







Beyond Open Innovation: scientific mapping and the synthesis of the Co-innovation process as a new paradigm

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Authors' Notes

We have no conflicts of interest to disclose.

Acknowledgment: Coordination for the Improvement of Higher Education Personnel (CAPES).

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Cite as – American Psychological Association (APA)

Silva, L. M. C., Vieira, K. C., Grützmänn, A., & Prado, J. W. (2024, Mayo/Aug.). Beyond Open Innovation: scientific mapping and the synthesis of the Co-innovation process as a new paradigm. *International Journal of Innovation - IJI*, São Paulo, 12(2), p. 1-73, e24539. <https://doi.org/10.5585/2024.24539>

Abstract

Purpose: Mapping the theoretical framework of publications on Open Innovation (OI) and Co-innovation regarding the concept of value and synthesizing the literature on Co-innovation, seeking the flow of contributions and proposing a research agenda.

Design/Methodology/Approach: A bibliometric analysis and integrative review was carried out through articles, reviews and conference articles published in international databases according to Prado et al. (2016) and Torraco (2016).

Originality: Studies have revisited, refined and criticized OI over the years, whose theoretical field has advanced and debated the emergence of new concepts, such as Co-innovation. However, the discussion about how this new paradigm emerges and dialogues with OI and can be considered an evolutionary theme is still lacking in the literature.

Results: Although publications and temporal trends on Co-innovation have shown to be promising, the highlighted authors did not present temporal extension of their productions and the field is still in constant oscillations. Despite the streams of contributions with important scope in the construction of the paradigm, the theme still needs epistemological discussions for theoretical consolidation.

Theoretical and methodological contributions: This study contributes to epistemological advances on OI and stimulates reflection for discussions and development of contemporary approaches to innovation.

Management contributions: This research presents dimensions and stages of Co-innovation processes with elements that impact its practice. Furthermore, it sheds light on the importance of selecting partners (identifying different actors and their roles in the co-creation process) and establishing adequate mechanisms to encourage client participation.

Keywords: open innovation, Co-innovation, value creation, bibliometric study, integrative review

Para além da Inovação Aberta: mapeamento científico e síntese do processo de Co-inovação como novo paradigma

Resumo

Objetivo: Mapear a conjuntura teórica das publicações sobre Inovação Aberta (Open Innovation-OI) e Co-inovação quanto ao conceito de valor e sintetizar a literatura sobre Co-inovação, buscando o fluxo das contribuições e propondo uma agenda de pesquisa.

Desenho/Metodologia/Abordagem: Realizou-se uma análise bibliométrica e revisão integrativa por meio de artigos, revisões e artigos de conferências publicados nas bases internacionais conforme Prado et al. (2016) e Torracó (2016).

Originalidade: Estudos têm revisitado, refinado e criticado a OI ao longo dos anos cujo campo teórico tem avançado e debatido a emergência de novos conceitos, a exemplo da Co-inovação. Porém, a discussão sobre como esse novo paradigma surge e dialoga com a OI e pode ser considerado um tema evolutivo ainda carece na literatura.

Resultados: Embora as publicações e tendências temporais sobre Co-inovação tenham se mostrado promissoras, os autores destacados não apresentaram extensão temporal de suas produções e o campo ainda está em constantes oscilações. Apesar das correntes de contribuições com abrangências importantes na construção do paradigma, o tema ainda necessita de discussões epistemológicas para consolidação teórica.

Contribuições teóricas e metodológicas: Este estudo contribui para os avanços epistemológicos sobre OI e estimula a reflexão para discussões e desenvolvimento de abordagens contemporâneas de inovação.

Contribuições gerenciais: Esta pesquisa apresenta dimensões e estágios dos processos de Co-inovação com elementos que impactam sua prática. Ademais, lança luz sobre a importância de selecionar parceiros (identificando diferentes atores e seus papéis no processo de co-criação) e estabelecer mecanismos adequados para incentivar a participação dos clientes.

Palavras-chave: inovação aberta, Co-inovação, criação de valor, estudo bibliométrico, revisão integrativa

Más allá de la Innovación Abierta: el mapeo científico y la síntesis del proceso de Co-innovación como nuevo paradigma

Resumen

Propósito: Mapear el marco teórico de las publicaciones sobre Innovación Abierta (Open Innovation-OI) y Co-innovación respecto al concepto de valor y sintetizar la literatura sobre Co-innovación, buscando el flujo de contribuciones y proponiendo una agenda de investigación.

Diseño/Metodología/Enfoque: Se realizó un análisis bibliométrico y revisión integradora a través de artículos, revisiones y artículos de congresos publicados en bases de datos internacionales según Prado et al. (2016) y Torracó (2016).

Originalidad: Estudios han revisado, refinado y criticado la OI cuyo campo teórico ha avanzado y debatido el surgimiento de nuevos conceptos, como Co-innovación. Sin embargo, la discusión sobre cómo emerge este nuevo paradigma y dialoga con la OI y puede considerarse un tema evolutivo aún no se encuentra en la literatura.

Resultados: Si bien las publicaciones y tendencias temporales sobre Co-innovación se han mostrado prometedoras, los autores destacados no presentaron extensión temporal de sus producciones y el campo aún se encuentra en constantes oscilaciones. A pesar de las corrientes

de contribuciones con alcance importante en la construcción paradigmática, el tema aún necesita discusiones epistemológicas para consolidación teórica.

Aportes teóricos y metodológicos: Este estudio contribuye a los avances epistemológicos sobre OI y estimula reflexión para discusiones y desarrollo de enfoques contemporáneos de innovación.

Aportes de gestión: Esta investigación presenta dimensiones y etapas de los procesos de Co-innovación con elementos que impactan su práctica. Además, arroja luz sobre la importancia de seleccionar socios (identificando diferentes actores y sus roles en la co-creación) y establecer mecanismos adecuados para fomentar participación del cliente.

Palabras clave: innovación abierta, Co-innovación, creación de valor, estudio bibliométrico, revisión integradora

1 Introduction

Chesbrough (2003) coined the term "Open Innovation" (OI), which refers to a shift towards more open innovation structures. OI has gained popularity in both public management and academic circles, making it one of the most widely discussed topics in the innovation management literature (Chiaroni, Chiesa, & Frattini, 2011; Huizingh, 2011; Chesbrough, 2012; West, Salter, Vanhaverbeke, & Chesbrough, 2014). This concept has sparked reflections on how innovation can help companies overcome their boundaries and enhance value creation with external entities (West & Bogers, 2014; West et al., 2014). The OI paradigm offers new perspectives and contrasts with the traditional closed approach (Lichtenthaler, 2008). It has been explored in different industries, societies, sectors, and at various levels of government over the last decade (Borges et al., 2016; Pitassi, 2014; West et al., 2014; Gassmann, Enkel, &

Chesbrough, 2010; Yin, Ming & Zhang, 2020). This paradigm shift has become irreversible, as pointed out by Gassmann et al. (2010), and is a significant area of interest for researchers and practitioners alike.

Over time, the concept of OI has been validated, modified, and expanded upon, leading to the development of other ways of exploiting external sources of innovation (West & Bogers, 2014). Co-innovation has emerged as a hot spot in the field of innovation, as a new paradigm in the OI evolutionary literature and in the value creation process (Adomako & Nguyen, 2023; Zhou et al., 2023). In Co-innovation new ideas and perspectives from various sources are integrated into a platform to generate new organizational and shared value (Lee et al., 2012). Co-innovation platforms facilitate co-value creation throughout the innovation cycle and helps increase the performance of new product development processes through the convergence of knowledge from participating organizations (Abhari et al., 2017a; Ozturk, Turker, & Nasir, 2023). While Co-innovation offers multiple benefits to organizations in terms of value creation, it needs to be explored in the field of innovation management since the uncertain and complex nature of AI is also inherent in its processes (Abreu & Urze, 2016; Zhou et al., 2023), leading to confusion among researchers who use the terms synonymously or as a specific form of OI (Romero & Molina, 2011; Ombrosi et al., 2019).

The literature approach to (co-)value creation has changed over time, as it is considered central to the epistemological structure of both OI and Co-innovation. Thus, this study aims to explore the evolution of the Co-innovation paradigm and clarify its context of value creation. The research question guiding this study is: How can we scientifically map studies on (co-)value creation in the evolutionary context of OI for Co-innovation, and how have Co-innovation studies influenced the leveraging of OI? The objective of this article is to analyze the research

front to map the theoretical context of studies on OI and Co-innovation regarding value creation, synthesize existing contributions from Co-innovation studies, and propose a research agenda that streamlines the flow of knowledge in this area.

Co-innovation presents a novel challenge that requires profound changes to relevant rules and represents a promising paradigm for theory. Thus, it is necessary to streamline research flows and provide a structure that illuminates current understandings. Scholars agree that a systemic approach to Co-innovation can provide a more complete understanding of the topic. From a practical perspective, Co-innovation offers organizations multiple benefits, including value creation, growth, maintenance, survival in the market, and increased profitability. This research aims to consolidate existing approaches in the evolutionary literature on OI and Co-innovation for value creation, strengthening this new innovation paradigm.

The study is organized as follows: firstly, we will explore the evolutionary context of open innovation leading up to Co-innovation. Then, we will present the theoretical underpinnings of the Co-innovation paradigm, including its key characteristics and performance scenarios. Next, we will outline our methodology for data collection, treatment, and analysis, as well as present the results and main findings from the research front. Finally, we will reflect on the implications of Co-innovation as a paradigm.

2 Theoretical Background

The traditional approach to business strategy is to prioritize internal competencies and establish barriers to competition. However, with globalization, this approach is no longer sustainable, and companies are turning to alternative approaches to innovation (Rothwell, 1977; Scarbrough, 2003; Chesbrough, 2003; Vrande et al., 2009). Collaborative innovation, a shift from closed innovation, involves partnering with external entities to develop inter-organizational relationships that promote sustained competitive advantage. Open innovation, on the other hand,

involves using both internal and external ideas and pathways to markets. Co-innovation, the latest innovation paradigm, focuses on creating shared value through continuous feedback loops and active customer participation. It is a process that generates an object and has been conceptualized as a strategic innovation management tool by several authors ((Lee et al., 2012).

