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Specific Characteristics and Determinants of Open Innovation in SMEs: A Systematic Literature Review

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Abstract. Open innovation (OI) assumes that businesses combine external and internal ideas as the primary means to accelerate internal innovation or access the market to commercialize their technologies. OI has recently been studied in small and medium-sized enterprises (SMEs). However, to date, little has been done to create a conceptual framework for these studies, particularly in terms of classifying them by specific characteristics and determinants of OI. We propose such a framework, based on a systematic literature review of 130 papers. The papers were critically evaluated and examined to see how the literature has evolved in recent decades. Theoretical and managerial implications are discussed. The study reveals that much progress has been made on this subject, although the literature is very recent and many areas remain unexplored.

Keywords. Open innovation, SMEs, determinants, characteristics, systematic literature review.

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1. Introduction

Recent years have seen a dramatic increase in Open Innovation (OI) research in the literature on business innovation. This kind of openness works in two directions: on the one hand, a business opens itself up to knowledge from outside actors; on the other hand, it deliberately makes commercially useful internal knowledge available to the market (Chesbrough, 2003; West et al., 2006).

Previous studies have focused on OI in large R&D-intensive enterprises that use external technological knowledge to strengthen internal research (outside-in) and that outsource internal knowledge to generate additional funds (inside-out) (Chesbrough, 2003). In these studies, OI takes various forms depending on the direction of knowledge flows (Chesbrough et al., 2006) and is primarily technology-driven. It has three main determinants: use of ICTs and knowledge management systems (Dodgson et al., 2006); available resources, especially innovation networks (Dittrich and Duysters, 2007); and, most importantly, the sector and industry (Gassmann, 2006). The benefits of opening up the innovation process are widely accepted by large corporations, such as Philips, Xerox, Eli Lily, BASF, and Procter & Gamble, and within the software development community (Chesbrough, 2010).

More recently, researchers have been looking at OI in SMEs and have begun to explore its characteristics and determinants (Brunswicker and Vanhaverbeke, 2015; Spithoven et al., 2013; Usman and Vanhaverbeke 2017). Some studies have shown possible advantages for SMEs, in particular an improved capability to cope with the limitations of being a small business that lacks resources and skills (Bianchi et al., 2010; Van De Vrande et al., 2009; Chesbrough et al., 2006). Other studies have shown possible disadvantages: SMEs are highly sensitive not only to the costs of OI but also to its risks, and such risks may hinder their development (Ham et al., 2017; Huang et al., 2015; Taheri et al., 2018). Use of OI seems to be favoured by some SME characteristics, in particular flexibility, informality and risk-taking, and hindered by others, particularly small size, lack of human and financial resources, limitations of scale and absence of technological assets (Spithoven et al., 2013; Ahn et al., 2015; Basco and Calabro, 2016). Thus, SMEs are an interesting subject for study of OI.

Despite recent interest in the subject, research remains limited and studies scattered, fragmented or sometimes contradictory. There is a need for a conceptual framework that will consolidate and bring together all relevant studies about OI in SMEs, so that we may explore its specific characteristics and identify the determinants that enable SMEs to innovate in an open environment. For these reasons, we did a systematic review of the literature.

Our research questions were:

- What are the characteristics of OI in SMEs?
- What are the main determinants of OI in SMEs?

- How do these different elements relate to each other within an integrated conceptual framework?

The answers would be helpful in theoretical and practical ways. In academia, they would improve understanding of OI in SMEs and help identify its characteristics and determinants in that specific context. To our knowledge, no systematic review of the literature has brought these different elements together into a framework that could be used to analyse their interconnections and complementarity. We could thus better understand the complex relationships between OI characteristics and OI determinants. Researchers would also have a road map with which they could go further and test whether previous research results can be generalised to different contexts. Finally, our findings would in practice help SME managers and decision-makers make evidence-based recommendations on OI in their organisations.

The rest of the paper is structured as follows. The next section will present a brief theoretical framework for the OI concept, a discussion of OI characteristics that have mainly been studied in large businesses and an overview of the emerging literature on OI in SMEs. The following sections will discuss the relevance of using a systematic literature review to address this issue and our methodology. Next, we will review the current state of the literature, as shown by selected articles on OI characteristics and determinants in SMEs and propose an integrated conceptual framework. The paper will end with the theoretical and managerial implications of our review as well as its originality. We will also identify what remains to be learned about OI in SMEs and develop a roadmap for future research.

2. Theoretical framework

2.1. Definition of open innovation

Open innovation is “the use of the purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the market for external use of innovation, respectively” (Chesbrough et al., 2006, p.1). This definition implies that the business opens itself up in order to benefit from external knowledge and to create opportunities for co-operative innovation processes with partners, customers and/or suppliers (Gassmann and Enkel, 2004). For Van der Ploeg (2011), OI is simply the integration of external knowledge to create value for customers. It refers to an emerging model of innovation in which businesses use research and development that may be outside their organisational boundaries (Chesbrough, 2003). Thus, they resort to collaborative strategies to access and use knowledge available outside their boundaries and, reciprocally, to make their own knowledge and technologies available to the market.

2.2. General characteristics of OI: practices, tools and actors

OI is defined not by a single activity but by a set of elements, activities and practices that, together, complement each other and affect the purpose and outcome of the innovation process. Thus, to understand the characteristics of OI, we looked to the approach developed by Battistella et al. (2017). We chose this approach because it provides a broader look at

studies on the subject. According to the authors, OI can be understood in terms of three main characteristics: practices, tools and actors.

2.2.1. OI practices

OI practices are activities that businesses adopt and deploy to implement OI (Vrande et al., 2009). The literature on OI in large businesses tells us that it can be implemented through inbound (outside-in), outbound (inside-out) and coupled processes. The following Table 1 presents the main OI practices (inbound, outbound and coupled processes) identified in large businesses with some associated examples.

Table 1: Main OI practices

OI practices	Examples	Authors
Outside-in (inbound process): integration of knowledge from external sources to increase innovation	Customer involvement; external networking; external knowledge sourcing; R&D collaboration; mergers and acquisitions; strategic alliances; IP-in licensing/inward licensing of IP; mass customisation; crowdsourcing	Chesbrough et al. (2006); Lichtenthaler (2008, 2011); Gassmann (2006); Henkel (2006)
Inside-out (outbound process): the process of a business earning money by putting its ideas on the market, by selling intellectual property and by transferring ideas to the external environment	Sale of intellectual property licences; open-sourcing; sale of innovation projects; joint ventures for commercialisation of technology	Chesbrough et al. (2006); Lichtenthaler (2008, 2011); Gassmann (2006); Henkel (2006); Vrande et al. (2009); Gassmann and Enkel (2004)
Coupled process: co-creation with complementary partners in strategic networks, both to integrate external knowledge and skills and to outsource its own knowledge and skills	R&D collaborations; strategic/technology; alliances/consortia; joint ventures	Gassmann and Enkel, (2004); Enkel et al. (2009)

2.2.2. OI tools

OI tools are instruments, interfaces and technologies that help businesses adopt and implement OI. Aloini et al. (2015) have studied these tools and identify three main types: technological, organisational and management. Table 2 presents some examples of technological, organisational and managerial tools used to implement OI.

Table 2: Technological, organisational and managerial tools for OI

OI tools	Examples	Authors
Technological tools: related to information and communication technologies (ICTs), such as Web 2.0 or social media networks, which enable businesses to interact with different sources of knowledge	Free software; crowdsourcing platforms; web-enabled innovation brokers; new technologies for data mining, simulation, prototyping and visual representation to support development of new products (DNP)	Krogh and Hippel (2003), Dahlander and Gann (2010); Lee et al. (2010); Krogh and Hippel (2003); Di Gangi and Wasko (2009); Leimeister et al. (2009) Whelan et al. (2014); Dodgson et al. (2006);
Organisational tools: researchers have discussed how theories about organisational structure can be coupled with the OI paradigm, and which concepts from these theories meet the needs of the OI paradigm	Such concepts as specialisation, formalisation and decentralisation are being increasingly studied to understand their influence on OI gains	Ihl et al. (2012)
Managerial tools: combination of routines, practices and incentives to support OI implementation	Suggestion boxes, which promote exchange and sharing of ideas Workshops or collaborative projects, which jointly support sharing of high levels of uncertainty and risk	Igartua et al. (2010)

2.2.3. OI actors

The actors involved in the OI process can be either internal or external to the organisation, related or not to the value chain. Table 3 presents the different actors who may be associated with implementation of OI: suppliers and customers, users and consumers, spin-offs and spin-outs, internal employees, CEOs, geographic communities and communities of practice, governments, policy makers and other political and economic institutions, universities and research centres, etc.

Table 3: Examples of OI actors

OI Actors	Examples	Authors
Actors related to the value chain	Suppliers and customers; users and consumers; spin-offs and spin-outs	Chesbrough and Brunswicker (2014); Theyel (2013)
Internal actors	Internal employees and CEOs	Chesbrough and Brunswicker (2014); Chesbrough (2003); Burcharth et al. (2014);
External public actors	Communities and communities of practice; government, policy makers and other political and economic institutions; universities and research centres	Chesbrough (2006)
External private actors	Intermediaries: Many companies are supporting the OI process more and more through direct involvement in communities (as members) or through indirect involvement (as sponsors)	Giannopoulou et al. (2011); West and Lakhani (2008)

2.3. Open innovation and SMEs: foundational studies

Within the extensive literature on adoption of OI, research on small and medium-sized enterprises (SMEs) has gained considerable momentum. Indeed, the latest studies show that business size has an impact on OI use and implementation (Keupp and Gassmann, 2009; Lichtenthaler and Ernst, 2009; Vrande et al., 2009). Although SMEs are able to implement the OI paradigm, they do so less often and differently (Harland and Nienaber, 2014; Holzmann et al., 2014; Vrande et al., 2009). Earlier work has shown a big difference in innovation strategies between small and large businesses (Acs and Audretsch, 1990; Vossen, 1998). OI in SMEs has its own characteristics, which are poorly described by the existing literature on OI in large businesses. The lessons learned from the latter are not transferable to the former. Despite similarities between the two business models, the differences are so substantial that managers need a specific conceptual framework to successfully manage OI in SMEs. To this end, several authors have tried to identify the differences. For Vanhaverbeke (2017), SMEs differ from large businesses in that they lack a portfolio of innovation projects; consequently, they do not need to frame their innovation activities in a closed or open innovation funnel. Furthermore, because OI is managed by the entrepreneur or founder of the SME, and not by the manager of research and development, it becomes integral to the entrepreneurial process. Finally, OI networks are managed differently in SMEs than in large businesses. An SME deals with its innovation partners much more through individual relationships based on trust and informal communication. These differences thus warrant a specific focus on OI in SMEs.

