



# A Systematic Literature Study from 2013 to 2018: The Role of Knowledge in Open Innovation

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## ABSTRACT

Knowledge plays a key role in the process of open innovation (OI). Nevertheless, by following the knowledge management (KM) lens OI has been barely examined. Therefore the aim of this paper is to provide a systematic review of the knowledge activities examined by previous literature to support OI results. The measures were taken to revise previous studies systematically in order to carry out a valuable literature review. After a collective analysis, we were able to garner a final review on 24 articles. We subsequently identified and analyzed them by three major processes of OI. The findings enhanced the understanding of the various sources of knowledge practices and was able to identify the best practices based on inbound, outbound and coupled processes to support OI activities. The empirical evidence found in the literature, highlights the shortcomings of the state-of-the-art and proposes possible avenues for studies. Despite knowledge being the most relevant resource integrated in OI activities, this is the first attempt to highlight how knowledge should be managed in an OI context by adopting knowledge lens. In addition to our research, we also recognize relevant topics that have been understudied so far which we are proposing as potential avenues for study.

**Keywords:** Open Innovation, Closed Innovation, In-bound Open Innovation, Outbound Open Innovation, Knowledge Management

**JEL Classifications:** O10, O11, O31

## 1. INTRODUCTION

The idea of open innovation (OI) is a powerful strategic method for growing the competitive edge of organisations, which has been increasingly developed recently in the business environment by scientists and professionals (Chesbrough and Bogers, 2014; Bogers et al., 2017). Essentially, the OI model can be configured as “a centralized innovative system of deliberate and regulated transfer of information across organizational boundaries” (Chesbrough and Bogers, 2014. p. 4). Nevertheless, businesses that follow this model are looking for the control of controlled inflows and outflows of knowledge to boost their internal innovation cycles and further optimize the outcomes.

Organizations are therefore expected to follow appropriate organizational and strategic approaches for effectively identifying,

managing, interacting, harnessing and exchanging existing knowledge internally or externally, in order to contribute to productivity (Alavi and Leidner, 2001). The OI model companies ‘experience is highly relevant (Lichtenthaler, 2011; Tsai et al., 2015). For instance, earlier studies have shown that companies transitioning from closed to OI innovations must upgrade their information structures to comply with new approaches to innovation (Chiaroni et al., 2010; 2011). Nevertheless, just recently, researchers have started to pay more attention to the ad hoc implementation (Martin-de Castro, 2015; Soliman, 2015).

In contrast, the use of a lens for management of information was hardly studied by OI. Nevertheless, it is remarkable that the exchange of knowledge plays a central role in the OI model (Lichtenthaler, 2011; Tsai et al., 2015). Nevertheless, while some credible literature reviews on OI have been published in recent

years (e.g., Bogers et al., 2017; Hossain et al., 2016; Randhawa et al., 2016; West and Bogers, 2014), very little studies have taken advantage of the knowledge perspective. The paper therefore aims to provide a comprehensive analysis of literature by discussing and integrating existing viewpoints on the use of information that helps to execute the OI strategies effectively. In other words, to clarify the current research status in the area, to recognize research holes and finally to suggest potential paths for study, we try to identify and systematize the most important developments in the literature concerning information's role in that OI effectiveness.

The OI model can be extended to a wide range of strategies and, obviously, specific business practices are needed for innovative businesses to thrive. Past studies have defined three types of OI processes, referred to as: (i) inbound OI process; (ii) outbound OI process; and, (iii) coupled OI process (West and Bogers, 2014). For the search and acquisition of existing knowledge, the inbound OI protocol generally applies. The OI process involves transferring internal knowledge to third-party agencies. Specifically, a common use of resources by various developing organizations is addressed by the integrated OI system (Enkel and Lenz, 2009). These separate OI processes require specific information practices based on the various directions of their flows. In this context, we organize a discussion of previous research findings, which also differentiates knowledge experience by the particular typology of the OI method to which they refer.

The study was performed gives two key values. Having analyzed these research papers, the results of the review offered a wide range of OI and knowledge understanding. The next section discusses the methods used to perform the study of the literature. We address the methods adopted for gathering relevant papers for the study in section 3. The 4<sup>th</sup> section discusses the literature review results and goes deeper with the research questions listed in the survey, assessing the importance for information study and OI. The final section explains the findings and weaknesses of our study.

## 2. SYSTEMATIZATION OF LITERATURE

In management literature, information is increasingly considered the most important tool for an organisation (e.g., Grant, 1996) it is particularly important in depth to maintain the creativity of firms and to promote their longevity to achieve sustainable competitive advantages (e.g., Kogut and Zander, 1992; McEvily and Chakravarthy, 2002). Given this significant sensitivity function in growing market competitiveness, firms must implement proper KM practices in order to code, save, share, transmit and leverage their knowledge assets efficiently and efficiently. (Alavi and Leidner, 2001). Consequently, proper KM activities will promote the creative success of the companies (Alegre et al., 2011; Darroch, 2005).