Lee et al. (2012) defines collaborative innovation as an evolution of closed innovation, driven by the practical openness of the global market and advances in ICTs. Co-innovation strategy, the latest paradigm in innovation, has emerged as a novel approach to co-create value with external entities, including customers. It represents a macro-level shift in the evolution of innovation for value creation, including closed innovation (Innovation 1.0), collaborative innovation or symbiosis (Innovation 2.0), open innovation (Innovation 3.0), and Co-innovation (Innovation 4.0) (Lee et al., 2012; Yin et al., 2020). External entities have been recognized as contributors to innovation in companies, particularly through symbiotic networks that facilitate knowledge exchange (West et al., 2014, Borges et al., 2016, Randhawa et al., 2016).

Co-innovation is a process or configuration of innovation that generates an object, rather than a result itself, according to several authors, including Saragih and Tan (2018). Co-innovation, focused on the creation of shared value, has emerged as a continuous process with feedback effects that provide various competitive values. Companies must understand current innovation strategies and prioritize customer voice in value creation to achieve success (Abhari et al., 2017a). Co-innovative companies have effectively emerged with innovative ideas and cooperation activities, resulting in performance profiles. Studies exemplifying Co-innovation's philosophy and applicability have increased in recent years (Wang et al., 2015). The presented Table 1 shows a set of Co-innovation definitions in chronological order of publication.

Table 1

Definitions of Co-innovation

| AUTHOR | YEAR | DEFINITION |
|-------------------|------|---|
| Lee et al. | 2012 | a new paradigm, where new ideas and approaches from different internal and external sources are aggregated on a platform in order to develop new organizational and shared values. |
| Dawson et al. | 2014 | a form of partnership between companies, suppliers or customers in the co-creation of an innovation, in order to share knowledge, costs and benefits to create unique value for the benefit of its final consumers. |
| Bitzer and Bijman | 2015 | a joint process for the development of an innovation between different actors, covering several levels of the chain and engaging complementary innovations in technology, organization and institutions. |
| Saragih and Tan | 2018 | a shared work of generating innovative and exceptional design conducted by various actors from companies, customers and collaborating partners. |
| Yin et al. | 2020 | a complex collaborative and adaptive network formed by different innovation chains, focusing on innovation activities supported by several innovators, and dealing with the flow of innovation resources, such as data, information, knowledge, capacity, service, etc. |

Source: The authors

3 Methodology

To achieve the aim and objectives of this research, we commenced with a bibliometric study. This method was selected as it can aid in assessing the actual potential of specific groups and/or institutions by quantitatively evaluating the productivity of researchers, groups or research institutions. The study was characterized by quantitative evaluation techniques that measure the diffusion of scientific knowledge and information flow in specific approaches.

The procedures for the collection, processing and analysis of bibliometric data were configured following the research framework for a bibliometric article review in do Prado et al. (2016), which is shown in Table 2.

Table 2

Proposed research framework for the article review

| STAGE | PROCEDURE | DESCRIPTION | |
|-------|---|-------------|--|
| 1 | Operationalization of the research | 1.1 | Choice of scientific base(s) or journals |
| | | 1.2 | Delimitation of the terms that represent the field |
| | | 1.3 | Delimitation of other terms to determine the results |
| 2 | Search procedures (filters) | 2.1 | Title (field term) AND topic (direction) |
| | | 2.2 | Use of Boolean operators AND and OR |
| | | 2.3 | Filter 1: Delimitation in only articles, review and conf. paper |
| | | 2.4 | Filter 2: All years |
| | | 2.5 | Filter 3: All areas |
| | | 2.6 | Filter 4: All languages |
| 3 | Selection procedures (Database) | 3.1 | Download references – Mendeley software |
| | | 3.2 | Download references in spreadsheet format |
| | | 3.3 | Download references for use in the Bibliometrix |
| | | 3.4 | Organization of references in Mendeley |
| | | 3.5 | Organization of analysis matrix in spreadsheet |
| | | 3.6 | Importing data to analysis software |
| 4 | Adequacy and organization of the data | 4.1 | Elimination of duplicate articles in the database |
| | | 4.2 | Elimination of articles through floating reading |
| | | 4.3 | Elimination through the analysis of the polysemy of the terms |
| | | 4.4 | Search for complete articles in .pdf |
| 5 | Analysis of the Research Front (Research front) | 5.1 | Analysis of temporal trends regarding the volume of publications and citations |
| | | 5.2 | Analysis of the authors and their productions |
| | | 5.3 | Analysis of the journals that published the most |
| | | 5.4 | Analysis of countries and affiliations of selected articles |
| | | 5.5 | Analysis of the most cited studies and references |
| | | 5.6 | Keyword analysis |
| | | 5.7 | Analysis of publication categories |

Source: Adapted from do Prado et al. (2016)

In this phase, data were collected from Elsevier’s Scopus database. Scopus was chosen because it has broad data coverage (more than 20,000 national and international scientific journals) and diverse metadata, e.g., those on authors, affiliations, bibliographic information, journals, countries, and languages (Mugnaini, Fujino, & Kobashi, 2017).

The search was performed by mining articles, reviews and conference papers on the Scopus web platform; these were queried using terms and specific locations according to the

following string: (TITLE ("co-innovation*" OR coinnovation OR "open innovation") AND ALL ("value co-creat*" OR "co-creat* value" OR "value creat*" OR "creat* value" OR "value generat*" OR "generat* value" OR "value development" OR "develop* value" OR "value production" OR "produc* value" OR "value innovation*")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "re")).

Based on the search string, data collection was performed on 01.10.2022, and a total of 980 documents were initially selected. Of these, 122 were excluded after refinement by document type, leaving 858 documents—800 referring to OI and 58 to Co-innovation.

Regarding our data treatment and analysis, as described in Table 2, after collection, the data were exported to Mendeley and Bibliometrix software to organize the references and perform the necessary analyses. This analysis focused on the research front, highlighting the temporal trends in each theoretical context of OI and Co-innovation in terms of publication and citation value, the set of producers and the products generated.

In the next phase of the research, we conducted an integrative review following Torracco (2016) approach. This involved a thorough analysis of the focal literature, including critical synthesis and identification of new insights, to review the evolution of the topic within the field, particularly emerging trends. The review focused on the conceptual framework of Co-innovation, taking into account the primary contributions of relevant studies, and identified potential avenues for future research.

This methodological approach started with the location of each publication, i.e., the selection of databases Ebsco, Oxford Academic, Sage Journals, Scopus, Springer, Web Of Science (WOS) e Wiley Online Library. The selection of databases was motivated by the quantitative relevance of their content; these databases contain numerous high-quality qualitative

studies and scientific articles in the social sciences and subareas of business administration, public administration and accounting.

As part of the study collection process, the term “co-innovation” or the co-innovation terms contained in titles were queried along with at least one of the terms "value co-creat*", "co-creat* value", "value creat*", "creat* value", "value generat*", "generat* value", "value development", "develop* value", "value production", "produc* value" ou "value innovation*", contained in the body of each document. The inclusion of this refinement by title using co-innovation terms ensured that the queried studies were completely relevant to both our subject and research question.

We examined several databases and found that only Scopus (65 documents), WOS (10 documents), and Springer (43 documents) contained studies that met our selection criteria, resulting in a total of 118 documents. After refining the results by considering only articles, conference papers, and reviews in the final stage of publication, we excluded 59 of the initial 118 documents, leaving 59 for further processing.

To select the sample studies, we applied our established criteria, which involved excluding documents that were irrelevant to our research question, not available online, duplicates (selecting only the most recent and complete version), incomplete or unrevised documents such as technical reports, expanded abstracts, presentations, or books, and documents lacking an alphabetic writing system such as an abjad, abugida, syllabary, or logograph.

We performed the selection process in three steps: Step 1 - reading titles, abstracts, and keywords (which led to the exclusion of 23 studies), Step 2 - reading the introduction and conclusion (which excluded 2 studies), and Step 3 - reading the full articles (which excluded 2 additional studies). As a result, we selected 32 out of the 59 documents for review. For our data

analysis, we combined and synthesized the studies based on their themes using the hermeneutics approach, as outlined in Bengtsson's (2016) content analysis method.

4 Results and Discussion

To begin with, we will present the analysis of the selected studies related to the Research Front, taking into account the bibliometric context of Open Innovation (OI) and Co-innovation. First, we will present general data on scientific production and the average citations per year. Then, the results will be organized into two dimensions: one regarding the set of producers (authors, journals, affiliations, and countries) and another regarding the set of products (documents, keywords, and citation coupling). After presenting the overview of Co-innovation studies in comparison to OI, we will delve into the nature of Co-innovation by synthesizing the studies, discussing their contribution flows, and proposing future research directions.

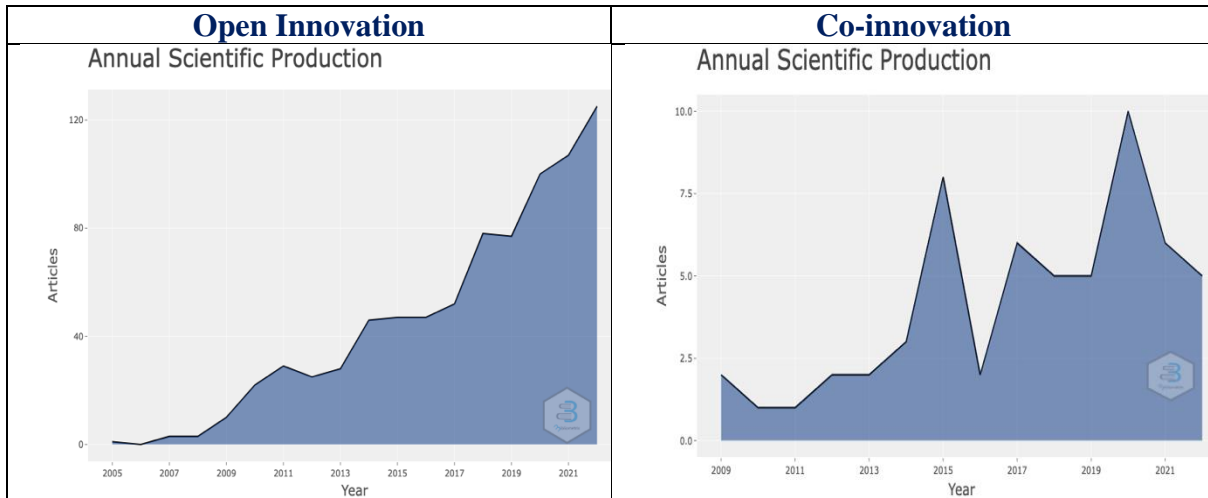
4.1 Analysis of the Research Front

The major documents concerning OI comprise 330 publications published between 2005 and 2022. Concerning the types of documents we selected, 607 were articles, 154 were conference papers and 39 were reviews. On the other hand, 52 documents referring to Co-innovation were published from 2009 to 2022. Our analysis of Co-innovation involved 35 articles, 19 conference papers and 4 reviews.

