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Abstract

Purpose. The growing interest on ecosystems on both managerial and academic side reflects a vibrant field of study, nevertheless the subject is very heterogeneous and in particular concerning a particular form of ecosystems: collaborative ecosystems, the present study would shed light on these.

Design/methodology/approach. The definition gap existent and the multiplicity of fields and composite studies on collaborative ecosystems have made it necessary to conduct a systematic literature review (SLR) of the phenomenon, a bibliometric analysis and content analysis.

Findings. The research offers an overview of the phenomenon, three main cluster categories emerged: ecosystem, competition and open innovation; this cluster offering a comprehensive schematization of the research topics.

Originality. A combination of research methods was used to identify the intellectual structure of collaborative ecosystems. In addition, we propose a taxonomy for collaborative ecosystems, opening the study to new lines of investigation and providing a new research agenda.

Research limitations. Limitations of this research are that the investigation has been confined to specific keywords related to collaborative ecosystems that led to a strict selections of papers to analyzed and in having confined the investigation to publications in the managerial area. Further research will be able to expand the selection of keywords or use more strings and proceed to comparative analysis of results. Another limitation is the small number of databases assesed (only Scopus and Web Of Science) and in have confined the analysis to specific clusters emerged from the quantitative analysis of papers.

Managerial implications. By proposing a taxonomy of collaborative ecosystems, the paper highlights what solutions and architectures an ecosystem manager must consider when developing collaborative ecosystems, what factors he or she must pay attention to in order to ensure their development and survival, and what elements determine the development of an ecosystem, in particular the management of innovation and knowledge and the scarcity of resources in a hyper-competitive environment.

Keywords: Collaborative ecosystems – Collaborative ecosystems taxonomy – Systematic literature review – Bibliometric analysis - Content analysis.

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1 Introduction

In recent years, both scholars (Akyuz and Gursoy 2020; Penter et al. 2019; Taratori et al. 2021) and consulting firms (Deloitte 2022) have shown a growing interest for collaborative ecosystems, particularly to study how they work and how they influence the competitive environment.

The term ecosystem, which comes from biology, generally refers to a “biological system composed of all the organisms found in a particular physical environment, interacting with it and each other” (Oxford English Dictionary 2017). This definition can be declined in the economic system: to maintain a solid competitive advantage, firms must be able to collaboratively coordinate shared activities and processes with players within a larger ecosystem environment.

To be able to survive technological progress, realize new business opportunities and bring value solutions to life, enterprises must share their different skills to create a relationship in which each entity influences and is influenced by the others (Chesbrough and Appleyard 2007). Therefore, more and more companies and organizations are showing strong interest in developing ecosystem-based business models, attracted by the possibility of accessing new markets, new resources and skills and to expand their value chain (Bouncken and Kraus 2022).

The resulting inter-firm collaboration provides companies with development opportunities that would be precluded if they operated independently (Muldoon et al. 2022; Moore 1993). Notwithstanding the growing number of companies participating in collaborative ecosystems in industry and services in recent years, there is a lack of a consolidate definition of the term “collaborative ecosystem”, which is up to now inaccurately attributed (Sharmelly and Ray 2018) to Moore (1993), who defined, instead, the “business ecosystem”. Moreover, the studies conducted so far do not provide a reference model that can synthesize and formalize the basic concepts, principles, and recommended practices.

The literature on the topic of collaborative ecosystems is characterized by certain peculiarities: the heterogeneity of application areas; the different declinations of the phenomenon; and, from a methodological point of view, the prevalence of contributions in the form of case studies, as opposed to conceptual articles.

The scientific production dealing with collaborative ecosystems consists mainly of papers that adopt a "phenomenon-driven" approach in which, more and more often, there is room for case studies that cover different sectoral contexts and circumscribe the analysis to single business realities, leaving researchers and managers without a comprehensive vision of the phenomenon.

These characteristics make a systematization of the studies in this area more necessary than ever.
Through a systematic analysis of the management literature, this paper builds a theoretical framework to provide a detailed understanding of the current state of research and to present and discuss interesting insights for future studies also through the identification of possible connections between already published contributions (Kraus et al., 2020).
In addition, the development of a theoretical framework is particularly relevant to a scientific production primarily adopting the case method because it enables the conceptualization of studies based on the observation of real phenomena, which are considered, in the uniqueness of their manifestation, as part of a specific context and, for this reason, difficult to generalize. Given the scope and the number of retrieved papers, we opted for the systematic literature review as the main methodological tool of this study. We retrieved the relevant literature by adopting Prisma 2020 flow diagram, a commonly used framework for systematic literature reviews. The main results are based on in-depth qualitative coding and analysis of the themes and topics emerging from the retrieved papers. The qualitative content analysis is, indeed, a fundamental methodological tool we adopted to render the results of the systematic literature review replicable and represents a standard for what concerns a systematic evaluation of qualitative themes and topics within a well-defined research area. Moreover, to place the results in a broader research context, we complemented the systematic literature review with a bibliometric analysis of the retrieved papers.
We analyzed the temporal evolution of studies, the distribution of studies by journal, the most prolific authors, and identified the main keywords, which were divided into three categorical clusters based on their correlation patterns. In this way, three topics were generated offering a comprehensive schematization of research topics concerning collaborative ecosystems. We enriched the results of the systematic review through content analysis methodology by adopting MAXQDA Analytics Pro 2022. In addition, we focus on the ten most cited articles, which made the most relevant contribution to subsequent research on collaborative ecosystems. Through the content analysis it was possible to enrich the current state of the art of the theory by developing a taxonomy of the different declinations of the phenomenon so as to define new lines of investigation providing a new research agenda.

2 Theoretical background

There is a consensus in the literature that the continuous and unpredictable challenges posed by the competitive environment (Wareham et al., 2014), the instability of market demand (Autio and Thomas, 2014; Rong et al., 2015), the speed of technological change that renders current know-how obsolete (Wareham et al., 2014) along with digital innovation (Endres et al., 2022), have fundamentally changed the way organizations collaborate and compete (Senyo et al., 2019), leading to the proliferation of collaborative ecosystems, which are the result of the sharing of skills, knowledge, solutions and goals to be achieved by their constituent bodies.
In recent years, economic and managerial studies have shown a growing interest in the ecosystem concept (Adner, 2017; Jacobides et al., 2018; Moore, 1993), to the point that scholars have come to believe that "individual firms are no longer adequate to serve as the primary unit of analysis" (Baldwin, 2012), and have proposed the use of a new perspective from which to identify dynamics that are difficult to track with traditional models of analysis.
As early as the 1930s, British botanist Tansley (1935) used the term "ecosystem" to describe a community of organisms interacting with each other and their surrounding environments, competing and cooperating with each other over available resources, co-evolving and adapting together to any natural imbalances.
Hannon (1997) points out that economics and ecology have in common the study of dynamic, organic systems. Studying the analogy between biology and business, Lewin (1999) explains that businesses, like biological organisms, operate within a rich network of interactions. According to the scholar, enterprises share some basic properties of natural ecosystems. Biological ecosystems and business systems are complex adaptive systems and thus follow the same deep laws.
In 1993, Moore introduced the concept of "business ecosystem", which he defined as "an economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. This economic community produces goods and services of value to customer, who themselves are members of the ecosystem. The member organisms also include suppliers, lead producers, competitors and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments and to find mutually supportive roles".
This definition was echoed by Iansiti and Levien (2006), who later defined business networks as ecosystems, organized around a key species and "characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival".
This perspective, which Adner (2017) calls "ecosystem-as-affiliation," emphasizes the breakdown of traditional industry boundaries, increased interdependence and the potential for symbiotic relationships in productive ecosystems. It also

focuses on issues of access and openness, highlighting measures such as the number of partners, network density and the centrality of actors in larger networks.

In 2017, Adner defined the ecosystem emphasizing the concept of value. According to the author, ecosystem is defined by "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize". In this perspective, which the author calls "ecosystem-as-structure", ecosystems are viewed as networks of interdependent enterprises that produce distinct components that together constitute a common value proposition, which the individual enterprise would not be able to achieve alone (Autio and Thomas, 2020; Moore, 1993; Parente et al., 2019; Shipilov and Gawer, 2019).

The role of the orchestrator is due to the fact that ecosystem partners have individual goals and agendas but, at the same time, must mutually develop and adapt their modules in reciprocal relationships with other partners (Adner, 2017; Jacobides et al., 2018; Kapoor, 2018).

This perspective emphasizes the breakdown of traditional industry boundaries, increased interdependence and the potential for symbiotic relationships in productive ecosystems.

On closer inspection, to gain competitive advantage, firms not only adopt their own resources, knowledge, and capabilities, but also base their business models on shared resources, network externalities, knowledge spillovers, local endowments, and public support (Audretsch et al., 2019; Bouncken and Kraus, 2022;). In their analysis of the relationship between ecosystem actors, Jacobides et al. (2018) focus on the nature of complementarities among ecosystem participants and the fungibility of their investments, proposing a definition of an ecosystem as a set of actors with varying degrees of multilateral complementarities that is not generic and not completely hierarchically controlled. Thus, an important feature of ecosystems is that their constituent components are complementary (Jacobides et al., 2018). This implies that firms cannot create value unless all the components that make up the ecosystem are present.

Ecosystems are everywhere, not just in natural environments, and increasingly businesses are transcending their traditional operational boundaries and creating, or participating in, new flexible and adaptive business networks that jointly pursue ambitious goals. Cooperative networks within collaborative ecosystems thus emerge (Moore, 1993).

The motivations that lead a company to participate in a collaborative ecosystem can be traced to the following: effective resource management; direct financial gain; good public relations; good partnerships with stakeholders; acquisition of data; technical assistance; employee satisfaction; reduction of media criticism; an attractive alternative to litigation; and an attractive alternative to command-and-control regulations (Brody and Cash, 2004).

The literature has been prolific with studies that have investigated the ecosystem in areas such as strategy (Iansiti and Levien, 2006; Parente et al., 2019), manufacturing (Brophy et al., 2020) and business innovation (Adner and Kapoor, 2010; Davis and Eisenhardt, 2011) and has arrived at different declinations of the collaborative ecosystem concept.