The latest developments in the industrial world lead companies to change their innovation paradigms to make their creative processes in line with the OI model more accessible to knowledge sharing in organisations (Chesbrough, 2003). This paradigm of innovation requires that companies manage deliberate knowledge inflows and outflows to improve innovation processes and leverage results, their competitive gain is rising (Chesbrough and Bogers 2014).

Academics and practitioners in previous years received attention from the OI model (e.g., Bogers et al., 2017; Chesbrough and Crowther, 2006; West and Bogers, 2014; West and Bogers, 2014). Nevertheless, the latest KM OI literature is systematized and reviewed is lacking, in spite of the importance of the existing of KM practices to enhance firms product efficiency (Alegre et al., 2013; Ferraris et al., 2017; Santoro et al., 2017).

Several prior OI studies have in fact employed a system for classification of OI behaviours (e.g., Dahlander and Gann, 2010; Enkel and Lenz, 2009; West and Bogers, 2014). These studies allow to define three different processes based on knowledge flows guided by the focal company as (i) inbound OI process, (ii) outbound OI process and (iii) coupled OI process.

The inbound approach applies primarily to activities where firms derive and use knowledge developed and/or retained by other organisations, as vendors, clients, competitors universities, research centers and non-organization-affiliated individuals (Dahlander and Gann, 2010; Enkel and Lenz, 2009; Huizingh, 2011). Inbound OI operations usually include the acquisition or licensing of labels, crowds and spin-in from external businesses (Enkel and Lenz, 2009; Wang et al., 2012; West and Bogers, 2014).

In comparison, the OI process involves the internally developed transfer of knowledge into the external environment. Nonetheless, this mechanism characterizes OI activities in which focal firms leverage R&D ventures, provide information to external entities or spin-offs (Dahlander and Gann, 2010; Enkel and Lenz, 2009; Huizingh, 2011). For example, the practice of outbound OI refers to out-licensing of intellectual property (IP), the commercialization of technologies developed internally in different markets and the spin-off of existing technologies (e.g., Chesbrough, 2003; Enkel and Lenz, 2009).

The inbound and outbound processes are combined during the coupled process (Enkel and Lenz, 2009). Therefore, there are overlapping flows of knowledge from the focal organization to the external environment, as well as flows of knowledge from the external environment to the focal organization (Enkel and Lenz, 2009). Typical OI activities related to the joint process include building partnerships and cooperation with other organizations, forming joint R&D consortia and or networks with external collaborators (Chesbrough and Bogers, 2014; West and Bogers, 2014). A brief description of the OI process classification indicates that specific knowledge flows pertain to OI activities. The activities of companies that take up the OI paradigm should therefore be adapted to their specific practices in order to manage the different types of knowledge flows and effectively promote innovative companies' processes (e.g., Gupta and Govindarajan, 1991). According to these arguments, we decided to use the framework of the OI processes to study and to systematize literature findings. The existing documents will therefore be analyzed according to the perspective OI processes.

## 3. METHODOLOGY

We adopted the guidelines of Tranfield et al. (2003) for systematic analysis to classify a category of papers to be included in the study.

Nonetheless, a comprehensive re-evaluation is deemed essential to make an effective assessment of a literary body's contributions involving a consistent sequence of reproductive phases that help academics to improve the overall review processes (i.e., Ardito et al., 2015; Savino et al., 2017; Natalicchio et al., 2014; Crossan and Apaydin, 2010; Keupp et al., 2012).

Therefore, we have taken the following steps to incorporate a consistent and replicable approach, in accordance with the criteria for a systematic review (Tranfield et al., 2003). In order to achieve this, two keywords were identified: "open innovation" and "knowledge management." The resulting search string therefore is ("open innovation" and "knowledge management").

Consequently, in line with the guidelines for systematic review, we have taken these steps to implement a clear and replicable approach (Tranfield et al., 2003). Therefore, there were listed two keywords: "open innovation" and "knowledge management." Thus, the resulting search line is "open innovation" and "knowledge management." In particular the key word "open innovation" reflects our emphasis on the OI model. We have chosen to use the term knowledge as a whole because of its generic existence, to restrict the research focus in practice to papers based on KM literature (Kakabadse et al., 2003). Secondly, for the articles we have specified inclusion criteria. In addition the journal articles are to have an index of Social Science Citation Index for publications in peer reviews and the publications must, therefore, leaving out books, book chapters and conference proceedings. Previous research has found that the use of these parameters will ensure the recognition of the most relevant articles relating to the subject under review (e.g., Crossan and Apaydin, 2010; Keupp et al., 2012; Savino et al., 2017). Thirdly, the defined search string has been used to search for articles related to the database, i.e., the title, abstract, keyword (Rashman et al., 2009) and to use the "topic" search field. Only articles published since 2013 were considered in the search process. We did not indicate the date of commencement, but listed the first article published in 2013, tracking papers until the completion of the search process in December 2018. An initial selection of 50 papers was given by this method. In order to ensure that the only high quality research is included, all of the other documents have been filtered according to the journal's quality. While a journal rating can be disputed, the good journal ranking is widely considered to be a reliable measure of research rigor and efficacy, based on journal editors and expert reviews and quotation statistics by a consultancy panel. Consequently, the study of articles published in major journals has been agreed to focused narrowly. Fourthly, through analysis of the specific content of the articles and checking whether all inclusion criteria are met, of the initial 50 items in our survey, we have chosen 24. Two publications have not been written in English, nine articles have been withdrawn, fifteen articles did not actually address OI and knowledge practices. In addition, we analyzed and grouped the articles within the framework proposed in section 2. In other words the emphasis of each article is on inbound, outbound, and coupled processes. In Appendix A (Table 1) are provided the list and summaries of articles analyzed. In order to contextualize our research, it is appropriate to monitor growth in the field first. Recent articles on knowledge and OI have seen a significant rise in