Figure 1 displays the volume of publications over time corresponding to the two themes. The annual scientific production of OI research shows an average of 4.26 publications per year. Although the first publications occurred in 2005, in 2009, their volume began to increase significantly. In 2006, there were no publications; although there were some fluctuations, e.g., a reduction between 2012 and 2013, the volume of publications continued to be promising. Indeed, 2022 is the most active year, with a total of 125 publications.

Figure 1

Annual scientific production



Source: Research data

In terms of Co-innovation, the annual scientific output associated with this concept averages 4.66 publications, which is higher than that of OI. However, the selected studies on Co-innovation have shown significant fluctuations since their publication debut in 2009. The most significant peaks were observed in 2015 with 8 studies and in 2020 with 10. However, these peaks were always followed by a significant decrease. For instance, in 2016, the number of published studies decreased significantly to only 2, and in 2021, it decreased to 6. Thus, the field of Co-innovation research appears to be unstable and requires further research for its consolidation. However, since Co-innovation is a relatively novel topic in the field of innovation, these fluctuations can be interpreted as a temporal process of validation and/or theoretical dissemination.

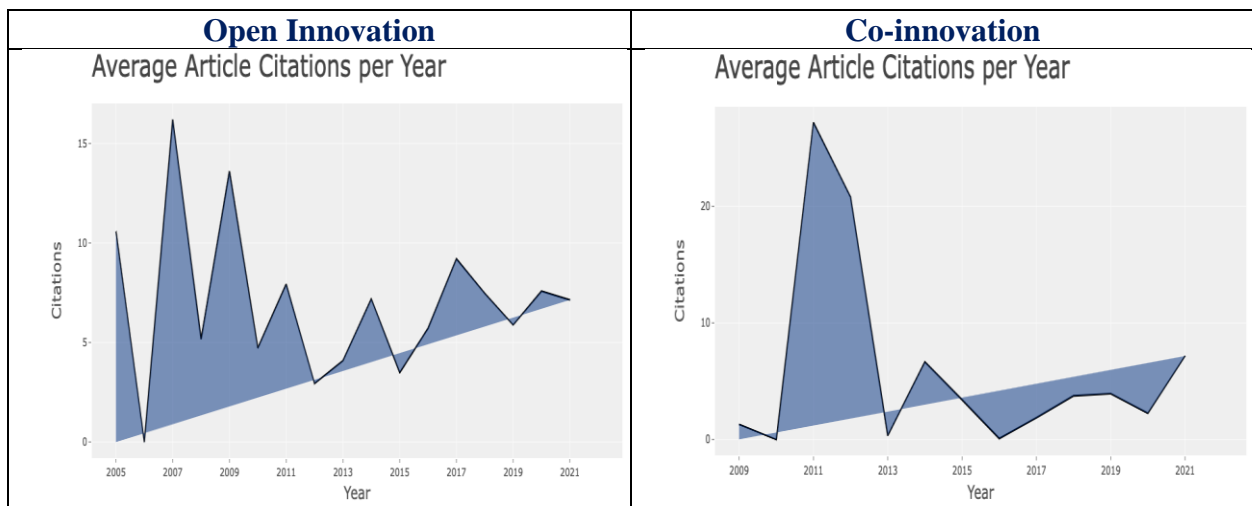
In summary, Figure 1 shows that while publications related to OI have shown a clear increase over time, those related to Co-innovation have exhibited a drop in recent years. Even though the present study was conducted in 2022, when the previous year (2021) is taken as a

reference, there has been a significant decrease in Co-innovation publications. Hence, despite over a decade of published studies, research on Co-innovation still lacks consistency.

Regarding the average number of citations per year, Figure 2 shows the results of our analysis of the citations of the selected articles over time.

Figure 2

Average number of citations per year



Source: Research data

Among the selected OI studies, the average number of citations per document is 28.11, and the average number of citations per year is 4,651. Although Kirschbaum (2005) authored the first published study, with 17 citations per year, the average annual number of citations per document peaks in 2007 and 2009. Here, the seminal articles Enkel, Gassmann and Chesbrough (2009) and Chesbrough and Appleyard (2007) explore the phenomenon of OI and discuss it from the perspective of strategy. Among the years with significant fluctuations, the years 2012, 2013 and 2015 show decreases in the average number of citations per year.

Regarding the field of Co-innovation, the average number of citations per document is 23.95 and the average number of citations per year is 3,227. Unlike OI, the initial studies in this

field are the most frequently cited: these studies include Romero and Molina (2011), which concerns value Co-innovation in the network era, and a seminal article Lee et al. (2012) that applies a theoretical argument to the implementation of Co-innovation involving convergence, collaboration and cocreation for organizational value—and thus creates a new paradigm of OI. Significant oscillations are evident in 2010 and 2016.

While 2012 witnessed the lowest average citations for OI, it was also the year with the highest average citations for Co-innovation, especially due to Lee et al. (2012). Accordingly, the proposal of the Co-innovation paradigm likely arose at an opportune moment; indeed, the weakening of OI discussions, represented by a drop in the average number of citations, provided a field favourable to advances, new approaches and new theoretical perspectives.

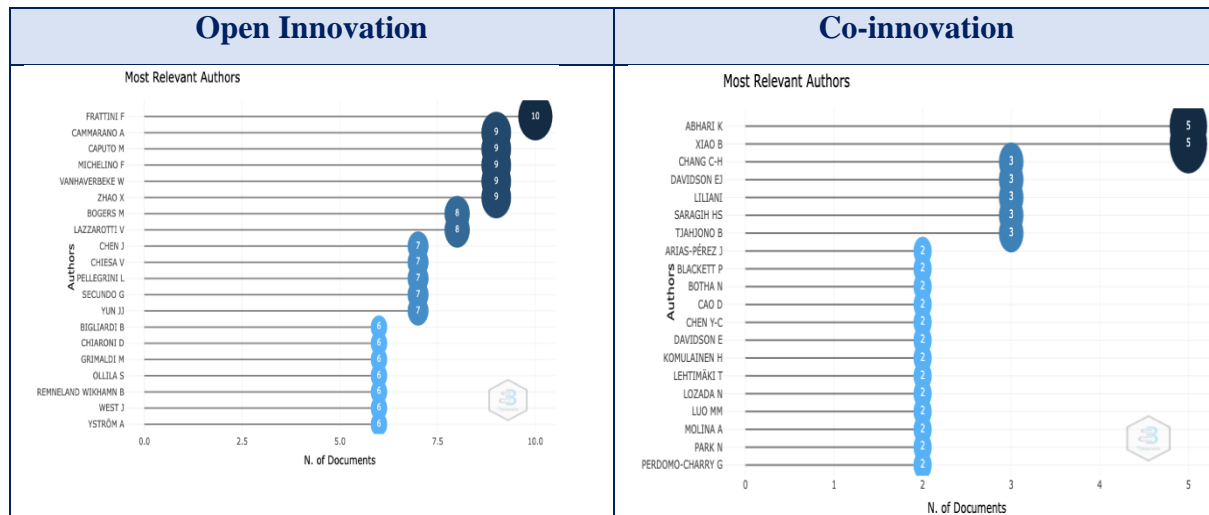
4.1.1 Set of producers: Analysis of authors, journals and countries

Figure 3 presents the top 20 most relevant authors in the focal topics. In the field of OI, Frattini stands out with authorship in 10 articles, followed by Cammarano, Caputo, Michelino and Vanhaverbeke, each with 9 studies to their credit.

In the field of Co-innovation, the 20 most relevant authors include Abhari and Xiao with 5 publications each, as well as Davidson, Chang and Saragih with 3 each. Notably, Abhari, Xiao and Davidson have collaborated on scientific production related to this subject.

Figure 3

Analysis of the most relevant authors



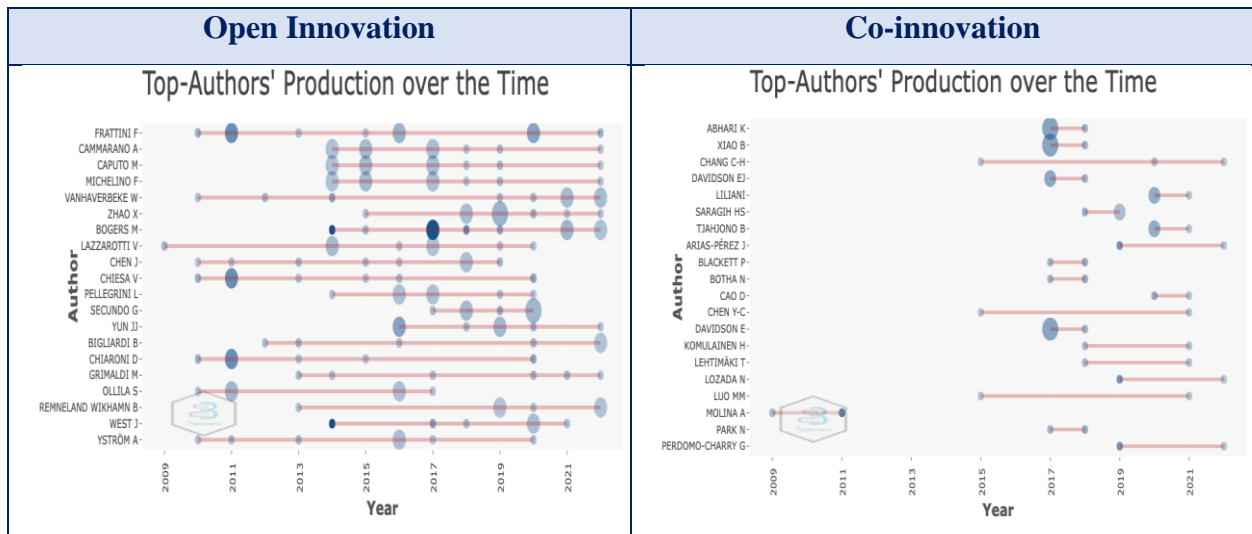
Source: Research data

We also sought to assess the production of these authors over time (Figure 4). Thus, among the OI authors, Frattini F. with his 10 studies and Vanhaverbeke with his 9 have the longest period of publication (from 2010 to 2022).

