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LITERATURE REVIEW

Knowledge Management and Project Uncertainty in Open Innovation Context: Trends and Contributions of Literature

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ABSTRACT

Goal: We aims to map the literature that correlates uncertainty management and Open Innovation at project level, identifying the main contributions of knowledge management.

Design/Methodology/Approach: We applied the Systematic Literature Review - SLR approach associated with Bibliometric analysis. To sample compose we use the Scopus and Web of Science databases. We also use the Bibliometrix R package to managed the sample process compose and bibliometric analysis and content analysis to identify the main topics.

Results: The contributions mainly discuss the performance of OI projects to generate competitive advantage for organizations. The sample are categorized in technical, market, organizational and resource uncertainties. There is a greater focus on market and organizational uncertainties justified by the propagation of uncertainty.

Limitations of the investigation: Even with transparency in the analysis and sample composition, the discussions may be subject to subjective interpretations by the authors.

Practical Implications: This study has managerial implications. Our study helps managers identify core KM mechanisms in OI projects that enable sharing, integration, and knowledge flow between the network partners. Our findings show that the main challenge lies in organizational culture and the change of mindset, which influences the opening to new partnerships, knowledge sharing, and internal and external partners' trust to leverage innovation. For that, managers have to be aware of the KM barriers such as lack of trust or information asymmetry.

Originality/ Value: We correlate uncertainties management in the OI projects, considering the influence of KM. We present conceptual maps. We identified emerging topics and we suggest a theoretical model of the research.

Keywords: Knowledge Management; Open Innovation; Uncertainty; Opportunities; Project.

1. INTRODUCTION

To ensure long-term competitiveness , in the perspective of knowledge dissemination and project life cycle, organizations have looking for development of the capacity to explore, plan and create new business (Bogers et al., 2018; Silva et al., 2021; Toma et al., 2018). Through the input and output knowledge flows, the organizations brings innovative projects with Open Innovation Model (Bagherzadeh et al., 2021). Chesbrough (2003) defines Open Innovation (OI) as the use of internal and external sources of knowledge, markets and technologies to accelerate the innovation of the companies. This is supported on transfer, creation and sharing of knowledge (Shmatko et al., 2021).

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Innovation projects have different attributes, such as strategic relevance, complexity of innovation tasks, type of knowledge and project uncertainty (Bagherzadeh et al., 2021). Some researchers has identified that project uncertainty is the most important attribute (Bagherzadeh et al., 2021; Gomes et al., 2021), because the OI happens in the project level (Du et al., 2014). Neglecting project attributes, like uncertainty, can difficult the understanding of successful OI management (Bagherzadeh et al., 2021; Kobarg et al., 2019; Papa et al., 2021).

Although, uncertainty in OI projects can be perceived differently in the collaborative context. This perception implies how information or knowledge shared between the actors is provided (Gomes et al., 2018). Gomes et al (2021) argues that literature has a gap in explain the influence of project uncertainty in OI and how organizations develop interorganizational collaboration skills to minimize the propagation of uncertainties. Also, the development of projects in OI is subject to asymmetry of information and intellectual property (Teece, 2007). Rice et al (2008) affirms that project uncertainty has different sources and, for Gomes et al (2021), their treatment is based on existing knowledge in the organization. Knowledge guides managers in understanding how uncertainties can affect projects, what should be done about it, and how this uncertainty affects the environment (Gomes et al 2018).

There are few studies that address open innovation at the project level (for example Bagherzadeh et al., 2021; Du et al., 2014; Masucci et al., 2020; Silva et al., 2021) and there is an large gap when this discussion approach the uncertainty inherent in OI projects (such as Bagherzadeh et al., 2021; Gomes et al., 2021). Bagherzadeh et al. (2021) addresses the level of openness, external partner, mechanism, formalization of collaboration and internal practices for the success of OI management. Masucci et al. (2020) claim innovative projects in OI increases the portfolio and the possibility of retaining control over intellectual property. Gomes et al (2019) identifies categories of uncertainties (primitive, structural and elementary) and aspects related to the management of these uncertainties. Papa et al. (2021) investigates the effects of adopting OI and the role of knowledge management (KM). Gomes et al (2018) complements by stating that collective uncertainties that also affect members of the innovation ecosystem, which in turn can affect the life cycle and development of new projects (Gomes et al., 2018). Du et al. (2014) analyzes the relationship between open innovation (from the outside in) and the financial performance of projects.

Despite its relevance to theory and practice, knowledge about the influence of uncertainty in OI projects on the performance of innovation at the project level remains limited. Some authors such as Gomes et al. (2018) and Silva et al. (2021) recognize that there is a gap in the OI literature at the project level, pointing out the need for further investigations on Knowledge Management in OI projects. Thus, this article aims to map the literature that correlates uncertainty management and Open Innovation at project level, identifying the main contributions of knowledge management.

2. THEORETICAL BACKGROUND

2.1 OI Projects and Knowledge Management (KM)

Chesbrough (2003) introduced the Open Innovation Model. He argues that the concept is based on the principle that innovation is more than internal efforts and formalization in the organization. New ideas can be developed from the company's internal or external environment. The beneficial effects of OI are knowledge and resources sharing, such as information about customer and resource demands, market needs and technology (Du et al., 2014; Kobarg et al., 2019; Shmatko et al., 2021). The advantages also extend to skills and competencies related to the technology and market aspects underlying the innovation and the innovation process itself (Kobarg et al., 2019), as well as the sharing of project uncertainties (Du et al., 2014). The concept and practice of OI underscores the importance of broad external search and subsequent integration involving customers and suppliers (Teece, 2007). It is the systematic performance of the exploration, retention and exploitation of knowledge inside and outside the boundaries of the organization throughout the innovation process (Lichtenthaler, 2011).

Based on Chesbrough (2003) model, some researchers observed that organizations adopt different OI strategies to deal with uncertainties in their projects. These strategies involve inbound OI (the internal use of external knowledge), outbound OI (the external use of internal knowledge), or both through active collaboration with external partners and the result of combining input and output activities. For this, the organization takes advantage of the knowledge of other companies (outbound), while allowing the exploration of its internal knowledge (inbound) (Chesbrough, 2020; Papa et al., 2021; Lopes and de Carvalho, 2018).