This specific focus is especially justified by the inherently contradictory position of SMEs with regard to OI. On the one hand, they seem naturally suited to OI. For Brunswicker and Vanhaverbeke (2015), SMEs are generally more flexible, less formal and better

able to make fast decisions than larger businesses. They are less risk-averse and often have specialised knowledge in one area. As a result, they can better identify and seize opportunities more quickly, especially opportunities to innovate with external partners. For Chesbrough (2010), they have several advantages in this respect over large businesses: their small size makes them a good fit for small markets (which are less interesting for large businesses); they are more focused than larger and more diversified businesses, which have more diffuse objectives; they are better able to offer services in specialised or limited fields; their entrepreneurial vision attracts more enterprising and dynamic R&D employees; their faster decision making enables them to respond more quickly to customer feedback or the challenges of their competitors and evolve their own business models. On the other hand, SMEs are disadvantaged by their lack of human and financial resources, limitations of scale and lack of technological assets (Ahn et al., 2015; Basco and Calabrò, 2016; Spithoven et al., 2013). These disadvantages are a hindrance to what they can offer to innovation partners. Thus, SMEs have characteristics that both enable and hinder their use of OI. In this respect, they provide an interesting context for study (Ramirez-Portilla et al., 2017). All these reasons explain the need to learn more about OI in SMEs, its different modalities and the conditions or determinants of its effectiveness.

To our knowledge, the literature does not currently offer an integrated conceptual framework for OI in the specific context of SMEs. In addition, researchers have not yet grouped together OI characteristics and determinants to provide a comprehensive picture. To get such a picture, one must go through the literature and consult a large number of scientific papers. Our paper will help remedy this shortcoming.

3. Relevance of a systematic literature review

A systematic literature review identifies, selects, evaluates and summarises primary studies, data and research findings on a specific subject (Becheikh et al., 2006; Cook et al., 1997; Tranfield et al., 2003). It is now widely viewed as the least biased and most rational way to synthesise research data and as a powerful tool to collect the best available knowledge for decision making.

In this research, use of a systematic review has several justifications. First, it would be new. We searched the *ABI/INFORM Global*, *Business Source Premier* and *Web of Science* databases for systematic literature reviews of peer-reviewed journals on OI in SMEs. The search was for titles that had the terms "*Open innovation"* and "*SME"* or *"small and medium-sized enterprises"* and "*literature review"* or "*overview"* or "*review".* To date, there have been four general systematic literature reviews on OI in SMEs, but none of them was focused on the specific characteristics and determinants of OI in SMEs. Table 4 shows how our review compares to the previous ones.

Table 4: Comparison between previous literature reviews and ours

	Hossain (2015)	Hossain and Kauranen (2016)	Odriozola-Fernández et al. (2019)	Torchia and Calabrò (2019)	Our review
Type	Systematic review	Systematic review	Bibliometric analysis.	Systematic review	**Systematic review**
Purpose	To examine current research on OI in SMEs	To synthesise the extant literature on OI in SMEs	To provide a comprehensive overview of research on OI in SMEs.	To assess the current state of research on OI in SMEs to understand why and how SMEs apply OI	**To examine the specific characteristics of OI in SMEs and explore its determinants.**
Period	2003-2014	No restrictions	No restrictions	1983-2017	**2003-2019**
Results	The paper presents challenges for innovation management, absorptive and desorptive capacities, policy for open innovation, dynamic capabilities, some OI practices in SMEs (collaboration, networking, patenting), benefits of OI and relationship between OI and performance	The paper presents some OI practices in SMEs (networking and collaboration), transformation of an SME from a closed to an open approach, relationship between innovation and technology management and overall OI performance of SMEs	The paper summarises the main areas of interest in OI: impact of OI on a company's performance and organisational structure; OI as a mechanism to hasten new product development; analysis of the inbound/outbound dimensions of OI; legal issues involved in managing intellectual property rights when OI is implemented	The paper identifies five main research focuses on open innovation in SMEs: OI, internal capabilities, innovation performance, methodologies and tools, regional and industry insights	**The paper identifies the main OI practices in SMEs, OI determinants and the relationships between practices and determinants**
Databases	Web of Science and Scopus	Web of Science and Scopus	Web of Science	Business Source Premier, Scopus (Elsevier), EBSCO	**Web of Science, ABI/INFORM Global and EBSCO**

Second, a systematic literature review is indicated when the concept under study has an abundant literature. To ensure the literature was sufficiently abundant, we did a search using the keywords *"Open innovation"* and *"SME"* in the main databases on management (*ABI/INFORM Global*, *Business Source Complete* and *Web of Science*). Because several

thousand texts were obtained from each of the databases, we concluded that a systematic literature review was justified.

Third, such a review would be useful because several cited studies have demonstrated the growing importance of OI in SMEs (Wynarczyk et al., 2013; Parida et al., 2012). This practice is encouraged by more and more public policies. Nevertheless, decision-making and diagnostic tools are currently lacking to identify OI characteristics and determinants. To date, despite a large number of studies on the subject, little effort has been made to produce a systematic synthesis of current knowledge. A systematic review is therefore relevant and needed. It will ultimately provide managers, stakeholders and policy makers with conclusions and lines of action that can help them develop and promote innovation in SMEs.

4. Methodology

In our review of the literature, we were inspired by the method of Tranfield et al. (2003). According to these authors, the systematic review process should go through the following stages: 1) formulating an explicit research question, 2) setting the inclusion and exclusion criteria, 3) searching for relevant studies, 4) selecting studies according to the inclusion and exclusion criteria, 5) evaluating the selected studies, 6) summarising and synthesising the results of the review, and 7) interpreting the results. This section will cover stages 1) to 4). The other stages will be discussed in the Results section.

4.1. Formulating the research questions

Our systematic review aims to answer three research questions:
1) How can OI in SMEs be characterised?
2) What are the main determinants of OI in that context?
3) How do these determinants relate to each other within an integrated conceptual framework?

4.2. Setting the inclusion and exclusion criteria

To be included in the literature review, the study must meet a set of criteria. Table 5 summarises the inclusion and exclusion criteria used to select papers for study.

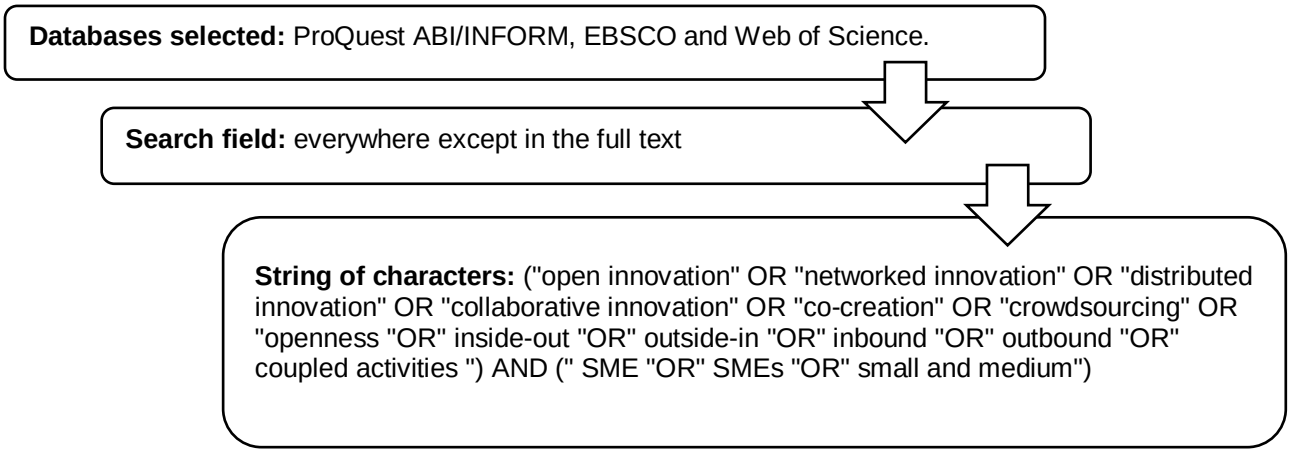
Table 5: Inclusion and exclusion criteria for study selection

Inclusion criteria	Exclusion criteria
1) **Be about OI in SMEs** as the main concept (particularly the characteristics and/or determinants of OI) and answer at least one of the three previously identified research questions. 2) **Be a scientific article published in a peer-reviewed journal** because these publications are peer-reviewed and thus meet a certain level of rigor and quality determined by committees of researchers in the field. 3) **Was published between January 2003 and December 2018**. In 2003, Chesbrough introduced the concept of OI in his book "Open Innovation: The New Imperative for Creating and Profiting from Technology". 4) **Be written in English or French**, the two languages most often used by the most relevant management databases. 5) **Include empirical work or be a conceptual study**. Because the OI concept is still new and has only been recently applied to SMEs, we included any relevant article we found on the subject, whether empirical or conceptual. Such papers provided us with broader coverage of the subject.	Are not included: 1) Dissertations, theses, or books 2) Editorials, book reviews 3) Single case studies or success stories.

4.3. Searching for relevant studies

With assistance from an expert social science librarian, we selected the following databases for the literature review: *ProQuest ABI/INFORM Global*, *EBSCO* and *Web of Science*. In addition, the recentness of the subject led us to define the search field rather broadly, so as not to limit the literature search excessively and to include a rather large number of articles in the results. Thus, as a starting point for each query in the databases, the search was *"everywhere except in the full text".* The literature search in each database was conducted using a pre-established string of characters in both English and French. The search string used key words from previous OI scientific literature reviews. It had two distinct components: "*open innovation"* and "*SMEs"*. The first component included key words related to "*open innovation".* The literature reviews we consulted on OI showed us that authors generally use several synonyms to describe the subject. We chose the terms "*network innovation",* "*distributed innovation",* "*collaborative innovation",* "*co-creation",* "*crowdsourcing",* and "*openness",* as suggested by Grimaldi et al. (2017) and Randhawa et al. (2016) in their systematic reviews of the OI literature. Each of the strings was then entered into the previously selected databases. A total of 1,050 papers were identified from all 4 databases. All identified documents were processed using EndNote software to identify and eliminate duplicate studies. Figure 1 summarises our search for relevant studies.