Interestingly, although the production time of Borges and West is relatively short (Borges from 2014 to 2022 and West from 2014 to 2021), since 2014, their reviews of OI in terms of the use of external entities for innovation have been the most significant over time, with a total of 120 yearly citations. In addition, Borges in partnership with other authors, also stands out due to a 2017 study on OI assessing the established and novel perspectives in the field, with 82.3 citations per year. Therefore, Borges and West have the highest citation peaks over time.

Figure 4

Analysis of authors' production over time



Source: Research data

In view of this fact, the importance of partnerships in the development of studies and discussion on consolidation themes and new research perspectives on certain theoretical approaches is observed and, above all, the attention to a more critical look at the continuity of productions of the intellectual body of theoretical approaches over time.

Regarding Co-innovation, Chang has the longest publication duration (from 2015 to 2020), with only 3 studies. Although not considered a highlight, the authors with greater citation strength are Molina with 24,917 citations per year, and Arias-Pérez, Lozada and Perdomo-Charry, each of whom have 9,750 citations per year, all in 2019.

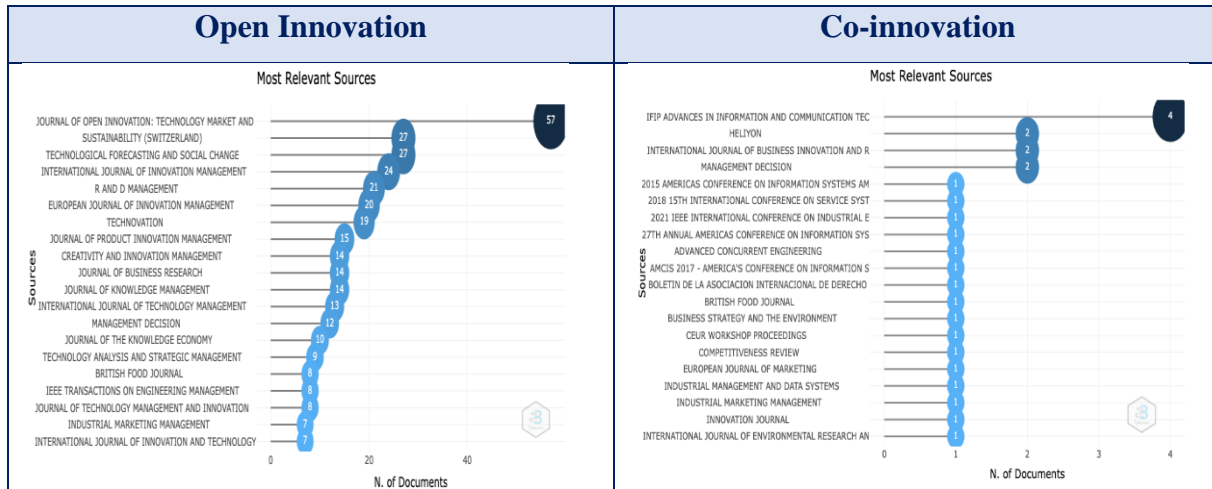
Figure 4 suggests that the Co-innovation authors do not prolong their studies; many appear with only two publications. This result is worrisome because the nonoccurrence of relevant publications can compromise the maintenance and strengthening of the topic in the literature.

Notably, the relevant authors (Figure 3) for Co-innovation have not demonstrated any production over time. Although Abhari and Xiao published 5 studies between 2017 and 2018, they have not continued to research Co-innovation.

Figure 5 illustrates the 20 most relevant publication outlets in terms of the number of publications. Thus, for OI, the Journal of Open Innovation: Technology, Market and Complexity stands out with 57 studies. Sustainability and Technological Forecasting and Social Change have 27 each, the International Journal of Innovation Management has 24, and R&D Management has 21.

Figure 5

Analysis of the most relevant journals



Source: Research data

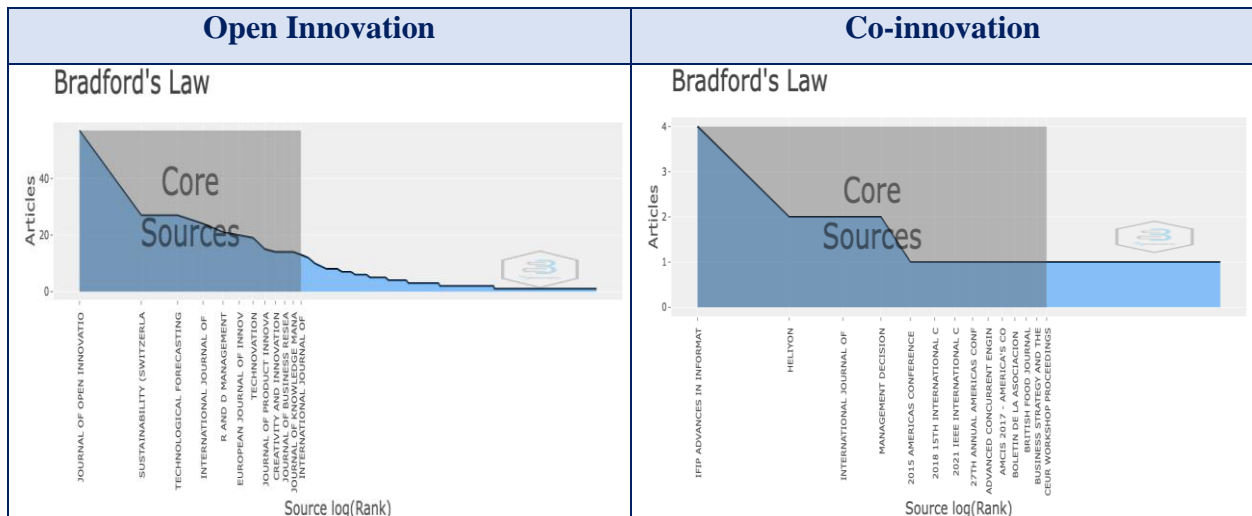
For Co-innovation, IFIP Advances in Information and Communication Technology has 4 publications; moreover, Heliyon, the International Journal of Business Innovation and Research and Management Decision have 2 publications each.

Regarding our two themes and the journals that have published the most documents (Figure 5), for OI, the Journal of Open Innovation: Technology, Market and Complexity stands out, as its scope and theme are entirely focused on OI. This result highlights the relevance of OI for both the consolidation of the topic and the demand represented by the scientific interest in relevant publications.

Figure 6 illustrates Bradford’s Law for the most active journals in terms of their productivity. The clustering of both OI and Co-innovation publications shows 3 areas of activity—zone 1 and its respective journals comprise the core of the publications on the topics, where 12 journals are the most relevant for OI and 14 for Co-innovation.

Figure 6

Analysis of the grouping of journals according to Bradford’s Law



Source: Research data

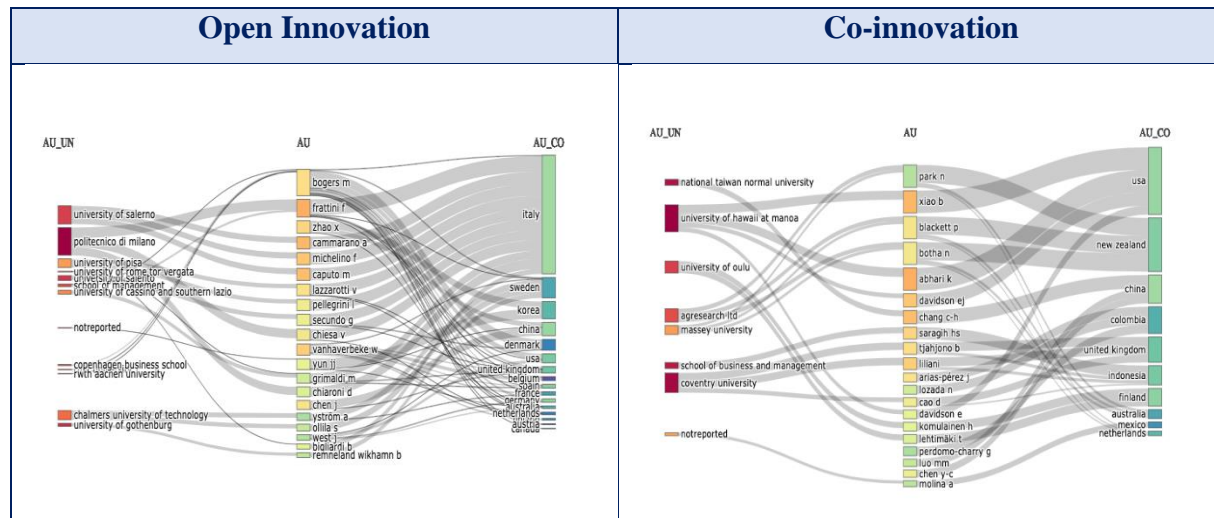
On the other hand, while for OI, the presence of stronger journals is noteworthy, for Co-innovation, most journals in zone 1 offer only one published study on the subject. Therefore, it is

difficult to identify the journals with greater strength because the relevant publications are distributed in a very dispersed manner.

Finally, we analysed the locations of the production of the set of relevant publications. To better delineate the work of researchers outside their own countries, production was also analysed in terms of affiliation. Thus, Figure 7 graphs the three fields with the most relevant interrelationships of affiliations, authors and countries.