publications in recent years (Chesbrough and Bogers, 2014). Our research confirms that in fact, over the past five there has been a significant increase in publications on knowledge and OI (Figure 1).

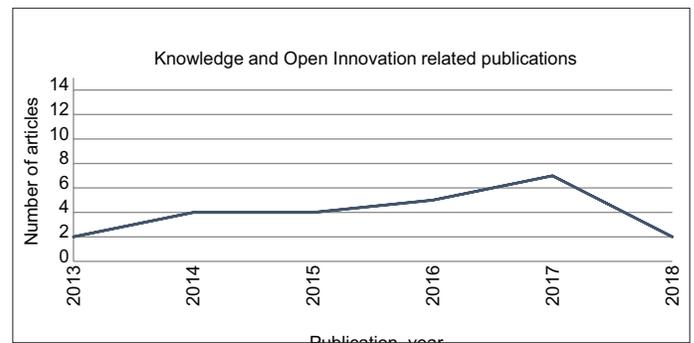
Figure 1 gives an insight into the journals published in the selected papers. The statistic shows that 24 separate articles are covered by the subject being studied in management literature.

Finally, we examined how the emphasis was split into three OI processes between the contributions considered. This section classifies and discusses about 24 identified empirical studies related to knowledge and OI across global regions. We examined how the emphasis was shared amongst the considered contributions on the three OI processes. The greatest attention was given to the inbound OI 55% of the contributions, followed by the coupled OI 23%, and only 22% of the contributions focused on the inbound OI. A detail classification of reviewed literature according to knowledge types shown in Figure 2.

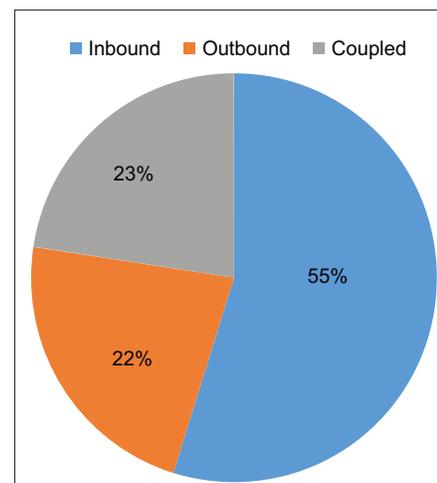
#### 4. LITERATURE FINDINGS

The key findings on the value and use of KM practices in academic literature to encourage and sustain adoption. The analysis, as mentioned above, is divided into three areas, based on the OI method. The first section deals with the inbound OI process and the second section displays findings from the outbound OI process, and the final section gives a summary of the coupled OI process.

**Figure 1:** Number of articles per year



**Figure 2:** Reviewed literature according to open innovation process



#### 4.1. Inbound OI Process

Inbound OI procedures are established through external information streams to update and improve knowledge of firms and innovation (Enkel and Lenz, 2009). Nevertheless, the acquisition of external expertise does not guarantee highly innovative results. In fact, the implementation of KM practice, which effectively integrates the internal knowledge base into external knowledge, is the prerequisite for achieving external knowledge (Zobel, 2017; Scuotto et al., 2017). In order to achieve that goal KM systems should allow the distribution, sharing and transfer of the knowledge acquired within a company (Zobel, 2017).

Thus effective KM approaches have been proposed to address these challenges in the current academic literature (Borjigen, 2015; Davis et al., 2015; Wu et al., 2016). One solution is to develop specific processes that support the company in exploring the competitive environment, to find interesting opportunities which may be accepted by the market (Wu et al., 2016). Interesting possibilities are found in identifying specific processes that help companies understand the competitive environment. The solution requires an overview of external experience based on feedback from different departments, such as employees, agencies, administrators, vendors and consumers from within and outside. In conclusion, this approach aims to promote knowledge transfer between internal and external information by establishing the methods of trust needed in order to analyze options with a broader collective understanding. (Wu et al., 2016).