Innovation on OI model is created by accessing, leveraging and absorbing knowledge flows across company boundaries (Chesbrough, 2017). For this process, as associations dependent on their resources for detecting, seizing advantage of and adapting opportunities (Teece, 2007), while

they develop their capacity to absorb knowledge for their projects. As innovations are valuable combinations of knowledge, property rights and control over this knowledge determine how much innovative companies can benefit from such knowledge (Teece, 1986). The flows of knowledge between different actors in collaborative innovation allow the combinations of knowledge necessary for project success to be achieved (Ritala et al., 2018). In this way, absorptive capacity provides a robust basis for learning by increasing the perspective that the information received relates to what is already known (Cohen and Levinthal, 1990).

The transfer, sharing and integration of knowledge supports the OI process. For this organizations must demonstrate trust in external partners of knowledge to achieve innovation success. Knowledge generates value and innovation when qualified and used in the context of projects (Bacon et al., 2019). The exchange of knowledge between partners tends to be reciprocal to generate benefits for the project, within and outside the context of the partnership, which is a necessary condition for OI (Ritala et al., 2018).

2.2 Project Uncertainty

Uncertainty refers to situations in which it is impossible to quantify the results of a given event, that is, the effect is unknown (Knight, 1921). Galbraith (1973) considers that uncertainty is the difference between the amount of information needed to perform a task and the amount of information possessed by the organization. Bennett e Lemoine (2014) argues that uncertainty also involves a lack of knowledge about whether an event will have significant ramifications.

Rice et al. (2008) predict that these uncertainties come from different sources: technical, organizational, market and resources. These sources of uncertainty are associated with the component under development, the customer, the internal aspects of the organization and the resources (capital and competences) essential for the projects, respectively. (Rice et al., 2008). Project uncertainty refers to the extent of change in project-related technologies and customer preferences (Akgun et al., 2006), as well as its viability and market acceptance (Courtney et al., 2017).

Based on knowledge, uncertainty can be perceived or anticipated. There are uncertainties that can be anticipated and formalized in terms of questions and there are uncertainties that are hardly perceived (Barbosa and Saisse, 2019; O'Connor and Rice, 2013). In OI projects, such uncertainties can still be propagated among partners. The propagation of uncertainty is related to information shared between project partners and affected by distortions caused by the different knowledge bases and interpretations of the partners (Gomes et al., 2018).

Dealing with uncertainties in this context requires extensive interaction through the exchange of knowledge between project partners (both inside and outside the focal company). In this way, the relevant and necessary knowledge is available to all partners involved (Bagherzadeh et al., 2021). Rice et al. (2008) recommends the Learning Plan, an interactive approach that consists of converting unknowns into knowns through experimentation. This approach guides learning by trial and error, allowing assumptions to be tested where there is an accumulation of knowledge. (O'Connor and Rice, 2013).

A collective uncertainty has an interdependent nature, in that it affects the decision making or performance of a group of actors (Gomes et al., 2018). However, the search for external knowledge is complex, involving uncertainties and characteristics such as tacitness, competitiveness and indivisibility of knowledge, which may not be conducive to its detection and transfer (Lopez-Vega et al., 2016).

Uncertainty management may require understanding how managers and associations frame the unknowns in the project prioritization and selection process. It aims better alternatives to the correct balance of resources, considering the interrelationships between projects, and the need to compose a portfolio capable of sustaining a company's future competitive advantages (Gomes et al., 2019). Thus, project managers must be cautious in selecting the external source of knowledge to avoid opportunism and information asymmetry (Courtney et al., 2017; Gomes et al., 2021). Knowledge is a critical resource for the innovation, competitiveness and survival of organizations (Rosell et al., 2017). The complexity of the projects requires organizations to engage with external partners and this tendency becomes stronger when the project is more uncertain (Bagherzadeh et al., 2021).HRM Practices and Employee Engagement

It is evident from the previous studies that HRM practices help in enhancing the skills, level of motivation and opportunities among the employees (Jiang, 2012). Skill improving practices like appropriate recruitment and selection, specific training programs assist in improving the skilfulness of employees' whereas opportunity improving practices, empower the employees and help them to make use of their potentiality to reach the goals of the business. Motivation enhancing techniques like career encroachment, work safety and performance advice help to increase employee level of motivation and commitment. (Jiang, 2012). The present study focuses on one of the employee behavioural outcome which is employee engagement. Therefore, HRM practices may

be helpful in explaining engagement of employees.

3. METHODOLOGY

To achieve the objective of this paper, we applied the Systematic Literature Review - SLR approach associated with Bibliometrics. As a structured, replicable and transparent process, the SLR allows the identification of the main scientific contributions of an area, theoretical evolution and main issues related to specific theme. (Carvalho et al., 2013; Tranfield et al., 2003). SLR applies the existing knowledge base for mapping research and provide evidence-based discussion (Alves et al., 2021; Aria and Cuccurullo, 2017). Bibliometric analysis enables the identification of literature patterns, analyzing the volume of publications carried out during the study period. Through bibliometric analysis, there is an identification of the most important topics, approaches and methods, as well as the main definitions in relation to the theme (Carvalho et al., 2013).It provides a structured analysis that infers trends over time and main topics researched (Aria and Cuccurullo, 2017; Pereira et al., 2020).Employee participation and Employee Engagement

Employee Participation is the degree to which workers get involved with the business leaders in discussions focused towards achieving the business goals and objectives. When employees are involved in the decisions making process and suggestive discussion forums their behavioural consequences such as Organizational Commitment and Employee Engagement gets enhanced and in turn helps to achieve business objectives (Alima Aktar, 2018). (Ugwu, 2017), opined that it is essential for workers to get involved in participative decision-making process as it helps them to incorporate positive attitude aligned with better performance, which is also supported by the studies of (Kıngır, 2010). Decisions involving employees' Participation helps to create sense of trust and association towards the organization, creates a healthy work environment which reduces stress and positively affects employee engagement (Martin, 2015). High level of employee participation facilitates employee positive behaviour at workplace to attain competitive advantage.

Based on the insights obtained the hypothesis was framed as, H02: There is no relationship between employee participation and employee engagement.

3.1 Sampling Process

The sample is composed for scientific contributions presents in Scopus and Web of Science (WoS) databases, because together they offer a large volume of quality productions with high impact factors (Carvalho et al., 2013). For this, we apply the strings "uncertaint*" and "open innovation*". Initially Scopus provided 172 documents and WoS provided 157.

We limited the sample to type of production, applying in Scopus to "articles" and "review" (totaling 100 documents) and in WoS to "article", "early access" and "review" (114 documents). Thus, we considerated all articles until 2021, removing 6 articles on Scopus published in 2022 and 4 on WoS. In addition, 81 duplicate articles were identified that were removed, totaling a sample of 123 articles

Figure 1 shows the sample composition process for this research. All titles and abstracts were read to exclude articles that were not in accordance with the scope of this study. 36 articles were excluded for not being consistent with the scope of the research. In general, these articles only mention, but not provides a discussion about OI. Others still discuss risks and indicate that their treatment is dedicated to uncertainties (not build a discussion about it). The inclusion and exclusion criteria are shown in Table 1.