Figure 7

Analysis of authors, affiliations and countries



Source: Research data

For OI, Italy, Sweden, Korea, China and Denmark stand out. The authors of the studies produced in Italy are mostly affiliated with the University of Salento and the Politecnicianus of Milan. Borges who was already noted for his relevance and production over time (Figures 3 and 4), is affiliated with 4 institutions and active in 13 countries. Such breadth in activity can generate benefits related to diverse networking and insights from different perspectives, which may justify the positive performance of this author relative to those who conducted other relevant studies.

Regarding Co-innovation, the three-point graph shown in Figure 7 shows countries and affiliations that are quite different from those corresponding to OI. The most active countries in terms of relevant authors are the United States, New Zealand, China, Colombia and the United Kingdom. The highlighted affiliations include the following universities: University Of Hawaii at Manoa, Coventry University, and Massey University and Agresearch Ltd. China, however, is active in both fields. In contrast, the affiliations related to Co-innovation are rather distributed, with only Hawaii being moderately highlighted.

Therefore, based on our results regarding the set of authors, notably, in the case of Co-innovation, the most relevant authors work together. However, regarding these authors' production over time, there is a lack of support for the theme—the featured authors have not presented a temporal extension of their work.

On the other hand, regarding the performance of the most relevant journals, OI stands out due to journals with an editorial scope entirely focused on the subject. From the perspective of Bradford's Law, 14 journals make up the central axis of the sources of publication on Co-innovation, and there is significant dispersion.

Finally, concerning affiliations and countries, which are represented by our graph of the three fields, the most important countries are Italy and Sweden for OI and the United States and New Zealand for Co-innovation. This finding points to a strong continental mix of research on the concepts, which may suggest a need for a research agenda that explores the characteristics of their performance in greater depth.

4.1.2 Product set: Analysis of documents, keywords and citations

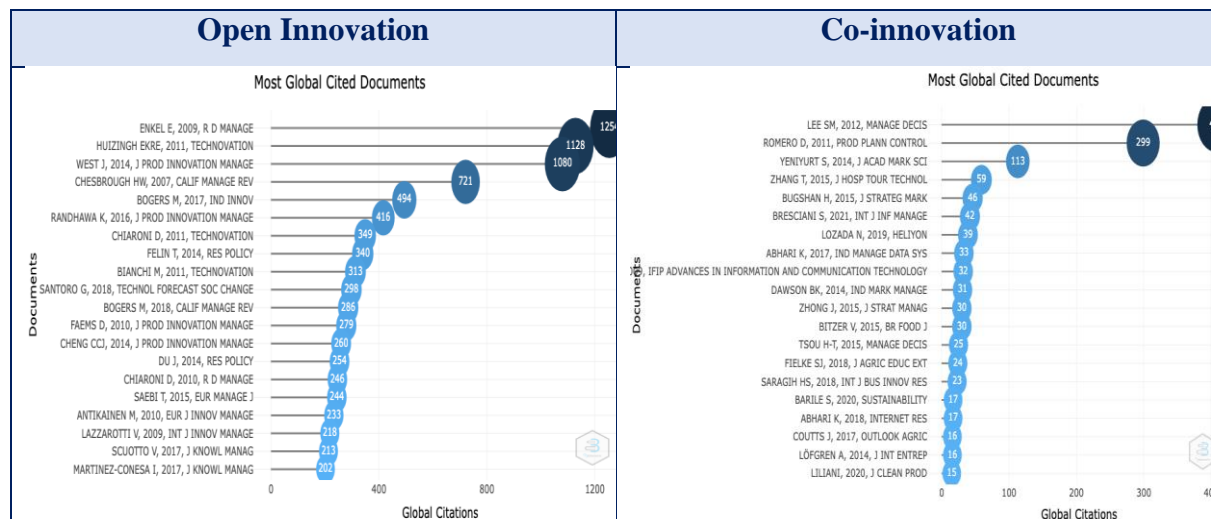
Based on the results presented in the articles themselves, as well as their respective citations and keywords, Figure 8 shows the top 20 most cited studies globally. In the field of OI, the most frequently cited studies include Enkel et al. (2009) with 1254 citations, Huizingh (2011)

with 1128 citations, West and Bogers (2014) with 1080 citations, Chesbrough and Appleyard (2007) with 721 citations, and Bogers et al. (2016) with 494 citations. Other authors whose studies stand out in terms of both their number of citations and current production have sparked new discussions on OI. Scuotto et al. (2017) and Martinez-Conesa et al. (2017) explore OI approaches in small and medium enterprises, while Santoro et al. (2018) discuss OI in terms of knowledge management and the Internet of Things.

Regarding Co-innovation, Lee et al. (2012) is the most frequently cited study with 408 citations. This seminal article identifies Co-innovation as a novel post-OI paradigm. Other studies that stand out include Romero and Molina (2011) with 299 citations, Yenyiyurt et al. (2014) with 113 citations, Zhang, Kandampully and Bilgihan (2015) with 59 citations, and Bugshan (2015) with 46 citations. However, it should be noted that many studies are cited not because they use Co-innovation as a new paradigm, but rather because they use the term as a synonym for OI or to refer to a specific form of OI, such as in Romero and Molina (2011).

Figure 8

Analysis of the most cited studies



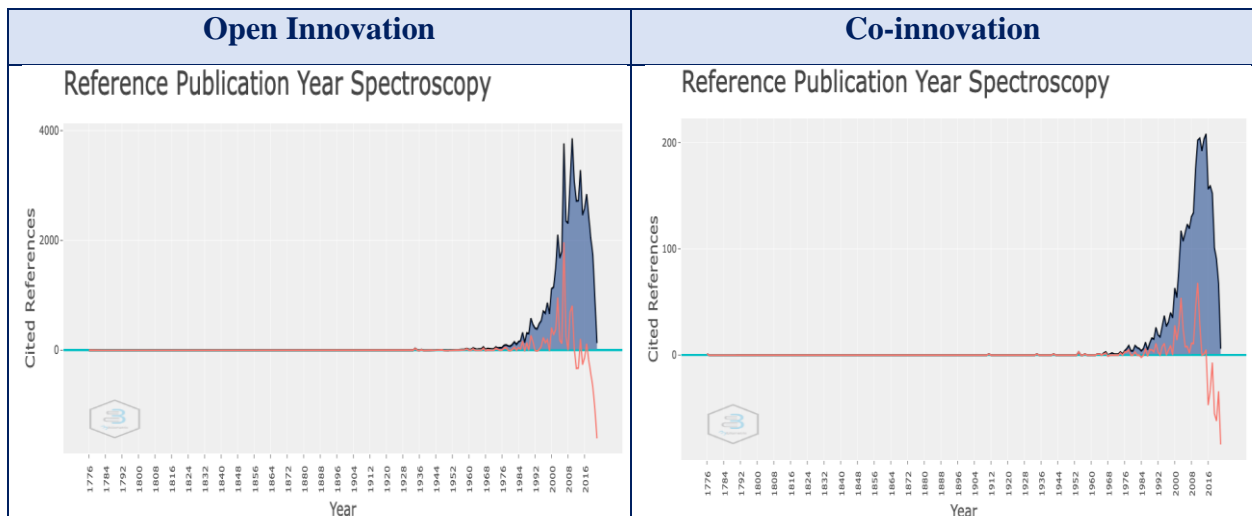
Source: Research data

Recent studies that stand out among the 20 most cited documents on Co-innovation are those of Bresciani, Ciampi, Meli and Ferraris (2021), who evaluates the use of big data for Co-innovation processes; Barile, Grimaldi, Loia and Sirianni (2020), who addresses innovation in ecosystems and proposes sustainable Co-innovation; and Liliani, Tjahjono and Cao (2020), who investigates Co-innovation from the perspective of supplier-customer collaboration.

Offering a better analysis of the performance of these articles through a longitudinal illustration of reference spectroscopy, Figure 9 illustrates how one of the references has been cited over time and the peaks of the studies that have been significant in this process.

Figure 9

Reference Spectroscopy Analysis



Source: Research data

For OI, in terms of time, the references cited include studies from 1776 (with 2 citations), i.e., the research of Smith (1776). In addition, the following years stand out as prominent years: 2003 with 2106 references, which mostly correspond to the seminal research of Chesbrough on “the era of open innovation”; 2006 with 3766 references, including the studies of Laursen and Salter (2006) and Chesbrough and Crowther (2006) with 92 and 57 local citations, respectively;

and 2010, the final peak, with 3858 references, including the study by Dahlander and Gann on the extent to which innovation is open.

The time frame of the references cited for Co-innovation also begins in 1776 with the study of Smith (1776); that is, both topics are rooted in the same economic work. In turn, regarding the time frame of the published references, the years to highlight are 2003 with 117 citations and 2011 with 202 citations. In 2003, Chesbrough (2003) seminal article on OI stands out—this is to be expected, given that this is when Co-innovation emerged as a promising successor to OI. In 2011, Baldwin and Von Hippel (2011) and Romero and Molina (2011) discussed collaborative innovation and the initial approaches to Co-innovation. These results of our reference spectroscopy on co-innovation are consistent with those of Lee et al. (2012) and Yin et al. (2020), tracing the four shifts of the innovation paradigm towards value creation—from closed innovation to collaborative innovation, then to OI, and now, to the Co-innovation paradigm.