Collaborative ecosystems thus take on the function of innovation accelerators through the sharing and exchange of knowledge and experience among actors, and co-innovation networks are thus activated (Abreu et al., 2018).

Collaborative arrangements have the advantage of allowing firms, which make up the ecosystem, to mitigate the risks associated with innovation and share the necessary resources. In other words, it is assumed that the existence of a "healthy" collaborative environment enables firms to operate more cost/time/quality efficiently in the development of innovation processes and thus be more competitive. Most often, collaborative networks are networks characterized by an active collaboration between ecosystem actors, which is not limited to companies alone, but involves different actors (e.g., government, universities, and research centers) in a multistakeholder logic (Yan et al., 2018; Yan et al., 2020), strengthening processes and improving the final result. In this direction, collaborative ecosystems open up prospects for development in which the economic and social dimensions find a synthesis in the concept of sustainability (Ppadopoulos et al. 2010), and business models enjoy the hybridization between differentiated but converging orientations in the perspective of the shared value generated by business activity, the value generated by business activity is shared with all business stakeholders (Kramer and Porter, 2011).

The literature analysis on collaborative ecosystems shows that, although recent, the phenomenon is of considerable interest to scholars.

Therefore, we believe it is necessary to frame the topic on a theoretical level through a systematic review of studies conducted so far in order to identify connections among already published contributions and obtain a solid scientific basis that can support future research and thus advance this field of research (Kraus et al., 2020; Vrontis et al. 2020).

To achieve this goal, we have formulated the following research questions:

RQ1: What has been the evolution of scientific production and citations on collaborative ecosystems over time?

RQ2: What are the main conclusions noted in the existing literature and related future research?

3 Methods and tools

The decision to perform the systematic literature review on the topic stems from a recent and growing academic interest in collaborative ecosystems. This methodology is known for its explicit, objective, organized, holistic, and transparent protocols that support the researcher in exploring existing knowledge on a specific topic of interest (Williams et al., 2021; Vrontis, *et al.*, 2022a; Battisti *et al.*, 2023). It is precisely the understanding of the current state of knowledge that can provide the basis for outlining the development of different research paths (Bhattacharyya 2022; Fisch and Block 2018; Candeia Fernandes and Franco, 2022; Yaghmaie and Vanhaverbeke, 2020; Vrontis *et al*., 2022b). A systematic literature

review is widely accepted as a valuable tool for management research (Transfield et al., 2003; Vrontis et al. 2020). Hence, we consider it adequate to achieve the objective of the present work. The validity of the selected method is also justified by the fact that almost all the scientific output available for this study (obtained by querying the Web of Science and Scopus databases) is exploratory and has a strong qualitative emphasis. Following the rigorous review protocol suggested by Xiao and Watson (2019), a search query was performed on a research area that is not very broad—as far as the field of management is concerned—guaranteeing the validity of the obtained results. A keyword closely related to the research objective was selected for the search query; hence no variants or synonyms were used. The Web of Science and Scopus-indexed databases were chosen; the need to use the two databases is justified because they are considered complementary (Ferreira et al., 2016) and include only quality peer-reviewed articles (Goecks et al., 2022).
Regarding the time horizon, no restrictions were applied to include all existing literature.
In order to ensure scientific robustness and inclusiveness, the selection of articles to be included in the analysis was made by considering only articles published in peer-reviewed journals (within the research area of "Management" of Web of Science and "Business, Management and Accounting" of Scopus). In addition, as suggested by some scholars (Adams et al., 2017; Hiebl, 2021; Kosravi et al. 2019), given the importance of capturing heterogeneity and ensuring the relevance and inclusiveness of sources in order to improve the results of a systematic literature review of the management field, the available "grey literature" (five conference papers, three book chapters, and two reviews) was also considered.

[INSERT HERE FIGURE 1]

Contributions published in a language other than English, those duplicated between the databases, those completely irrelevant, and those in the publication process for which the full text could not be acquired were excluded for the final retrieval. No complementary databases, such as Google Scholar, were used because it would not have been possible to restrict the analysis to scientific production in the Management category; hence, the systematicity component of the review could have suffered.
To reduce the degree of subjectivity in the application of inclusion and exclusion criteria, the analysis of abstracts, full papers, and cross-references was conducted separately by each author; the results were then discussed, and a consensus on the inclusion was reached (Booth et al., 2012). A qualitative assessment of the contributions was performed by reading them entirely while simultaneously checking their substantive ontology and the appropriateness of their empirical or conceptual focus.
The following search query was used:
- Scopus:
(TITLE-ABS-KEY ("collaborat* ecosystem*") AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (LANGUAGE , "English"))
- Web Of Science:
"collaborat* ecosystem*" (Topic)
Refined By: Web of Science Categories: Management or Business or Social Sciences Interdisciplinary or Economics. Document Types: Article or Proceeding Paper or Book Chapters. Languages: English

After performing a rigorous screening process to ensure compliance with the selection criteria, the dataset used for the systematic literature review resulted in 86 articles published between 2003 and 2022.
The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) algorithm (Page *et al.*, 2021) was used to schematically describe the followed search protocol and ensure a transparent and replicable process. In fact, as shown in Figure 2, following the PRISMA 2020 guidelines, the flow chart summarizes the selection of articles through the different stages of a systematic literature review, mapping the number of records identified, specifying those included and excluded, and the reasons for exclusions.

[INSERT HERE FIGURE 2]

After creating the dataset, as a first step, a systematic literature review was performed by critically reading and synthesizing all the included scientific contributions (Duque-Uribe et al., 2019). Next, a bibliometric analysis was conducted to detect the productivity and impact of scientific production, along with the interactions among scholars and the themes that define the overall intellectual structure of the topic of interest. Finally, through content analysis we defined current trends by identifying the themes of each cluster and suggestions for future research. It is precisely the combination of all three method includes proaches (SLR, bibliometric analysis, and content analysis) that allows us to understand and

discover the intellectual structure of a research area and present a complete synopsis of the topic of the paper (Bhandari, 2023; Fatima, Singh, 2023).

3.1 Bibliometric analysis

Although the scientific production on the topic of interest covers a broad period, ranging from 2003 to the end of 2022, it shows a highly discontinuous trend with some periods of absence of publications.
From a time perspective, as shown in the figure below (Fig. 3), scholarly interest in the topic becomes constant only from 2019 onward. The year 2022 is also when the largest number of contributions were published, while over 60% of the existing literature was published between 2018 and 2022.

[INSERT HERE FIGURE 3]

Scientific production is published in many heterogenous journals (over 60). Sustainability was found to have the highest number of publications (8), followed by Technological Forecasting and Social Change and International Journal of Technology Management (2 publications each). The other 61 journals published only one paper on this topic. The increasing interest of researchers in collaborative ecosystems that highlights the potential relevance of a systematic review such as this (Manz 2019). Same considerations are for citations. As for the most prolific authors, no one stands out because no particular name was found to be associated with more than one published contribution. After checking the eligibility of the articles and selecting those to be included, following the suggestions of Donthu *et al.* (2021), bibliometric networks were constructed to enrich the analysis so that relationships between research items could be highlighted through citation analysis, co-citation analysis, co-authorship analysis, and co-occurrence network analysis of the author. In order to obtain an effective visual representation, VOSviewer (version 1.6.18) was used obtaining the co-occurrence of bibliographic material (Cobo *et al.*, 2011), similarity matrices based on the strength of association were created (Van Eck and Waltman, 2010). As a measure of similarity, association strength (Van Eck and Waltman, 2009) was used, which, according to several scholars (Van Eck and Waltman 2009), is the observed co-occurrence between the two terms as compared to the degree to which each term co-occurs with other terms in the article sample. The result generated by VOSviewer is a two-dimensional map that includes the clusters with the most important keywords, in which the correlation of the terms is represented as a function of the distance between the terms: closer the terms, stronger their relationship (Van Eck and Waltman, 2010). A co-occurrence threshold of at least two articles was applied to include them in the mapping and classify them according to the scheme defined by Lee *et al.* (2014). Applying this criterion, out of 241 keywords, VOSviewer extrapolated 15 keywords that exceeded the threshold value. The 15 keywords were manually reduced to 12 because three of them were not directly pertinent to research topic (“Design/Methodology/approach” “Semi-structured interviews” and “Longitudinal case study”).
The main keywords were broken down into 3 categorical clusters and corresponding topics, each identified by a different color. We assigned the cluster names based on the largest node's name therein (denoting the largest number of occurrences) they are: ecosystems (red cluster), open innovation (green cluster) and competition (blue cluster). As shown in Figure 4, clusters are quite distant from each other, and main theme is ecosystems, which serves as "bridge" to connect the other two relevant structures.
Hence, there is no overlap in researched topics.

[INSERT FIGURE 4]

To perform a chronological analysis of the obtained network according to the average year of publication of articles, overlay Visualization mode was selected.
From Figure 5, it is possible to observe a concentration of scholarly production in the period 2017-2020. Scholars' interests initially were based on aspects that contribute to competitive enterprises, while later, research inquiry focused mostly on ecosystems, most popular in 2018. In recent years, however, latter themes have been associated with open innovation, value creation, and business models until it comes—indirectly—to the circular economy.

[INSERT HERE FIGURE 5]

In order to detect the most cited documents, we performed citation analysis using "Documents" as unit of analysis. By selecting the minimum number of citations that a document must have equal to 10, out of 28 results, only 9 exceeded threshold value. The paper by Santoro *et al.* (2018) had the highest number of citations (300), closely followed by the papers by Gerlak and Heikkila (2011) with 149 citations, and Goyal *et al.* (2018) with 102 citations, table 1 and figure 6.

