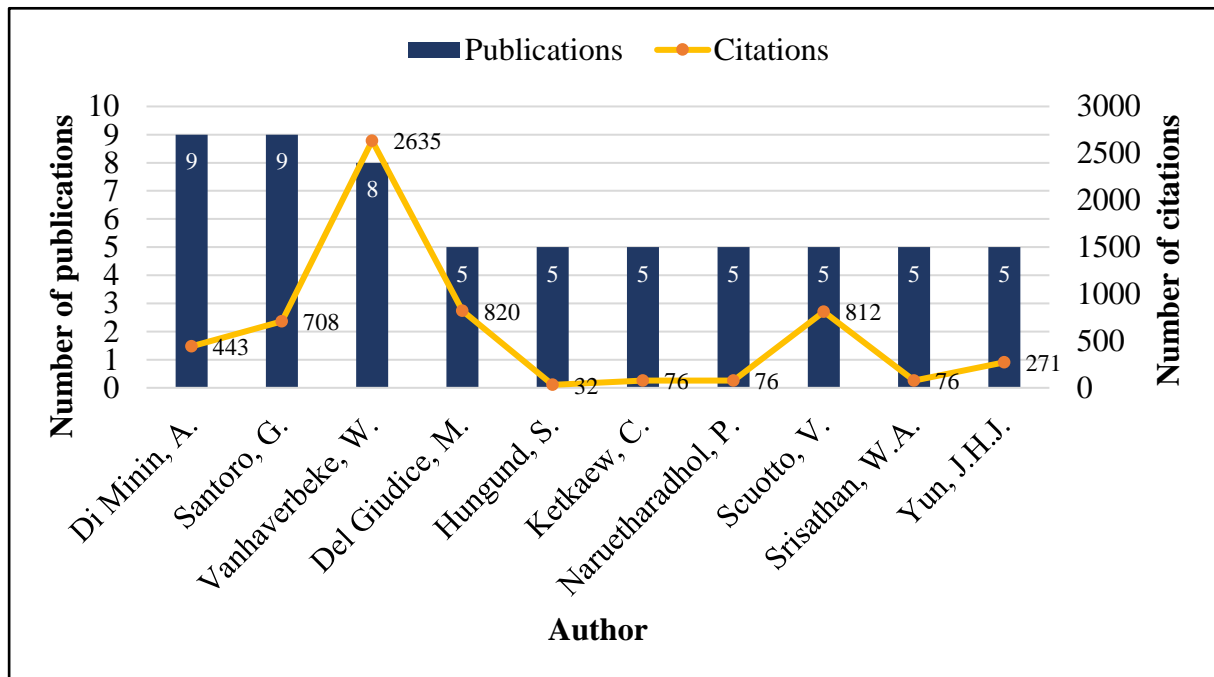


Figure 4. Most productive authors

Most influential journals

Rank	Journal	Articles	Citations	SJR 2022
1	Journal of Open Innovation Technology Market and Complexity	44	922	0.736
2	Technological Forecasting and Social Change	19	1249	2.644
3	International Journal of Innovation Management	17	163	0.488
4	European Journal of Innovation Management	16	319	1.142
5	Technovation	16	2599	2.410
6	Technology Analysis and Strategic Management	13	475	0.774
7	Journal of Business Research	12	632	2.895
8	IEEE Transactions on Engineering Management	10	133	1.002
9	Journal of Knowledge Management	10	876	2.220
10	International Journal of Entrepreneurship and Innovation Management	9	153	0.298

Table 2. Most influential journals

Note: SJR = SCImago Journal Rank

Journal of Open Innovation Technology Market and Complexity leads Table 2 with 44 published articles on OI in SMEs. Despite its relative longevity compared to other journals, it has fostered a welcoming environment for scholarly discussions. Following closely, four different journals, namely *Technological Forecasting and Social Change* (19), *International Journal of Innovation Management* (17), *European Journal of Innovation Management* (16), and *Technovation* (16), exhibit similar publication numbers. Remarkably, *Technovation* stands out with the highest impact, having 2599 citations, aligning with the findings in Table 1, where it published several highly cited articles. Although not leading in citations and article count, *Journal of Knowledge Management* holds the highest SJR score.