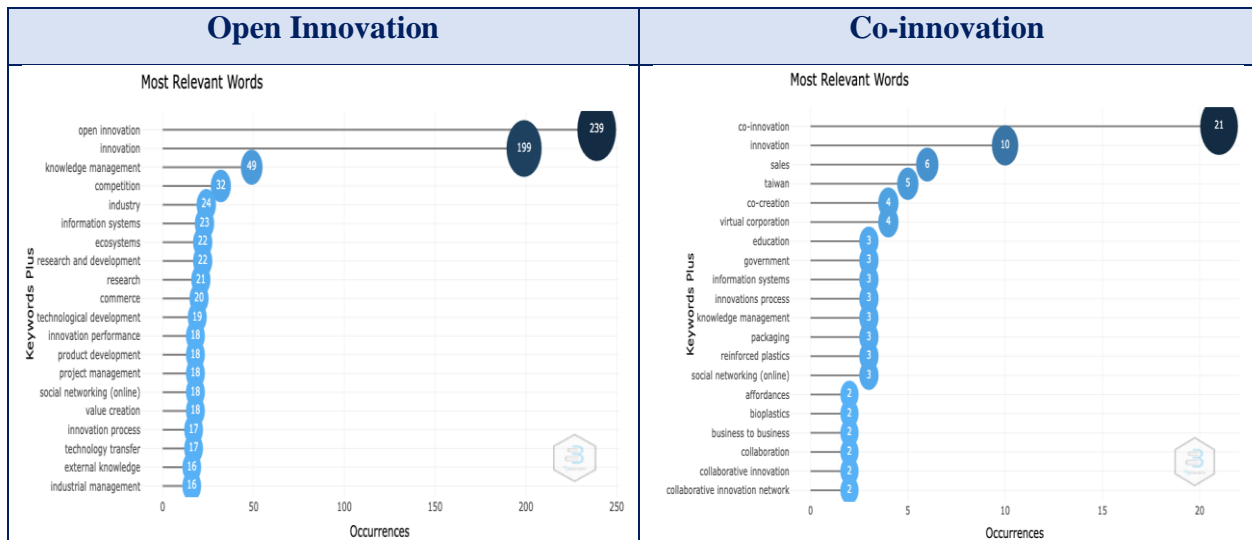
Finally, regarding the set of products, we analysed the most relevant keywords (see Figure 10) by considering their occurrence in the selected studies. For OI, of course, the most frequent words are “open innovation” and “innovation”, with 239 and 199 occurrences, respectively. However, some words are notably pertinent to the evolutionary context of OI with respect to Co-innovation; thus, “knowledge management” has 49 occurrences and “ecosystem” 22.

For Co-innovation, the terms “Co-innovation” (21) and “innovation” (10) appear to be the most cited. Additionally, “cocreation” (04), “knowledge management” (03) and “collaborative innovation” (02), which form part of the conceptual structure of Co-innovation,

are also observed. The presence of words focused on virtual scenarios, such as “virtual corporation” (04), “information systems” (04) and “online social networks” (03), is also noted.

Figure 10

Analysis of the most relevant keywords



Source: Research data

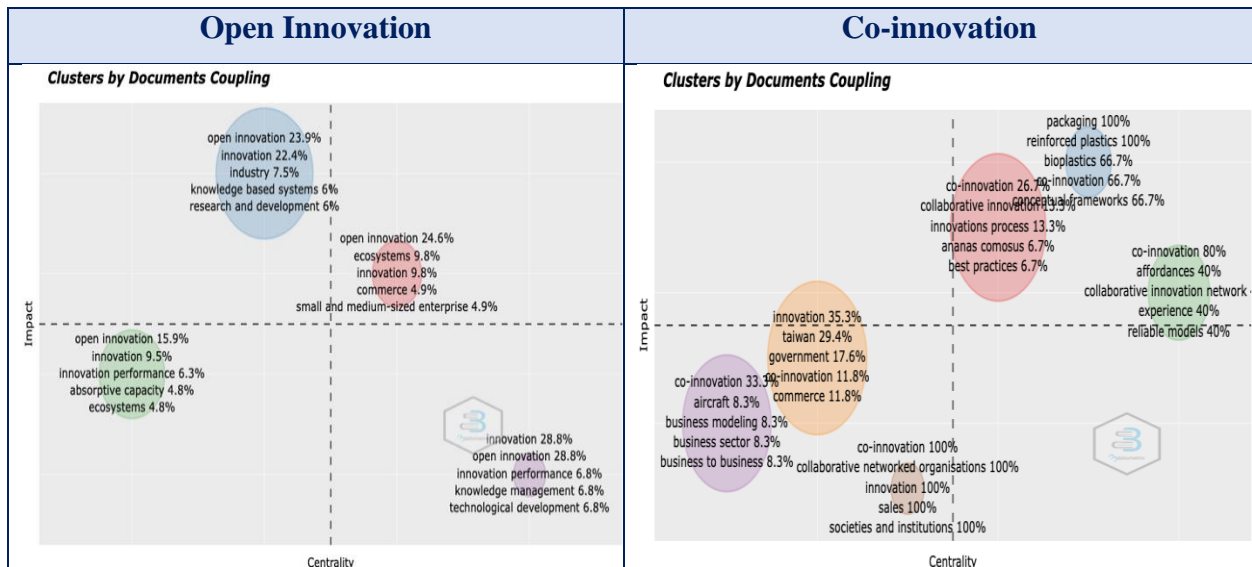
To enhance our final analysis of the documents and their content, we created a coupling map (Figure 11) based on references and impact on global citation score. The documents were considered units of analysis, and the five most significant keywords were used as cluster labels based on the entire sample studies.

For the field of OI, the coupling of the documents resulted in four clusters. Cluster 1 highlighted "ecosystems", "trade", and "small and medium-sized enterprises", with significant frequency, centrality, and impact. Recent publications from 2015 to 2022 were also present, with studies by Borges et al. (2016) standing out in terms of local citations. Cluster 2 contained the words "industry", "knowledge-based systems", and "research and development" and had the highest frequency and impact, particularly with studies by West et al. (2014) and Randhawa et al. (2016), despite its low centrality.

Cluster 3 contained words like "innovative performance", "absorption capacity", and "ecosystems", with moderate frequency, lower centrality, and impact than other groups. Studies by Hossain (2016) and Zhu (2019) are examples of this cluster. Cluster 4 had the lowest frequency and impact and contained "innovative performance", "knowledge management", and "technological development." Centrality was the most relevant factor in this group, with studies by Huizing (2011) and Obradovic (2021) being the most prominent.

Figure 11

Analysis of the coupling map



Source: Research data

According to these results, for OI, the topics focused on knowledge management, innovation systems and ecosystems, and small and medium enterprises have the greatest impact on citations, and they are extensively discussed in the OI literature.

Moreover, six clusters were created for the field of Co-innovation. For cluster 1, which has a medium impact, centrality and frequency, as well as the words “collaborative innovation” and “innovation process”, stand out. In cluster 2, which has a low frequency and moderate

centrality but a greater impact than all the other clusters, "conceptual frameworks" stands out as the strongest keyword.

In turn, the impact and frequency of cluster 3 are moderate, but the centrality of this cluster is the highest of all; the highlighted words are "collaborative network innovation" and "reliable models". On the other hand, the centrality of cluster 4 is the lowest; moreover, its impact is low, and its frequency is moderate. Nevertheless, the words present dialogue from different perspectives, such as "business modelling" and "business to business". Corroborating this new line of discussion, cluster 5 stands out in its presentation of "government" as a keyword. Its frequency is the highest, although its impact and centrality are moderate to low.

Finally, cluster 6, despite having a moderate level of centrality, has the lowest impact and frequency; "collaborative network organizations" and "societies and institutions" are emphasized in its documents.

In general, the scores of local citations on the Co-innovation coupling map are notably higher in clusters 1, 5 and 6, with Lee et al. (2012), Romero and Molina (2011), Yenyurt et al. (2013) and Zhang et al. (2015) being the strongest. In addition, although "Co-innovation" is present in all clusters, many of the words identified in this analysis of Co-innovation comprise important nomenclature in the empirical context under study with few connections and theoretical contributions; for example, these include "ananas comosus" in cluster 1, "reinforced plastics" and "bioplastics" in 2, and "aircraft" in 4.

Based on our results regarding the set of products, regarding the evolutionary context with respect to OI for Co-innovation, we found that only 3 of the most relevant studies on Co-innovation have a significant number of citations. Our reference spectroscopy corroborated the

progress of OI and the reference peaks of the publications on Co-innovation from 2003 to 2011, demonstrating and reinforcing that this field of study is still in constant oscillation.

Regarding our analysis of the keywords and coupling map, “knowledge management” is among the most relevant keywords for both OI and Co-innovation is, and this result reinforces the importance of processes related to value creation in organizations. In turn, the coupling map reveals the terms and objectives of studies with great impact, frequency and centrality; e.g., for OI “knowledge management”, “systems” and “innovation ecosystems” are the constituent terms in the cluster with the greatest impact, and for Co-innovation, “conceptual landmarks” has the greatest impact.

4.2 Overview of the Co-innovation approach: Past, present and future

Based on our bibliometric results, we synthesized the studies on Co-innovation, including their contributions. We therefore identified seven contribution streams (Table 3).

Table 3

Conjuncture of studies on Co-innovation

| Contribution flows | Investigated approaches | Representative studies |
|---|---|---|
| Theoretical-methodological framework | Core and structural and functional elements of Co-innovation | Lee et al. (2012); Bitzer and Bijman (2015); Abhari, Davidson and Xiao (2017c); Fielke et al. (2017); Saragih and Tan (2018); Zhang, Ni and Tang (2018). |
| | Principles of Co-innovation | Coutts et al. (2017). |
| | Analysis instruments and indicators | Abhari et al. (2017a); Abhari, Davidson and Xiao (2017b); Abhari et al. (2017c); Abhari, Davidson and Xiao (2018). |
| | Conceptual ramifications | Vollenbroek, Constantinides and Vries (2013); Wang et al. (2015). |
| Processes and practices | Dimensions of the Co-innovation process | Saragih, Simatupang and Sunitiyoso (2019); Barile et al. (2020); Klimas and Czakon (2022). |
| | Stages of the Co-innovation process | Chen, Kang, Liu and Sun (2020); Liliani et al. (2020). |
| | Co-innovation drivers | Vollenbroek et al. (2013); Bugshan (2014); Hsiao, Yang, Wang and Hajli (2015); Tsou, Cheng e Hsu (2015); Zhang et al. (2015); Zhang et al. (2018); Chen et al. (2020); Li Liphong, Qin and Gu (2020). |
| | Perceived risk of Co-innovation | Abhari et al. (2017b); Abhari et al (2018). |
| Actors and their relationships | Main actors | Yeniyurt et al. (2013); Zhang et al. (2015); Wang et al. (2015); Qiu and Fan (2016); Liliani et al. (2020); Klimas and Czakon (2022). |
| | Experiential value of Co-innovation | Qiu and Fan (2016); Abhari et al. (2017c); Abhari, Xiao and Davidson (2017d); Lehtimäki, Komulainen, Oinonen and salo (2018). |
| Networks and Ecosystems | Co-innovation networks | Abhari et al. (2017d); Wang et al. (2015). |
| | Context of Systems and Ecosystems | Wang et al. (2015); Zhong and Nieminen (2015); Barile et al. (2020); Klimas and Czakon (2022). |
| Digital/online field | Use of big data, artificial intelligence and cognitive computing | Lozada, Arias-Pérez and Perdomo-Charry (2019); Chen et al. (2020); Bresciani et al. (2021); Ciasullo, Montera and Douglas (2022). |
| | Online/Virtual Communities and Social Media Platform | Vollenbroek et al. (2013); Bugshan (2014); Hsiao et al. (2015); Zhang et al. (2015); Zhang et al. (2018); Li et al. (2020). |
| Sustainable perspective | Sustainable Co-innovation | Barile et al. (2020). |
| | Green Co-innovation | Chang (2020); Liliani and Tjahjono (2020); Liliani et al. (2020). |
| Segmentation by activity and size | Primary innovation and agricultural and agri-food innovation system | Bitzer and Bijman (2015); Fielke et al. (2017); Coutts et al. (2017). |
| | Small Business Resilience | Ciasullo et al. (2022). |

Source: the authors

According to Table 3, the first group of contributions concerns the theoretical and methodological framework of Co-innovation. These studies are characterized by approaches focused on the core, structural and functional elements and principles that shape Co-innovation and the development of analysis instruments and indicators with novel conceptual ramifications.

