Assessing the interplay between Open Innovation and Sustainability-Oriented Innovation: A systematic literature review and a research agenda

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Abstract

Open Innovation and Sustainability-Oriented Innovation are undoubtedly two of the most debated topics of the last decades, gaining the interest of policymakers, practitioners, and scholars all over the world. Even if they have been usually described as two independent research fields, there are some emblematic examples presenting interplay and synergy between these topics, represented either by the hybrid perspectives of *Open Sustainable Innovation*, i.e., the Open Innovation approach acting as an enabler of Sustainability-Oriented Innovation, and *Sustainable Open Innovation*, which instead analyzes how firms developing Sustainability-Oriented Innovation also adopt the Open Innovation approach. On the basis of these two perspectives and through a systematic literature review, this paper investigates the relationships between the Open Innovation and Sustainability-Oriented Innovation approaches and frames these relationships by developing an innovative framework, which highligths the main aspects characterizing the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*. The proposed framework highlights the Open Innovation practices and strategies enabling Sustainability-Oriented Innovation, as well as the contextual factors enabling both practices and strategies for Sustainability-Oriented Innovation. In addition, it shows how firms developing Sustainability-Oriented Innovation have a similar orientation towards the adoption of the Open Innovation approach both in terms of how they engage stakeholders, and the innovation capabilities they develop. Finally, a research agenda identifying the central issues and the key research gaps is offered for further development in future studies.

Keywords: *Open innovation; Sustainability-oriented innovation; Open sustainable innovation; Sustainable open innovation; Systematic literature review; Research agenda.*

Introduction

Open Innovation and Sustainability-Oriented Innovation are among the most important approaches stimulating the academic debate in recent years (Erik G Hansen & Große-dunker, 2013; Lazzarotti & Manzini, 2009; West & Bogers, 2014), having progressively gained the interest of policymakers, practitioners, and societies all over the world (Ahn et al., 2019; Calabrese et al., 2018; Neutzling et al., 2018). On the one hand, Open Innovation theorizes and analyzes how firms expand their innovation process far beyond their boundaries by using external technology and knowledge flows to improve the success of innovation efforts (Chesbrough, 2006). Therefore, Open Innovation can especially support firms to generate several benefits. Among others, it is worth mentioning that Open Innovation allows for accelerating the time-to-market process, enriches the know-how of the firms, increases the market success of innovative products and the access to foreign markets, and shares the risk and cost (Urbinati et al., 2021). On the other hand, Sustainability-Oriented Innovation involves making intentional changes to a firm's philosophy and values by integrating ecological and social aspects into its products, processes, and organizational structure (Choi et al., 2018; Schoenherr & Talluri, 2012), serving the specific purpose of generating social and environmental values, as well as economic returns (Adams et al., 2016; Guo et al., 2020).

Since the first theorization of Open Innovation by Chesbrough (2003), it has been demonstrated that firms need to innovate to stay competitive in the market, and that collaborations are at the core of openness, allowing them to innovate effectively and efficiently (Bogers et al., 2017; Chesbrough & Bogers, 2014). In parallel, scholars have noted that collaborations are at the core of Sustainability-Oriented Innovation, particularly because of the disruptiveness of sustainability-oriented outcomes, which extend beyond individual firm boundaries (Wiener et al., 2020). Collaborations for innovation (Barringer, 2000; Murphy & Arenas, 2010) and especially for Sustainability-Oriented Innovation (Savage et al., 2010) are considered critical also from the macro-economic perspective, since they can drive radical sustainable changes and promote ethical considerations to create jobs, economic value, and reduce environmental impacts (Fassin, 2000; Goodman et al., 2017).

Although research on Sustainability-Oriented Innovation suggests that sustainability-oriented outcomes may benefit from the implementation of Open Innovation practices, such as the case of alliances with external stakeholders, very few studies have tapped into the intersection of these pieces of literature to investigate the relationships between Open Innovation and Sustainability-Oriented Innovation. Indeed, very limited contributions are available about how the Open Innovation approach

may act as an enabler of Sustainability-Oriented Innovation (Inigo et al., 2020), and, to the best of the authors' knowledge, even less is the scientific attempt that analyzes how firms developing Sustainability-Oriented Innovation also adopt the Open Innovation approach (Du et al., 2022).