Figure 1. Summary of our search for relevant studies



4.4. Selecting the studies

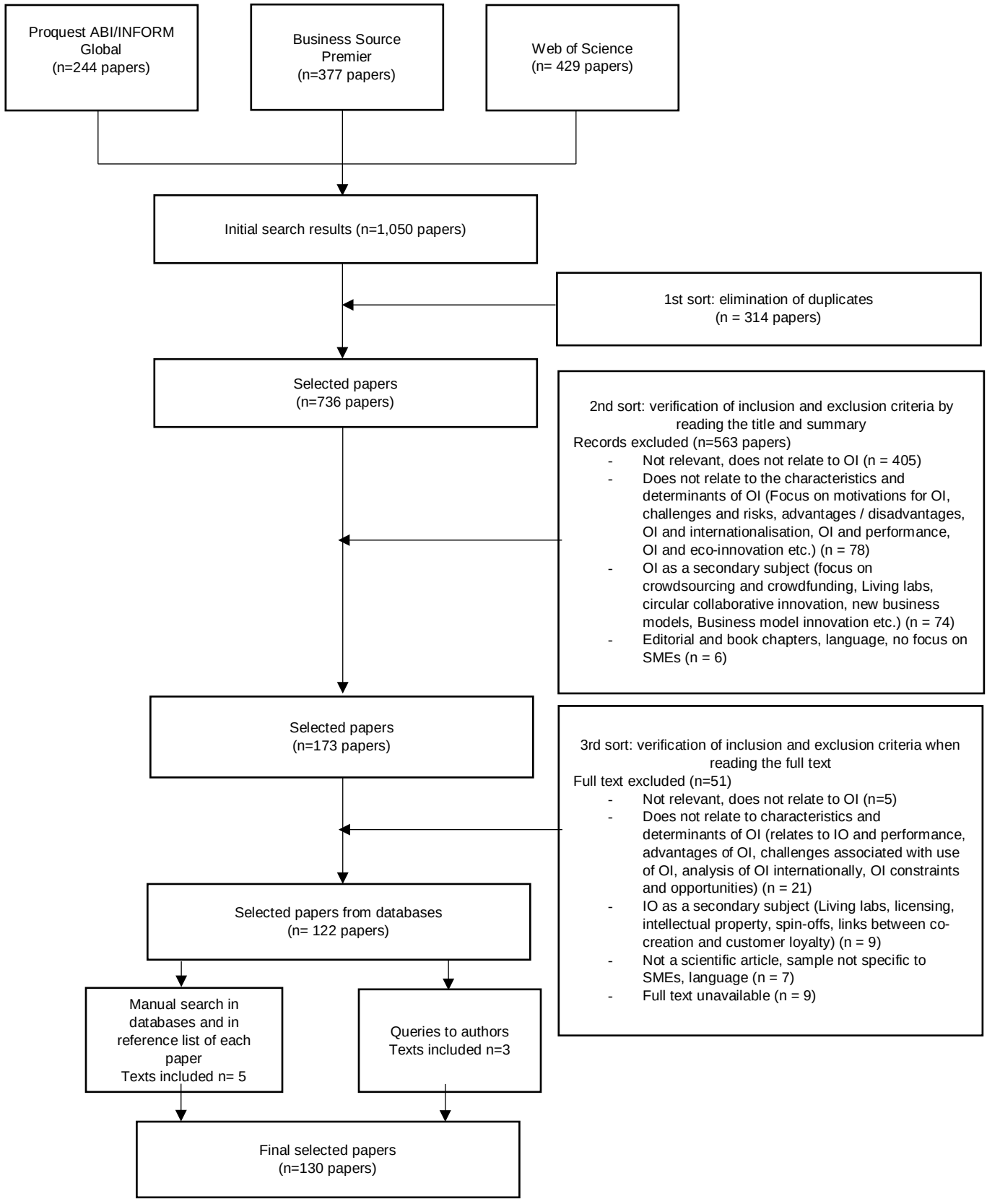
After compiling the data in Endnote, we performed a triple sort.

1) During the first sort, we searched the databases, applied the inclusion and exclusion criteria and eliminated duplicates. At the end of this initial sort, 736 unique papers were selected.
2) During the second sort, we verified the initial sort by reading the title and the summary of each paper. We exercised much caution throughout this stage and, in case of doubt, kept the papers for the next sort. The papers we selected here focused on OI in SMEs. We set aside papers that did not discuss OI or any of its practices (inbound, outbound or coupled process) as a dependent variable. The list was thus reduced to 173 papers.
3) During the third sort, we read the full text of each selected paper and verified the inclusion and exclusion criteria. As a result, 51 documents were excluded because they did not meet any of the criteria. At this point, 122 papers were kept.

After the sorts, we manually searched through the reference lists of the selected papers as well as the ten most recurrent academic journals in our sample of 122 papers. The objective was to identify scientific articles that met our inclusion and exclusion criteria but had not been identified using the pre-established character strings and in the selected databases. The manual search led us to add 5 articles to our previous total.
Finally, a personalised email was sent to the main authors of each of the selected papers. The answers obtained were again analysed according to our inclusion and exclusion criteria, leading us to add 3 more articles. Our final total was therefore 130 articles.

A summary of the selection process is given in Figure 2.

Figure 2. Method for selecting scientific papers



On a Microsoft Excel spreadsheet, we listed the bibliographic data (author, title, year, journal) for each selected paper, the type of research (qualitative, quantitative or conceptual), the country of the study, the industry or area of activity and the subject of the paper (practices, tools, actors, determinants or multiple subjects). This document is available upon request to the authors. Appendix 1 provides summary information on each selected paper of the systematic literature review.

5. Results of the review

This part of our paper will explore the results of our systematic literature review. We analysed the results descriptively and analytically. The descriptive analysis presents the main trends by year of publication, by academic journal, by geographic area, by methodology, by industry and by topic. The analytical synthesis provides answers to our research questions by identifying the main characteristics (listed in terms of practices, tools and actors involved in OI) and the main determinants associated with the practice of OI in SMEs.

5.1. Descriptive analysis

5.1.1. Year of publication:

All of the selected texts were published between 2006 and 2019. No article was published before 2006, and research on OI in SMEs truly started in 2009. Indeed, from 2006 to 2009, the term "open innovation" was still unknown, and studies on the subject used various names, without explicitly mentioning the term "open innovation". It was in 2009 that the expression really began to take off, with the main paper by Van de Vrande et al. (2009) on OI practices in a sample of Dutch SMEs. Since then, the literature on the subject has grown considerably with a peak in 2017, when 24 articles were published on the subject.

5.1.2. Academic journals:

The selected 130 papers come from 92 academic journals, an indication that this literature is very fragmented and especially multidisciplinary. Several fields of research now include studies on OI in SMEs. Of the 92 journals we identified, the leading ones are: *Technology Innovation Management Review* (6 papers), *Business Process Management Journal* (4 papers), *R&D Management* (4 papers), *Technology Analysis & Strategic Management* (4 papers), *International Small Business Journal (4 papers), Journal of Technology Management & Innovation* (3 papers), *Journal of the Knowledge Economy* (3 papers), *Technovation (3 papers), Small Business Economics* (3 papers) and *Technological Forecasting and Social Change* (3 papers).

5.1.3. Geographic areas:

Most of the papers concerned Europe (64 articles) and Asia (20 articles). Italy, Spain and South Korea were the top three countries, with respectively 12 papers, 11 papers and 8 papers. Other papers adopted a multi-country approach, studying SMEs in several contexts.

Most of the time, the contexts were European and American, the authors often taking a comparative approach. There was very little interest in OI in South American or African SMEs (2 papers each).

5.1.4. Methodologies

The methodology was most often qualitative (53 papers) or quantitative (52 papers). In quantitative studies, researchers extensively surveyed international or national institutions to validate their hypotheses. The latter studies were a response to earlier calls for more quantitative research in order to generalise results, validate hypotheses and enable policy makers to justify and develop more policy to support OI (Van de Vrande et al., 2009). Among the different qualitative methods, the leading one was the case study (36 papers). The others were mixed-method studies (14 papers) and conceptual articles (11 papers).

5.1.5. Industries

Most of the papers took a multi-sectoral approach, selecting different SMEs from different industries. Single-industry studies were mostly on manufacturing (41 papers) or services (13 papers). Other industries were trade distribution, natural resources or mining.

5.1.6. Themes

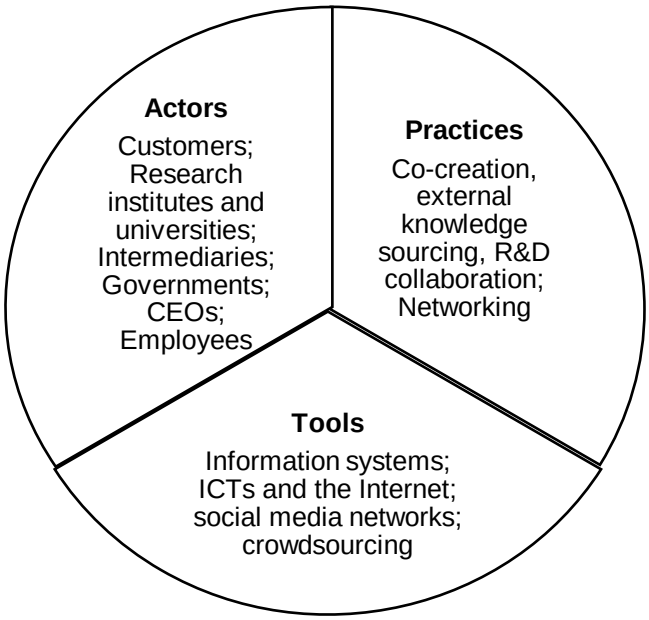
In addition, we categorised the selected papers according to whether they were about practices, tools, actors or determinants of OI. Most of them dealt with determinants of OI (54 papers) or practices associated with implementation of OI in SMEs (26 papers). A large proportion dealt with two or more of these characteristics simultaneously (30 papers).

5.2. Analytical synthesis

We synthesised the selected papers analytically in order to answer our research questions. An integrated conceptual framework which summarise the relationships between the different results was then proposed and studied. Most of the time, the various papers did not categorise the characteristics of OI. We thus made an effort to do so through analysis and integration. This categorisation makes it easier to understand the current state of knowledge.

The following Figure 3 summarises the main characteristics of OI in SMEs.

Figure 3. Main OI characteristics in SMEs



5.2.1. OI practices in SMEs

The literature shows that OI in SMEs mainly takes the form of inbound practices (outside-in) (Battistella et al., 2017; Bianchi et al., 2011). Of these practices, the main one is collaboration or partnership with external actors. The authors study different forms of collaboration that SMEs can carry out with external partners: participation/involvement by customers (or end users) and suppliers during the innovation process (Theyel, 2013; Vrande et al., 2009; Yun and Mohan, 2012; Haukipuro et al., 2018; Morgan et al., 2018), external knowledge sourcing (Brunswicker and Vanhaverbeke, 2015; Deutsch, 2013; Tripathi, 2016; Pustovrh et al., 2017; Su et al., 2016) and collaboration in R&D (Spithoven et al., 2013; Vrande et al., 2009; Mitze et al., 2015; Rodríguez-Ferradas and Alfaro-Tanco, 2016). Other forms include collaboration between start-ups and large businesses (Usman and Vanhaverbeke, 2017; Jang et al., 2017), acquisitions (Mawson and Brown, 2017) and collaboration in technology. All of these forms contribute positively and significantly to SME inbound processes and financial performance. Other forms of collaboration, such as networking, also appear in the literature. For some authors, a business can accelerate its internal innovation by participating in innovation networks with different agents who are involved in co-creation activities (Corréia et al., 2015; Vrande et al., 2009; He and Wang, 2016).

5.2.2. OI tools in SMEs

The literature most often mentions technological tools. The Internet and new technologies enable SMEs to generate value through collaboration with other businesses and through co-

creation with customers (Bell and Loane, 2010). One such tool is crowdsourcing, which has enabled many co-creators, often amateurs, to perform tasks that were formerly the preserve of a few specialists (Ruiz et al., 2016). Advancement in virtual technology may offer new platforms for external engagement. Some authors have, for example, explored how suppliers and customers use videoconferencing as a tool for collaborative innovation. Videoconferencing is a platform when distance is a barrier, being used for engagement in both directions to facilitate cognition and affect, thereby helping form and cement trusting relationships. (Hardwick and Anderson, 2019). Businesses can also collaborate with their stakeholders via their websites or social media platforms. They may collaborate via email, enquiry forms, surveys, blogs and online communities (e.g., clubs, friends of the company). Interaction beyond the company website may take place on various social networking sites, such as Facebook, Twitter, YouTube and LinkedIn, distributor platforms (e.g., Amazon) and review sites (e.g., Yelp, Ciao) (Mariussen and Ndlovu, 2012). Candi et al. (2018) have studied social media and suggest that SMEs are likely to benefit in their innovation processes by connecting to customers through social media. Social media provide a new way to access knowledge and can thus promote innovation, specifically by positively influencing knowledge creation and helping foster the innovation process (Papa et al., 2018). The authors found that OI in SMEs can be accelerated through exchange of knowledge via social networks, such exchange being key to innovation (Hitchen et al., 2017; Scuotto et al., 2017). In addition to these technological tools, IO can be encouraged via idea development contests, suggestion boxes or collaborative project workshops, all of which promote and support knowledge sharing among collaborative partners (Battistella et al., 2017; Igartua et al., 2010).