Table 1 - Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Database	Web of Science and Scopus.	-
Type of publication	Article, review, and Early Access.	Other types.
Period of time	Until 2021.	-
Search Parameters	Strings present in titles, abstracts or keywords.	Strings present in other parts of the article.
Alignment with the research objective	Uncertainties in OI projects.	Articles that discussed risks in projects and that clashed with the IO discussion.

Source: The authors.

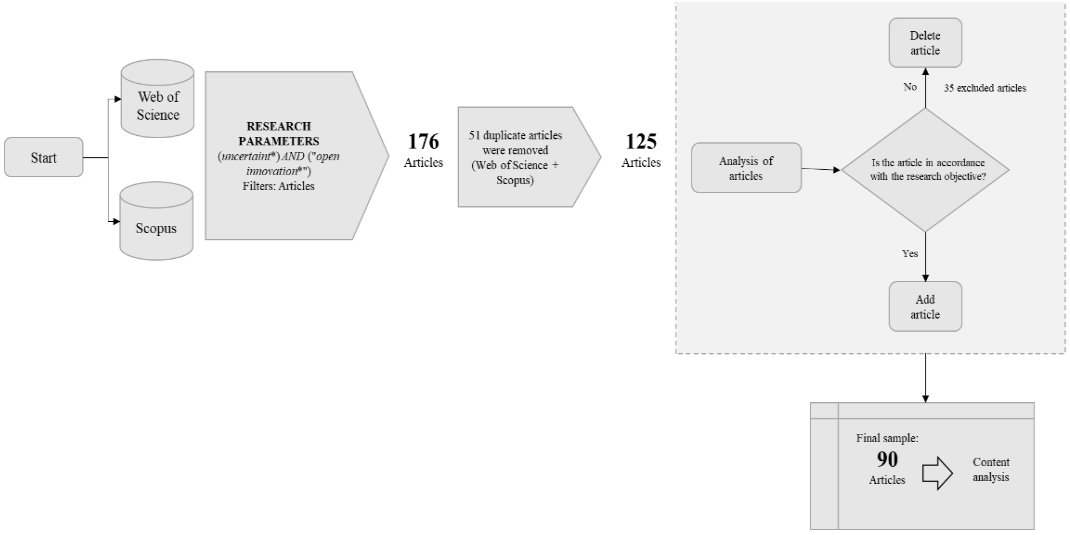

Figure 1 - Flowchart of the search process and sample composition.
Source: The authors.

3.2 Data analysis

A bibliometric analysis was conducted based on the consolidated sample after screening, as this approach allows the analysis of scientific publications and information such as authorship, affiliation, citations and keywords, making it possible to know the correlations of articles on a particular research topic (Lopes and de Carvalho, 2018). RStudio's statistical computing environment was used for the pre-processing and cleaning of bibliographic metadata from Scopus and WoS databases, thus removing duplicate files and joining ".bib" files.

Bibliometric analyzes were performed in the Bibliometrix R package, which provides a set of tools for quantitative bibliometric research. The R language is an open source environment and ecosystem (Aria and Cuccurullo, 2017). We analyzed the trends and evolutions of the research field and provided a conceptual structure mapping and network mapping of the sample. Then, the content analysis of each article was carried out separately, using the Mendeley software. Content analysis allows the identification of definitions and theoretical models (Lopes and de Carvalho, 2018) that supports the discussions of the sample results.

4. ANALYSIS OF RESULTS

4.1 Bibliometric Analysis

With the Biblioshiny (Bibliometrix), it was possible to analyze the Thematic Evolution in two slice-time (see Table 2). In the first period, the focus remained on innovation and uncertainty themes. The uncertainties need to be identified and mitigated between strategic alliances based on the organizations' internal knowledge and consequently knowledge sharing. In the second period (2019-2021), crowdsourcing and performance themes stood out. Crowdsourcing involves individuals from geographically distinct places, promotes generation and reward for the generation of ideas (Cappa et al., 2019). The relationship between OI projects and performance highlighting the importance of project selection aligned with organizational strategy. From this perspective, managers seek to identify the specific OI projects' benefits and thus seek strategic partnerships and alliances to fill gaps in knowledge or technologies.

Table 2 - Thematic Evolution.

From 2004-2018	To 2019-2021	Terms	WII	II	OC	SI
Decision makers	Crowdsourcing	Decision making	0,33	0,33	2	0,17
Innovation	Open Innovation	Innovation	0,32	0,25	12	0,11
Open innovation	Firms	Firms	0,50	0,50	5	0,05
Open innovation	Open Innovation	OI management	0,55	0,25	22	0,04
Open innovation	Performance	Performance; knowledge	0,67	0,17	11	0,04
Open innovation	Research and	Research and development	0,45	0,25	9	0,04

	development					
Uncertainty	Competitive advantage	Competitive advantage	0,33	0,33	3	0,07
Uncertainty	Research and development	Dynamic capabilities	0,18	0,25	2	0,07

Note: Weighted Inclusion Index (WII); Inclusion Index (II); Occurrences (OC).
Source: The authors.

The Figure 2 shows the thematic map, emploring the themes accordingly centrality and density. At the upper-right quadrant appears the motor themes (strong centrality and high density) with two bubbles, one refers to OI in the midst of an environment of uncertainty, technology and knowledge transfer; while the other concern to competitive adavantages of OI in manufacturing firms. Innovation performance is related to exploration and exploitation. The sample relates exploitation to knowledge already assimilated, applying it in OI projects to refine it and creating new processes. The upper left quadrant represents niche themes that highlight the bubble grouping exploration and exploitation process and their impact on innovation performance. Other niche theme emcompasses the generation of new knowledge in the OI project. Two important constructs of strategic management and innovation appear in the thematic map in Figure 2 as emergent themes (the lower-left quadrant), which are absorptive capacity and dynamic capabilities. These two constructs are based on the application and assimilation of knowledge to guarantee competitive advantage and organizational strategy. These are constructs related to knowledge management in companies and in the collaboration network of OI projects.