Most involved countries

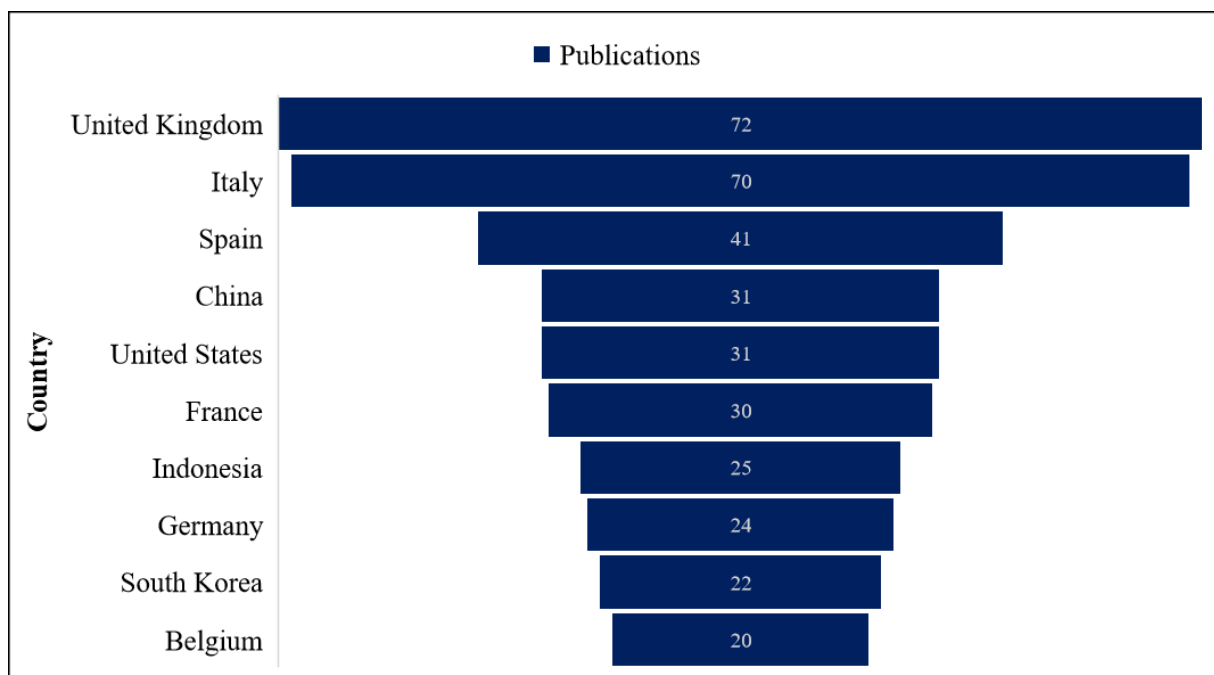


Figure 5. Most involved countries

Figure 5 shows the most involved countries leading research on OI in SMEs. Remarkably, the top three nations are all in Europe, with the *United Kingdom* leading with 72 publications, *Italy* and *Spain* with 70 and 41 articles, respectively. Surprisingly, the *United States* has the same number of articles (31) as *China*, despite the origin of the OI concept derived from the

U.S. Two Asian nations, *Indonesia* and *South Korea*, are noteworthy in the ranking, with *Indonesia* surpassing *South Korea* in the number of articles despite entering the field later in 2017. *Journal of Open Innovation Technology Market and Complexity* has published most Indonesian articles (16).

Most relevant affiliations

Table 3 aligns with the statistics in Figure 5, with 9 out of the 10 institutions situated in Europe. Despite the United Kingdom leading in the number of publications, only *University of Cambridge* is among the most relevant affiliations. Italian institutions dominate the ranking, with four institutions contributing 35 articles to the overall scientific production. Particularly, *University of Turin* receives 1571 citations for all its affiliated articles. *Federal University of Rio Grande Do Sul* stands as the sole institution from South America in Table 3, despite Brazil not appearing in the most involved countries. Additionally, while *Hasselt University* from Belgium contributes only five articles, it has the highest number of citations (2578) among the top 10, attributed to its affiliation with the most cited article.