To develop the concept of Co-innovation, which was previously limited to managerial thinking about innovation (Bitzer & Bijman, 2015), some authors, e.g., Lee et al. (2012) and Saragih and Tan (2018), in particular, have explored the philosophical underpinnings of Co-innovation to contribute theoretically to its analytical pillars via a better conceptualization and development of its main elements. Thus, in addition to the conceptualization itself, whose facets, exposed by our framework, can be seen in Table 1, we highlight the definition of the platform as the core element of Co-innovation.

The platform is a virtual environment where authors can contribute to value creation via new ideas and solutions, providing a variety of resources, functions and technology while transmitting information to facilitate the correspondence between product attributes and consumer preferences (Lee et al., 2012; Abhari et al., 2017c; Zhang et al., 2018). In short, the platform, as the core, should include engagement, cocreation and convincing experiences for value creation (Lee et al., 2012).

Concerning these platforms, authors point to elements that characterize Co-innovation, which we define as structural and functional elements. Regarding the structural elements, we have considered components that are inserted into a context and are responsible for Co-innovation. Some authors, such as Lee et al. (2012), Bitzer and Bijman (2015), Abhari et al. (2017a), and Saragih and Tan (2018), have described these components based on the dimensions

of Co-innovation. Thus, to advance the initiatives of Saragih and Tan (2018), Table 4 below lists the main structural elements that we call the “6 Cs of Co-innovation”.

Table 4

The 6 Cs of Co-innovation

| | Dimensions | Description | Authors |
|---|-------------------|--|---|
| 1 | Convergence | Value creation through new products/services/ventures, processes and business models. | Lee et al. (2012); Saragih and Tan (2018). |
| 2 | Collaboration | Multi-actor character of the innovative process, where each actor brings specific knowledge and resources, in a shared purpose. | Lee et al. (2012); Bitzer and Bijman (2015); Abhari et al. (2017a); Saragih and Tan (2018). |
| 3 | Co-creation | It includes the wide range of possible actions from submitting a new solution to an organizational problem to suggesting a new product feature through cooperative work with all interested parties, especially customers. | Lee et al. (2012); Abhari et al. (2017a); Saragih and Tan (2018). |
| 4 | Complementation | Intelligent combination of technological, organizational and institutional innovation. | Bitzer and Bijman (2015); Saragih and Tan (2018). |
| 5 | Coordination | Adjustments and changes across the chain to make innovation at one stage of the chain a success. | Bitzer and Bijman (2015); Saragih and Tan (2018). |
| 6 | Communication | Related to the creation and demonstration of the image and socio-professional identity of the actors. | Abhari et al. (2017a). |

Source: the authors

Table 4 shows that the 6 Cs of Co-innovation cover a broad range of phenomena, including the convergence of ideas, collaborative arrangements, and the co-creation of experiences with stakeholders within a complementary and coordinated context, while ensuring effective communication among the actors involved (Lee et al., 2012; Bitzer & Bijman, 2015; Abhari et al., 2017a; Saragih & Tan, 2018).

Functional elements also play a significant role in Co-innovation. Fielke et al. (2017) developed a practical conceptual model, which emphasizes the importance of networks in value creation, explicit understanding of motivations, the capacity and legitimacy of the entire network, and the existence and diffusion of knowledge to reach a mutual agreement on the desired results.

Furthermore, Coutts et al. (2017) identified nine principles for successful implementation of Co-innovation in practice. These principles include taking the time to understand a problem from multiple perspectives, inclusivity, valuing all sources of knowledge, active listening and understanding, shared vision or ambition for change, honest, open and constructive interactions, awareness of the broader context, flexibility and adaptability, and continued commitment to the process of Co-innovation.

Co-innovation studies have also developed instruments and indicators to measure Co-innovation phenomena from various perspectives. These instruments include measuring the Co-innovation experiences of actors, the risk of Co-innovation, and Co-innovation platforms themselves. Abhari et al. (2017c) developed an instrument to measure the Co-innovation experiences of actors, while Abhari et al. (2017b, 2018) developed instruments to measure the risk of Co-innovation and its various aspects. Abhari et al. (2017a) developed an instrument to measure co-innovation platforms themselves. This last instrument is of great importance in the theoretical and methodological construction of Co-innovation; it enables theoretical and practical contributions by proposing a useful diagnosis of aid to organizations, evaluating the possibilities, understanding the influencing factors and consequently improving the functions and services of their platforms (Abhari et al., 2017a).

In the theoretical-methodological framework, certain trends have emerged regarding the ramifications of Co-innovation, such as online Co-innovation and Co-innovation networks (Vollenbroek et al., 2013; Wang et al., 2015). However, it is debatable whether co-innovation represents a "new paradigm" or whether these are simply reflections of existing open innovation practices in online and networked contexts. The studies have identified dimensions and stages of the Co-innovation process, as well as elements that affect its practice, either positively or negatively.

Drawing on the studies by Saragih et al. (2019), Barile et al. (2020) and Klimas and Czakon (2022), it is possible to structure the co-innovation process into eight dimensions: co-discovery, co-creation/design, co-development, co-implementation, co-delivery, co-dissemination, co-capture and co-learning. Barile et al. (2020) also identify psychological and contextual dimensions, along with knowledge management at micro, meso, macro and meta levels, which act as facilitators of value co-creation within ecosystems.

These dimensions and stages range from the development of the concept to the product itself, with a focus on the generation, integration and evaluation of ideas. However, there are elements that can interfere with the practice of Co-innovation. Two drivers have been identified to reduce the complexity of the process, with the first being the selection of reliable and complementary business partners with experience and compatibility, as noted by Tsou et al. (2015).

Recent studies suggest that Co-innovation communities should focus on fostering interactions between customers and between customers and the company to improve engagement with users (Li et al., 2020). Active participation of end-users in the innovation process has been shown to facilitate the co-creation of value, as users can share knowledge, information, ideas,

and preferences that contribute to the production of innovative content (Bugshan, 2014; Hsiao et al., 2015; Zhang et al., 2015; Zhang et al., 2018; Chen et al., 2020; Li et al., 2020). However, the practice of Co-innovation can be threatened by Co-innovation risk, which includes financial risk, risks of intellectual property rights, time risk, and social or reputational risk (Abhari et al., 2017b; Abhari et al., 2018).

To overcome the challenges of Co-innovation, companies need to establish adequate reward and feedback mechanisms to encourage customer participation (Zhang et al., 2015; Li et al., 2020). Companies can use Co-innovation platforms such as virtual communities of practice (Hsiao et al., 2015), online Co-innovation communities (Zhang et al., 2015), or social media (Bugshan, 2014; Hsiao et al., 2015) to facilitate the participation of end-users in the innovation process.

The role of various actors, such as companies, government units, suppliers, universities, and laboratories, in the co-creation process has been extensively studied. These actors can assume different roles in the co-creation process, whether in the direct creation of value or in its support, whether in encouraging entrepreneurship or in leadership (Wang et al., 2015; Klimas & Czakon, 2022). The role of the supplier-buyer (Yeniyurt et al., 2013; Liliani et al., 2020), the government, industry and university triad (Wang et al., 2015), and customers (Zhang et al., 2015; Qiu & Fan, 2016) has been particularly emphasized.

Moreover, it is essential to understand the experiential benefits that affect the participation and contribution of actors to improve the results of Co-innovation (Abhari et al., 2017c). Although discussions about relationship value have focused more on utilitarian elements (Lehtimäki et al., 2018), the sustainability of Co-innovation depends on the actor's experience

throughout the innovation cycle. Therefore, Co-innovation communities should focus on creating a positive experience for actors to enhance their participation in the Co-creation process.

The recent literature on Co-innovation highlights the importance of fostering interactions between customers and between customers and the company to improve engagement with users. The role of various actors in the co-creation process has been extensively studied, and the experiential benefits that affect their participation and contribution have been emphasized. Companies should establish reward and feedback mechanisms to encourage customer participation and create a positive experience for actors to enhance their participation in the co-creation process. Thus, the experiential value of Co-innovation will reflect a context of relationships that encompass subjective, temporal and contextual aspects as devices that transfer experiences of value from individuals between individuals and organizations over time (Lehtimäki et al., 2018). Perceptions of value tend to vary between individuals and groups and the experience of Co-innovation can comprise five main experiential benefits: professional, learning, emotional, social and utilitarian (Abhari et al., 2017c; Lehtimäki et al., 2018).

Based on this information, this last discussion, when expanded, corroborates with the next contribution flow found: networks and ecosystems. In the quest to complement resources, knowledge and skills, Co-innovation is seen as a scenario that explores the complexity of multi-actor and multi-level innovation, encompassing institutional and organizational changes arising from new technologies (Bitzer & Bijman, 2015; Wang et al., 2015). Therefore, the interaction between the multiple actors and the exchanges of knowledge and technology transfer experienced can be observed through the network construct (Wang et al., 2015).