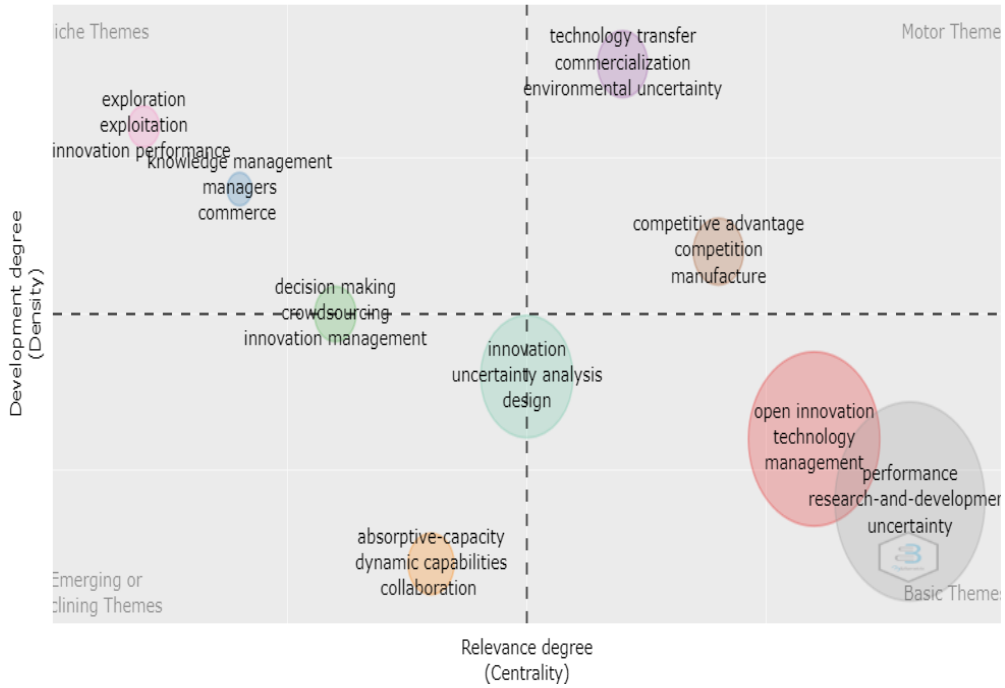

Figure 2. Thematic Map.
Source: The authors.

The OI adoption allows detection of market needs and faster new technologies development, improving competitive advantage. For this, at the project level, it is necessary mutual trust between the collaboration partners for knowledge and technologies sharing. The concept map in Figure 3 shows two clusters. The blue cluster shows how investiments in OI improve performance, productivity, and customer satisfaction through cross functional integration and involvement. The red cluster is broader, covering topics related to projects uncertainties and the methodologies applied in the sample.

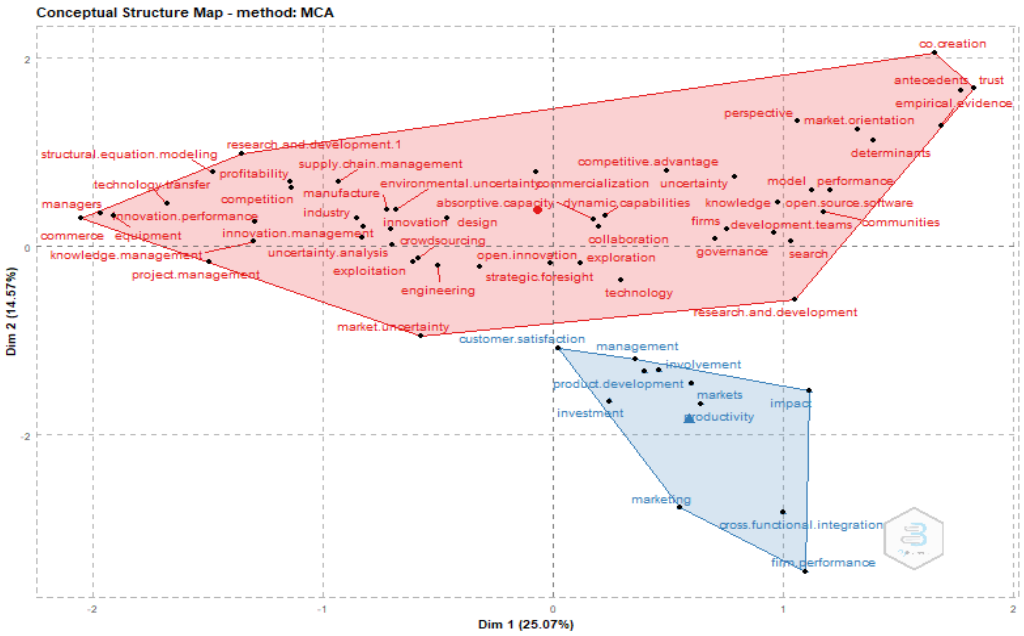

Figure 3. Conceptual Structure Map.
Source: The authors.

5. DISCUSSION

5.1 Project Uncertainty in OI

Interdependence in OI infers from the concern with how the partner deals with uncertainties so as not to negatively affect the performance of the partners (Gomes et al., 2021b). For complex projects such as companies spend more time with external partners when project uncertainty is high. This indicates that uncertainty strengthens the relationship between project complexity and openness (Bagherzadeh et al., 2021). That is, it depends on the amount of information available on the network (Wilson and Ettlie, 2018) and these project uncertainties reside mainly in changes in environmental conditions, results and expectations (Gomes et al., 2021b).

It is important to highlight that the sample defines uncertainty regarding the amount of information available for the development of projects. Uncertainty reduction is achieved through the collection and analysis of information that increases the chances of a successful project (Buganza et al., 2011; Eslami and Lakemond, 2016; Gomes et al., 2021b; Rönnberg-Sjödin, 2013; Sjödin, 2019a). Because it is the availability of information, the sample understands that the time performance of projects is increased when there are frequent meetings with partners, training, project progress and exposure of the status of individual contributions to quality assurance (Heger and Rohrbeck, 2012; Stüer et al., 2010). Uncertainties are coded by the sample as defined by Rice et al. (2008) and has the distribution as shown in Table 3.

Table 3 - Project Uncertainty.

Code	Project Uncertainty	Sample	References
PU_1	Technical	19%	1,16,24,21,27,37,38,46,48,50,53,61,69,82,85,86,87.
PU_2	Market	42%	1,5,6,7,11,12,14,17,18,21,23,24,27,24,28,31,32,34,35,36, 38,39,40,42,43,50,54,60,61,63,65,66,70,72,77,80,86,90.
PU_3	Organizational	34%	5,6,11,12,14,15,16,24,26,30,32,33,36,37,39,45,51,50,52, 53,56,62,64,67,65,68,71,81,83,88,89.
PU_4	Resource	38%	6,11,16,18,21,24,25,26,27,28,29,32,34,35,36,40,42,44,4 9, 51,55,59,57,60,61,63,64,66,67,73,74,77,79,86.