Rank	Affiliation	Country	Publications	Citations
1	University of Turin	Italy	15	1571
2	Sant'Anna School of Advanced Studies	Italy	10	643
3	Luleå University of Technology	Sweden	7	770
4	University of Cambridge	United Kingdom	7	531
5	University of Padova	Italy	5	271
6	University of Beira Interior	Portugal	5	62
7	University of Siena	Italy	5	48
8	Federal University of Rio Grande Do Sul	Brazil	5	94
9	Hasselt University	Belgium	5	2578
10	Polytechnic University of Valencia	Spain	5	232

Table 3. Most relevant affiliations

Most sponsoring parties

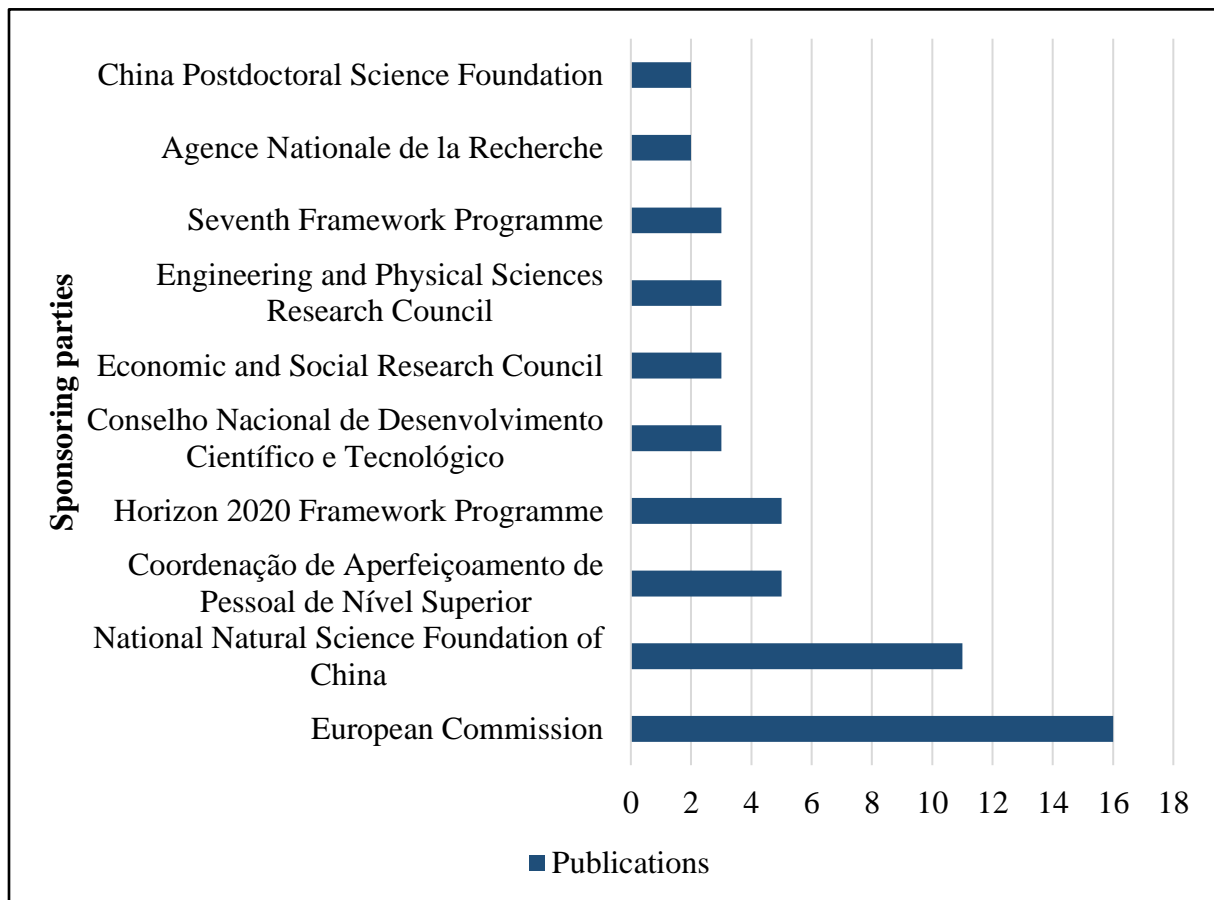


Figure 6. Most sponsoring parties

Figure 6 details the top sponsors from 2007 to 2024. *European Commission* prominently funds research in this area, with other European contributors including *Horizon 2020 Framework Programme*, *Economic and Social Research Council*, *Engineering and Physical Sciences Research Council*, *Seventh Framework Programme*, and *Agence Nationale De La Recherche*. This elucidates the prevalence of research on OI in SMEs within European affiliations.