5.2.3. OI actors in SMEs

The literature indicates that OI can benefit from external and internal actors. External actors are non-competitive partners, such as customers, consultants/intermediaries and public research institutes. The main sources of innovation, and the most valued ones, are value chain actors, such as suppliers and customers (Battistella et al., 2017). End users and customers are also considered to be proactive participants in the development process. SMEs thus increasingly bring end users into development of products or capabilities (Chesbrough and Brunswicker, 2014; Lee et al., 2010; Scuotto et al., 2017). In addition, by collaborating with research and development laboratories, technology centres, industry associations, universities and public research and innovation institutions, SMEs can overcome the limitations of their small size and compete with larger businesses (Hitchen et al., 2017; Carvalho and Moreira, 2015; Gabriele et al., 2017; Roper and Hewitt-Dundas, 2013; Deschamps et al., 2013). SMEs are increasingly willing to work with academic groups and universities, seeing them as their main source of technological knowledge (Marangos and Warren, 2017). In other cases, a central role is played by government programs and policies (Vrgovic et al., 2012). Although the SME itself decides to move from closed innovation to open innovation, the government can influence this decision through direct and indirect financial incentives and initiatives (Rangus and Drnovsek, 2013). Governments, policymakers and other political and economic institutions create the context for regulation,

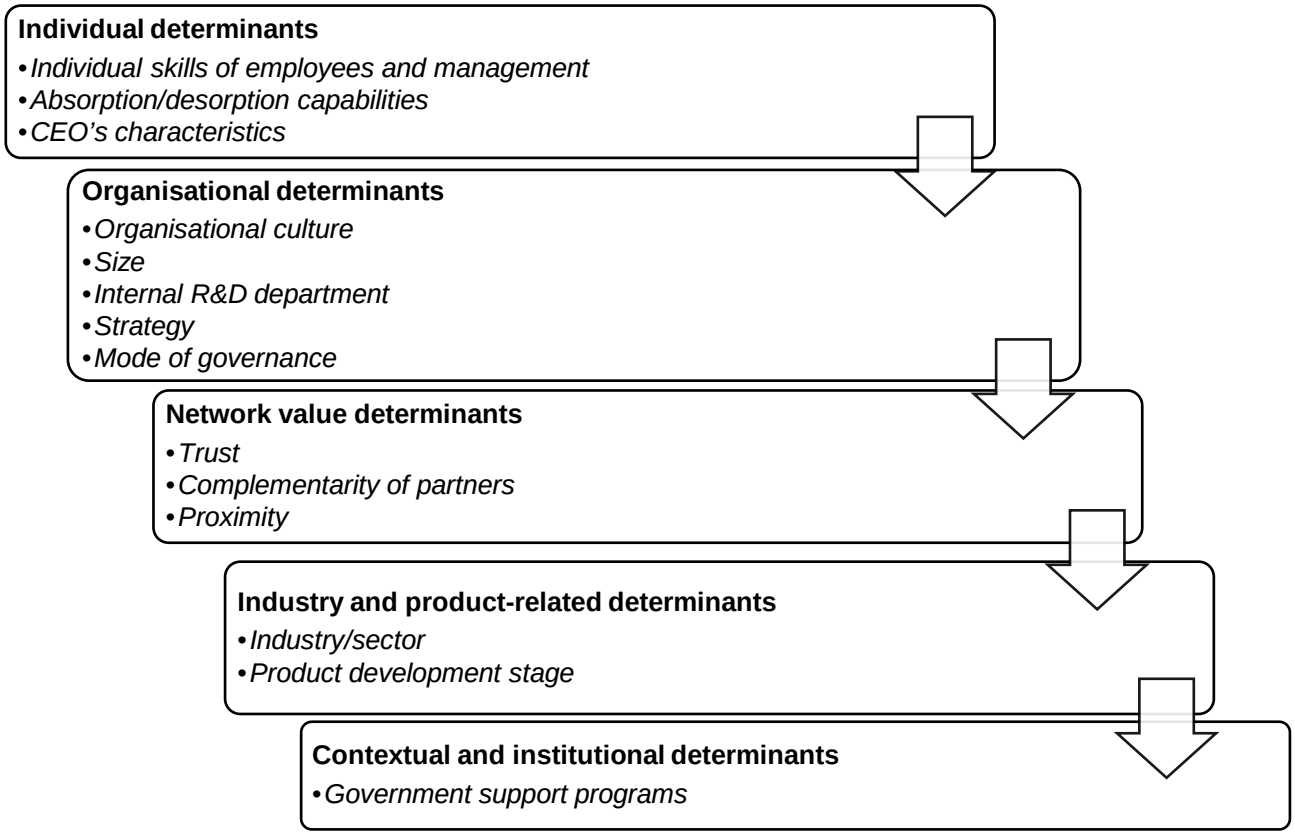
intellectual property law, capital markets and industry structures in which businesses can innovate (Battistela et al., 2017). These external actors (R&D laboratories, technology centres, industry associations, universities, governments, public research and innovation institutions) are often called intermediaries. In general, intermediaries are considered to be the main drivers for development of innovation networks (Iturrioz et al, 2015; Thi Mong Chau and De la Ville, 2012). Several studies have highlighted the role of context-dependent intermediaries in developing a shared innovation strategy. As stated by Deschamps et al. (2013), the OI process has eight main categories of intermediaries: technology transfer offices, university technology commercialisation offices, industry associations, R&D consortia, college technology-transfer centres, private consultants, university research centres and government agencies (advisors affiliated with industrial R&D support programs).

In addition, the main OI internal actor is the CEO. Indeed, the CEO's characteristics will strongly influence major decisions, such as adoption of OI, because decision making is usually highly centralised (Ahn et al., 2017). Using data from Korean SMEs, Ahn et al. (2017) show that a positive attitude in the CEO, as well as entrepreneurial orientation, patience and education, can play an important role in facilitating OI. Also important is the role of the start-up manager, whose prior experience with large businesses is crucial to determining the success of the relationship between the start-up and a large business. Internal employees are also mentioned as a critical source of innovative ideas (Usman and Vanhaverbeke, 2017; Chesbrough and Brunswicker, 2014). Finally, most SMEs benefit from new knowledge gained during internal foresight workshops with non-R&D employees (Battistela et al., 2017).

5.2.4. OI determinants in SMEs

Several studies have examined the determinants of OI in SMEs. Most of these studies conclude that a set of factors affect the practice of OI in SME (Dufour and Son, 2015; Bigliardi and Galati, 2016; Dries et al. 2014; Lahi and Elenurm, 2015; Grama-Vigouroux et al., 2019; Teirlinck, 2018). Using a multi-level approach, we grouped and classified them as individual, organisational, network value, industry/product-related and contextual/institutional. Our approach is summarised in Figure 4.

Figure 4: Multi-level approach toward OI determinants in SMEs



5.2.4.1. Individual determinants

The individual skills of the employees and the CEO will determine OI in an SME. Human capital is key to SME involvement in collaborative activities (Comacchio et al., 2012). Lavrynenko et al. (2018) present the OI skills required of SME employees. They find that companies put emphasis on hard and digital skills, while general or soft skills (leadership, communication, etc.) are considered obvious. One must be able to adapt to the use of ICTs and new technologies; for employees, the most relevant OI skills seem to be ICT- or Internet-related (Gryczka, 2014; Lee et al., 2010). Employees often gain such skills through their absorptive capacities—a prerequisite for benefiting from external knowledge. Absorptive capacity is the ability to detect, value, assimilate and apply new knowledge to become more innovative (Grimaldi et al., 2013). Thus, SMEs with good absorptive capacity demonstrate a greater propensity to access and use external sources of knowledge for innovation (Candi et al., 2018). The ability to absorb knowledge is key to facilitating the effectiveness of innovation. Limited absorptive capacity may be a major barrier to OI adoption in SMEs (Huang and Rice, 2015). In addition, absorptive/desorption capacities play an important role in interactions with potential co-operating partners. In the collaborative process, their importance shifts from the enterprise level to the personal level and concerns each

employee individually (Braun et al., 2012). SMEs often lack this capacity and therefore need to rely on technology intermediaries (Spithoven et al.; 2010). Teirlinck and Spithoven (2013) argue that OI practices, such as research co-operation and R&D outsourcing, require internal R&D employees with good absorptive capacity. Thus, employees must be willing and able to gain external knowledge to improve the effectiveness of their innovations.

For SME managers, it has been proposed that the main OI influence factor is the innovation leader, manager or entrepreneur and his/her personal characteristics, commitment, knowledge and attitudes, which may in turn be helped or hindered by his/her education and creativity and by societal attitudes (Lahi and Elenurm, 2015). A management team with a wide range of managerial skills and experience can increase OI capabilities (Wynarczyk, 2013). The founders' prior experience, education and innovation capabilities determine how open the SME will be to external knowledge networks (Taheri et al., 2018). Personal characteristics like openness and leadership are advantages (Lahi and Elenurm, 2015). Therefore, if an SME embraces OI, it is much likelier to have a management team with diverse capabilities, experiences or expertise in both scientific (innovation and R&D) and non-scientific (finance, marketing or international) areas (Wynarczyk, 2013; Taheri et al., 2018). The dominant coalition that controls an SME changes its interests, motivations and behaviours, including a propensity to adopt OI (Basco and Rodriguez, 2009). Thus, different management styles may be associated with different OI strategies (Marangos and Warren, 2017; Brunswicker and Vanhaverbeke, 2015). Also important are the management skills needed for strategy development and management training in OI. Leaders need to develop specific organisational capacities for implementation of OI activities during an initial learning period (Salvador et al. 2013). Similarly, engagement-based HR and HR practices positively influence the innovation climate and contribute to inbound and outbound processes (Popa et al., 2017).