Source: The authors.

There is a greater focus on market and organizational uncertainties justified by the propagation of uncertainty (see Gomes et al., 2021). The context is collaboration for innovative, market-oriented and new product/technology projects.

OI projects are characterized by high technical and market uncertainty (Kutvonen et al., 2014). The uncertainties associated with technology transfer, on the other hand, reside in the added value, such as receipt of payment and errors in sales forecasts (Holmes, 2009). This requires careful knowledge transfer processes (Thomas and Obal, 2018). Given market and technical uncertainty, Absorptive Capacity plays an important factor in the development of new products, due to factors related to knowledge distribution, project acceptance and competitive environment (Li et al., 2020). This technical uncertainty is compounded by market uncertainty, when early-stage technology projects also address an uncertain market (Chesbrough, 2004). In this case, the Dynamic Capabilities mitigates the effect of market and technology uncertainties when codified within the organizational structure, resources, processes and culture (Stüer et al., 2010).

To reduce market uncertainty, the companies tend to use traditional sources of market intelligence, such as: user participation, co-creation with competition and study of similar products (Stüer et al., 2010). Sensing of knowledge and information from these sources often leads to service offerings with incremental improvements (Flammini et al., 2017; Thanasopon et al., 2016).

The value of the diversity of the portfolio of alliances in high-tech industries is also recognized, given the technological complexity, market uncertainty and diverse skill sets for innovative projects (Garcia Martinez et al., 2017). Sandulli et al. (2012) argues that the adoption of open innovation is positively related to technology complexity and market uncertainties. Attention to signs of uncertainty propagation can be an important aspect of cognitive ability and can contribute to a firm's dynamic capabilities. (Gomes et al., 2021b).

Organizational uncertainties reside mainly in information and communication technology for collaborative networks (Gomes et al., 2021b; Wiener, 2018). In addition, the sample considers that knowledge for projects is a strategic resource and that its absence enhances organizational uncertainties, especially when related to the market and technology (Gomes et al., 2021b; Le Masson et al., 2019; Vaid and Honig, 2020). Organizational uncertainties are reduced through strong collaborative organizational leadership, stakeholder management, strategic project alignment and definition of success criteria for innovative projects (Anokhin et al., 2011; Ben Arfi et al., 2019; Dahabieh et al., 2018; Wiener, 2018). Furthermore, a high level of formal interorganizational control means members' understanding of project objectives, process and their own functions (Cheng and Shiu, 2020; Dahabieh et al., 2018; Heger and Boman, 2015; Lu et al., 2017).

Limited resources is a driver for the development of OI projects, as resource uncertainty is mitigated by network participants (Athaide et al., 2019). As collaborative networks with greater financial and technological resources and cover larger markets (Cardoso and Ramos, 2016; Dahabieh et al., 2018; Shmatko et al., 2021). Knowledge sharing reduces resource uncertainty by enabling the development of new technologies or the creation of markets (Gilsing et al., 2016; Thanasopon et al., 2016; Villasalero, 2018).

5.2 Main topics: a model proposal

The majority of the sample discusses the relationship of KM with uncertainty in OI projects, extending to knowledge flows, integration and sharing, as shown in Table 4. The researchers also point to factors that enhance uncertainties, while other authors address some capabilities to be developed by organizations so that OI projects are successfully completed in the face of uncertainties. Each of these topics presented in Table 4 are discussed below.

Table 4 - Main Topics Codification.

Dimension	Code	Description	%	References
Knowledge Management	KM_1	Knownledge Sharing	37%	2,6,8,9,12,13,17,18,19,26,28,20,22,24,27,31,34,9, 40,41,42,45,46,52,60,62,69,74,77,78,82,86,88.
	KM_2	Knowledge Integration	12%	7,11,13,18,20,24,37,40,80,82,86.
	KM_3	Knowledge Flow	17%	3,9, 18,22,36,40,44,51,60,64,66,78,79,86,84.
Uncertainty Enhancer	UE_1	Communication	34%	2,5,6,7,8,10,13,16,18,19,21,22,23,24,26,27,28,31, 33,34,36,39,46,48,50,53,67,70,83,84,86.
	UE_2	Intellectual Property	28%	2,7,10,11,13,15,16,17,18,19,20,25,29,36,38,39,40, 42,54,55,58,63,69,75,90.
	UE_3	Organizational Culture	21%	2,4,8,9,10,18,23,26,31,33,45,52,61,65,69,72,73, 79,87.
	UE_4	Lack of Trust	19%	2,3,5,11,18,22,23,25,26,28,30,33,34,37,50,55,75.
	UE_5	Information Asymmetry	11%	13,22,23,30,35,36,41,50,68,76.

Capabities for Organization	CO_1	Partnership	26%	4,5,6,11,15,16,18,21,22,40,50,52,55,56,57,59,60, 62,71,72,81,84,86.
	CO_2	Inbound	19%	4,5,3,9,17,20,21,35,36,44,51,52,57,58,62,78,79.
	CO_3	Outbound	13%	3,9,17,20,36,44,51,52,58,62,78,79.
	CO_4	Absorptive capacity	17%	2,11,12,14,21,24,35,36,49,43,52,60,62,83,86.
	CO_5	Dynamic Capabilities	9%	4,14,31,35,43,49,68,69,89.
	CO_6	Network structure	17%	4,7,11,16,25,29,34,39,41,43,49,52,56,57,60.

Source: The authors.

The organizations seek strategic alliances that, in a collaborative process, analyze solutions through internal and external ideas to the organizations. In this process, there is a sharing of knowledge and technologies. However, OI projects also have organizational, technical, market and resource uncertainties, which are potentiated if there is no mutual trust in the network. Thus, through the KM process, organizations share knowledge for the project, mitigate uncertainties and develop organizational capabilities for innovation. As a result, they strengthen their strategic alliances and create economic value.

Thus, we present the conceptual structure of this study from the correlation between the constructs, presented in the previous conceptual maps. The literature in general recognizes that the input to the development of OI projects is customer opportunities and needs. Therefore, the OI model advocates the organization of internal and external ideas for the mutual application of knowledge and technologies. In this process, organizational, technical, market and resource uncertainties arise. Thus, KM acts in the processing of new and existing knowledge for the development of action plans to deal with these uncertainties. The output of this process would be the strengthening of strategic alliances, improvement of technologies and management techniques.