To address the identified research gap, a systematic literature review is conducted in the current research to achieve two main objectives: investigating the relationships between the Open Innovation and Sustainability-Oriented Innovation approaches, and accordingly, framing these relationships through the development of an innovative framework, which highlights the main aspects characterizing the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*. Indeed, the proposed framework conceptualizes the relationships between Open Innovation and Sustainability-Oriented Innovation both in the case where the Open Innovation approach acts as an enabler of Sustainability-Oriented Innovation (i.e., *Open Sustainable Innovation*) and in the case where the research analyzes how firms developing Sustainability-Oriented Innovation also adopt the Open Innovation approach (i.e., *Sustainable Open Innovation*). Findings show that in the case of *Open Sustainable Innovation*, three main research areas emerge, including the Open Innovation practices (inbound and outbound) enabling Sustainability-Oriented Innovation, the Open Innovation strategies enabling Sustainability-Oriented Innovation, and the contextual factors (internal or firm-related, and external or industry-related) enabling both practices and strategies for Sustainability-Oriented Innovation. In the case of *Sustainable Open Innovation*, two main research areas emerge, including stakeholder engagement, and innovation capabilities. In this regard, firms developing Sustainability-Oriented Innovation show a similar orientation towards the adoption of the Open Innovation approach both in terms of how they engage stakeholders in their innovation activity, and the innovation capabilities they develop.

Our study offers therefore relevant contributions to better understand the state-of-the-art at the intersection between Open Innovation and Sustainability-Oriented Innovation and traces future research perspectives. Furthermore, practitioners can benefit from the proposed framework by using it as an instrument for designing Open Innovation strategies and practices aimed at developing Sustainability-Oriented Innovation.

The remained of the paper is organized as follows. First, the two considered topics are conceptualized, with an overall presentation of both the Open Innovation and Sustainability-Oriented Innovation approaches. Then, the research methodology is described in detail, followed by the results of the systematic literature review. The proposed framework is presented and discussed afterward, and the central issues and the key research gaps at the intersection between Open Innovation and Sustainability-Oriented Innovation are summarized in a research agenda. Finally, conclusions, limitations, and avenues for future studies are offered.

Topics conceptualization

This research is placed based on two main concepts, namely Open Innovation and Sustainability-Oriented Innovation. In the following sub-sections, the main definitions and dynamics of these concepts, as well as the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation* are presented and discussed.

Open Innovation: practices, strategies, and contextual factors

Open Innovation has been defined as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model" (Chesbrough & Bogers, 2014).

Chesbrough (2003) identified two separate practices utilizing external innovations internally and externally commercializing internal innovations, named 'inbound open innovation' (or 'outside–in') and 'outbound open innovation' (or 'inside-out'), respectively (see for example, Hu et al., 2015; Spithoven et al., 2010). Moreover, it has been seen that firms often combine these inbound and outbound practices in a coupled model (Enkel et al., 2009). The inbound open innovation practice especially refers to the absorption and internal use of external knowledge to exploit the discoveries of new ideas, which can happen, for example, through exploiting licensing-in, joint development agreements, and firm acquisitions. Conversely, the outbound open innovation practice investigates the outside environment to access the commercialization of a specific technology. This can happen, for instance, through exploiting licensing-out, equity investments, and spin-offs (Elia et al., 2020).

In addition, the Open Innovation approach can exploit pecuniary and non-pecuniary mechanisms (Chesbrough & Bogers, 2014), depending, respectively, on the presence or absence of financial resources involved in the process of exchange (Dahlander & Gann, 2010). Accordingly, the possible combinations between the inbound-outbound practices and the related pecuniary and non-pecuniary mechanisms of Open Innovation have been identified by Dahlander and Gann (2010), resulting in proposing four types of Open Innovation strategies, including acquiring (inbound Open Innovation – pecuniary), sourcing (inbound Open Innovation – non-pecuniary), selling (outbound Open Innovation – pecuniary), and revealing (outbound Open Innovation – non-pecuniary).

In addition to the Open Innovation strategies and practices, few studies have emphasized the role played by internal and external contextual characteristics enabling the same strategies and practices, and consequently, the Open Innovation performance of firms (Huizingh, 2011). Internal contextual factors are related to organizational features, such as the culture and the entrepreneurial or intrapreneurial mindset, while external contextual factors are represented by socio-economic

environmental trajectories, such as globalization and technology development, as well as policymaking initiatives, such as norms and regulations.