In the earlier analysis, China emerges as the leading Asian contributor, with 31 scientific publications on OI in SMEs. This can be explained by two Chinese research foundations, *National Natural Science Foundation of China* and *China Postdoctoral Science Foundation*, supporting 13 published articles. Additionally, Brazil, through *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* and *Conselho Nacional de Desenvolvimento*

Científico e Tecnológico, plays a role in funding research on the topic. This explains Brazil's absence among the most productive countries, while a Brazilian university contributes to the most relevant institutions in scientific production.

3.2.Document Bibliographic Coupling Analysis (DBCA)

The ARTIREV software enabled the selection of the most significant 88 articles out of 451 publications in the database for DBCA. Figure 7 illustrates the bibliographic coupling analysis of documents from the last five years, with 6 clusters.

The first cluster (red) in Figure 7 includes 29 articles exploring the influence of *OI adoption on innovation performance, firm performance, and business model innovation*. In the direction of innovation performance, research investigates various perspectives that affect the adoption of OI concerning trust and dependency (Hameed and Naveed 2019), social media usage (Freixanet et al. 2021), social network analysis (Woods, Galbraith, and Hewitt-Dundas 2022), organizational learning ambidexterity (Tian et al. 2020). Other research focuses on firm performance affected by knowledge-sharing practices and top management knowledge values in OI (Singh et al. 2021), cost-leadership and differentiation strategies (Ngo 2023), eco-innovation and technological capabilities (Valdez-Juárez and Castillo-Vergara 2021), absorptive capacity (Cuevas-Vargas, Aguirre, and Parga-Montoya 2022). Additionally, some researchers have shifted from the performance focus to understanding the impact of the OI paradigm on business model innovation (Ibarra et al. 2020; Liao, Liu, and Ma 2019).

The second cluster (green), comprising 25 articles, addresses *OI practices*, which deal with research on inbound and outbound OI modes. External knowledge sourcing is the specific subject that several researchers pay attention to (Del Sarto et al. 2023; Gimenez-Fernandez, Sandulli, and Bogers 2020; Oliveira, Gentile-Lüdecke, and Figueira 2022; Santoro et al. 2018), as this strategy belongs to the most applied mode in OI – the inbound process

(Markovic et al. 2021; Priyono, Moin, and Putri 2020), become quick adaptors (Peñarroya-Farell and Miralles 2022), and innovate their business models (Jabeen et al. 2022).

The fourth cluster (purple) in Figure 7 comprises seven articles in which the theme of *entrepreneurship* is investigated. These studies aim to understand entrepreneurs' knowledge and resilient mindset when adopting OI (Santoro, Bertoldi, et al. 2020; Usai et al. 2018) and the characteristics that influence their propensity toward openness (Santoro, Quaglia, et al. 2020).

Clusters 5 (bright blue) and 6 (orange) each have only two articles. **The fifth cluster** explores *economic growth*, while **the sixth** focuses on *sustainable innovation*. However, the articles within these two clusters are not explicitly related to the scope of the OI concept. They only highlight certain aspects of OI research in their content, such as licensing or external collaborative strategies.

4. DISCUSSION & CONCLUSION

Over the last two decades, research on OI has become well-established; however, the role of the OI paradigm in SMEs has received more attention in recent years. This research aimed to illuminate the evolution of research on OI in SMEs and the emergence of research themes in the field. The research used ARTIREV software and the Scopus database to facilitate the application of a bibliometric analysis, which helped discover the whole structure of scientific production and identify several research trends in OI in SMEs.