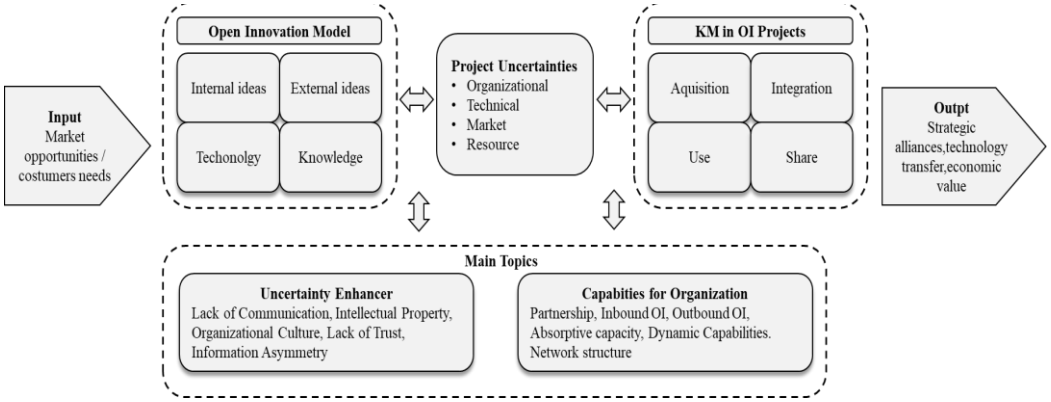

Figure 4. Topics related to uncertainty in open innovation projects.
Source: The authors.

5.3 Knowledge Management

Sharing knowledge mutually benefits the organization and the customer. It can take the form of mutual innovation, co-learning. change and search for solutions to complex problems (Ben Arfi et al., 2019; Sjödin, 2019b; Thomas and Obal, 2018). It is responsibility of organizations involved in the network to define the depth and complexity of knowledge, given the uncertainties present in the open innovation model (Thomas and Obal, 2018). This collaboration must keep the database always up to date (Li et al., 2020), what requires systems for knowledge storage and communication management (Feller et al., 2009).

Information gaps in the form of uncertainty, and the negative effects they can cause, generate critical problems in OI projects (Rönnberg Sjödin et al., 2016). The uncertainty associated with these projects, it is recommended to develop approaches for sharing knowledge, ideas and know-how (Ahn et al., 2017; Salembier et al., 2020). In this case, processing information about the technical, operational and technology requirements between project partnerships is essential (Rönnberg Sjödin et al., 2016).

These variables in the context of KM in projects are related to knowledge sharing, communication and cooperation (Feller et al., 2009; Li et al., 2020). They involve input and output flows of knowledge related to innovation, as they are connected to external networks

for input and output innovation. The common feature in exchanges is that a flow of knowledge takes place, whether it is a transfer of knowledge within the organization's boundaries or a transfer of knowledge from outside. This does not depend on the direction or flow of knowledge (Inbound or Outbound) or what is its receiver or source (Ahn et al., 2017; Brem and Nylund, 2021; Rönnberg-Sjödin, 2013; Villasalero, 2018). However, the flow of knowledge is critical for the success of open innovation projects in the face of uncertainties (Ahn et al., 2017; Bogers et al., 2018b; Santoso et al., 2020).

To deal with the uncertainties inherent in innovative projects, an integration of knowledge must be symmetrical between the partners (Rosell et al., 2017). This requires effective communication and governance management. The main objective of external knowledge integration can be described as capturing knowledge from the other partner through means that allow knowledge sharing (Eslami and Lakemond, 2016; Huang and Wu, 2014; Rosell et al., 2017; Thomas and Obal, 2018). The knowledge integration processes in these collaborations are located in innovative projects characterized by a high degree of complexity and uncertainty (Rosell et al., 2017).

5.4 Uncertainty Enhancer

The collaborative approach in innovative projects challenges the sharing and integration of knowledge, across transmitted and organizational boundaries, to reduce uncertainty (Feller et al., 2009; Sjödin, 2019b). This implies mutual trust for problem solving in projects. Trust enhances resource sharing and acquisition, while reducing conflicts (Ford et al., 2012; Lu et al., 2017).

Intellectual property makes knowledge sharing difficult (Hallberg and Brattström, 2019; Noh and Lee, 2020; Toma et al., 2018) and development of new technologies (Athaide et al., 2019; Holmes, 2009). Consequently, it makes it difficult for companies to engage in open innovation initiatives (Rahmanzadeh et al., 2020) due to the governance of those responsible in the network (Kim et al., 2015). This intellectual protection is enhanced by the asymmetry of information (Feller et al., 2009).

The development of collaborative projects requires efficient interorganizational communication (Bagherzadeh et al., 2021; Thomas, 2013). Communication must be clear so that there is no ambiguous information (Rönnberg-Sjödin, 2013; Sjödin, 2019). The greater the degree of project innovation, the greater will be the efforts to share knowledge and communication (Kim et al., 2015; Rosell et al., 2017). Another important fact to be considered is that associations from different regions may present relevant cultural differences, generating communication barriers (Ford et al., 2012). One of the causes of the propagation of uncertainty is poor or non-existent communication between teams and project members (Gomes et al., 2021b). This propagation of uncertainties happens when project time members are unaware of the activities of others (Colombo et al., 2016; Gomes et al., 2021b). The information asymmetry also enhances uncertainties (Ford et al., 2012; Lu et al., 2017). Therefore, not all external collaboration makes a success, it is the people who determine the organization's culture (Ben Arfi et al., 2019; Thomas, 2013; Wiener, 2018). Thus, organizational culture influences knowledge sharing, as individuals establish relationships of trust and influence the success of collaborations in terms of knowledge exchange. Good social interactions and trust can decrease information asymmetry in the network.

In addition, communication in innovative projects encourages creative thinking and the generation of ideas (Thanasopon et al., 2016). Adopting open innovation requires strong leadership, as it depends on reallocating resources and establishing a new organizational culture. Limiting the nature of knowledge import and export, OI sets a new innovation model and organizational structure (Ahn et al., 2017; Brem and Nylund, 2021; Kutvonen et al., 2014). Finally, projects in open innovation environments leverage their performance through innovation such as defining intellectual property, a culture that facilitates building trust, and governance equipment for the creation and sharing of knowledge (Alexy et al., 2013; Santoso et al., 2020; Zhang and Lv, 2015).

5.5 Capabilities for Organization

Organizations benefit from open innovation projects by gaining additional knowledge from partnerships. Adopting OI in projects requires capabilities such as open culture, connectivity, strategic and structural flexibility (Nitzsche et al., 2016; Villasalero, 2018). Cheng e Shiu (2020) add that in dynamic environments, the ability to manage alliances complements inbound/outbound strategies to increase project performance.