[INSERT HERE TABLE 1]

[INSERT HERE FIGURE 6]

Territorially, the most prolific countries include Italy, which ranks third with four contributions, after the United States (9) and Australia (6). They were followed by Canada, China, Germany, and India with two contributions each.
Performing the analysis of co-authors according to country of affiliation, a selection criterion was applied with a minimum threshold value of 1 in order to have a complete picture of the spatial contexts involved in studies on collaborative ecosystems. The results, table 2, yielded 19 countries distributed in three clusters rather far apart. The largest cluster is the middle one, which also contains the United States of America, which has the highest total linkage strength among all countries. Since we have chosen the Overlay Visualization mode (figure 7), we can find how the Co-authorship network analysis of countries allows us to note that, in the first phase, studies were conducted in countries belonging to North America and South America (Canada in 2010 and Brazil in 2015), later in Hungary and the USA (the year 2016). In 2018 countries such as France and Australia emerged, while in 2020, it was India, and in 2021 Saudi Arabia.

[INSERT HERE TABLE 2]

[INSERT HERE FIGURE 7]

To identify the most representative literature on collaborative ecosystems, we performed a co-citation analysis and identify the most influential authors and the relationships between them within the scholarly area of interest (Di Guardo and Harrigan, 2012; Ferreira et al., 2016). The co-citation approach assumes that scholarly contributions that are frequently co-cited are likely to embody similar, related, or complementary concepts (Di Guardo and Harrigan 2012). Therefore, using "Cited authors" as the unit of analysis and a minimum of 10 citations per author, the analysis resulted in 2634 authors, of which only 8 exceeded the threshold value (table 3). While analyzing the selected authors, one author who did not have strong links was manually eliminated. The remaining seven are divided into two clusters (figure 8): in the red cluster (consisting of 4 items), the most cited work emerges, which is that of Bocken, while in the green cluster (consisting of 3 items), Chesbrough stands out.

[INSERT HERE TABLE 3]

[INSERT HERE FIGURE 8]

Bibliometric analysis was completed by the Co-Occurrence Network Analysis of Author. Only four of the 115 authors' keywords extracted from articles on collaborative ecosystems were used twice. Among all keywords, the most frequently used are open innovation, followed by business models, circular economy, and emerging markets. While the keyword business models has two links (with open innovation and with circular economy), open innovation and circular economy have only one link (the one with business models). As shown in the figure below, the three keywords became relevant in 2019, although circular economy appeared before the others.

[INSERT FIGURE 9]

3.2 Analysis of retrieved literature and results

We enriched the results of the systematic review through content analysis methodology, again adopting MAXQDA Analytics Pro 2022 software. The content analysis aims to systematically and objectively examine the existing scholarly output on the studied topic to detect key themes for future research. The use of this method is recognized as very valuable in management studies because of the interesting results it can generate (Bell and Waters, 2018; Krippendorff, 1980).
In the first step, we manually performed a careful and detailed coding of the data summarized in an articulated system of codes and subcodes. For this study, the criteria of emergent coding outlined by Haney et al. (1998) were followed by employing sampling units so that we could detect: the most frequently used keywords, other designations that can be associated with collaborative ecosystems, the most frequently adopted research methodologies for studying collaborative ecosystems in academia, the business sectors that most frequently experience this change, and the main suggestions for future research. This phase was carried out individually, and then all the choices made were shared, discussed, and approved by the research team.

3.3 Other designations that can be associated with collaborative ecosystems

Analyzing the existing literature, as summarized in Figure 10, additional topics emerged that might be considered as evolved forms of collaborative ecosystems.

Collaborative digital platform ecosystems are found when independent companies in an industry agree to develop and govern a digital platform with the goal of generating mutual benefit (Costabile et al., 2022).

Collaborative multi-partner ecosystems are associated with the transformation of supply chain activities generated by blockchain technology. This fosters the creation of IT-based, transparent, and trustworthy collaborative networks that promote complete integration, visibility, and traceability among partners (Akyuz and Gursoy, 2020).

On the demand side, a group of companies agreeing to bridge the skills gap, either as part of the outsourcing process or to use applications that can process big data, may result in the creation of a collaborative sourcing ecosystem (Penter et al., 2019).

We speak of a collaborative innovation ecosystem concerning changes in corporate business models to incorporate new knowledge flows and interaction with stakeholders to implement value chain transformation through open innovation to create cooperative value (Randhawa et al., 2021). According to Taratori et al. (2021), "collaborative" is a keyword highlighting the role of smart ecosystems in solving complex problems. In addition, they pointed out that the triple helix model can be the pioneer of "smart" collaborative ecosystems. The emergence of open collaborative ecosystems has resulted in a profound evolution of the competitive environment (Gastaldi et al., 2015). This type of collaborative ecosystem is formed to take advantage of opportunities arising from innovative legislative and institutional arrangements (Briggs et al., 2010). Collaborative manufacturing ecosystems provide a large volume of data collected in factories and derived from machines, sensor measurements, and manufacturing processes. All these data have the function of effectively supporting decision-making among collaborative ecosystem partners (Nizamis et al., 2018).

[INSERT HERE FIGURE 10]

3.5 Research methodologies used

Using the word combination search function of the MAXDICTIO section of MAXQDA, we were able to detect the most frequent methodologies used in published research on collaborative ecosystems. The most recurrent method used, with a frequency of 16, is the case study modeled on the prescriptions of Yin (1994; 2014). This qualitative approach is appropriate for holistically identifying and understanding complex phenomena and, more specifically, issues for which research is at an early stage—and, therefore, not highly developed—by answering "how" and "why" questions. A strength of the case study is that it facilitates a convincing demonstration of conceptual themes and related causal forces more than empirical research can (Siggelkow, 2007) and the possibility of creating empirically testable theories. In the reviewed literature, the case study method was predominantly in the form of single case studies and, in a few papers (with a frequency of 2), as multiple case studies.

A frequency of 2 was found for the design-led method. The use of the design-led method is justified by the authors (Brophy et al., 2020; Randhawa et al., 2021) to take a holistic design view by including the user at the center of the process—the user who is to be actively involved—in addition to technical and market factors, and technological, organizational and environmental aspects. In one publication, a literature review on collaborative ecosystems associated with a case study was carried out (Sharmelly and Ray, 2018).

Correlation analysis and probit model (both with a frequency of 1) were used to capture specific information that can support business decisions and strengthen motivations to participate in collaborative ecosystem management initiatives (Brody et al., 2006). In Abreu et al. (2018) the fuzzy logic method was used to model inaccurate modes of reasoning, which play an essential role in making rational decisions in environments marked with uncertainty and imprecision. The last detected methodological approach is the analytic hierarchy process, which is considered a "young" model (Saaty, 1987; Vargas, 1990) for investigating the driving forces of sustainable collaborative ecosystem development (Yan et al., 2020).

3.6 The most cited publications

Based on the analysis of the top ten most cited publications (Tab. 5), we argue that while the areas of investigation in some cases are very specific (Dyke et al., 2005; Bai and Velamuri, 2021; Baldassarre et al. 2020; Gerlak and Heikkila, 2011; Goyal et al., 2008; Randhawa et al., 2021; Sharmelly and Ray, 2018), there is a common thread linking them, namely the function of collaborative ecosystems as enablers of innovation. On closer inspection, collaborative arrangements, the basis of collaborative ecosystems, are also instrumental in addressing complex social problems, which impact the economic system and business models, where the capacity for collective learning is crucial in the perspective of their resolution. Such is the case with collaborative ecosystems that facilitate the transition to sustainable development (Baldassarre et al., 2020; Goyal et al., 2008) or collaborative ecosystems that help to restore the ecological integrity of

entire natural areas (Gerlak and Heikkila, 2011). Overall, we can conclude that the topic of collaborative ecosystems is treated by the most accredited literature from a multiple perspective (table 3), starting with the recognition that in order to realize new business opportunities and give rise to valuable solutions, it is necessary for the actors participating in the ecosystem to share their expertise, creating a relationship in which each entity influences and is influenced by the others (Davis, 2014; Gastaldi et al., 2015; Santoro et al., 2018).

[INSERT HERE TABLE 4]

4 Discussion

From the analyzes conducted on the main keywords, three clusters were identified that represent a schematization of the research topics related to collaborative ecosystems.
This classification allows giving an order to the heterogeneity of the literature on collaborative ecosystems by identifying the main themes that unite them. The three clusters are: ecosystem; competition; open innovation. In addition, the analysis of the literature conducted has also allowed us to formalize a taxonomy on collaborative ecosystems that aims to guide and open up new lines of research and theoretical developments.
We will now proceed to the analysis of each node; the presentation of the taxonomy; and finally, we will present the managerial implications and future research related to collaborative ecosystems extracted from the analyzed contributions.

4.1 Cluster 1 - Ecosystems

This first cluster, named is ecosystem, composed by four nodes: ecosystems, commerce, life cycle, and supply chains.
As might be expected, the literature on the subject can only start from a definition of ecosystem and its vital environment (Baldassarre *et al.*, 2020; Chen *et al.*, 2020; Costabile *et al.*, 2022; Dyke *et al.*, 2005).
To effectively manage resources to achieve strategic goals, companies must consider the interests of different stakeholders (Dyke *et al.*, 2005). For Baldassarre *et al.* (2020), the term ecosystem emerges as a new lens to frame such collaborations. Collaborative ecosystems are frequently created where the resources are strategic or particularly precious, scarce or for which protection is necessary as common goods or in the case of large projects that often see the involvement of the state or supranational organizations (Chen *et al.*, 2020; Costabile *et al.*, 2022; Dyke *et al.*, 2005; Gerlak and Heikkila, 2011; Taratori *et al.*, 2021; Yan *et al.*, 2018).
Governance issues are crucial (Bai and Velamuri, 2021; Baldassarre *et al.*, 2017; Brophy *et al.*, 2020; Santoro *et al.*, 2018; Randhawa *et al.*, 2021). The second node of the cluster is made to the platform (Chen *et al.*, 2020; Costabile *et al.*, 2022; Davis 2014) and, in particular, to the growing importance of e-commerce (Akyuz and Gursoy, 2020; Goyal *et al.*, 2018) and service sector (Nizamis *et al.*, 2018; Penter *et al.*, 2019; Quero and Mele, 2022; Sundmaeker and Einramhof, 2015). Regarding the node related to the supply chain the focus is on its profound changes (Penter *et al.*, 2019) and greater complexity (Shabah, 2015).