5.2.4.2. Organisational determinants:

Several research projects have shown that an SME is influenced in its capability to implement and manage OI by organisational factors, such as internal R&D capacity, organisational culture and structure, size, ownership structure, organisational stage and ability to identify potential partners with complementary resources (Gurau and Lasch, 2011; Huang and Rice, 2009; Naqshbandi, 2018). A major OI determinant is the existence within the SME of an R&D department. The OI model suggests that internal innovation—often referred to as internal R&D practice—should be weighed against other sources of knowledge. Nonetheless, before seeking innovative solutions or increasing innovation through external sources of technology and knowledge, a business needs to have strong R&D capabilities (Ramirez Portilla et al., 2017). Internal R&D is thus key to the OI model. Combined with inbound and outbound practices, it can help an SME increase its innovation capability and performance (Hameed et al., 2018). So an SME should first develop a good capability for internal innovation while partially opening up its innovation process, rather than opening it up entirely (Verbano et al., 2015). Wynarczyk (2013) also shows that internal R&D capacity is the most crucial component of the OI process. Investments in internal R&D are

considered key to invention, innovation and increased productivity. In addition, the size of the technical staff in the R&D department is seen as critical to OI practice and success. OI in SMEs is influenced by another organisational factor: an open organisational culture that promotes knowledge sharing and exchange. OI requires a culture that recognises and encourages learning and creativity while emphasising motivation to collaborate and openness to knowledge. Several studies have shown that an innovative and open culture will foster creativity and support learning, knowledge creation and co-operation among employees, thus producing more sources of OI and higher levels of innovation, activity and financial performance (Fontana et al., 2006; Grimsdottir and Edvardsson, 2018; Rangus and Drnovsek, 2013; Szymanska, 2016; Mazur and Zaborek, 2016). A favourable climate for OI promotes systemic knowledge management, considered a fundamental facilitator of OI (Kim and Ahn, 2019). According to Scuotto et al. (2017), the knowledge-based approach is one of the main determinants of OI, leading to preference for informal inbound OI modes. Furthermore, organisational structure is important, particularly specialisation and centralisation, because both favour use of inbound and outbound OI (Gentile-Lüdecke et al., 2019). Size is probably another major organisational factor. Earlier works showed that innovation strategies differ considerably between small and large businesses (Vossen, 1998; Acs and Audretsch, 1990, cited by Van de Vrande et al. 2009). Innovation processes are generally more structured and professional in large businesses than in small ones. As an SME grows, it increasingly develops and creates formal structures, which are shaped by recruitment of skilled workers and by introduction of management rules and procedures. For Van de Vrande et al. (2009), business size can influence adoption of OI; they found significant differences in adoption of OI practices between different size classes. OI is used and adopted less often by small organisations than by medium-sized ones, which have the scale and resources to organise a broader range of innovation activities. This finding has been corroborated by several authors, who find differences in OI implementation between micro, small, medium and large businesses, with the last size class (large businesses) being more involved in OI activities than the others (Rangus and Drnovsek, 2013; Dooley et al., 2015). Finally, other studies have related OI in an SME to such factors as the type of SME, whether it is family or non-family (Basco and Calabro, 2016; Lee et al., 2009; Lambrechts et al., 2017), its business model (Braun 2015) and its business strategy (Verbano and Venturi, 2014).

5.2.4.3. Value network determinants

We have previously seen that an SME's contact network is essential to OI. This network is effective only under certain conditions, an important one in the literature being complementarity. Complementarity between innovation partners is essential to sharing of corporate resources and capabilities and creates synergies within the network (Rehm and Goel, 2017; Papa et al., 2018; Huang et al., 2015). The actors of the network must exchange complementary resources. These network relationships require establishment of "fit" between the partners, who must be able to adapt to each other. An effective network must be targeted and coherent with a high level of resource complementarity and a relationship

of trust (Pullen et al., 2012). Another condition is the mode of governance and the organisational form of the innovation network. It is necessary to evaluate how the network is to be organised, which coordination and control mechanisms are to be put in place and which partners are to be involved. Coherence has to be established among a series of factors (goal identification, content and typology of partners involved in the network) and with the mode of governance (Lazzarotti et al., 2012). An innovation network will also succeed to the extent that it is trusted. Anderson and Hardwick (2017) have studied trust as a social artefact within an innovation network. They see trust as a process and show that different types of trust are involved in the collaborative process. In this process, the relationship within a knowledge exchange network goes from transactional to social, the first stages being characterised by technical knowledge and the later, more mature ones by better knowledge of the person and greater personal trust. The success of collaborative innovation is thus due to relationships of increasing trust (Teirlinck, 2018). SMEs should develop trusting relationships with some of their major customers, who would thus be encouraged to contribute to the SME innovation process (Tobiassen and Pettersen, 2018). Finally, an innovation network is helped by proximity between innovation partners, a factor whose importance was discounted by previous work on OI but is now considered essential for SMEs. In fact, regional and national proximity is one of the main factors that lead SMEs to open up to external sources of innovation. Knowledge is sought within a short distance mainly because of lack of time, the need to deal with lack of knowledge quickly or the urgency of a problem. If SMEs do not have the capacity to invest in R&D for innovation, they will first engage in national collaborations to access new knowledge (Kapetaniou and Lee, 2018). Geographic proximity helps small businesses cope better with OI costs and risks (Jespersen et al., 2018; Teirlinck, 2018).

5.2.4.4. Industry and product determinants

The literature also shows that OI in SMEs depends on the industry or sector and on the product. SMEs adopt OI to the same extent in manufacturing and services, there being no major difference in this respect (Vrande et al., 2009). However, some differences appear in the type of OI. For example, service companies generally adopt inbound OI processes (Virlee et al., 2009). Rangus and Drnovsek (2013) compared services with manufacturing and found that service companies are significantly more involved than manufacturers in external participation, pre-acquisition, outbound IP licensing and employee involvement. Similarly, Grimsdottir and Edvardsson (2018) found differences in OI practices between two businesses, one in software products and the other in agribusiness. The product, particularly the stage of its development, also influences the adoption of OI and the type of OI implemented. While large businesses focus their collaborative efforts on external sources during the R&D stage, small ones primarily focus on OI during commercialisation. Indeed, insufficient marketing capacity has been identified as a major driver of SME OI adoption; it is precisely because SMEs lack marketing channels that they resort more to OI during commercialisation of the product. The initial study by Van de Vrande et al. (2009) already established that SMEs look to OI primarily for business activities, such as meeting customer

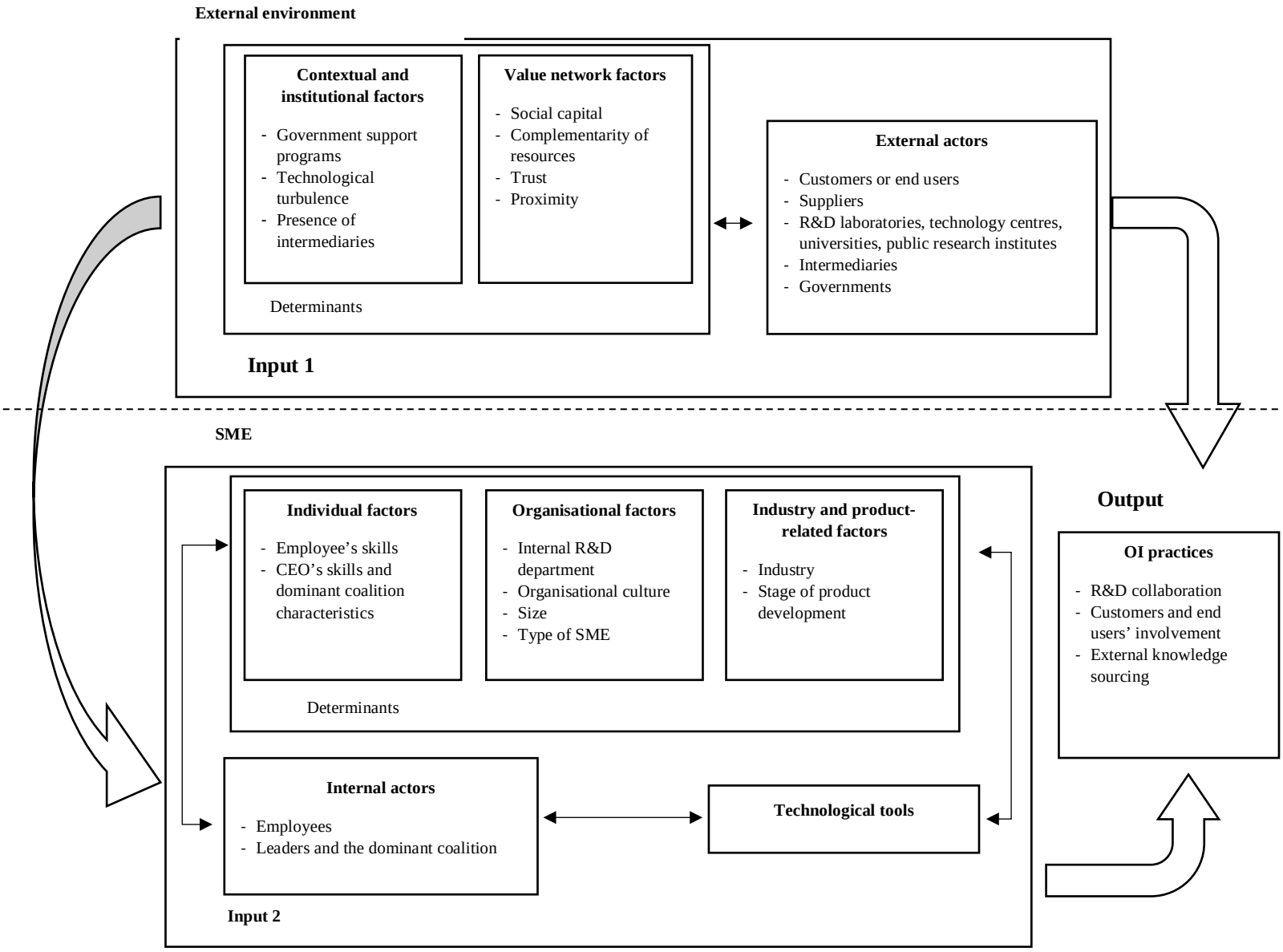
demand or keeping pace with competitors. Other authors have subsequently come to the same conclusion: OI is most important at the end of the innovation process, in particular during commercialisation (Theyel, 2003; Henttonen and Lehtimaki, 2017; Lee et al., 2010; Verbano et al., 2015; Yun and Jung, 2013).

5.2.4.5. Context and institutional determinants

A management concept will likely not have the same effect in all situations; consequently the effectiveness of OI will depend on the context. The literature identifies several contextual determinants of OI in SMEs: technological turbulence, presence of intermediaries in the environment, environmental dynamism and role of governments in promoting OI. The available sources of external knowledge and its nature (direct or indirect customers, suppliers, universities and research centres, IP experts, networks) are key to OI implementation by SMEs (Brunswicker and Vanhaverbeke, 2015). In addition, OI is directly affected by environmental dynamism, measured primarily by OI supportiveness of governments and public policies (Martinez Conesa et al., 2017; Popa et al., 2017). The level of environmental dynamism will determine the effectiveness of the company's capabilities and OI activities. Specifically, when the level of environmental dynamism increases, there is a corresponding increase in inbound activities, network capabilities and innovation capabilities, which can enhance radical innovation (Cheng and Sheu, 2018). In particular, SMEs can be educated about OI through innovation support systems that are offered by public actors, public policies and public programs (Gabriele et al., 2017). In fact, if a business has access to government R&D grants, it is significantly likelier to adopt OI (Wynarczyk, 2013). Consequently, appropriate policy initiatives, such as tax incentives, may actually help SMEs become active participants in technological innovation. To this end, it is necessary to increase the SME orientation of policies, programs, infrastructures, institutional supports, financial subsidies and agencies that specifically target innovation (Pervan and al., 2015; Arbussa and Llach, 2018).