This allows companies to assess the value of OI, increase opportunities to create new

products, and develop capabilities to deal with uncertainty. (Cheng and Shiu, 2020). Networks or partnership structures between co-innovators are decisive in the perception of uncertainties, given the information and knowledge flows between them that enable the potential for innovation in the partnership and treatment of uncertainties (Ahn et al., 2017; Cardoso and Ramos, 2016). In a context of uncertainty, infrastructure and knowledge flows must be strategically protected. Information is a strategic asset and of considerable relevance (Cardoso and Ramos, 2016). Absorptive capacity and organizational culture are considered success factors for open innovation projects (Nitzsche et al., 2016).

Another important point is the type of open innovation adopted by the organization: inbound or outbound. The sample articles converge in stating that outbound OI is frequently adopted in projects for the commercialization of new technologies. Inbound I is rationed with companies focusing on analyzing the internal environment to acquire knowledge in addition to their innovation activities (Nitzsche et al., 2016; Santoso et al., 2020; Thanasopon et al., 2016; Villasalero, 2018).

Since external knowledge is an important source for the development of new products, the absorptive capacity helps the company to acquire, assimilate and explore external knowledge, which complements the development of internal knowledge for the innovation process in projects (Cheng and Shiu, 2020; Li et al., 2020; Nitzsche et al., 2016). It still implies the perception of new markets (Ben Arfi et al., 2019; Rosell et al., 2017; Thanasopon et al., 2016). Furthermore, Cheng e Shiu (2020) affirms that absorptive capacity only compliments entry strategies, not exit strategies.

For OI projects, the authors refer to dynamic capabilities consisting of interorganizational processes for the dissemination, interpretation and implementation of strategic knowledge (Heger and Boman, 2015; Vaid and Honig, 2020). This is done through partnerships with customers, suppliers, universities and other associations that may contribute to the project (Ben Arfi et al., 2019; Cardoso and Ramos, 2016; Huang and Wu, 2014; Thanasopon et al., 2016). From this perspective, the structure of the network depends on the levels of collaboration and interdependence of partners, which affects the propagation of uncertainties (Ben Arfi et al., 2019; Gilsing et al., 2016).

6. CONCLUSION

Through a Systematic Literature Review, our study discusses the influence of KM on OI project uncertainties. We categorized the study sample into technical, market, organizational and resource uncertainties. Thus, we note that market uncertainties are the most recurrent in the OI model, followed by resource, organizational and technical uncertainties, respectively.

Based on the conceptual maps presented in the study, our content analysis showed the main topics discussed in the sample: KM, uncertainty enhancer and capabilities. We provide a conceptual model from this coding and explain each of these topics according to sample considerations.

We note that KM is a enable for the perception and response to these uncertainties through the sharing, integration and flow of knowledge between the network partners. For this, efficient and continuous means of communication are needed to avoid barriers to KM such as lack of trust or information asymmetry. The organizational culture in this context influences both the opening to new partnerships, as well as the sharing of knowledge and trust in internal and external partners to leverage innovation.

Thus, it is up to the organization to develop dynamic capabilities and absorptive capacities for knowledge integration. This flow of knowledge flows from the project level to the organizational level as well as across the network structure. For this reason, the managers of these projects must pay attention to the management of knowledge input and output strategies.

This study also has managerial implications. It fosters an understanding that the OI model must be better understood to justify the considerable effort and uncertainties, as well as the process and potential benefits of this approach in projects. Integrating a partner into your project development effort can enable you to gain competitive advantage and take advantage of market opportunities.

Finally, this study has limitations arising from the methodological approach applied. The results refer to a specific sample limited until 2021. However, it is suggested to apply the constructs identified here in survey-type research to assess their correlations. With this, it will be possible to propose a valid model with application in managerial practice.

Appendix A - Research Sample.

ID	Autoria	S*	W*	Coding	ID	Autoria	S*	W*	Coding
1	Chesbrough (2004)	347	242	PU_1, PU_2.	46	Thomas,Obal (2018)	-	6	KM_1, UE_1, PU_1.
2	Alexy *et al* (2013).	184	168	KM_1, UE_1, UE_2, UE_3, UE_4, CO_1, CO_4.	47	Gama (2019)	5	5	CO_5, CO_6, PU_2.
3	Bogers*et al* (2018)	157	117	KM_3, UE_4, CO_2, CO_3.	48	Stüer *et al* (2010)	5	-	UE_1, PU_1, PU_2.
4	Vrande *et al* (2010)	-	82	UE_3,CO_2, CO_3, CO_5,CO_6.	49	Liu *et al* (2019)	-	4	CO_4, CO_5, CO_6, PU_4.
5	Heger and Rohrbeck (2012)	75	71	UE_1, UE_4, CO_1, CO_6, PU_2, PU_3.	50	Gomes *et al*(2021)	3	2	UE_1, UE_4, UE_5, CO_1, CO_3, PU_1, PU_2, PU_3.
6	Agogué *et al* (2013)	65	-	KM_1,UE_1,CO_1, PU_2,PU_3,PU_4.	51	Sydow,Müller (2020)	3	3	KM_3, CO_2, PU_3, PU_4.
7	Leydesdorff,Ivanova (2016)	61	-	KM_2,UE_1, UE_2, CO_6	52	Ben (2019)	3	0	KM_1, KM_3, CO_1, CO_2, CO_3, CO_4, CO_6, PU_3.
8	Thomas (2013)	-	57	KM_1, UE_1, UE_3, PU_2.	53	Szajnfarber ,Vrolijk (2018)	3	-	UE_1, PU_1, PU_3.
9	Stefan,Bengtsson (2017)	51	43	KM_1, KM_3, UE_3, CO_2, CO_3,	54	Flammini (2017)	-	3	UE_2, PU_2, PU_4.
10	Boudreau and Lakhani (2015)	-	45	UE_1, UE_2, UE_3.	55	Athaide (2019)	-	3	UE_2, UE_4, CO_1.
11	Stefan and Bengtsson (2017)	44	37	KM_2,UE_2, UE_4, CO_1, CO_4, CO_6, PU_2, PU_3, PU_4.	56	Masson *et al*(2019)	-	3	CO_1, CO_6, PU_3.
12	Martinez *et al* (2017)	43	37	KM_1, KM_2, KM_3,CO_4,PU_2, PU_3.	57	Wan *et al* (2019)	2	2	CO_1, CO_2, CO_6, PU_4.
13	Feller *et al* (2009)	41	26	KM_1, KM_2, UE_1, UE_2, UE_5.	58	Dilan *et al* (2019)	2	1	UE_2, CO_2, CO_3.
14	Heger and Boman (2015)	-	32	CO_2,CO_5, PU_2,PU_3.	59	Cardoso and Ramos (2016)	2	3	CO_1, PU_4.
15	Anokhin*et al* (2011)	30	18	CO_1,UE_2,PU_3.	60	Silva, Dacorso (2014)	2	-	KM_1, KM_3, CO_1, CO_4, CO_6, PU_2, PU_4.
16	Pollok*et al* (2019)	29	22	UE_1,UE_2, CO_1, CO_2, PU_1, PU_3, PU_3.	61	Ziegler *et al*(2019)	1	-	UE_3, PU_2, PU_3, PU_4.
17	Sandulli *et al* (2012)	28	23	KM_1, UE_2, CO_2, CO_3 PU_2.	62	Cheng,Shiu (2020)	1	0	KM_1, CO_1, CO_2, CO_3, CO_4, PU_3.
18	Carayannis *et al* (2017)	27	26	KM_1, KM_2,KM_3,UE_1, UE_3,UE_4,PU_2,PU_4.	63	Renna (2020)	1	-	UE_2, PU_2, PU_4.
19	Kim *et al*(2015)	25	20	KM_1, UE_1, UE_2.	64	Johnston (2020)	1	1	KM_3, PU_3, PU_4.
20	Buganza *et al* (2011)	23	-	KM_1, KM_2, UE_2, CO_2, CO_3.	65	Zhang and Shuang (2019)	-	1	KM_3, PU_2, PU_3.