4.2 Cluster 2 – Competition

The second cluster, named competition, is the sum of three nodes: competition, emerging market, and innovation. The first node is related precisely to the competition, in particular to hyper-competition and a growing scarcity of resources (Brody *et al.*, 2006; Penter *et al.*, 2019; Randhawa *et al.*, 2021; Konstantinidis et al. 2021).
Academics are “principal orchestrators” of innovation, second node of the cluster. They, better than others, are able to coordinate and manage innovation and ecosystems. Sectors that are experiencing change are the sectors where the most investment is made in research and it is no coincidence that the health sector is the one that appears most frequently (Randhawa *et al.*, 2021; Thakur *et al.*, 2018; Youn *et al.*, 2022). Also, sectors where digititalization has had a disruptive impact, e.g. the financial sector (Sundmaeker and Einramhof, 2015) and innovation related as blockchain (Akyuz and Gursoy, 2020) or finally where the need for careful management of resources is greater: timber and forestry industry (Brody *et al.*, 2006; Dyke *et al.*, 2005), aquaculture (Costabile *et al.* 2022), science and natural park (Biggs *et al.*, 2010; Gerlak and Heikkila, 2011; Yan *et al.*, 2020), circular and sharing economy and small-medium firm (Bai and Velamuri, 2021; Quero and Mele, 2022; Santoro *et al.*, 2018; Stewart and Gapp, 2018). The last node, emerging markets is focus on startups active in the circular economy, e.g. Sharmelly and Ray (2018), starting from the application of institutional theory recognize the role of collaborative ecosystems and frugal innovation in creating product innovation and create value both for business and, above all, for consumers.

4.3 Cluster 3 – Open innovation

The third cluster that emerged from the analysis is the Open innovation cluster, constituted by the following four nodes: business model, circular economy, open innovation, and value creation. The cluster is the larger and more distant from the other two but strictly related especially the node of ecosystem for cluster one and the innovation node for cluster two.

Open innovation paradigm facilitates the creation of collaborative ecosystems and allow a firm to create value through external stakeholders (Randhawa *et al.*, 2021). Correct management of knowledge and an open innovation that appraise both knowledge's internal and external sources is a key point for competitive advantage creating an "open knowledge system" (Santoro *et al.* 2018) develop "lean" business model (Thakur *et al.*, 2018). Circular economy is the third node that weave this cluster (Goyal *et al.*, 2018) and business model (Abreu *et al.*, 2018; Goyal *et al.*, 2018) evidence that value creation depends on the role of companies in the ecosystem (Quero and Mele 2022). Value could be created from new resources or by reusing those already present, making it possible to create (Goyal *et al.*, 2018) a new ecosystem characterized by zero waste and resilience. Openness in innovation itself is a signal from companies in terms of willingness to collaborate (Santoro *et al.*, 2018). Ecosystem boundaries depend on the platform and the type of knowledge resources that the platform provides, this last is the fourth node of the analysis and it is transversal to all the contributes (Akyuz and Gursoy, 2020; Brophy *et al.*, 2020; Quero and Mele, 2022; Randhawa *et al.*, 2021; Taratori *et al.*, 2021).

4.4 A taxonomy of collaborative ecosystems

Our analysis showed that substantial literature has developed on the topic of collaborative ecosystems, characterized by the heterogeneity of application areas and the different declination of the phenomenon.
To date, scholars have not provided a definition of "collaborative ecosystem" and have presented different meanings of the term. However, no shared system of categorization of such collaborative models has been identified.
Based on these assumptions, and to bring order to such a broad and heterogeneous field, we have developed a taxonomy (Geddes and Lindebaum 2020) of the main types of collaborative ecosystems proposed in the literature. We believe that it can be useful to guide future studies and facilitate companies in the process of identifying and selecting the type of collaboration best suited to their objectives. Therefore, from the studies conducted so far on the topic, we propose a taxonomy (table 5), which we will now explore in each of its elements.

[INSERT HERE TABLE 5]

4.5 A research agenda for collaborative ecosystems

A research agenda for the future has been developed which starts from the following indications highlighted by the literature investigated (table 6).

[INSERT HERE TABLE 6]

5. Research limitations

The work is not immune to some limitations inherent in the methods and analysis techniques used. The first limitation is the small number of databases assessed (only Scopus and Web Of Science); therefore, we may have missed some additional papers on collaborative ecosystems present in other databases. Another limitation of this research is that the investigation has been confined to a specific set of keywords related to collaborative ecosystems within the managerial area. Hence, only further research can expand the selection of keywords or use more elaborated queries for the proper comparative analysis of results to enlarge the field of investigations and not confine it to articles only in English. A further limitation is to have conducted the investigations and reflections on the basis of specific quantitative clusters identified. Therefore, it is important that future research, as the literature on the topic grows, further investigates which themes and elements are related to collaborative ecosystems. Finally, some limitations of the paper are related strictly to the bibliometric analysis method used therein. While it allows us to assess the broader picture of the state of art, a bibliometric review certainly lacks the depth of thematic exploration of a systematic literature review. The problem here lies the compromise. As we opted for a more holistic understanding of the phenomenon of collaborative ecosystems and were interested in analysis that transcends the mere thematic explorations of concepts and topics within the field but includes the description of the meta-characteristics of the state of the art (in particular, who are the main contributors and how they are related), we opted in favor of a combination of systematic literature review, bibliometric analysis and content analysis. The latter was performed regardless of the fact that the number of papers retrieved (86) seems to allude to the appropriateness of a systematic literature review only. Indeed, we believe that a bibliometric literature review is still useful in this case as 1) the field of study is emergent, and no proper bibliometric assessment has been performed in the past, 2) it allowed for a more nuanced understanding of meta-characteristics of the field, something that would be impossible to accomplish with a mere systematic literature review, 3) it complements and does not substitute a systematic literature review which is also included in the paper. Hence, with a complementary bibliometric assessment, even if the corpus of the assessed papers is still low, we were able to "take a snapshot" of the state of the art in the interim, given that the research program is still new and emerging.

6. Conclusion and managerial implications

The contemporary scenario appears to be rich in collaborations and this analysis confirmed that the literature on the topic of collaborative ecosystems have relevant peculiarities that only a literature review could led to order.

At theoretical level this analysis enrich the literature present at the date because it allows to define a taxonomy of collaborative ecosystems whose declinations favour interesting insights for the development of promising future research paths. From the analysis of the literature, it is not possible identify a single reference journal confirming the heterogeneity of application areas, but the frequency of publication is increasing over time. The method most frequently adopted to study collaborative ecosystems is the case study. A single collaborative ecosystem is most frequently studied going in depth, but there are also studies that focus on multiple cases. The most quantitative approaches are regressions, probit models and fuzzy analyzes aimed at understanding the functioning and willingness to participate in collaborative ecosystems. In terms of sectors that are most influenced by collaborative ecosystems, we note that they are the sectors where the need for innovation is strongest, but also sectors and markets, such as emerging ones, where resource management is more delicate, because collaborative ecosystems have the ability to solve complex problems. In order to resolve this complexity and to operate at their best, they exploit the technological potential through personal platforms.

The bibliometric analysis conducted on the keywords connected has identified three main clusters. The first cluster refers to the keyword ecosystem identifies the nature and environment in which a collaborative ecosystem develops. The second cluster of the competition determines the boost to the life of the ecosystem to compete in a scenario that requires continuous innovation and the management of increasingly scarce resources. The last cluster is that of open innovation, in collaborative ecosystems innovation, thanks to more blurred boundaries and trust among the participants, can be generated in a more transparent way and we could dare to be more flexible.

On a managerial level, the study highlights how in the contemporary scenario, thanks also to new technologies such as artificial intelligence and blockchain (Chaudhuri et al. 2023), but in general all phenomena concerning digitisation and the development of a 5.0 Society, there is a growing interconnection between ecosystems and the development and emergence of collaborative ecosystems. For example in the banking ecosystems and the intersections present where the collapse of one bank ecosystem can lead to the failure of many others, and which determines how crucial it is to initiate and manage collaborative relationships between them on a managerial and social level. Likewise, the clash and transformation taking place in the service sector, where both the financial and health ecosystems are increasingly evident in collaborations with more technological ecosystems, or the development of smart cities and environmental challenges that impose new collaborative solutions. As we see in the face of such changes, this study provides a clear taxonomy of the type of collaborative ecosystem to be put into action in order to achieve a specific objective, the motivations underlying their emergence and diffusion, and the criticalities present.Several are theimplications, in fact the study highlight that the management of collaborative ecosystems requires adequate planning of resources, roles and the sharing of a shared common plan. During the different life stages of a collaborative ecosystem, its components must be able to accept governance changes since their life path and project could. The role of companies in ecosystems can be different and not all at different levels derive the same advantage from it. It is important to create commitment and synergy right away as well as to keep them both alive over time. The new ecosystem managers have to be prepared to face the new challenges that collaboration between ecosystems can open up. These managers must therefore carefully define who will orchestrate the ecosystem in the different stages of process development or for the achievement of a goal having in mind how an ecosystem operates, they will have to be prepared to focus on the medium term given the relevance of many projects that lead to the creation of collaborations between ecosystems, and they will have to be skilled diplomats able to strengthen co-opetition strategies between the different parts of collaborative ecosystems. At the managerial level, knowledge management and facilitation of Open Innovation practices will be important at an internal level (Santoro et al. 2019) but also at ecosystem level, as well as managing the communication and networking strategies of the collaborative ecosystem in the best possible way by fostering the intersection of nodes and complementing which ones to leverage in order to preserve and strengthen the collaborations established voluntarily or forcibly. Those called to administer collaborative ecosystems must try to operate in a detached manner and be attentive to the needs of individual components as well as of the entire ecosystem, potential future research could thus investigate the skills and capabilities necessary to achieve both.