Co-innovation network constitutes professional communities enabled by social mechanisms and can influence the formulation of policies, regulations and communication. The

network is the basis for understanding the behavior of actors in Co-innovation, since it defines the scope of actors' involvement, seen as one of the main challenges faced (Abhari et al., 2017b; Abhari et al., 2017c).

Of the observed studies, Wang et al. (2015) emphasizes academic entrepreneurship companies regarding the flow of academic knowledge between universities and industry. However, discussions beyond networks and entering the context of systems and ecosystems were noted, with emphasis on Wang et al. (2015) with the idea of Regional Innovation Systems, Zhong and Nieminen (2015) with Platform Ecosystems, Barile et al. (2020) with the context of Ecosystems of services, and Klimas and Czakon (2022) more recently with approaches on Ecosystems of Innovation.

Faced with these last two flows, there is a tendency to observe the phenomenon of Co-innovation more broadly, in a way that recognizes the importance of the potential individualities of actors and groups but contemplates the holistic and synergistic situation of the ecosystem.

The contribution flows that are inherent to Co-innovation are complemented by insights from the literature on the topic. The emergence of the internet, social media, and user empowerment has led to the sharing of resources and knowledge across physical and virtual channels for cooperative innovation development (Vollenbroek et al., 2013; Bresciani et al., 2021). Initially, the prominent field was Big Data, which has been widely used for data capture, storage, and analysis, reflecting the need for a data-driven culture and digital readiness across the Co-innovation network (Lozada et al., 2019; Ciasullo et al., 2022).

The benefits of Big Data in Co-innovation are significant in generating knowledge across all economic sectors, enhancing intentional and direct innovation processes, and improving organizational capacity, efficiency, and agility in co-creation, collaboration, and communication

(Bresciani et al., 2021; Lozada et al., 2019). Cognitive computing and artificial intelligence can also leverage unstructured data and improve dynamic capabilities for co-innovation (Chen et al., 2020).

In addition to these aspects, online/virtual communities and social media platforms are also vital facilitators and drivers of Co-innovation. These platforms enable end-users to share and acquire updated information, which provides access to suppliers, customers, and consultants to obtain information about products and services (Hsiao et al., 2015). These platforms can also foster social awareness, production of social capital, instant communication, greater customer listening, and participation in product design (Bugshan, 2014; Zhang et al., 2015; Zhang et al., 2018). Co-innovation communities can serve as a means of product introduction, messaging channels, frequently asked questions (FAQs), surveys, virtual laboratories, etc., and can be a practical tool in developing innovation strategies (Li et al., 2020; Bugshan, 2014).

Therefore, the digital/online field plays a crucial role in Co-innovation, facilitating dialogues with promising knowledge technologies and contributing to administrative management processes and customer interactions. This movement is characterized by contribution processes and practices, with the digital/online field serving as a support in boosting Co-innovation. Following the same line, another observed flow refers to discussions on sustainability. Called here a sustainable perspective, this flow is characterized by the presence of more recent studies such as Barile et al. (2020), Liliani and Tjahjono (2020), Liliani et al. (2020), and Chang (2020).

The concept of Co-innovation has evolved to include sustainable development, which is sometimes referred to as "green Co-innovation" or "sustainable Co-innovation." This perspective encompasses economic and social development, cultural renewal, and eco-sustainability, and

involves the convergence of technological, human, relational, cultural, and social spheres.

Governments, business partners, and consumers are increasingly concerned about environmental issues, making the adoption of green practices essential.

In addition, there is a need for a systemic approach to innovation, and Co-innovation can serve as a useful path to influence and potentially change the context of the agricultural innovation system. Studies such as Bitzer and Bijman (2015), Fielke et al. (2017), and Coutts et al. (2017) highlight the importance of understanding the success or failure of innovation initiatives in agrifood chains in developing countries. These studies examine primary innovation and the agricultural and agrifood innovation system, considering factors such as activity segment and organization/scenario size to delimit discussions and analyze specific phenomena.

In addition to these, discussions focused on the size of companies were also evident, in particular with regard to the resilience of Small Enterprises. According to Ciasullo et al. (2022), Co-innovation can be seen as a promising strategy in the capacity and maintenance of continuity for small businesses in times of crisis.

In view of the contributions flows and their respective investigated approaches (Table 3) as well as the discussion of the state of the art of research on Co-innovation, Table 5 summarizes the main recommendations for future research.

Table 5

Suggestions for future research on Co-innovation

| Contribution flows | suggestions |
|---|--|
| Theoretical-methodological framework | <ul style="list-style-type: none"> - Analyze the main qualifiers of the Co-innovation platform that differentiate it from the Open Innovation approach. - Investigate new instruments that can diagnose or characterize the presence of co-innovation in certain contexts. - Seek to present a possible taxonomy of Co-innovation in order to consolidate its epistemological structure and avoid ambiguities. - Discuss Co-innovation in the light of actor-network theory, presenting existing convergences and divergences. |
| Processes and practices | <ul style="list-style-type: none"> - Describe in greater detail the dimensions of the Co-innovation process, allowing you to understand its stages. - Investigate which barriers and at which stages affect the co-innovation process. co-innovation risks. co-innovation risk management through the nature of its procedural dimensions. |
| Actors and their relationships | <ul style="list-style-type: none"> - Discuss the advances of “n-helix” in the field of co-innovation and the participation of different actors and institutions. co-innovation platform as the axis of discussion. - Compare stakeholder participation and governance across co-innovation activities at different stages. |
| Networks and Ecosystems | <ul style="list-style-type: none"> - Explore the behavior of co-innovation in certain ecosystems (innovation, knowledge, platform, business, etc.) - Understand the role of potential actors and institutions present in innovation ecosystems that work with projects on co-innovation platforms. |
| Digital/online field | <ul style="list-style-type: none"> co-innovation activities, bringing as an example experiences that did not work out. - Investigate the perception of customers who participate in online communities in co-innovation processes, considering the stages from co-creation to post-consumption. - Research new ICTs in parallel with advances in co-innovation platforms: are they walking the same path? |
| Sustainable perspective | <ul style="list-style-type: none"> - Discuss co-innovation from the perspective of sustainable approaches such as the UN Sustainable Development Goals, ESG Index, etc. - Determine the main challenges faced in the development of co-innovation considering a certain phenomenon. - Investigate the role of ecosystems in building a sustainable co-innovative process, bring a case study. |
| Segmentation by activity and size | <ul style="list-style-type: none"> - Describe the barriers faced by developing countries in the development of co-innovation in certain sectors. - Discuss the role of MSEs in ecosystems that develop co-innovation compared to larger companies. |

Source: the authors

5 Final Considerations

The field of open innovation (OI) has undergone significant changes over time, leading to the emergence of a new paradigm known as Co-innovation. As a result, there has been a need to understand the evolution of these themes in terms of value creation, which has been the subject of numerous studies. To gain insight into this development, this study conducted a bibliometric analysis of 681 studies in the SCOPUS database, mapping the theoretical conjuncture of OI and Co-innovation research regarding value creation, as well as an integrative review regarding the flow of contributions from studies on Co-innovation. The findings show promising trends in terms of the volume of publications, temporal trends in scientific production, and average number of citations per year for both OI and Co-innovation.

With regards to the set of producers, it has been observed that the most relevant authors for Co-innovation work collaboratively. However, there is a concern regarding the continuity of their work over time. In terms of journal performance, OI-related research is predominant in journals with a sole focus on the subject. Based on Bradford's Law, 12 journals play a central role in the publication sources for Co-innovation, thereby emphasizing the importance of considering these journals for publishing on the subject. Notably, Italy and China are highlighted for OI, while New Zealand and the United States are highlighted for Co-innovation.

Analyzing the set of products, it has been observed that the most significant studies on Co-innovation have garnered a substantial number of citations. Through reference spectroscopy, it was found that the major citation peaks for Co-innovation occurred in 2003, 2010 and 2011, which demonstrates that the field of study is still undergoing constant evolution.

Regarding the keywords, the term "crowdsourcing" is frequently used in association with OI, which may indicate a new scenario for the innovation paradigm in this field. Additionally,

significant, frequent and central terms and objectives of studies were identified, highlighting "resources" and "collaborative innovation network".

Concerning the main approaches and differences between the concepts of OI and Co-innovation, based on the analyzed research, it is observed that both share the premise that companies should seek external sources of knowledge and collaborate with other companies, research institutions, and individuals to promote innovation. However, there are some significant distinctions between the two approaches.

OI has a broader scope and encompasses all innovation activities that involve collaboration with external actors, such as suppliers, customers, and end-users. In turn, Co-innovation is more specific and focuses on collaboration between companies for the joint development of new products, services, or processes.

Another important distinction is that Co-innovation involves deeper and closer collaboration between companies, including sharing resources and risks. On the other hand, OI can involve more superficial partnerships, such as acquiring knowledge through conferences or workshops. In summary, while Open Innovation is a more comprehensive approach to promoting innovation, Co-innovation is a more specific form of collaboration between companies for the joint development of new products, services, or processes.

In addition to the arena between OI, this research emphasized Co-innovation and identified discussions around the theoretical-methodological framework, processes and practices, actors and their relationships, networks and ecosystems, digital/online field, sustainable perspective, and segmentation by activity and carriage. In general, by reviewing, synthesizing and proposing research flows still necessary to consolidate the Co-innovation literature, this study highlights important fields for its past, present and future epistemological construction.

Finally, the limitation of this study is that it focuses only on theoretical databases, which suggests that future studies investigate the problem using empirical approaches.

Authors' contributions

| Contribution | Silva, L. M. C. | Vieira, K. C. | Grützmann, A. | Prado, J. W. D. |
|----------------------|-----------------|---------------|---------------|-----------------|
| Contextualization | X | X | X | X |
| Methodology | X | X | X | X |
| Software | ---- | ---- | ---- | ---- |
| Validation | X | X | X | X |
| Formal analysis | X | X | X | ---- |
| Investigation | X | ---- | ---- | X |
| Resources | X | X | ---- | ---- |
| Data curation | X | X | ---- | ---- |
| Original | X | X | X | ---- |
| Revision and editing | X | X | X | ---- |
| Viewing | X | X | X | ---- |
| Supervision | X | ---- | ---- | ---- |
| Project management | X | ---- | ---- | ---- |
| Obtaining funding | X | X | ---- | ---- |

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