Researchers in the field of Open Innovation have mostly discussed Open Innovation practices (i.e., inbound, outbound, and coupled), Open Innovation strategies (i.e., acquiring, sourcing, selling, and revealing), and contextual factors (internal or external) in relation with the development of more traditional innovations, such as incremental or radical innovations (Inauen & Schenker-Wicki, 2012; Kobarg et al., 2019), while neglecting, for example, their role for developing Sustainability-Oriented Innovation. Hence, very few studies provide empirical examples and theoretical efforts related to the adoption of Open Innovation for the development of sustainable products. In a recent research conducted by Bogers et al. (2020), the authors describe how the Danish beer manufacturer, Carlsberg, has developed the Green Fiber Bottle as part of its sustainability program through an Open Innovation approach. In addition, Cappa et al. (2019) highlight the importance of personal and social rewards in supporting the open sustainable innovation framework to generate sustainable and innovative outcomes. Morevoer, existing research acknowledges Big Data as an Open Innovation source to accelerate the innovation process within organizations through using purposive knowledge inflows and outflows (Del Vecchio et al., 2018). Moreover, Rauter et al. (2019), in a study about the role of Open Innovation partners in improving sustainability innovation performance, show that in addition to universities and customers, as well-known partners, intermediaries, and Non-Governamental Organizations (NGOs) can strengthen innovation performance through clarifying the link between sustainability and economic innovation performance. However, these contributions remain mostly isolated in the current scientific research, thus suggesting that further empirical and theoretical contributions are required to deepen the role that Open Innovation can play in the face of sustainability transition pathways, such as the development of Sustainability-Oriented Innovation.

Sustainability-Oriented Innovation: definitions and perspectives

Innovation is a key aspect in firms, as it is aimed at refreshing products and services, renewing the organizational structure and business model, and ensuring their survival in the long term (Savino et al., 2017). More recently, the concept of innovation has gained much importance in scientific research to pursue environmental and social objectives beyond the firm's economic achievement. In this context, the concept of Sustainability-Oriented Innovation has gained prominence, as it represents a process or direction towards sustainability, which calls firms for developing innovations that reconcile economic, environmental, and social goals (Cillo et al., 2019; Van Horne & Dutot, 2017).

Sustainability-Oriented Innovation has been defined in the existing literature in several ways. For example, Tello & Yoon (2008) define sustainable innovations as "the development of new products, processes, services and technologies that contribute to the development and well-being of human

needs and institutions while respecting natural resources and regeneration capacities" (p. 165). Moreover, Bos-Brouwers (2009) defines sustainable innovations as "innovations in which the renewal or improvement of products, services, technological or organizational processes not only delivers an improved economic performance, but also an enhanced environmental and social performance, both in the short and long term have the capacity to generate positive social and environmental impacts" (p. 422). Furthermore, Hansen & Grosse-Dunker (2012) define sustainability-oriented innovation as "the commercial introduction of a new (or improved) product (service), product-service system, or pure service which – based on a traceable (qualitative or quantitative) comparative analysis – leads to environmental and (or) social benefits over the prior version's physical life cycle ('from cradle to grave')" (p. 1). Furthermore, Boons and Lüdeke-Freund (2013) highlight how "sustainability considerations (environmental, social, and financial)" should be "integrated into company systems from idea generation through to Research and Development (R&D) and commercialization" (p. 12).

More recent research highlights how Sustainability-Oriented Innovation "involves making intentional changes to an organization's philosophy and values, as well as to its products, processes, or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns" (Adams et al., 2016). The research conducted by Adams et al. (2016) mostly addresses the topic through three main perspectives: (i) a technically focused, product-oriented view, promoting incremental adjustments in practice to address environmental challenges, (ii) the extent to which Sustainability-Oriented Innovation thinking extends across the firm, and (iii) whether or not innovations are internally oriented, addressing internal issues, or are designed and targeted to impact a wider socio-economic system beyond the firm's immediate boundaries and stakeholders. In addition to these perspectives, Sustainability-Oriented Innovation has been mostly considered a common ground for incumbent firms, with prior research mainly dealing with Sustainability-Oriented Innovation in large firms (Hahn & Scheermesser, 2006; Nidumolu et al., 2009). On the contrary, few existing contributions provide knowledge on the specificities of Sustainability-Oriented Innovation in Small and Medium-sized Enterprises (SMEs), although these typologies of firms are increasingly recognized as central contributors to sustainable development (Klewitz & Hansen, 2014). In particular, SMEs possess idiosyncratic organizational structures and capabilities that allow them to innovate differently from large, incumbent firms, especially in terms of Sustainability-Oriented Innovation (e.g., Aragón-Correa et al., 2008).