Research on OI in SMEs started in 2007 with only two articles. After that, it witnessed a steady increase in scientific production from 2007 to 2017, with several critical articles that mark its evolution. The study by van de Vrande et al. (2009) addresses the motivations and purposes of SMEs in implementing open innovation practices. Other articles investigate the role of networks (Lee et al. 2010) and emphasize the importance of OI practices (Brunswicker

and Vanhaverbeke 2015; Parida, Westerberg, and Frishammar 2012; Spithoven, Clarysse, and Knockaert 2011; Spithoven, Vanhaverbeke, and Roijackers 2013). Andre Spithoven and Wim Vanhaverbeke are the two key authors who contributed most during this period. After 2017, scientific production dramatically decreased in 2018 but stably increased until 2020. Alberto Di Minin and Gabriele Santoro are two prominent authors. Their research concentrates on external knowledge sourcing (Santoro et al. 2018), OI practices (Marullo, Minin, et al. 2020; Santoro, Ferraris, and Winteler 2019), OI propensity and entrepreneurship (Santoro, Bertoldi, et al. 2020; Santoro, Quaglia, et al. 2020). Additionally, other research considers aspects of digitalization and Big Data in OI (Crupi et al. 2020; Del Vecchio et al. 2018). After 2021, scientific production has increased significantly, with 2023 alone witnessing the publication of 68 articles. This period's three most productive authors include Chavis Ketkaew, Phaninee Naruetharadhol, and Wutthiya Srisathan. These authors collaborated during this timeframe to research open eco-innovation (P. Naruetharadhol et al. 2021; Wutthiya Aekthanate Srisathan et al. 2023), OI and ambidextrous innovation (Wutthiya A. Srisathan, Ketkaew, and Naruetharadhol 2023), and OI for Industry 4.0 (Phaninee Naruetharadhol et al. 2022).

While scientific production on OI in SMEs receives significant global attention, most articles are from developed European nations. This trend is due to financial support from various European foundations, especially European Commission. Among the top involved countries, China significantly contributes to OI in SME research, starting in 2011 with support from National Natural Science Foundation of China and China Postdoctoral Science Foundation. Surprisingly, despite China's substantial contribution, none of its universities feature among the relevant affiliations. In contrast, Federal University of Rio Grande Do Sul in Brazil positions itself obviously among the top 10 institutions, despite Brazil not being among the top 10 nations involved. This result may be justified as an outcome of two Brazilian funding foundations appearing on the list of the most sponsoring parties.

The study helped shed light on divergent research trends in OI in SMEs. The most noticeable trend is how OI adoption affects firm and innovation performance and their business model innovation. The relationship between OI and performance has been extensively explored since OI's spawning. However, OI's influences on business model innovation could be an exciting research path as OI adoption requires firm business model transformation (Chesbrough & Bogers, 2014). Note that adopting OI does not inherently mean that firms possess an open business model (Vanhaverbeke and Chesbrough 2014). Understanding how firms with OI adoption innovate their business models from a closed to an open one and vice versa, can be intriguing. The second theme is OI practices in SMEs, in which most research focuses on the inbound OI mode, as it is the most widely applied strategy in companies (Chesbrough & Brunswicker, 2014). However, the outbound and coupled processes also play an essential role in OI (Gassmann and Enkel 2004), and current research seems to neglect the importance of these strategies. It, therefore, is a promising direction for researchers to understand the role of these two modes in various aspects of SMEs. Other research themes were discovered in the bibliographic coupling analysis, including OI challenges, OI in crisis times, entrepreneurship, economic growth, and sustainable innovation. OI adoption can be a big challenge for SMEs since these companies face different difficulties in resources, capabilities, and liabilities of smallness and newness (van de Vrande et al. 2009; Vanhaverbeke 2017). However, a high level of openness can help entrepreneurs and their firms identify opportunities for collaboration, innovation, and entrepreneurship (Nambisan, Siegel, and Kenney 2018). Research, therefore, on how various managerial and cognitive aspects of entrepreneurs facilitate the adoption of OI and manage OI-related risks can be a fruitful research path.

5. CONTRIBUTIONS

This study contributes to the literature on OI in SMEs in three ways. Firstly, it uncovers the evolutionary structure of the field by detailing constituents related to its development. Secondly, it sheds light on current research themes in the OI literature on SMEs over the last five years, helping future researchers explore specific aspects of OI in SMEs. Lastly, it provides guidance for novice researchers and doctoral students seeking to learn in the field. From a practical perspective, the research also provides OI managers and practitioners with concise information to swiftly identify crucial sources of scientific knowledge and analysis for their OI adoption.

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