In order to help businesses avoid NIH and BI syndrome it may be worth expanding information distribution chain beyond domestic workers or specialists (Borjigen, 2015). Companies are able to share an increasing amount of internal knowledge with outside parties and are therefore urged to take part in specific tasks and make use of their know-how and skills in developing solutions for focal companies' internal innovation issues (Borjigen, 2015). The discovery of outsourcing questions is therefore a major objective of KM, and its achievement has attracted attention from academics, because it is a crucial step towards the promotion of external information inflow (Davis et al., 2015).

The NASA also studied another method for the management of NIH syndrome, in which a Solution Management Guide (SMG) assists managers and problem solvers in identifying and acquiring external expertise, the needs of the enterprise, taking into account available resources and constraints on initiatives that present innovation issues. In particular, the SMG is an interactive Web guide to educate workers about the characteristics and advantages of traditional as well as transparent problem resolving approaches, including use of crowd-sourcing channels and other OI methods (Davis et al., 2015). Moreover in order to prevent NIH syndromes, the NASA Directorate rewards employees, together with acquired solutions providers, to discover engineering challenges that can be addressed with external assistance.

Of course, after the discovery of an internal problem in the field of innovation, a company that adopts integrated OI processes must identify potential useful external sources of information and the

means to obtain necessary knowledge. A broad consensus has been reached on the possibility of accessing a variety of external source tools, specifically companies (including competitors, suppliers and clients), universities, research centers and individuals, to incorporate an inbound OI mechanism (Ritala et al., 2013; Borjigen, 2015; Lopes et al., 2017). However, companies' strategic orientations are affected by the extent to which they refer to different sources (Ritala et al., 2013; Yan and Azadegan, 2017). In reality, only companies characterized by creativity, proactivity and risk-taking can access a wide variety of sources (Ritala et al., 2013). In addition, businesses that concentrate on acquisition of consumers and the growth of products are designed to leverage market-related sources of information such as clients, competitors and partners (Ritala et al., 2013). The technical drive approach of companies, with a focus on R&D, and the implementation of state-of-the-art innovative products, is also preferred by professional associations and standardization bodies, consultants, research institutes, and universities (Ritala et al., 2013). The implementation of effective KM systems is particularly important in companies pursuing science-based innovation activities (Alexander and Childe, 2013; Diaz-Diaz and Saa-Perez, 2014).

Nevertheless, previous studies have revealed that organizations must reach a critical absorption level to implement an effective learning process from different external sources (Diaz-Diaz and Saa-Perez, 2014). Nonetheless, increasing the IP management efficiency with an autonomous organizational unit and dedicated organizational responsibilities may be the first step towards achieving a satisfactory level of absorption capacity (Knoskova, 2015). Indeed it facilitates inbound IP management by the use of dedicated framework to identify ways of promoting the acquisition of information and preventing opportunistic actions by external players (Chesbrough and Crowther, 2006). Specifically, the creation of IP management systems that help companies to improve their ability to exploit external codified information like patents and industrial designs (Knoskova, 2015), to increase their positive attitude towards external know-how inflows (Knoskova, 2015). Furthermore (Knoskova 2015; Zobel, 2017), the actual value of an ingoing OI method requires the efficient acquisition of tacit knowledge while patent transfers, product designs, concept and written documents are relatively straightforward (Alexandre and Childe, 2013; Valentim, 2016). Organizations could therefore promote the acquisition and integration of tacit knowledge through the use of rich media, face-to-face meeting, staff exchange and joint monitoring of the transfer of knowledge process, as well as the implementation of devised ICT systems, promotion of video-conferencing and provision of project management tools (Alexandre and Childe, 2013). Alliances (Valentim et al., 2016; Yan and Azadegan 2017), which are more appropriate when businesses focus primarily on the demand and competitiveness of the resulting new product, provide a crucial weapon in access and acquire tacit knowledge (Yan and Azadegan, 2017). In comparison, when a company's main goal is to sell very new products it should choose buy strategies (Borjigen, 2015; Yan and Azadegan, 2017). There were several explanations for this in the quest and in the autonomy of information providers (Yan and Azadegan, 2017). Search and knowledge provider

autonomy have certain reasons to be found (Yan and Azadegan, 2017). Therefore, recent research has focused on the role of innovation agents, particularly crowdsourcing platforms addressing innovation challenges to external parties (Borjigen, 2015; Davis et al., 2015).

Finally, a particular area of interest for KM literature in the incoming OI phase is the change from closed innovation to an OI approach. An effective internal database of information is created for the purpose of gathering and reviewing employee ideas and patenting activities in order for external knowledge to be developed in the business. Of course KM is becoming more complex and ICT systems are being implemented to support cross-functional team management and interaction, the creation of an information database with contact data and project results and to help employees search and share in patents and academic papers, which are accessed through dedicated databases.