Independent from the typology of the firm, being either a large, incumbent one or a SME, however, scholars operating in the field of Sustainability-Oriented Innovation have mainly missed deepening how the development of this peculiar innovation may benefit from the implementation of the Open

Innovation approach. Indeed, to address Sustainability-Oriented Innovation, firms should think more strongly in terms of Open Innovation as an important approach. This is while internal firm members are often not fully aware of the full range of potential social and environmental impacts. The interaction with a wider range of stakeholder groups (e.g., suppliers, clients, policymakers, non-governmental organizations, community members, and local authorities) and their systematic integration in the innovation process is key to advancing towards Sustainability-Oriented Innovation (Erik Gunnar Hansen & Grosse-Dunker, 2012). Although Open Innovation has been mainly driven by business objectives, societal challenges have more recently turned the attention to a wider range of objectives to which Open Innovation is relevant (McGahan et al., 2021). In this regard, the adoption of openness to tackle societal challenges has brought a promising avenue for research, as well as in practice (Chalmers, 2013; Harsanto et al., 2022). Mirvis et al. (2016), in a study on corporate social innovation, show that a huge part of the exchanged knowledge in corporate social innovation is a tacit one, which firms develop from shared experiences and interactions. Open Innovation plays an important role in the success of social enterprises in growing and progressing in their operations (Yun et al., 2017). Inclusion, which can be achieved through Open Innovation practices, such as co-creation platforms, open source, and product development partnerships, has been acknowledged as a key principle in responsible innovation to enable an innovation that delivers societal benefits (Eppinger, 2021). Nevertheless, despite the increasing interest in Open Innovation research, the literature lacks a clear framework of the relationship between Open Innovation and innovation processes in organizations designed to enact a 'transformative' societal change or societal innovation (Tuckerman, 2022).

Hybrid perspectives of Open Sustainable Innovation and Sustainable Open Innovation

The interplay between Open Innovation and Sustainability-Oriented Innovation has been acknowledged in the literature (Bogers et al., 2020; Cappa et al., 2016). On the one hand, the Open Innovation approach is characterized by practices (i.e., inbound, outbound, and coupled), strategies (i.e., acquiring, sourcing, selling, and revealing), and contextual factors (internal or external) that can also enable the development of Sustainability-Oriented Innovation beyond the more traditional incremental and radical innovations (Schuurman et al., 2016). On the other hand, Sustainability-Oriented Innovation may benefit from the openness of the firm towards external stakeholders, given the power of Open Innovation to support sustainable innovations (Adamczyk et al., 2011). An effective co-evaluation of Open Innovation requires the integration of evaluation capacities with stakeholder management (Paskaleva & Cooper, 2018). Roszkowska-Menkes (2018), in defining the

relationship between Open Innovation and corporate social responsibility, identify four themes, including employee engagement, external stakeholder engagement, open approach to corporate social innovation, and corporate social responsibility-driven selective revealing. Building on this research, we highlight the existing interplay between Open Innovation and Sustainability-Oriented Innovation through the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*, as depicted in Figure 1. *Open Sustainable Innovation* means the Open Innovation approach acting as an enabler of Sustainability-Oriented Innovation, while *Sustainable Open Innovation* analyzes how firms developing Sustainability-Oriented Innovation also adopt the Open Innovation approach.

These hybrid perspectives have been used as a theoretical guide to conduct the systematic literature review and to subsequently develop an innovative framework aimed at framing the relationships between Open Innovation and Sustainability-Oriented Innovation.