At the societal level, public and policy makers will be able to enable the development of collaborative ecosystems in order to better manage resources, especially scarce ones, to reduce the risks associated with innovation and the major challenges they face, and to create value for multiple counterparts by developing them on multiple fronts. Policy makers will need to be attentive above all to ensure good governance between the different levels of collaborative ecosystems and to guarantee the proper functioning of the network over time and a wise management of the knowledge that fuels the open innovation that is generated and that often underpins collaborative ecosystems. It will be important for research and academia to highlight the contribution that as evidenced by this review they can make in ensuring and developing collaborative ecosystems in the best possible way, especially those that in the taxonomy rise to the typology of smart collaborative ecosystems, grassroots and innovative ones.

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Yin, R. K. (1994). Case study research: design and methods. Sage Publications, Thousand Oaks, California, USA.

Yin, R. K. (2014). Case Study Research: Design and Methods. SAGE, Thousand Oaks, CA.

Youn, S. H., Geismar, N. and Pinedo, M., (2022). 'Planning and scheduling in healthcare for better care coordination: Current understanding, trending topics, and future opportunities'. *Production and Operation management*, 1- 17 https://doi.org/10.1111/joms.12854

Response to the Editor and Reviewers

Manuscript ID EMJB-10-2023-0276

"~~Collaborative Ecosystems: a new research agenda and taxonomy through a systematic literature~~"

NEW TITLE: "Collaborative Ecosystems: a taxonomy and new research agenda"

Dear Editor and Associate Editor,

We are grateful to the Editor and the Reviewers for their valuable comments and suggestions on the above manuscript. We are very glad to hear that they are satisfied and thank you and the Reviewers for your effort and availability towards our article. We have revised the manuscript to address the concerns raised by the Reviewers. In the revised manuscript, all new additions and changes are highlighted and we opt for change the title due to revision and improvement of the paper after the very useful and kind revisions in "*Collaborative Ecosystems: a taxonomy and new research agenda".*

We improved the introduction and revised the language, as suggested. We revised and strengthened the methodology part. In particular, we have explained the selection of the bibliometric method for analysing a smaller sample than suggested by Donthu et al. (2021), highlighting the validity of this method in answering the research questions that guided this paper.

The managerial and theoretical implications have been increased and we hope that the relevance of the study and the possible opportunities that the development of collaborative ecosystems will open up will become clearer. We have introduced possible social implications. We have highlighted the limitations of the research and the possible future research determined by them.

We have revised all figures and tables, we apologise again for the error but some final revisions and attention to the character limit have led us to revise our work.

We thank you again and hope very much that this revised version will satisfy the minor revisions made by the two Reviewers; if not, we remain at your disposal to make further revisions and improvements to the work.

Answer to Reviewer 1

1. Originality: Does the paper contain new and significant information adequate to justify publication? Clarity of Aim and Objectives?: It is a very interesting article, with clear aim and objectives Abstract: The four sub-headings (Purpose, Design/methodology/approach, Findings, Originality) and their accompanying explanations are included. However, due to the purpose of the study the following sub-headings, Research limitations/implications or Practical implications will further highlight the significance of the study.

Answer 1: Really thanks for your kind evaluation and to have appreciate our efforts. We have added some managerial and social implications so as to how the paper contribute at theoretical level.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored? Correlation between Literature Review and Results? Correlation between Aim/Objectives/Hypotheses and Results?: The Theoretical background is well presented. The conceptual framework is well presented.

Answer 2. Thanks again for your consideration and deep evaluation.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: The article has a well-structured methodology. Bibliometric analysis. It is not clearly presented the number of the articles that are included in the analysis. Are they 85? According to Donthu et al (2021) a bibliometric analysis should not be used when the dataset is small and manageable enough that its content can be manually reviewed. The authors should further explain why they perform a bibliometric analysis while the number of the articles are so few.

Answer 3. Dear Reviewer, absolutely, we have updated the methodology by explaining why we chose the bibliometric method on a reduced number of contributions. We specify that in total and as shown in the figure, 86 contributions were analysed. The bibliometric analysis, as mention in a new dedicated sections to limitations, as suggested to enhance by Reviewer 2, not left space to the interpretation of the researcher's different considerations, allows to have a specific vision of the architecture and it allowed for a more nuanced understanding of meta-characteristics of the field. The systematic literature review, it complements and does not substitute a systematic literature review which is also included in the paper. Just to better clarify this issue, we have added the following to the end of Section 3: *After creating the dataset, as a first step, a systematic literature review was performed by critically reading and synthesizing all the included scientific contributions (Duque-Uribe et al., 2019). Next, a bibliometric analysis was conducted to detect the productivity and impact of scientific production, along with the interactions among scholars and the themes that define the overall intellectual structure of the topic of interest. Finally, through content analysis we defined current trends by identifying the themes of each cluster and suggestions for future research. It is precisely the combination of all three method includes proaches (SLR, bibliometric analysis, and content analysis) that allows us to understand and discover the intellectual structure of a research area and present a complete synopsis of the topic of the paper (Bhandari, 2023; Fatima, Singh, 2023).*

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: Results and Discussion are well presented

Answer 4. Again, we are very thankful for your attentive reading and support.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: Conclusions are interesting. The number of the articles for the bibliometric analysis is a limitation that should be mentioned. Maybe limitations should follow the "Discussion" section. In the conclusion section implications for research, practice and/or society should be discussed. It is not clear in the introduction or in the conclusion section how the paper bridge the gap between theory and practice, how can the research be used in practice, for example in teaching, to influence public policy, in research (contributing to the body of knowledge), to impact upon society. These issues should somehow be addressed.

Answer 5. Dear Reviewer, unfortunately the number of characters led us to cut this part, which we have now increased both in contribution and theoretical and socio-managerial implications in the specific paper section. In addition, we have included a specific section to describe the research limitations as you suggested and for which we thank you. We hope they are now of interest and enjoyment to you.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: Some sentences in the section of "Introduction" are confusing. For example, the text from line 27 to line 29, i.e. "…Firms to be able ….by the others (…2007)", is not understandable. The Introduction needs further lanuage editing.

Answer 6. Dear Reviewer we have reviewed the introduction and as written we regret the error in the numbering and positioning of the images due to the final revisions and the enthusiasm to submit our work. We thank you for your attention and precision that will allow us to arrive at a significantly improved and solid work.

Answer to Review 2

Additional Questions:

1. Originality: Does the paper contain new and significant information adequate to justify publication? Clarity of Aim and Objectives?: The paper addresses a current and relevant topic and appears to contain new and significant information that could justify publication. The clarity of aim and objectives in this excerpt is strong. The background and rationale are well-established, the literature gap is clearly identified, and the purpose of the study is directly linked to addressing this gap. The research questions are specific, relevant, and align with the overall objective of advancing the field of collaborative ecosystems.

Answer 1: Dear Reviewer we are very pleased and delighted to read your valuable comments, thank you.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored? Correlation between Literature Review and Results? Correlation between Aim/Objectives/Hypotheses and Results?: The paper appears to demonstrate an adequate understanding of the relevant literature and cites an appropriate range of sources and demonstrates a well-structured research approach where the literature review, research questions, methodology, and analyses are all cohesively aligned to address the central theme of collaborative ecosystems in business.

Answer 2: Thank you again for your attention and appreciating our efforts.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate? The paper's argument is built on a solid foundation of relevant theories. The research on which the paper is based is well-designed, and the methods employed are appropriate for the study's aims and scope. This methodological approach enhances the credibility and validity of the study's conclusions.

Answer 3: Dear Reviewer, we are glad of your evaluation and happy to hear that.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: For the paper to be effective, the results need to be presented in a manner that is both clear and analytically sound. Although conclusions integrate the results with the paper's theoretical framework, research questions, and methodological approach, results representation needs to be improved.

For example:

1. There were found two different Fig.8, and not found Fig.7;
2. Table 3 in the text referred as Table 5 (See chapter 3.6);
3. In the chapter 4.4 Table 6 is mentioned and it's not attached to the paper;
4. Fig.5 is attached but has no reference in the text;
5. Fig. 3 - "Documents by year" has no scale for dimension named Number of publications.

Answer 4: Dear Reviewer, thank you very much for your attention in reviewing our paper, as mentioned to Reviewer 1, the enthusiasm in submitting the paper led us to make these mistakes. Regarding the underlined elements on the results, we have also expanded this part.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: The paper articulates how its findings contribute to the existing body of knowledge by suggesting potential avenues for future research.

However, The paper needs to discuss how its findings can be applied in practical settings, particularly in business environments. This might include recommendations for how organizations can develop or manage collaborative ecosystems more effectively. The author briefly mentioned this matter in the conclusion, but it was not developed to a reasonable extent.

The study should also consider its broader impact on society. This could involve discussing how better understanding and management of collaborative ecosystems could affect societal issues like sustainability, economic development, or innovation.

Answer 5: Dear Reviewer, your expertise and valuable comments have been listened to and carefully followed by increasing and expanding these parts. Unfortunately, the limitation in the journal's characters meant that we had to choose which parts to reduce, we are glad that you gave us the opportunity to integrate and demonstrate how our study can support management and society at a political as well as academic level and what future research can look like. Thank you for making our paper better.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: Paper effectively conveys its message in terms of its use of technical language, clarity of expression, and suitability for the journal's readership. The use of figures, tables, and charts needs enhancement.

Answer 6: Dear Reviewer, we have improved tables, figures, and graphs as suggested. Thank you and we hope that the paper will now find its approval.