Our literature review suggests that these different elements are interrelated. Indeed, most studies have recognised a movement toward an integrated vision of innovation management and OI in particular. Adoption, implementation and success of OI depends not only on internal and external factors but also on the tools, the actors in the process and the relationships between all of these elements. Therefore, it is useful to look for OI in cases where SMEs adopt certain practices with technical tools, maintain relationships with certain actors and have certain characteristics at the individual, organisational, industrial or contextual level. Figure 5 is a proposed conceptual framework that illustrates how different elements relate to each other in terms of input-output. The relationships are then explained.

Figure 5. Conceptual framework of OI in SMEs



External environment indicators, named Input 1 here, together with SME-level indicators, named Input 2 here, contribute to implementation and success of OI in the SME (Output). External environment indicators include external determinants (contextual/institutional determinants and value network determinants) and external actors. SME-level indicators are internal determinants (individual, organisational, or industry/product-related), internal actors and technological tools. Previous studies have shown a reciprocal relationship between determinants and OI actors, whether internal or external (Verbano et al., 2013; Lee et al., 2010; Basco and Calabro, 2016). In addition, other studies have shown the existence of implicit relationships between OI internal actors (the manager and the employees) and use of technological tools. For example, one of the individual determinants of OI, identified earlier, is the ability of SME employees to develop ICT or Internet skills (Gryczka, 2014; Lee et al., 2010). Lavrynenko et al. (2018) believe that technical and numerical employee skills are fundamental to OI. However, the vast majority of the studies we reviewed have shown a reciprocal relationship and some interdependence between OI determinants, actors or tools on the one hand and adoption of OI on the other hand. Establishment and success of OI in an SME is therefore considered an output in our framework. Generally, businesses use different types of OI according to the evolution of the market, the SME's internal and external context, the actors involved, and the tools available. The type of OI and the corresponding result will differ from one organization to another because of differences in needs, in risk-taking ability, in the nature of the business, and in the industry. Furthermore, specific types of OI in SMEs will involve specific actors, tools or determinants.

Our framework shows interdependence between the different elements under study, specifically practices, tools, actors and determinants.

6. Contributions and suggestions for future research

This review has shown what the literature tells us about OI characteristics and determinants in SMEs and answers the research questions we initially formulated. We achieved this goal through a systematic review of the literature. The results show that OI in an SME differs considerably from OI in a large business. Some characteristics are specific to OI in SMEs. First, inbound OI is observed mainly in SMEs because many of them are still struggling to cope with the outbound activities due to strategic challenges, such as technology pricing or internal knowledge, disclosure of intellectual property and loss of critical knowledge, that may enrich a competitor's knowledge base and making the SME less competitive. Second, technological tools are the ones that most SMEs adopt; organisational and management tools are less common. Third, the literature review highlights external actors in the OI process and, even more so, internal ones. In the case of SMEs, the owner-manager strongly influences adoption of OI. His/her risk perception and position on OI will significantly influence its use, unlike the situation in a large business, where the executive has less power than the shareholder committee/owners. Finally, OI determinants in SMEs were grouped into five main categories: individual, organisational, network-related, industry-related and contextual. Of these categories, the organisational, individual and contextual determinants are the ones that appear in most of the papers we reviewed. Using these findings, we

propose a conceptual model of OI in an SME by presenting relationships of reciprocity and interdependence among the different elements.

Our research is relevant both in theory and in practice. On theoretical level, this research explains OI in SMEs by synthesizing the relevant literature on the subject. Indeed, while large businesses have gradually adopted OI, less has been known about SMEs in this respect. Our research fills this gap by providing better knowledge of OI characteristics in the specific SME case, as well as the determinants to be taken into account during OI implementation. Also, our proposed conceptual framework for the complex relationships between the characteristics and the identified determinants provides a complete map of research on the subject. By incorporating the interrelationships and interdependence of the OI characteristics with OI determinants, we complete the framework of Battistela et al. (2017), who studied OI practices, tools, and actors. On practical level, better understanding of the main determinants that influence adoption of OI could lead to more SME-oriented innovation strategies for managers. Our results would enable them to formulate evidence-based recommendations to support implementation of OI in their organization.

Despite the progress in the literature on OI in SMEs, significant theoretical and empirical gaps remain. To fill the theoretical gaps, more research is needed in such areas as outbound practices (sales of licenses, patents, or innovation projects), collaborations with competitors or large businesses, the specific case of start-ups, and organisational or managerial tools that facilitate OI implementation in SMEs. In addition, the operational aspects of implementing OI may show interesting differences from one type of SME to another. Indeed, SMEs are not a homogeneous group, and there are fruitful avenues for research on the impact of these factors and characteristics on various forms of SMEs. Such research would also assess the validity of the circumstances in which the frameworks of the present study were developed. It could also be interesting to start from the list of determinants identified to highlight the enablers and barriers of OI in SMEs. The analysis of risks and failure cases associated with the implementation of OI in SME could also be a fruitful research avenue.

Finally, most of the studies we reviewed focus on developed economies, particularly those of Europe (Italy, Spain) or Asia (South Korea). Little is known about the OI practices of SMEs elsewhere, such as in economies of North America, South America and Africa where SMEs account for much of the economy and face various obstacles to OI implementation. Because SMEs confront specific problems in such environments, due to contextual/cultural differences, more attention should be paid to the challenges of OI in those parts of the world.

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Appendix 1. List of authors selected for systematic literature review

	Year	Authors	Title	Journal	Methodology	Area	Industry	Focus on
1	2006	Fontana, R., Geuna, A., & Matt, M.	Factors affecting university–industry R&D projects: The importance of searching, screening and signalling.	Research policy	Mixed	Many countries	Many industries	Multiple
2	2009	Huang, F. and J. Rice	The role of absorptive capacity in facilitating "open innovation" outcomes: a study of australian smes inthe manufacturing sector	International Journal of Innovation Management	Quantitative	Australia	Manufacturing	OI determinants
3	2009	van de Vrande, V., J. P. J. de Jong, et al.	Open innovation in SMEs: Trends, motives and management challenges	Technovation	Quantitative	Netherlands	Many industries	Multiple
4	2010	Bell, J., & Loane, S.	New-wave'global firms: Web 2.0 and SME internationalisation	Journal of Marketing Management,	Qualitative	Many countries	Manufacturing	OI tools
5	2010	Bianchi, M., Campodall'Orto, S., Frattini, F., & Vercesi, P.	Enabling open innovation in small-and medium-sized enterprises: how to find alternative applications for your technologies.	R&d Management	Qualitative	Italy	Manufacturing	OI practices
6	2010	Igartua, J. I., J. A. Garrigos, et al.	How innovation management techniques support an open innovation strategy	Research-Technology Management	Qualitative	Spain	Manufacturing	OI tools
7	2010	Lee, S., G. Park, et al.	Open innovation in SMEs—An intermediated network model	Research Policy	Quantitative	South Korea	Many industries	Multiple
8	2010	Spithoven, A., B. Clarysse, et al.	Building absorptive capacity to organise inbound open innovation in traditional industries.	Technovation	Qualitative	Belgium	Many industries	Multiple
9	2011	Albors Garrigós, J., Zabaleta Etxebarria, N., Oliver, H., Luis, J., & Ganzarain Epelde, J.	Outsourced inovation in SMES: a field study of R&D units in Spain	International Journal of Technology Management	Qualitative	Spain	Manufacturing	OI practices
10	2011	Gurău, C., & Lasch, F.	Open innovation strategies in the UK biopharmaceutical sector	International Journal of Entrepreneurial Venturing	Qualitative	England	Manufacturing	OI determinants
11	2011	Sen, A. K. and Haq, K.	Product innovation by small and medium-sized firms through outsourcing and collaboration.	International Journal of Management & Marketing Research	Quantitative	USA	Manufacturing	OI practices
12	2012	Braun, A., Mueller, E., Adelhelm, S., & Vladova, G.	Knowledge flow at the fuzzy front-end of inter-firm R&D collaborations–insights into SMEs in the pharmaceutical industry.	International Journal of Entrepreneurship and Innovation Management,	Mixed	Germany	Manufacturing	OI determinants
13	2012	Comaccio et al	Boundary spanning between industry and university: the role of Technology Transfer Centres.	The Journal of Technology Transfer	Quantitative	Italy	Manufacturing	OI actors
14	2012	Lazzarotti, V., et al.	Setting up Innovation Networks: The Case of a Small Company in the Calibration Industry	Asia Pacific Management Review	Qualitative	Italy	Manufacturing	OI determinants

15	2012	Mariussen, A. and T. Ndlovu	Internet-enabled value co-creation in SME internationalisation: current practices from the UK food and drink industry.	European Journal of International Management	Qualitative	England	Distribution	OI tools
16	2012	Othman Idrissia et al	SMEs' degree of openness: the case of manufacturing industries.	Journal of technology management & innovation	Quantitative	Canada	Manufacturing	OI determinants
17	2012	Spithoven, A. and Knockaert, M.	Technology intermediaries in low tech sectors: The case of collective research centres in Belgium.	Innovation: Management, Policy & Practice	Mixed	Belgium	Many industries	OI actors
18	2012	Thi Mong Chau, N. and V. I. de la Ville	L'Open Innovation : un levier de création de valeur pour les PME exportatrices et innovantes ?	Gestion 2000	Qualitative	Belgium	Many industries	OI actors
19	2012	Vrgovic, P., P. Vidicki, et al.	Open innovation for SMEs in developing countries - An intermediated communication network model for collaboration beyond obstacles.	Innovation : Management, Policy & Practice	Conceptual	N/A	Many industries	Multiple
20	2012	Yun, J.-H. J. and A. V. Mohan	Exploring open innovation approaches adopted by small and medium firms in emerging/growth industries: case studies from Daegu-Gyeongbuk region of South Korea.	International Journal of Technology Policy and Management	Qualitative	South Korea	Services	OI practices
21	2013	Brunswicker, S., & Ehrenmann, F.	Managing open innovation in SMEs: A good practice example of a German software firm.	International Journal of Industrial Engineering and Management	Qualitative	Germany	Services	OI determinants
22	2013	Deschamps, I., Macedo, M. G., & Eve-Levesque, C.	University-SME collaboration and open innovation: Intellectual-property management tools and the roles of intermediaries.	Technology Innovation Management Review	Mixed	Canada	Many industries	Multiple
23	2013	Deutsch, C.	The seeking solutions approach: Solving challenging business problems with local open innovation.	Technology Innovation Management Review	Qualitative	Canada	Non précisé	OI practices
24	2013	Grimaldi, M., Quinto, I., & Rippa, P.	Enabling open innovation in small and medium enterprises: A dynamic capabilities approach.	Knowledge and Process Management	Qualitative	Italy	Manufacturing	OI determinants
25	2013	Iakovleva, T.	Open Innovation at the Root of Entrepreneurial Strategy: A Case from the Norwegian Oil Industry.	Technology Innovation Management Review	Qualitative	Norway	Natural ressources	OI actors
26	2013	Padilla-Melendez, A., A. R. Del Aguila-Obra, et al.	Shifting sands: Regional perspectives on the role of social capital in supporting open innovation through knowledge transfer and exchange with small and medium-sized enterprises.	International Small Business Journal-Researching Entrepreneurship	Qualitative	Spain	Many industries	OI determinants
27	2013	Rangus, K. and M. Drnovsek	Open innovation in Slovenia: a comparative analysis of different firm sizes.	Economic and Business Review for Central and South - Eastern Europe	Mixed	Slovenia	Many industries	Multiple
28	2013	Roper, S. and N. Hewitt-Dundas	Catalysing open innovation through publicly-funded R&D: A comparison of university and company-based research centres	International Small Business Journal	Mixed	Ireland	Manufacturing	OI actors