Research methodology

To better identify the relationships between Open Innovation and Sustainability-Oriented Innovation, a systematic literature review was conducted based on Denyer and Tranfield (2009) guidelines and following the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) framework (Liberati et al., 2009). Compared to traditional reviews, the systematic process of reviewing the literature provides additional knowledge within a domain by comparing the body of research through an objective process (Tranfield et al., 2003). Hence, systematic literature reviews, as replicable tools to capture, evaluate, and synthesize the body of knowledge in scientific fields (Perkmann et al., 2013), have been widely used in various research areas, such as sustainability (Ranjbari et al., 2021), green innovation (Karimi Takalo et al., 2021), entrepreneurship (Capolupo et al., 2022), and business resilience (Saad et al., 2021). In this regard, the present review beyond systematizing the existing body of knowledge aims at identifying research gaps and defining potential trade-offs between Open Innovation and Sustainability-Oriented Innovation to provide a guideline for further research.

To ensure the quality of systematic reviews, (i) designing an appropriate search string, (ii) selecting a reliable database with sufficient coverage of the scientific documents, and (iii) specifying inclusion and exclusion criteria for selecting relevant articles from the target literature play key roles (Shams Esfandabadi et al., 2022). On this basis, a structured search string using different combinations of the main keywords of this study (i.e., “open innovation” and “sustainability-oriented innovation”) was designed using Boolean operators “AND” and “OR” to collect relevant articles form the target literature in the Scopus database. In the next steps, the collected articles were screened based on the careful reading of their titles, abstracts, and full texts, and the most relevant articles were selected to

be scrutinized towards achieving the aim of this research. Besides, additional relevant articles were added to the sample through snowballing and hand-searching techniques.

The data collection process, as well as the overview of the final sample of articles analyzed in this research, are described in the following sub-sections.

Data collection

Data were collected in two stages: (i) a systematic search in the Scopus database, and (ii) snowballing and hand-searching. In the first stage, the Scopus database was selected as the main database of the present review to collect the most relevant articles since Scopus is one of the most comprehensive and largest citation databases of its kind (Magistretti et al., 2021). In comparison with other scientific databases, Scopus provides a wider coverage of journals, since only a small portion of scientific journals are not indexed in this database (Waltman, 2016). An initial list of keywords based on the existing literature reviews on the topic, such as open innovation, collaborative innovation, eco-innovation, green innovation, environmental innovation, and sustainable innovation, was elaborated and further discussed with a review panel of three experienced academics in the field of Open Innovation and Sustainability-Oriented Innovation. On this basis, given the objectives of this research to address the relationships between Open Innovation and Sustainability-Oriented Innovation, different combinations and synonyms of keywords related to these two approaches were formulated using Boolean operators. As a result, the following search string was designed to capture the articles from the target literature for further analysis within the title, abstract, and keywords fields: *("open innovation" or "collaborat* innovation") AND ("eco-innovation" OR "eco innovation" OR "ecological innovation" OR "environmental innovation" OR "green innovation" OR "sustainab* innovation" OR "sustainable-oriented innovation" OR "sustainable oriented innovation" OR "sustainability-oriented innovation" OR "sustainability oriented innovation" OR "innovat* sustainab*" OR "social innovation")*. To ensure the quality and sufficient coverage of the collected sample, the results were limited to only peer-reviewed research and review journal articles in the English language, without any time restriction, resulting in a list of 212 articles. This stage of data collection was finalized on February 6, 2023.

The collected articles were carefully screened by all authors based on their relevance to the current research objectives and the irrelevant articles were removed. All the papers that did not present a direct link with the possible role of Open Innovation as an enabler of Sustainability-Oriented Innovation, or those that did not highlight whether firms developing Sustainability-Oriented Innovation also adopted the Open Innovation approach, were excluded. In addition, only studies using the firm as the main unit of analysis were included in the review. Moreover, articles focused on a firm operating in a single industry and in a single country were excluded to confine the review to articles

whose results are more generalizable (Pittaway et al., 2004; Rashman et al., 2009). The screening was conducted first based on titles and abstracts (leading to the exclusion of 98 articles) and then based on the full text of the papers about which the decision for inclusion could not be made according to the title and abstract (resulting in the exclusion of 50 more articles). The overall inclusion and exclusion criteria considered in the data collection process are presented in Table 1.