#### 4.2. Outbound OI Process

The outbound processes for OI include the transfer of information to the external environment that is internally built (Chesbrough, 2003; Enkel and Lenz, 2009). The profit from knowledge transfer that could be significantly greater than the gains from internally utilizing expertise to develop new services or products should be defined by a reliable and efficient outbound OI mechanism (Fiegenbaum et al., 2014). Moreover, companies that rely on outbound OI mechanism should also ensure that its core expertise is not spread, as an integral tool through which it can preserve core competences and create more innovations (Fiegenbaum et al., 2014). Therefore, a KM instrument is essential that enables companies to retain or sell decisions by revealing projects not meeting their strategic goals and thus can be transferred to other companies without loss of competitive advantage (Knoskov, 2015). In some management practices this decision-making method can be facilitated by helping companies to consider the strategic health of R&D ventures. However, other empirical work finds that external knowledge sourcing induces R&D. Whether there exists a causal direction, or whether R&D and knowledge sourcing grow concurrently, the literature, in particular on manufacturing, suggests the existence of complementarity between inflows and outflows of knowledge, and supports “the idea that marginal return from engaging in one type of knowledge flow increases as the intensity of the other increases” (Cassiman and Valentini, 2015. p. 1).

Eventually, the competitiveness of the outbound OI processes was explored recently. Although the Fiegenbaum et al. study (2014) finds that the outbound approach is lower than the inbound option, the review Ahn et al. (2016) states that the outbound approach’s direct contribution to financial performance in businesses is the highest among the incentives that OI provides.

#### 4.3. Coupled OI Process

In the end, the Coupled OI addresses the extensive use of expertise by different organisations, including inflows of information and outflows alongside creativity (Enkel and Lenz, 2009). KM practices promoting information acquisition and distribution among different organisations are particularly complex since

knowledge is exchanged and managed by enterprises and institutions whose cultures, systems and strategic directives may vary. That means increasing business willingness to share information and reducing the risks of only one (or fewer) product. This involves, of course, the establishment of governance structures, in turn and at inter-organizational level, that could foster joint development, information management and dissemination among partner companies, with positive effects on the financial and innovative results of the firms (Bocquet and Mothe, 2015; Yap and Rasiah, 2017). The effect is more ambidexterity. In the recent past, a socially dominant innovation paradigm has increased the need for the effectiveness of connective force. Innovation is thus treated as a social mechanism in which the organizational limits and the distinction between external and internal borders are lost through conceptualizing the KM network into a grid (Mele et al., 2014). It should, however, be stressed that such a networking view of KM works only when it is close-knit and closely connected. The KM research objective therefore consists of creating “context conditions” that allow companies (and staff) to engage in an interactive and iterative knowledge generation, maintenance and leverage process (Eseryel, 2014). This approach is usually preferred face to face and physical contact. However, IT solutions will contribute to the co-development of new technology solutions for KM-related communication, collaboration and participation (Eseryel, 2014). In general, IT systems have been used. Von Krogh (2012) then provided the social media overview as a crucial and up-to-date way to manage information in a networking environment, which argued for the advantages of its accessibility and ease of use, even if some businesses still refuse to accept that. In addition, Bartolacci et al. (2016) recommended the incorporation of the Web 2.0 tools in mutual innovation environments, which would promote efficient knowledge interaction, taking the intellectual, social and physical needs of individuals into account. They specifically proposed to combat the lack of personal opportunities in traditional KM systems, to use gaming and social tools to give value to users, to allow them to share their knowledge of the system and to offer valuable contributions or ideas to emerging companies.

## 5. DISCUSSION AND FUTURE RESEARCH DIRECTIONS

This paper explored OI from a KM point of view by examining the empirical findings from three primary OI processes. The paper addressed OIs from a profound viewpoint. The review paper shows that in the large OI literature only 49 papers deal directly with KM issues. We defined key issues based on the above context. KM operations for inbound and coupled OI procedures were mainly tackled while outbound OI has remained scarce and needed more focus (Figure 2). Moreover the methodological approaches used in the reviewed papers in Appendix A are primarily quantitative in Table 1. This might mean that the KM lens is still in the early stages of OI testing. More work will build on the theory that has been built so far and provide further analyzes.

#### 5.1. Inbound OI Process

In order to develop the KM mechanisms that enable organization members to improve the value of foreign knowledge, the

**Table 1: Journals with relevant knowledge and open innovation publications****Journals included in review**

• Journal of knowledge management	• Technology analysis and strategic management
• Baltic journal of management	• Research-technology management
• Program: Electronic library and information systems	• Academy of economic studies of bucharest
• Production planning and control: The management of operations	• Journal of cleaner production
• Managing service quality	• Journal of product innovation
• Journal of the association for information systems	• International journal of production economics
• Journal of business and industrial marketing	• Knowledge management research and practice
• Journal of global entrepreneurship research	• International journal technology management
• R&D Management	• Technological forecasting and social change
	• Strategic management journal
	• Journal of business research

importance of integration of their knowledge with their existing knowledge (for example, Zobel, 2017) is an initial insight into the effectiveness of incoming OI procedures (Borjigen, 2015), and this can be achieved. These KM mechanisms, in turn, can support the NHI and BI syndromes reduction organizations and encourage the sharing of an opinion over OI processes throughout the organization. Despite the general guidance, however, there are specific recommendations as to how businesses should build KM strategies to achieve those goals that have been listed above. However, it remains unclear whether and how firm-specific characteristics and sectorial effects may impact on the type of KM practices that need to be implemented, since the requirements are unique (such as governance, degree and form of knowledge) and sectoral conditions (such as market competition and concentration, and strength of IP systems) that may affect the application of KM.