29	2013	Salvador, E., F. Montagna, et al.	Clustering recent trends in the open innovation literature for SME strategy improvements.	International Journal of Technology Policy and Management	Conceptual	N/A	N/A	OI determinants
30	2013	Spithoven, A., W. Vanhaverbeke, et al.	Open innovation practices in SMEs and large enterprises.	Small Business Economics	Quantitative	Many countries	Many industries	OI practices
31	2013	Teirlinck, P. and A. Spithoven	Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs	Technovation	Quantitative	Belgium	Many industries	OI determinants
32	2013	Theyel, N.	Extending open innovation throughout the value chain by small and medium-sized manufacturers.	International Small Business Journal	Quantitative	USA	Manufacturing	OI practices
33	2013	Wynarczyk, P.	Open innovation in SMEs A dynamic approach to modern entrepreneurship in the twenty-first century.	Journal of Small Business and Enterprise Development	Quantitative	England	Many industries	Multiple
34	2013	Wynarczyk, P., P. Piperopoulos, et al.	Open innovation in small and medium-sized enterprises: An overview.	International Small Business Journal: Researching Entrepreneurship	Conceptual	N/A	N/A	Multiple
35	2013	Xiaobao, P., et al.	Framework of open innovation in SMEs in an emerging economy: firm characteristics, network openness, and network information	International Journal of Technology Management	Quantitative	China	Many industries	OI determinants
36	2013	Yun, J. J. and W. Jung	Open Innovation of SMEs in Manufacturing from OI Structure Model.	Asia Pacific Journal of Innovation and Entrepreneurship	Qualitative	South Korea	Manufacturing	OI determinants
37	2014	Crema, M., Verbano, C., & Venturini, K.	Linking strategy with open innovation and performance in SMEs	Measuring Business Excellence	Quantitative	Italy	Manufacturing	OI determinants
38	2014	Dries, L., Pascucci, S., Török, Á., & Tóth, J.	Keeping your secrets public? Open versus closed innovation processes in the Hungarian wine sector.	International Food and Agribusiness Management Review	Quantitative	Hungary	Manufacturing	OI determinants
39	2014	Gryczka, M.	ICT usage as a key prerequisite for open knowledge environment creation.	Business & Economic Horizons	Quantitative	Poland	Many industries	OI tools
40	2014	Ma, X. F., et al.	Cross-border innovation intermediaries - matchmaking across institutional contexts.	Technology Analysis & Strategic Management	Qualitative	China	Many industries	OI determinants
41	2015	Braun, A.	Linking business model and open innovation-success and failure of collaborations.	International Journal of Entrepreneurship and Innovation Management	Qualitative	Germain	Manufacturing	OI determinants
42	2015	Brunswicker, S., & Vanhaverbeke, W.	Open innovation in small and medium-sized enterprises (SMEs): External knowledge sourcing strategies and internal organizational facilitators.	Journal of Small Business Management	Quantitative	Many countries	Many industries	OI practices
43	2015	Carvalho, A. C. S., & Moreira, A. C.	Open innovation profile in small and medium-sized firms. The perspective of technology centres and business associations.	International Journal of Innovation and Learning	Qualitative	Portugal	Manufacturing	OI actors

44	2015	Dufour, J., & Son, P. E.	Open innovation in SMEs–towards formalization of openness.	Journal of Innovation Management,	Qualitative	Sweden	Distribution	OI determinants
45	2015	Heeyong, N. and L. Sungjoo	Perceptual Factors Affecting the Tendency to Collaboration in SMEs: Perceived Importance of Collaboration Modes and Partners	Journal of Technology Management & Innovation	Quantitative	South Korea	Many industries	Multiple
46	2015	Hossain, M.	A review of literature on open innovation in small and medium-sized enterprises.	Journal of Global Entrepreneurship Research	Conceptual	N/A	N/A	Multiple
47	2015	Huang, F., J. Rice, et al.	Does open innovation apply to China? Exploring the contingent role of external knowledge sources and internal absorptive capacity in Chinese large firms and SMEs	Journal of Management and Organization	Quantitative	China	Many industries	OI determinants
48	2015	Iturrioz, C., et al.	How to foster shared innovation within SMEs' networks: Social capital and the role of intermediaries.	European Management Journal	Qualitative	Spain	Services	OI determinants
49	2015	Jonsson, L., et al.	Targeting Academic Engagement in Open Innovation: Tools, Effects and Challenges for University Management.	Journal of the Knowledge Economy	Qualitative	Sweden	Services	OI practices
50	2015	Krause, W. and C. S. L. Schutte	A perspective on open innovation in small- and medium-sized enterprises in south africa, and design requirements for an open innovation approach	South African Journal of Industrial Engineering	Quantitative	South africa	Many industries	OI practices
51	2015	Krupicka, A. and N. Moinet	L'intelligence marketing au service de la co-innovation.	La Revue des Sciences de Gestion	Qualitative	France	Manufacturing	Multiple
52	2015	Lahi, A. and T. Elenurm	SME Open Innovation implicating factors in different innovation phases	International Journal of Management Science & Technology Information	Qualitative	Many countries	Many industries	OI determinants
53	2015	Mitze, T., B. Alecke, et al.	Linking collaborative R&D strategies with the research and innovation performance of SMEs in peripheral regions: Do spatial and organizational choices make a difference?	Annals of Regional Science	Quantitative	Germany	Manufacturing	OI practices
54	2015	Pervan, S., Y. Al-Ansaari, et al.	Environmental determinants of open innovation in Dubai SMEs.	Industrial Marketing Management	Mixed	United Arab Emirates	Many industries	OI determinants
55	2015	Rehm, S. V., et al.	Role of Information Systems in Empowering Innovation Networks.	Mis Quarterly Executive	Qualitative	Europa (many countries)	Services	OI tools
56	2015	Verbano, C., M. Crema, et al.	The Identification and Characterization of Open Innovation Profiles in Italian Small and Medium-sized Enterprises.	Journal of Small Business Management	Quantitative	Italy	Manufacturing	Multiple
57	2015	Virlee, J., W. Hammedi, et al.	Open Innovation Implementation in the Service Industry: Exploring Practices, Sub-practices and Contextual.	Journal of Innovation Management	Qualitative	Belgium	Services	Multiple
58	2016	Basco, R., & Calabrò, A.	Open innovation search strategies in family and non-family SMEs: Evidence from a natural resource-based cluster in Chile.	Academia Revista Latinoamericana de Administración	Quantitative	Chile	Natural ressources	Multiple

59	2016	Bigliardi, B., & Galati, F.	Which factors hinder the adoption of open innovation in SMEs?	Technology Analysis & Strategic Management	Quantitative	Italy	Many industries	OI determinants
60	2016	Dooley, L., Kenny, B., & Cronin, M.	Interorganizational innovation across geographic and cognitive boundaries: does firm size matter?	R&D Management	Quantitative	Ireland	Many industries	Multiple
61	2016	Hossain, M. and I. Kauranen	Open innovation in SMEs: a systematic literature review	Journal of Strategy and Management	Conceptual	N/A	N/A	Multiple
62	2016	Huang, H. C., M. C. Lai, et al.	Resource complementarity, transformative capacity, and inbound open innovation	Journal of Business & Industrial Marketing	Mixed	ChinA	Many industries	OI determinants
63	2016	Krause, W. and C. S. L. Schutte	Developing design propositions for an open innovation approach for SMEs.	South African Journal of Industrial Engineering	Conceptual	N/A	N/A	OI practices
64	2016	Mazur, J. and P. Zaborek	Organizational Culture and Open Innovation Performance in Small and Medium-sized Enterprises (SMEs) in Poland	International Journal of Management and Economics	Quantitative	Poland	Many industries	OI determinants
65	2016	Millspaugh, J. and A. Kent	Co-creation and the development of SME designer fashion enterprises.	Journal of Fashion Marketing and Management	Qualitative	Many countries	Manufacturing	OI actors
66	2016	Rodríguez- Ferradas, M. I. and J. A. Alfaro-Tanco	Open innovation in automotive SMEs suppliers: an opportunity for new product development	Universia Business Review	Qualitative	Spain	Manufacturing	OI practices
67	2016	Shamsuzzoha, A., et al.	ICT-based solution approach for collaborative delivery of customised products.	Production Planning & Control	Mixed	Many countries	Many industries	OI tools
68	2016	Su, Y. S., H. Y. Hu, et al.	How can small firms benefit from open innovation? The case of new drug development in Taiwan	International Journal of Technology Management	Qualitative	Taiwan	Services	OI practices
69	2016	Sulaiman, S. N., et al.	Open Innovation as Business Driver: Investigating the Impact of Firm-Level Evidence on Opening Up to External Players.	IUP Journal of Entrepreneurship Development	Qualitative	Many countries	Many industries	OI practices
70	2016	Szymanska, K.	Organisational culture as a part in the development of open innovation - the perspective of small and medium-sized enterprises.	Management	Conceptual	N/A	N/A	OI determinants
71	2016	Tripathi, S. S.	Open Innovation in Indian Organizations: Types of Collaboration.	Technology Innovation Management Review	Conceptual	N/A	Manufacturing	Multiple
72	2016	Yoon, B., J. Shin, et al.	Open Innovation Projects in SMEs as an Engine for Sustainable Growth	Sustainability	Quantitative	South Korea	Many industries	OI practices
73	2016	Zastempowski, M. and N. Przybylska	Cooperation in Creating Innovation in Polish Small and Medium-Sized Enterprises in the Light of Empirical Studies	Journal of Competitiveness	Quantitative	Pologne	Many industries	OI determinants
74	2017	Ahn, J. M., Minshall, T., & Mortara, L.	Understanding the human side of openness: the fit between open innovation modes and CEO characteristics.	R&D Management	Quantitative	South Korea	Manufacturing	Multiple
75	2017	Anderson, A. R., & Hardwick, J.	Collaborating for innovation: the socialised management of knowledge.	International Entrepreneurship and Management Journal	Qualitative	Scotland	Manufacturing	OI determinants