Table 1 - Citation analysis results

Document	Citations
Randhawa K. (2021)	15
Baldassarre B. (2020)	25
Santoro G. (2018)	300
Goyal S. (2018)	102
Sharmelly R. (2018)	19
Gastaldi L. (2015)	15
Davis J.P. (2014)	10
Gerlak A.K. (2011)	149
Dyke J. (2005)	10

Source: our elaboration

Table 2 - Co-authorship network analysis of results by countries

Country	Documents	Citations	Total link strength
United States	9	301	6
Australia	6	37	4
India	2	109	3
Italy	4	317	3
Canada	2	10	2
France	1	102	2
Brazil	1	0	1
Cyprus	1	300	1
Finland	1	25	1
Greece	1	2	1
Hungany	1	0	1
Netherlands	1	25	1
Saudi Arabia	1	7	1
Spain	1	0	1
China	2	15	0
Germany	2	2	0
Norway	1	0	0
Singapore	1	1	0
Turkey	1	5	0

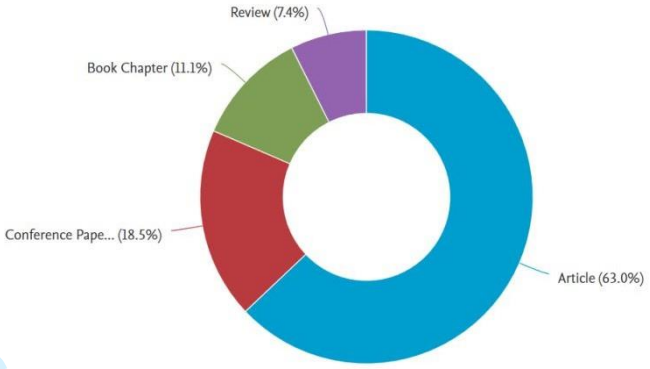
Source: our elaboration

Table 3 - Co-citations analysis results

Author	Citations	Total link strength
Tan H.P.	11	0
Bocken N.	13	13
Gulati P.	10	22
Adner R.	12	28
Chesbrough. H.	11	30
Gawer A.	10	36
Gummesson E.	101	100
Vargo S.L.	10	101