In fact, it seems that inbound OI problems can not be addressed internally on an ongoing basis (Borjigen, 2015). Companies can therefore opt for internal innovation problems by depending on the expertise and competences of external actors (Borjigen, 2015). Nevertheless, finding issues with outsourcing is a key task of KM, with little data on this (Davis et al., 2015). In order to sustain the identification of problems in external sources, more research is needed on the individual characteristics of organization members. In addition to the identification of outsourcing issues, businesses need to identify possible useful external sources of information that help them tackle the problems found and how external knowledge requires management (Ritala et al., 2013; Borjigen, 2015; Lopes et al., 2017). Although some of the know-how sources have shown their benefits with regard to specific problems with innovation and the benefits and drawbacks of many sources of knowledge, it remains unclear the KM practices need to be implemented and/or adopted first and foremost to choose external knowledge tools (Ritala et al., 2013; Diaz-Diaz and Saa-Perez, 2014).

Another idea promoting inbound IP processes is the use of special KM frameworks to secure IP rights. Nevertheless, KM procedure has been known to best suit differential IP regimes. This could be important in view of the growing use of platforms (e.g., crowd

sourcing platforms) for the acquisition and depend on procurement or allying strategies (e.g., Valentim, 2016; Yan and Azadegan, 2017). In particular, these solutions include serious IP issues, such as information leak and free movement behaviour, and may require different methods in order to effectively handle knowledge and to provide various possible outcomes for innovation. Nevertheless, no detailed analyzes were carried out in order to understand the most acceptable KM activities to be adopted when external information is derived from crowdsourcing channels, partnerships and market economics. More research to overcome this void can therefore give theoretical perspectives and practical useful applications.

## 5.2. Outbound OI Process

Reviewing the very few research on KM activities to help outbound OI procedures, companies face a large number of outputs, which may minimize the efficiency of OI approaches for organizational innovation. However, while the need for the adoption of KM procedures, aimed at promoting decision-making, has been noted, to mitigate these syndromes (Knoskova, 2015), there have been no concrete suggestions. In this context, more research should explore the particular nature of KMs to be adopted so as to avoid the risk of losing core information and to maintain the awareness that an organization can not use. In addition, it is also necessary to introduce KM practices to promote the selling of information, based on the type of knowledge held, to select potential customers as well as to connect internally with those of other organisations. Further research might also focus on designing and implementing KM practices which promote strategic fit between business functions when OI processes are developed (Lichtenthaler, 2007). Eventually, where focus companies directly offer expertise and when businesses engage in crowd source network competitions, there is a lack of differentiation between KM activities. Future studies can also produce in-depth analyses of KM activities in industries with more frequent production OI processes.

## 5.3. Coupled OI Process

Earlier studies have shown that the relative and connective capacities of different organizations help to alleviate problems of management of shared knowledge over time. The key cause of the problem is the heterogeneity between firms which needs more absorption ability, more developed governance structures, and integrated approaches to information management to better manage common knowledge (Bocquet and Mothe, 2015; Yap and Rasiah, 2017). Nonetheless, these observations fail to recognize that information is of different types (radical, incremental complex tacit etc.) and that different KM activities can be maintained for each form of knowledge. For this reason, future research will consider factors of expertise when evaluating KM activities in coupled OI processes.

No fine-set suggestions on mechanisms for managing common knowledge, such as human resources management practices, can indeed be found in the literature except for the role of IT tools (e.g., Ardito and Petruzzelli, 2017). There are also alacrities in research into governance structures and incentives that could help promote co-development, management and knowledge dissemination among member firms. Finally, in past studies there was a summary of the IP structures needed to manage common knowledge. Nonetheless, contingencies which can benefit IP tools instead of others (such as sector, firm size, value chain position etc.) have still not been studied and therefore the doors to additional investigation lines have been opened.

## 6. CONCLUSIONS

To conclude, the current research adds to existing OI literature by shedding new light on the role of KM activities in sustaining targeted inflows and information discharges in accelerating internal innovation processes. In particular, we study the current document in an attempt to give a general overview of the KM-practice activities that are to be taken to handle the three main OI procedures, namely inbound, outbound and couple OI procedures. The article can be a critical point of departure for future OI studies as it allows students to examine the KM model of the OI.