In the second stage of data collection, hand-searching and citation tracking (Adams et al., 2016) were conducted to prevent neglecting some important phenomena that are instead captured in other outlets or have orthodoxy in ontological or epistemological premises. As the topic that we investigate holds great importance for practice, we decided to include a larger array of sources to ensure both research rigor and the plurality of theories, methods, and phenomena. Consequently, 9 articles were added to the sample at this stage and the final sample for the analysis in this review consisted of 73 articles. Figure 2 illustrates the steps taken to collect data based on the PRISMA framework.

An overview of the collected data

This section provides an overview of the selected articles in terms of the year of publication, the geographical distribution, and the co-occurrence of the keywords. As can be seen in Figure 3, the attention towards openness and sustainability aspects simultaneously in the innovation process has increased from 2016 onwards. The first article in the sample, titled "Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms" was published in 2012 by De Marchi (2012), exploring the relationship between R&D cooperation strategies of the firms and their propensity to introduce environmental innovations.

The selected 73 articles in the field of Open Innovation and Sustainability-Oriented Innovation research have been published in 39 journals. The top three contributing journals in terms of the number of published articles are *Sustainability* (16 articles), *Journal of Cleaner Production* (7 articles), and *Technological Forecasting and Social Change* (5 articles). Besides, researchers from 35 countries have contributed to the field. The top three publishing nations in the field of Open Innovation and Sustainability-Oriented Innovation research are Italy (13 articles), Spain (10 articles), and China (8 articles), respectively.

To unfold the conceptual and thematic structures of the Open Innovation and Sustainability-Oriented Innovation research domain, the keyword-based analysis, which is a useful knowledge mapping tool to reveal the conceptual and thematic structures of research domains (Krey et al., 2022; Ranjbari et al., 2022), has been conducted in this section. Both author keywords and index keywords have been considered for the analysis by using the VOSviewer software version 1.6.16 (van Eck & Waltman, 2010). While the initial number of keywords was 469, after data cleaning, as an essential preparation step for conducting any keyword-based analyses (Ranjbari et al., 2020), the number of

keywords reached 420. The presented keywords co-occurrence network in Figure 4, contains 66 keywords, which have at least 2 occurrences. The size of the nodes in this network refers to the occurrences of the keywords (i.e., the higher a keyword's occurrence, the larger its relevant node size) and the thickness of the links between each pair of nodes refers to the co-occurrence of the two keywords (i.e., the higher the co-occurrence frequency of two keywords, the thicker the link between them).

As can be seen in Figure 4, the keywords "open innovation" (53 occurrences), "innovation" (33 occurrences), "sustainable development" (22 occurrences), "sustainability" (20 occurrences), and "eco-innovation" (11 occurrences) are the most frequent keywords in the studied domain. Furthermore, the highest co-occurrence frequencies can be observed between the pair of keywords "innovation" and "open innovation" (23 co-occurrences), "open innovation" and "sustainable development" (17 co-occurrences), "innovation" and "sustainability" (15 co-occurrences), and "open innovation" and "sustainability" (14 co-occurrences). On this basis, the attention towards "sustainable development" is evident while drafting articles regarding *Sustainable Open Innovation* and *Open Sustainable Innovation* in the literature. Moreover, Open Innovation has a positive impact on sustainable innovative development in companies (Stanisławski, 2022) and has been introduced as a strong tool to achieve sustainable development goals (Milana & Ulrich, 2022). Innovations aimed at sustainable development have become essential in the planning of businesses (Behnam & Cagliano, 2019).

Results

Data gathered from the systematic literature review were initially analyzed according to the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation* depicted in Figure 1. Findings are presented in the following sub-sections.

Open Sustainable Innovation

The Open Innovation approach acting as an enabler of Sustainability-Oriented Innovation can be classified in accordance with three main aspects, including the Open Innovation practices (inbound and outbound) enabling Sustainability-Oriented Innovation, the Open Innovation strategies (i.e., acquiring, sourcing, selling, and revealing) enabling Sustainability-Oriented Innovation, and the contextual factors (internal, or firm-related, and external, or industry-related) enabling both practices and strategies for Sustainability-Oriented Innovation.

These three aspects are depicted in Figure 5 and further detailed hereafter.