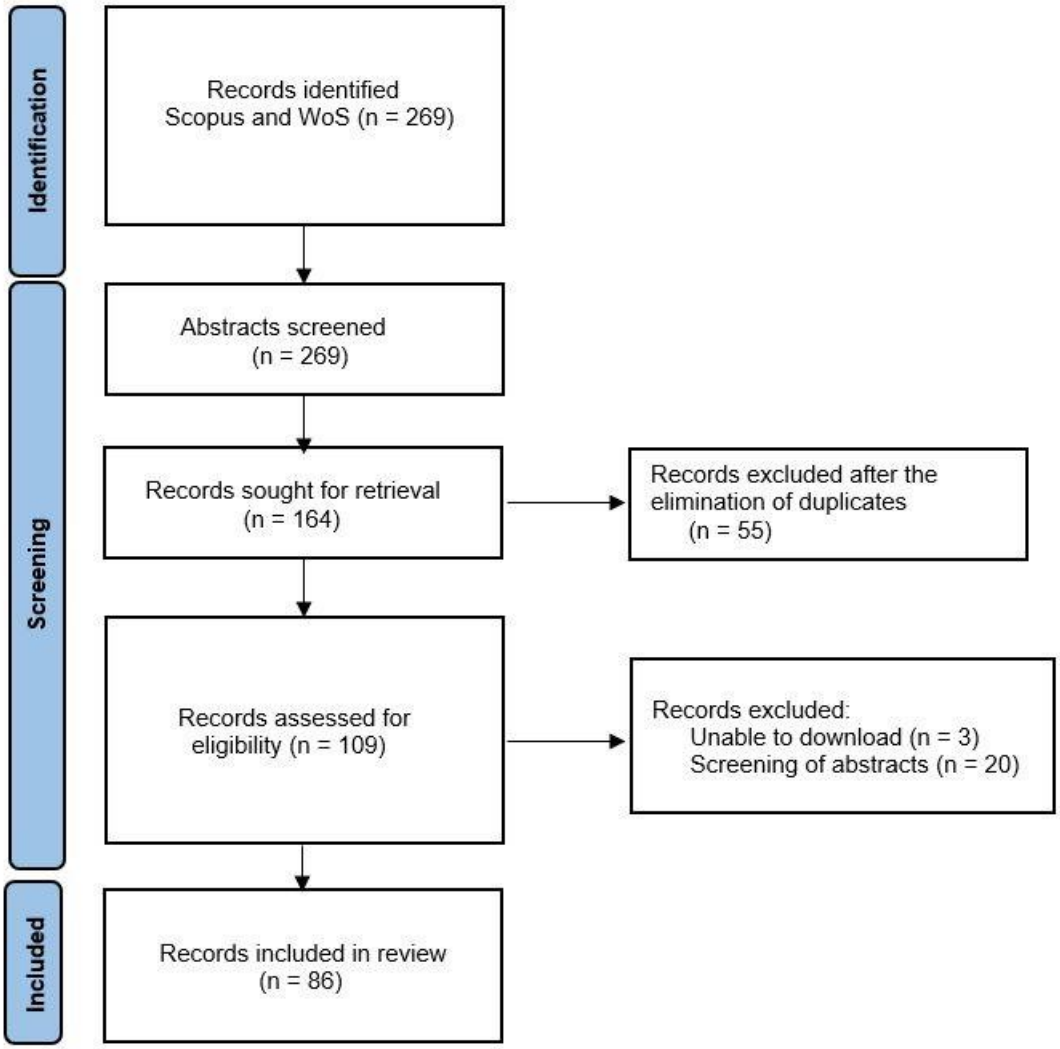
Source: our elaboration

Fig. 1- Documents by type



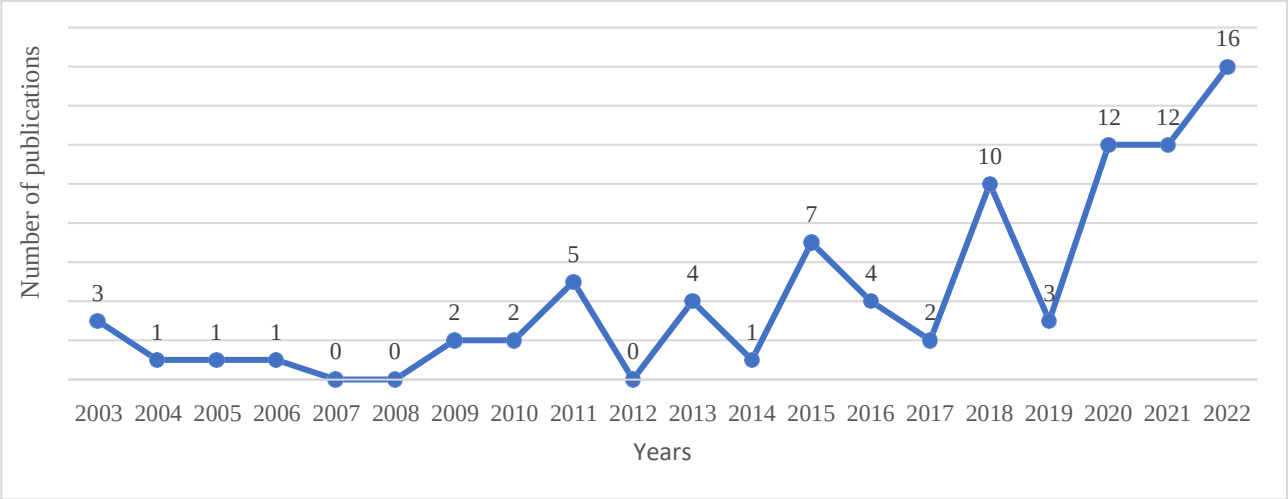
Source: Author's elaboration

Fig. 2 - Four stages of articles' selection based on PRISMA 2020 criteria



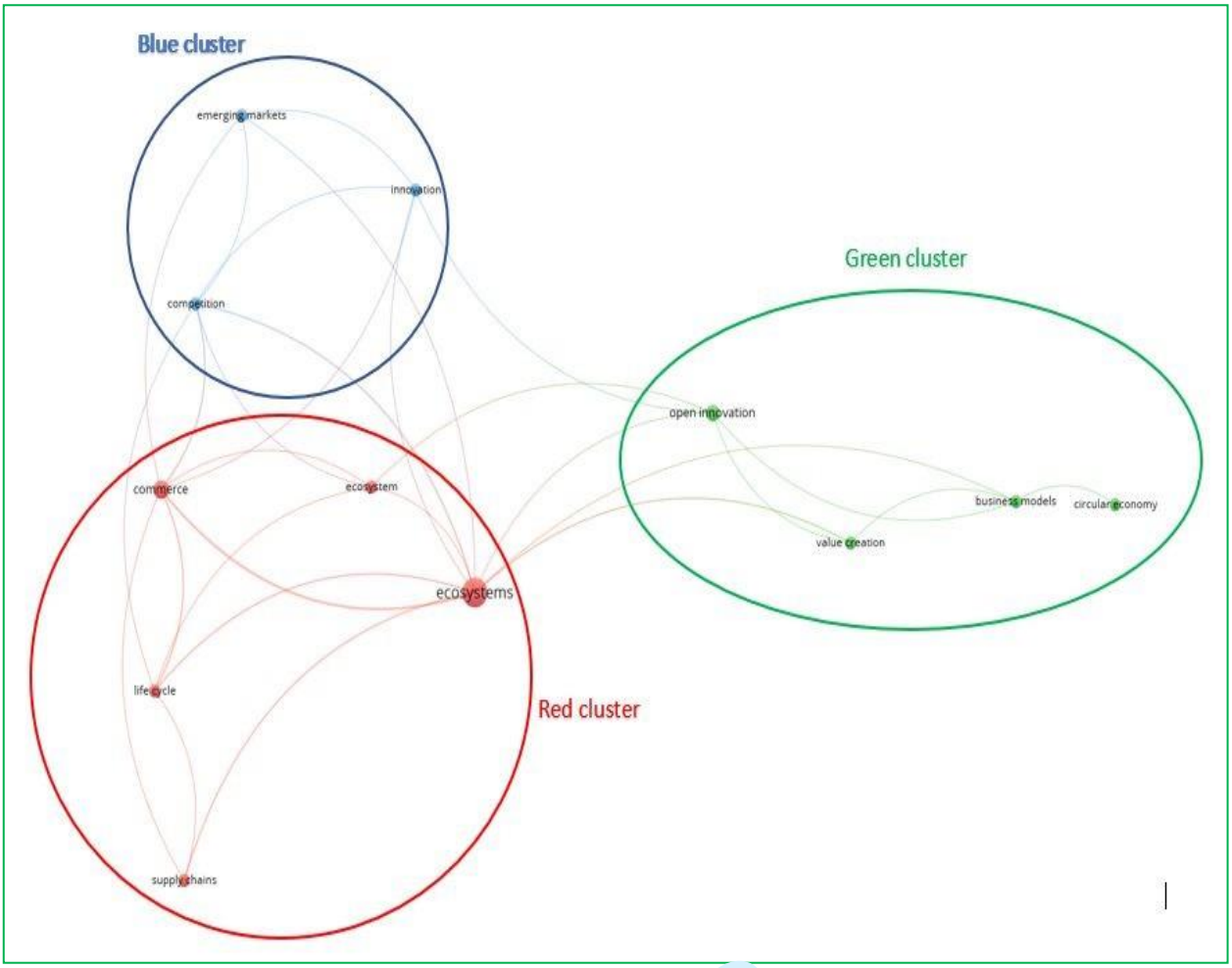
Source: Author's elaboration

Fig. 3 - Documents by year



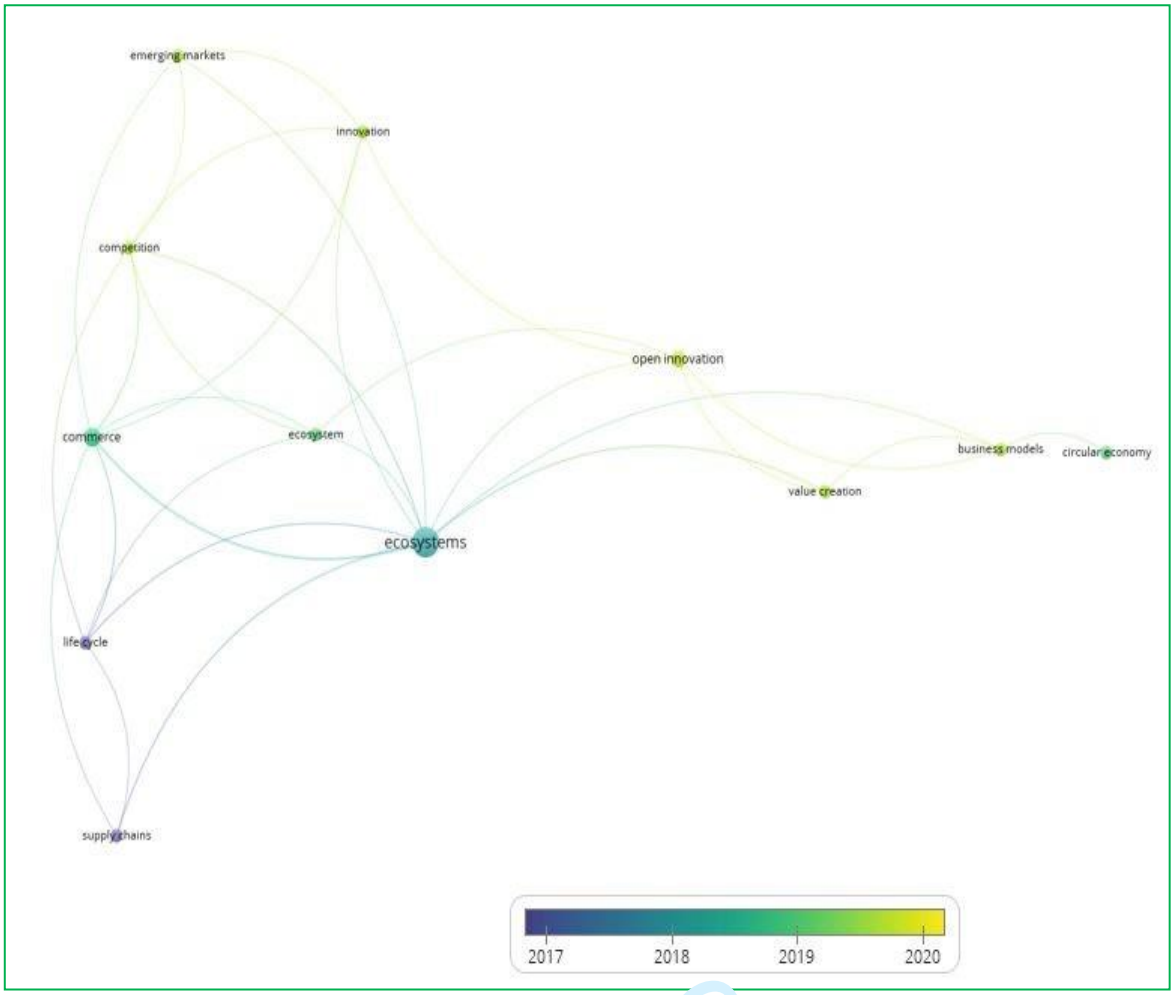
Source: our elaboration

Fig.4 - Keyword network clustering results



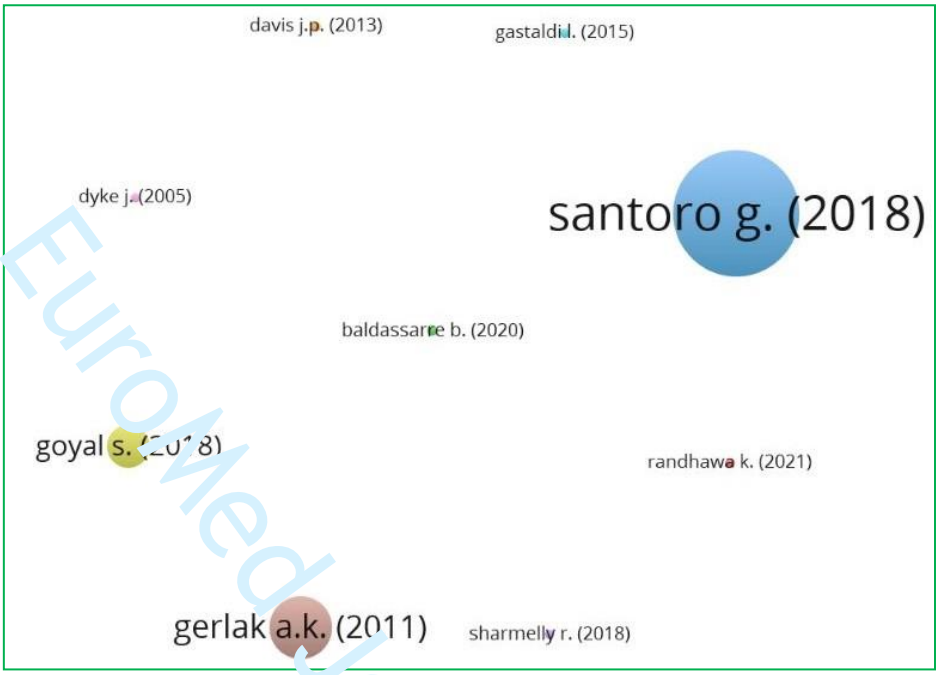
Source: our elaboration

Fig. 5 - Term co-occurrence map in abstracts and titles of retrieved records



Source: our elaboration

Fig. 6 - Citation analysis results

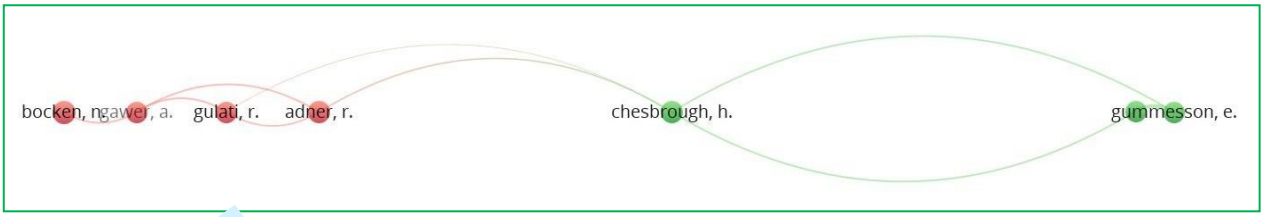


Source: our elaboration

Fig. 7 - Co-authorship network analysis of countries results (in Overlay Visualization)