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## APPENDIX A

S. No.	Authors	Methodology	OI process	Sample	Findings	Journal
1.	Ritala et al. (2013)	Hierarchical regression analysis	Inbound	Survey data in n=193 multisectoral Finnish firms during 2008-2009	Strategic orientations (i.e., customer, technological, and entrepreneurial) affect the types of external knowledge and external sources firms are willing to rely upon	Baltic journal of management
2.	Alexander and Childe (2013)	Interviews	Inbound	25 interviews with multiple responders, representing French and British companies, governmental agencies and academia	The transfer of tacit knowledge is crucial for a successful knowledge transfer, as well as to support the exploitation of the sourced knowledge Tacit knowledge can best be transferred using rich media channels (i.e., face-to-face meetings, video conferencing, web-conferencing)	Production planning and control
3.	Mele et al. (2014)	Theoretical approach+case study	Coupled	IBM company	The S-D logic can explain the changes in innovation practices, hence highlighting that knowledge is better managed when “ecosystem relationships” are built and governed	Managing service quality
4.	Diaz-Diaz and Saa-Perez (2014)	Regression analysis	Inbound	Survey of Business Strategies (Abalanced panel of 1.266 Spanish firms – 6.330 observations)	Firms with an excess of internal knowledge do not obtain better innovative results because, over time, firms tend to enter a state of inertia and need external sources of knowledge to renew their knowledge When a firm’s absorptive capacity reaches a certain level the interaction improves the innovation of the firm	JKM
5.	Fiengenbaum et al. (2014)	Agent-based simulation	Inbound, outbound, and coupled	SimISpace environment sustaining a stable financial income	Open innovation is a beneficial long-term strategy, but there are indications that the inbound approach is more profitable than the outbound one. For the outbound OI process to yield substantial returns, the income from trading the knowledge should be substantially higher than the benefit that could be gained from exploiting it internally to develop new products or services. Different levels of openness could be applied by companies strategically at different periods in their life-cycles, with more in-house R&D at early stages to increase their chances of discovering radical innovations, and then, when more established in the market, opening up to increase their chances of sustaining a stable financial income	IJTM
6.	Eseryel (2014)	Single case study	Coupled	An open source software development team within Apache Software Foundation	Intellectual engagement with knowledge-embedded information technology artefacts enabled knowledge transfer without requiring face-to-face interaction. Tacit knowledge is explicated by a combination of questions, troubleshooting, suggestions, and justification as part of problem resolution	JAIS

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S. No.	Authors	Methodology	OI process	Sample	Findings	Journal
7.	Bocquet and Mothe (2015)	Multiple case studies	Coupled	2 French clusters mainly consisting of SMEs located in Rhône-Alpes region	Establishing proper governance structure in clusters may favour the co-development, the management and the dissemination of knowledge among member firms, in turn enhancing ambidexterity at the cluster level	KMRP
8.	Borjigen (2015)	Theoretical approach+multiple case studies	Inbound	2 crowdsourcing experiment (Goldcorp challenge and DARPA XC2V challenge)	OI should tend towards a mass collaboration. Hence, knowledge management system should enlarge knowledge tails by involving external actors. Organisations should increasingly open internal knowledge	Program: Electronic library and information systems
9.	Davis et al. (2015)	Single case study	Inbound	Human Health and performance directorate (HH&P) at NASA Johnson space centre	To fundamentally reshape its culture, transforming itself from an organisation that relied on traditional problem-solving tools to one that embraces collaboration and OI tools, HH&P created a KM decision analysis tool. The tool was designed to educate employees about innovative problem-solving mechanisms and assist them in selecting a project management approach given the specific resources, needs, and constraints of the project. The revised reward system offers meaningful incentives to participation, keeping interest and engagement high and making the collaborative platform an ongoing element in HH&P's culture change	RTM
10.	Knoskova (2015)	Chi-square test	Inbound and outbound	Two-stage empirical survey in companies in Slovakia (in 2009 involved 102 companies, in 2014 involved 287 companies)	Active and passive IPR protection is a differentiating factor between innovators introducing new to the world products and incremental innovators. KM factors represented by (a) IP protection and (b) use of IP tools of others differentiate radical innovators from incremental ones	Academy of economic studies of Bucharest
11.	Wu et al. (2016)	Single case study	Inbound	Pharmco company	Three major recommendations for effective inbound OI processes have been provided. First, it is necessary to establish mechanisms through which internal stakeholders can circumvent barriers to knowledge sharing created by functional silos. Second, to ensure trustworthiness, processes similar to those employed in naturalistic enquiry should be employed. Finally, to ensure the integrity and avoid agency problems, the implementation of a systematic and transparent review mechanism is needed	Journal of business and industrial marketing
12.	Valentim et al. (2016)	Multiple statistical approaches	Inbound	Survey data in N=260 portuguese SMEs	SMEs are very dependent on tacit knowledge. The management of this type of knowledge represents the basis of absorptive capacity. In order to absorb tacit knowledge form external sources, SMEs form strategic alliances	Technology analysis and strategic management