21	Thanasopon (2016)	22	15	UE_1, CO_1, CO_2, CO_4, PU_1, PU_2, PU_4.	66	Leitner *et al* (2020)	-	1	KM_3, PU_2, PU_4.
22	Rönnberg-Sjödin (2013)	20	-	KM_1, KM_3, UE_1, UE_4, UE_5, CO_1.	67	Dahabieh *et al* (2018)	-	1	UE_1, PU_3, PU_4.
23	Ford (2012)	18	14	UE_1, KM_3, UE_4, UE_5, PU_2.	68	Vaid and Honig *et al* (2020)	-	1	UE_5, CO_5, PU_3.
24	Rosell *et al* (2017)	-	17	KM_1, KM_2, UE_1, CO_4, PU_1, PU_2, PU_3, PU_4.	69	Kutvonen *et al* (2014)	1	-	KM_1, UE_2, KM_3, CO_2, CO_5, PU_1.
25	Rahmanzadeh *et al* (2020)	15	16	UE_2, UE_4, CO_6, PU_4.	70	Wilson and Ettlie (2018)	1	0	UE_1,PU_2.
26	Sjödin *et al* (2016)	-	16	UE_1, UE_3, UE_4, PU_3, PU_4.	71	Durmaz*et al* (2021)	0	-	CO_1, PU_3.
27	Sjödin (2019)	14	12	KM_1, UE_1, PU_1, PU_2 PU_4.	72	Meidute-Kavaliauskiene (2021)	0	-	KM_3, CO_1, PU_2.
28	Pohjola and Puusa (2016)	14	11	KM_1, UE_1, UE_4, CO_6, PU_2, PU_4.	73	Rodrigues *et al* (2021)	0	-	KM_3, PU_4.
29	Gilsing *et al* (2016)	-	13	UE_2, CO_6, PU_4.	74	Shmatko*e t al* (2021)	0	-	KM_1, PU_4.
30	Lu *et al* (2017)	-	12	UE_4, UE_5, PU_3.	75	Pokrovskaia *et al* (2021)	0	-	UE_2, UE_4,
31	Bagherzadeh *et al*()	12	11	KM_1, UE_1, PU_2.	76	Yang *et al* (2021)	0	0	UE_5, PU_2.
32	Yoo (2019	11	-	UE_3,CO_5, PU_2, PU_3, PU_4.	77	Salembier *et al* (2021)	0	0	KM_1, PU_2, PU_4.
33	Yström *et al* (2015)	11	-	UE_1, KM_3, UE_4, PU_3.	78	Dai andYang(2020)	0	0	KM_1, KM_3, CO_2, CO_3.
34	Eiteneyer *et al* (2019)	-	11	KM_1,UE_1, UE_4,CO_6, PU_2, PU_4.	79	Santoso *et al* (2020)	0	-	KM_3, KM_3, CO_3, PU_4.
35	Nitzsche *et al* (2016)	9	4	UE_5, CO_2, CO_4, CO_5, PU_2, PU_4.	80	Huang and Wu (2014)	0	-	KM_2,PU_2.
36	Hsieh*et al* (2016)	9	10	KM_3, UE_1, UE_2, UE_5, CO_2, CO_3, CO_4, CO_6, PU_2, PU_3, PU_4.	81	Kuznetsov (2013)	0	-	CO_1,PU_3.
37	Eslami and Lakemond (2016)	-	9	KM_2, UE_4, PU_1, PU_3.	82	Tell (2008)		-	KM_1, KM_2,PU_1.
38	Holmes (2009)	9	6	UE_2, PU_1, PU_2.	83	Tajedin *et al* (2019)	-	0	UE_1, CO_4,PU_3.
39	Yström *et al* (2015)	-	8	KM_1, UE_1, UE_2, CO_6, PU_2, PU_3.	84	Götz and Jankowska (2020)	-	0	KM_3, UE_1, CO_1.
40	Toma *et al* (2018)	7	7	KM_1, KM_2, KM_3,UE_2, CO_1, PU_2, PU_4.	85	Pokrovskaia *et al* (2021)	-	0	KM_3,PU_1, PU_4.
41	Colombo *et al* (2016)	-	7	KM_1,UE_5, CO_6.	86	Li *et al* (2020)	-	0	KM_1, KM_2, UE_1, CO_1, CO_4, PU_1.

42	Hallberg and Brattström (2019)	5	4	KM_1, UE_2, PU_2, PU_4.	87	Brem and Nylund (2021)	-	0	KM_3,PU_1.
43	Guo *et al* (2016)	-	6	CO_2, PU_3, PU_4.	88	Back *et al* (2018)	-	0	KM_1,PU_3.
44	Villasalero (2018)	-	6	KM_3, CO_2, CO_3, PU_4.	89	Baaziz (2019)	-	0	CO_5,PU_3.
45	Wiener (2018)	-	6	KM_1, KM_3, PU_3.	90	Noh and Lee (2020)	-	0	UE_2,PU_2.

***Note**: (S) is the number of citations in Scopus and (W) is in Web od Science.

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