76	2017	Battistella, C., De Toni, A. F., & Pessot, E.	Practising open innovation: a framework of reference.	Business Process Management Journal	Mixed	Many countries	Many industries	Multiple
77	2017	Ferradas, M. I. R., et al.	Relevant factors of innovation contests for SMEs.	Business Process Management Journal	Qualitative	Spain	Manufacturing	OI determinants
78	2017	Gabriele, R., D'Ambrosio, A., & Schiavone, F.	Open Innovation and the Role of Hubs of Knowledge in a Regional Context	Journal of the Knowledge Economy	Quantitative	Italy	Many industries	Multiple
79	2017	Henttonen, K. and H. Lehtimaki	Open innovation in SMEs Collaboration modes and strategies for commercialization in technology-intensive companies in forestry industry	European Journal of Innovation Management	Qualitative	Finland	Services	OI determinants
80	2017	Hitchen, E. L., P. A. Nylund, et al.	Social media: open innovation in SMEs finds new support.	The Journal of Business Strategy	Qualitative	Spain	Services	OI tools
81	2017	Hochleitner, F. P., et al.	Inbound open innovation in SMEs: indicators, non-financial outcomes and entry-timing.	Technology Analysis & Strategic Management	Quantitative	Spain	Many industries	OI practices
82	2017	Hungund, S. and K. B. Kiran	Open innovation practices among Indian software product firms: a pilot study	International Journal of Innovation and Sustainable Development	Quantitative	India	Services	OI practices
83	2017	Jang, H., K. Lee, et al.	Development of an open innovation model for R&D collaboration between large firms and small-medium enterprises (SMEs) in manufacturing industries.	International Journal of Innovation Management	Qualitative	South Korea	Manufacturing	OI practices
84	2017	Lambrechts, F., Voordeckers, W., Roijakkers, N., & Vanhaverbeke, W	Exploring open innovation in entrepreneurial private family firms in low-and medium-technology industries	Organizational Dynamics	Qualitative	Many countries	Many industries	OI determinants
85	2017	Marangos, S. and L. Warren	A mapping for managers: open innovation for R&D intensive SMEs in the life sciences sector.	European Journal of Innovation Management	Qualitative	England	Services	OI practices
86	2017	Martinez-Conesa, I., P. Soto-Acosta, et al.	On the path towards open innovation: assessing the role of knowledge management capability and environmental dynamism in SMEs.	Journal of Knowledge Management	Quantitative	Spain	Manufacturing	OI determinants
87	2017	Mercandetti, F., C. Larbig, et al.	Innovation by Collaboration between Startups and SMEs in Switzerland	Technology Innovation Management Review	Mixed	Switzerland	Many industries	Multiple
88	2017	Popa, S., P. Soto-Acosta, et al.	Antecedents, moderators, and outcomes of innovation climate and open innovation: An empirical study in SMEs.	Technological Forecasting and Social Change	Quantitative	Spain	Manufacturing	OI determinants
89	2017	Pustovrh, A., M. Jaklic, et al.	Antecedents and determinants of high-tech SMEs' commercialisation enablers: opening the black box of open innovation practices.	Economic Research	Quantitative	Slovenia	Services	OI practices
90	2017	Ramirez-Portilla	Open innovation in specialized SMEs: the case of supercars.	Business Process Management Journal	Quantitative	Many countries	Manufacturing	OI determinants
91	2017	Rehm, S. V. and L. Goel	Using information systems to achieve complementarity in SME innovation networks.	Information & Management	Qualitative	Many countries	Many industries	Multiple

92	2017	Rodriguez Ferradas, M. I., Alfaro Tanco, J. A., & Sandulli, F	Relevant factors of innovation contests for SMEs.	Business Process Management Journal	Qualitative	Spain	Manufacturing	OI determinants
93	2017	Scuotto, V., et al.	Knowledge-driven preferences in informal inbound open innovation modes. An explorative view on small to medium enterprises.	Journal of Knowledge Management	Quantitative	England	Many industries	OI determinants
94	2017	Scuotto, V., G. Santoro, et al.	Shifting intra- and inter-organizational innovation processes towards digital business: An empirical analysis of SMEs.	Creativity and Innovation Management	Quantitative	Italy	Many industries	OI tools
95	2017	Scuotto, V., M. Del Giudice, et al.	The performance implications of leveraging internal innovation through social media networks: An empirical verification of the smart fashion industry	Technological Forecasting and Social Change	Quantitative	Many countries	Manufacturing	OI tools
96	2017	Tardivo, G., A. Thrassou, et al.	Value co-creation in the beverage and food industry	British Food Journal	Qualitative	Canada	Manufacturing	OI practices
97	2017	Usman, M. and W. Vanhaverbeke	How start-ups successfully organize and manage open innovation with large companies.	European Journal of Innovation Management	Qualitative	Netherlands	Many industries	Multiple
98	2018	Arbussã, A., & Llach, J.	Contextual Effects In Open Innovation: A Multi-Country Comparison.	International Journal of Innovation Management	Quantitative	Many countries	Manufacturing	OI determinants
99	2018	Baggio, D., Wegner, D., & Dalmarco, G.	Coordination mechanisms of collaborative R&D projects in small and medium enterprises.	RAM. Revista de Administração Mackenzie,	Qualitative	Brazil	Many industries	OI practices
100	2018	Bobera, D. and B. Lekovic	Use of Latest Technologies as a Mediator between Entrepreneurial Aspiration and Open Innovation Development	Engineering Economics	Quantitative	Many countries	Many industries	OI determinants
101	2018	Candi, M., Roberts, D. L., Marion, T., & Barczak, G.	Social Strategy to Gain Knowledge for Innovation.	British Journal of Management	Quantitative	Many countries	Many industries	OI tools
102	2018	Cheng, C. C., & Sheu, C.	Enhancing radical innovation: the interplays of open innovation activities, firm capabilities, and environmental dynamism	Asian Journal of Technology Innovation	Quantitative	Taiwan	Many industries	OI determinants
103	2018	Grimsdottir, E., & Edvardsson, I. R.	Knowledge Management, Knowledge Creation, and Open Innovation in Icelandic SMEs.	SAGE Open	Qualitative	Iceland	Many industries	OI practices
104	2018	Hameed, W. U., M. F. Basheer, et al.	Determinants of Firm's open innovation performance and the role of R & D department: an empirical evidence from Malaysian SME's.	Journal of Global Entrepreneurship Research	Quantitative	Malaysia	Many industries	Multiple
105	2018	Haukipuro, L., S. Vainamo, et al.	Innovation Instruments to Co-Create Needs-Based Solutions in a Living Lab	Technology Innovation Management Review	Qualitative	Finland	Many industries	OI tools
106	2018	Jespersen, K., D. Rigamonti, et al.	Analysis of SMEs partner proximity preferences for process innovation	Small Business Economics	Quantitative	Denmark	Many industries	OI determinants
107	2018	Kapetaniou, C. and S. H. Lee	Geographical proximity and open innovation of SMEs in Cyprus	Small Business Economics	Quantitative	Cyprus	Many industries	OI determinants
108	2018	Lavrynenko, A., N. Shmatko, et al.	Managing skills for open innovation: the case of biotechnology	Management Decision	Qualitative	Many countries	Manufacturing	OI determinants

109	2018	Naqshbandi, M. M.	Organizational Characteristics and Engagement in Open Innovation: Is There a Link?	Global Business Review	Quantitative	Malaysia	Manufacturing	OI determinants
110	2018	Papa, A., G. Santoro, et al.	Social media as tool for facilitating knowledge creation and innovation in small and medium enterprises.	Baltic Journal of Management	Quantitative	Italy	Many industries	OI tools
111	2018	Santoro, G., A. Ferraris, et al.	How SMEs Engage in Open Innovation: a Survey.	Journal of the Knowledge Economy	Qualitative	Italy	Many industries	Multiple
112	2018	Shamsuzzoha, A., et al.	Open Innovation in Small and Medium Size Enterprises-Perspective from Virtual Collaboration.	International Journal of Engineering and Technology Innovation	Mixed	Many countries	Manufacturing	OI determinants
113	2018	Taheri, M., Q. Ye, et al.	University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes.	Technology Analysis & Strategic Management	Qualitative	Many countries	Many industries	OI determinants
114	2018	Teirlinck, P.	Pathways for knowledge exchange in SMEs in software-driven knowledge-intensive business services	R&D Management	Qualitative	Belgium	Many industries	OI determinants
115	2018	Tobiassen, A. E. and I. B. Pettersen	Exploring open innovation collaboration between SMEs and larger customers.	Baltic Journal of Management	Qualitative	Many countries	Many industries	Multiple
116	2018	Waseem Ul, H., et al.	Determinants of Firm’s open innovation performance and the role of R & D department: an empirical evidence from Malaysian SME’s.	Journal of Global Entrepreneurship Research	Quantitative	Malaysia	Many industries	OI determinants
117	2019	Bacon, E., et al	Recipes for success: Conditions for knowledge transfer across open innovation ecosystems.	International Journal of Information Management	Mixed	Many countries	Many industries	OI determinants
118	2019	de Oliveira, L. S., et al.	Framework Proposal for Open Innovation Implementation in SMEs of Regional Innovation Systems	Journal of Technology Management & Innovation	Conceptual	N/A	N/A	Multiple
119	2019	Gentile-Lüdecke, S., et al.	Does organizational structure facilitate inbound and outbound open innovation in SMEs?	Small Business Economics:	Quantitative	China	Many industries	OI determinants
120	2019	Gomezel, A. S. and K. Rangus	Open innovation: it starts with the leader's openness	Innovation-Organization & Management	Quantitative	Many countries	Many industries	OI determinants
121	2019	Grama-Vigouroux, S., Saidi, S., Berthinier-Poncet, A., Vanhaverbeke, W. & Madanamoothoo, A	From closed to open: A comparative stakeholder approach for developing open innovation activities in SMEs,	Journal of Business Research	Qualitative	Many countries	Manufacturing	OI determinants
122	2019	Hardwick, J. and A. R. Anderson	Supplier-customer engagement for collaborative innovation using video conferencing: A study of SMEs	Industrial Marketing Management	Qualitative	England	Manufacturing	OI actors
123	2019	Jasimuddin, S. M. and M. M. Naqshbandi	Knowledge infrastructure capability, absorptive capacity and inbound open innovation: evidence from SMEs in France	Production Planning & Control	Quantitative	France	Many industries	OI determinants
124	2019	Kim, N. K. and J. M. Ahn	What facilitates external knowledge utilisation in SMEs? - An optimal configuration between openness intensity and organisational moderators.	Industry and Innovation	Quantitative	South Korea	Many industries	OI determinants

125	2019	Morgan, T., S. A. Anokhin, et al.	The role of customer participation in building new product development speed capabilities in turbulent environments	International Entrepreneurship and Management Journal	Quantitative	USA	Many industries	OI practices
126	2019	Odriozola-Fernández, I., et al.	Open innovation in small and medium enterprises: a bibliometric analysis.	Journal of Organizational Change Management	Conceptual	N/A	N/A	Multiple
127	2019	Oduro, S.	Examining open innovation practices in low-tech SMEs: insights from an emerging market	Journal of Science and Technology Policy Management	Mixed	Ghana	Services	OI determinants
128	2019	Ombrosi, N., et al.	Designing and managing co-innovation: the case of Loccioni and Pfizer."	European Journal of Innovation Management	Qualitative	Italy	Many industries	OI determinants
129	2019	Radziwon, A. and M. Bogers	Open innovation in SMEs: Exploring inter-organizational relationships in an ecosystem	Technological Forecasting and Social Change	Qualitative	Denmark	Many industries	OI practices
130	2019	Torchia, M. and A. Calabrò	Open Innovation in SMEs: A Systematic Literature Review	Journal of Enterprising Culture	Conceptual	N/A	N/A	Multiple