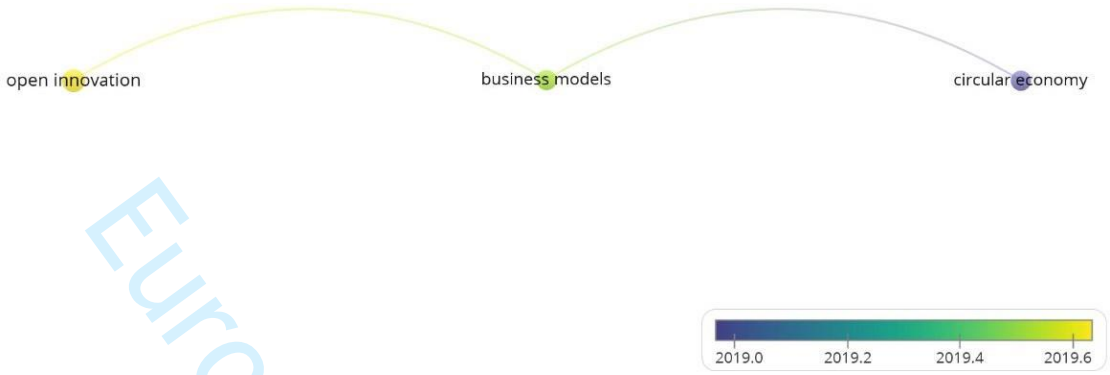
Source: our elaboration

Fig. 8 - Co-citations analysis results



Source: our elaboration

Fig. 9 - Co-Occurrence Network Analysis of Author results



Source: our elaboration

Fig. 10 – Evolved forms of collaborative ecosystems

Source: our elaboration

Table 4: Top ten most cited publications

Year	Authors	Title	Journal	Citations
2018	Santoro G., Vrontis D., Thrassou A., Dezi L.	The Internet of Things: Building a knowledge management system for open innovation and knowledge management capacity	Technological Forecasting and Social Change	300
2011	Gerlak A.K., Heikkila T.	Building a theory of learning in collaboratives: Evidence from the everglades restoration program	Journal of Public Administration Research and Theory	149
2008	Goyal S., Esposito M., Kapoor A.	Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms	Thunderbird International Business Review	102
2020	Baldassarre B., Keskin D., Diehl J.C., Bocken N., Calabretta G.	Implementing sustainable design theory in business practice: a call to action	Journal of Cleaner Production	25
2018	Sharmelly R., Ray P.K.	The role of frugal innovation and collaborative ecosystems: The case of Hyundai in India	Journal of General Management	19
2021	Randhawa K., West J., Skellern K., Josserand E.	Evolving a Value Chain to an Open Innovation Ecosystem: Cognitive Engagement of Stakeholders in Customizing Medical Implants	California Management Review	15
2015	Gastaldi L., Appio F.P., Martini A., Corso M.	Academics as orchestrators of continuous innovation ecosystems: Towards a fourth generation of CI initiatives	International Journal of Technology Management	15
2014	Davis J.P.	The emergence and coordination of synchrony in organizational ecosystems	Advances in Strategic Management	10
2005	Dyke J., Cash S.B., Brody S.D., Thornton S.	Examining the role of the forest industry in collaborative ecosystem management: Implications for corporate strategy	Corporate Social Responsibility and Environmental Management	10
2021	Bai G., Velamuri S.R.	Contextualizing the Sharing Economy	Journal of Management Studies	9

Source: our elaboration

Table 5: Taxonomy of collaborative ecosystems

Type of collaborative ecosystem	Description
Collaborative grassroots ecosystem	A collaborative grassroots ecosystem arises to take advantage of opportunities of innovative legislative and institutional arrangements (Biggs et al., 2010). Several countries have experimented with innovative legislative and institutional arrangements to stimulate the formation of collaborative grassroots ecosystem-management groups. For example, in Sweden a law was passed in the 1980s that allowed the formation of local fishermen's associations. The benefit of forming these associations is related to the possibility of accessing government funding, as well as having some legal powers related to setting fishing quotas and managing land use in the lake basins they manage.
Open collaborative ecosystem	An open collaborative ecosystem (OCE) is "based on principles of integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and extraordinarily rapid adoption. They also capture the elemental characteristics of the constant transformation of network ecosystems: the continual realignment of synergistic relationships of people, knowledge and resources for both incremental and transformational value co-creation" (Gastaldi et al., 2015). Open collaborative ecosystems are grounded on: integrated collaboration principles, which contribute to both incremental and radical value co-creation through synergistic relationships among people, knowledge and resources; developed innovation ecosystems; and advanced technologies that can be quickly implemented. In this perspective, with the emergence of OCEs there has been a profound change in the competitive landscape (Gastaldi et al., 2015; Quero and Mele, 2022). Collaborative ecosystems thus take on the function of innovation accelerators through the sharing and exchange of knowledge and experience among actors, and co-innovation networks are thus activated. In fact, firms involved in more types of collaborative ties in their competitive environment are more innovative. Collaborative arrangements have the advantage of allowing firms, which make up the ecosystem, to mitigate the risks associated with innovation and share the necessary resources, including knowledge In other words, it is assumed that the existence of a "healthy" collaborative environment enables firms to operate more cost/time/quality efficiently in the development of innovation processes and thus be more competitive.
Collaborative manufacturing ecosystem	A collaborative manufacturing ecosystem provides a high volume of data, collected from factories and commonly related to machine data, sensor measurements and production processes (Nizamis et al., 2018). This type of ecosystem meets the requirements of modern manufacturing processes that need to be agile and flexible to facilitate faster production cycles, higher productivity and reduced waste. Data and services have become the key enabler of production processes. The need to react to changing market demands requires linking supply chain data and services across enterprises and connecting value chain data within a factory to support decision making.
Collaborative sourcing ecosystem	Penter et al. (2019) introduced the concept of collaborative sourcing ecosystem to explain a longitudinal case studies of a global mining company ("GMC") and a group of its suppliers. The case study shows that adopting an open and collaborative sourcing ecosystem that draws on secondary markets helps to bridge the skills gap. In particular, GMC has developed a big data platform to support internal staff, customers, consultants, and third-party suppliers in creating applications that can transform the global mining and smelting industry to achieve a price premium for its products.
Collaborative multi-partner ecosystem	A "multi-partner collaborative ecosystem" is associated with the transformation of supply chain activities generated by blockchain technology (Akyuz and Gursoy, 2020). Blockchain technology will lead to the creation of transparent and reliable collaborative ecosystems that promote full integration, visibility and traceability among partners. Blockchain becomes an enabler of a collaborative network because of its inherent characteristics: it provides symmetric information between partners; increases efficiency and accuracy of operations, which leads to operational excellence; serves for the development of joint and efficient processes; provides full visibility and transparency; synchronizes material management and financial aspects; and increases trust and collaboration between partners.
Collaborative and smart	Taratori et al. (2021) introduced the concept of intelligent collaborative ecosystema and its key role in solving complex problems, such as rapid urbanization and climate change.

ecosystem	They pointed out that the triple helix model can be the pioneer of "smart" collaborative ecosystems. The central idea of this model is that "innovation ecosystems" in cities are developed together with three types of agents: universities; industrial sector and government (local, regional, national and international). The Triple Helix model (THM) aims to overcome the approach whereby each actor embarks on individual and, often, self-referential paths: the central government, with policies that are often not shared with the recipients; industry, with transfer processes that are not calibrated to local actors; and the university, with training paths that are not open to the surrounding context. As an alternative to this approach, the THM provides for government collaboration with the industry engaged in mechanisms for technology transfer, as well as its generation, and the university with an active role in training, also at the entrepreneurial level and in local community development. Therefore, the rationale behind the THM envisions that actors traditionally used to work separately operate in an integrated and participatory manner, also generating virtuous overlaps leading to the creation of shared value.
Collaborative innovation ecosystem	Randhawa et al. (2021) explain the evolution of the enterprise in moving from the traditional value chain to a collaborative innovation ecosystem. The authors examine how one company, a manufacturer of medical prosthetics, used cognitive artifacts to shift to open innovation and develop radical innovations in both its manufacturing technology and its business model. In doing so, the company went from mass production to highly customized production with prostheses made just-in-time from specific patient needs through the use of 3D printing. The company has thus transformed its value chain into a collaborative innovation ecosystem. The authors highlight however that these ties to external stakeholders can also provide constraints that limit a company's ability to evolve its strategy to pursue new opportunities, particularly in the cognitive understanding of how the company and its partners should create and capture value.
Collaborative digital platform ecosystem	Collaborative digital platform ecosystem is the result of agreements between independent companies working together to develop and govern a digital platform to generate mutual benefits (Costabile et al., 2022). Platform ecosystems comprise four types of actors: the central platform owner who facilitates collaboration and interconnection among participating firms, interface providers, service producers, and service consumers. Although a focal actor provides the necessary backbone, it is unlikely to exercise direct control over other independent participants. Platform ecosystems are organized around fundamental principles of modularity, heterogeneity, complementarity and interdependence. Despite the complexity stemming from the intertwining of organizations, institutions, markets and technologies, platform ecosystems are emerging in various sectors such as banking, healthcare, and energy.

Source: our elaboration

Table 6: A New Research Agenda for Collaborative Ecosystem

Gap	Research question	References
Collaborative Ecosystem nature	What are differences and categories of collaborative ecosystem?	Bai and Velamuri 2021
	What are the main elements and configuration in ecosystem design?	Akyuz and Gursoy 2020;
	And the organizational organizational behaviour in and between ecosystems?	Bai and Velamuri 2021
	How standardization and how non-generic complementaries could affect the collaboration and coordination in developing ecosystem's standards?	Costabile 2022
	What intercultural analysis of ecosystem could reveal?	Gastaldi et al. 2018
	What is the role of technology service providers and the availability of their implementation?	Brody et al. 2006; Penter et al. 2019
Collaboration out and in Collaborative Ecosystem	How ecosystems evolve over time and what effects collaboration and coordination entail?	Nizamis et al. 2018; Costabile et al. 2022
	Why do ecosystems settle in their nascent stages? And how do stakeholder expectations and values vary over time?	Brophy et al. 2020
	What are the roles and benefits of being in collaborative ecosystems?	Dyke et al. 2005
Collaborative Ecosystem strategy	What are different strategies adopted by different ecosystems?	Bai and Velamuri 2021; Chen et al. 2020
	What are and how implemented strategy at intra- and inter-ecosystem level? Especially for platform economies	Bai and Velamuri 2021
	What are motivation and benefit in participating in collaborative ecosystems?	Brody et al. 2006
Innovation	What are the factors in underlying innovation?	Gerlak and Heikkila 2011; Santoro et al. 2018
	What are factors in variety of underlying innovation?	Abreu et al. 2018
	What is and wich effect have the role of balanced centricity in innovation and the role it assumes at the process level?	Quero and Mele 2022
	What role standardization practices assume in ecosystem innovation?	Costabile et al. 2022
Open Innovation	how partnerships are generated, how companies decide to join the ecosystem, and whether, for example, there is a selection process or who leads the innovation	Brophy et al. 2020
	If and how collaborative's ecosystems could lead us to more smart cities	Taratori et al. 2021
Measure and Performance of Collaborative Ecosystems	What are the new indicators and performance measure for collaborative ecosystem?	Yan et al. 2020
	Which impact have collaborative ecosystem on resource management and at social and environment? And, in converse, what and which is the impact of society and environment on the collaborative ecosystem?	Dyke et al. 2005
Resource management	Insight into the use of mechanisms dealing with resource rigidity and routine rigidity?	Gastaldi et al. 2016
Business Model	At what level and how the business model learnings are influenced by undertaking the survey of different companies in emerging economies?	Baldassare et al. 2020
	How this impact on business model innovation in emerging markets?	Saquib and Satar 2021

Source: our elaboration