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S. No.	Authors	Methodology	OI process	Sample	Findings	Journal
13.	Ahn et al. (2016)	Structural equation modeling	Inbound, outbound, and coupled	Survey data in n=508 korean firms	The relationship between search, integrative, and firm performance confirms the importance of absorptive capacity in the OI process. Knowledge management capacity indirectly influences firm performance via desorptive capacity. Hence, these two capacities are essential elements in improving firm performance. Outbound OI processes are not frequently adopted but have a significant direct effect on firm performance. Regarding coupled OI processes, they do not directly affect firm performance but are helpful to sustain inbound and outbound OI processes	Technology analysis and strategic management
14.	Bartolacci et al. (2016)	Single case study	Coupled	Business innovation in virtual enterprise environments European project	Virtual spaces can be used to effectively enhance and support knowledge creation processes at the inter-organizational level. Specifically, the socialisation phase can also be supported by rich media in virtual spaces	JKM
15.	Lopes et al. (2017)	Single case study	Inbound	Brazilian business unit of a family owned large sized rubber product company	There is a consensus of the importance of KM to absorb external knowledge. The OI contributes to the generation of new knowledge by effectively managing the inflow of external knowledge. The knowledge generated as the result of an inbound OI process should be shared between the firm's partners	Journal of cleaner production
16.	Zobel (2017)	Structural equation modeling	Inbound	Survey data in n=119 firms Exnovate (European Network of Excellence on Open and Collaborative Innovation)	KM allows the right knowledge to reach the right employees KM measures a firm's focus on systems and tools that facilitate the codification, dissemination, and sharing of knowledge across firm boundaries, as well as internally to Downloaded by Griffith University At 06:47 10 September 2017 (PT) Excellence on Open and Collaborative Innovation) relevant business units and employees. KM processes (infrastructures that articulate, codify, and disseminate external knowledge resources) are components of the assimilation capacity	The Journal of Product Innovation
17.	Yan and Azadegan (2017)	Moderated structural equation modeling	Inbound	Survey data in n=267 new product development projects in 21 industries	Buy strategies outperform ally strategies in creating innovative products, regardless of the type of external source a firm engages with. When a firm's main objective is to bring highly novel products to the market, a buy strategy is likely to be more beneficial. When a firm's main objectives are focused on the financial aspects of the new product, allying with nonsupply-chain source strategy seems to be more suitable	International Journal of Production Economics

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S. No.	Authors	Methodology	OI process	Sample	Findings	Journal
18.	Yap and Rasiah (2017)	Multiple case study	Coupled	6 cases in IC industry in Taiwan and Malaysia	The paper argues that catch-up in the high-tech manufacturing industry requires a different roadmap and conditions compared to catch-up in a less technology-intensive industry. The relationship between firms at this stage is similar to value co-production; value is not simply added but is mutually created and recreated by combining or reconciling different values among actors.	Technological forecasting and social change
19.	Simeone et al. (2017)	Case study	Outbound	R&D project funded by the European Commission	The paper provides insights into the use of knowledge design outputs such as artifacts, sketches, visual representations or prototypes to translate ideas, theoretical and technical requirements, documents and outputs into formats that can be more easily understood and appreciated by various stakeholders.	JKM
20.	Remnel et al. (2017)	Case study	Outbound	Bio-pharmaceutical company	The enactment work of this initiative and identify three emerged managerial challenges, linked to (1) internal decision-making, (2) the cultural and psychological barriers of what we phrase as the “not- invented-elsewhere” syndrome, and (3) the ability to translate and communicate internal projects as attractive external proposals.	R&D management
21.	Hameed et al. (2018)	Survey (smart PLS3 (SEM)	Inbound, outbound	SME	R&D department reflects the positive effect of external knowledge and internal innovation on firm’s open innovation performance in SMEs.	Journal of Global Entrepreneurship Research
22.	Scuotto et al. (2017)	Structural equation modelling	Inbound	Structural equation modelling	Suggesting that the knowledge-driven approach is the strongest determinant, leading to a preference for informal inbound OI modes.	JKM
23.	Ardito et al. (2018)	Structural equation modelling	Inbound	Italian version of the European community innovation survey	The knowledge sources examined are positively related to innovation ambidexterity, analysis of their marginal effects suggests that sourcing knowledge from suppliers is more important than sourcing knowledge from customers and competitors, with competitors being the least relevant knowledge source. This finding is consistent with the fact that, compared to competitors, suppliers and customers have more direct interactions with firms. Therefore, there are more opportunities to exploit suppliers’ and customers’ knowledge in both radical and incremental innovation activities.	JBR
24.	Cassiman and Valentini (2016)	Survey (smart PLS3 (SEM)	Inbound and outbound	Belgian manufacturing firms	Firms buying and selling knowledge do increase their sales of new products, but at the same time their R&D costs increase more than proportionally.	Strategic management journal