Inbound and/or Outbound Open Innovation practices enabling Sustainability-Oriented Innovation

Searching for new knowledge outside the firm boundaries that can be newly combined with the existing technologies of the firm is often required for technological innovation (Li-Ying et al., 2018). Both external partnering and external sourcing can improve sustainable innovation performance (Zhang & Chen, 2022). Finding an appropriate partner with environmental expertise who can contribute new knowledge or technology to the firm is of paramount importance in this regard (Melander, 2018). In such collaborative innovations, it is required that firms combine contractual agreements with relational capabilities (e.g., trust), and also devote adequate effort to managing knowledge with external partners as well as with internal stakeholders, as these collaborations better work in a network context (Melander, 2018). Building external collaboration networks is found to be key to the sustainable innovation performance of strategic emerging industries in the context of Open Innovation (Yao & Huang, 2022) since firms in addition to reconfiguring their internal resources need to realign external collaboration networks (Yang et al., 2020). A strong collaboration ecosystem across the whole value-chain, based on relationships of shared interests and trust, is crucial to innovation (Gutiérrez & Macken-Walsh, 2022).

A study based on the Spanish food industry indicated that the factors positively associated with the probability for a firm to be listed among the most successful eco-innovators include the span of the external search, the joint adoption of eco-product and eco-process innovations, the collaboration with agents along the supply chain, knowledge-based capabilities, operational flexibility, and firm size (Moreno-Mondéjar et al., 2020). Furthermore, evidence from French manufacturing firms reveals that R&D collaborations and technology acquisitions have a positive correlation with environmental innovation in the short term. However, on a long-term basis, persistent R&D cooperation and technology acquisitions are linked with environmental innovation only at the production stage (Li-Ying et al., 2018). This depends on the fact that in the final use stage of the products, inbound innovation enables quick responses to market demands for environmental innovation (Li-Ying et al., 2018). The study conducted by Yao and Huang (2022) on Chinese firms highlighted the potential of R&D subsidies to promote sustainable innovation performance, which can be mediated by external collaborative networks and R&D investment. In addition, the research reveals the potential weakening effect of R&D subsidies on the positive relationship between external collaborative networks and sustainable innovation performance. On this basis, comprehensively considering the multiple potential effects of R&D subsidies to design more sophisticated policy tools for network coordination is of paramount importance for firms (Yao & Huang, 2022). Triguero et al. (2018) focused on the Spanish food and beverage industry and found that the span of the external

knowledge source affects most eco-innovations adopted by firms. Nevertheless, Milana and Ulrich (2022) showed that the internal R&D of firms plays an equally significant role as the inbound innovation activities in achieving sustainability and hence, Open Innovation only partly facilitates the creation of sustainable value.

Open Innovation strategies enabling Sustainability-Oriented Innovation

In a study conducted to analyze the effects of inbound and outbound Open Innovation practices on the performance of eco-innovation in firms, Leitão et al. (2020) outlined that Open Innovation strategies (i.e., sourcing, acquiring, revealing, and selling) positively affect the eco-innovation performance of firms. In particular, Mothe et al. (2018), by analyzing the Open Innovation practices for environmental innovation, highlighted that the acquiring strategy, attained through the acquisition of machinery, equipment, and software, seems to be more linked with eco-process than eco-product innovations. They also showed that in the sourcing strategy, there is a positive relationship between external market sources of information and firms' involvement in all types of environmental innovation, i.e., both eco-product and eco-process innovations (Mothe et al., 2018).

While both the selling and acquiring strategies (i.e., inbound and outbound Open Innovation practices characterized by financial transactions), as well as the sourcing strategy (i.e., inbound Open Innovation practice combined with a non-pecuniary mechanism), are well justified due to their clear advantages for the firms, the revealing strategy (i.e., the outbound open innovation practice combined with a non-pecuniary mechanism) can be a manly strategic decision, reflected by motivational factors, including co-creation with other firms, product enhancement, product diffusion, strategic spillovers, and seeking complementary capabilities (Verreynne et al., 2020). Individuals also require motivations, including enjoyment, a sense of community, self-efficacy, personal development, career development, reputation building, utilitarianism, altruism, ideological reasons, and reciprocity, to freely contribute to Open Innovation strategies when there are no pecuniary returns expected (Suhada et al., 2021).

Contextual factors enabling both practices and strategies for Sustainability-Oriented Innovation

Through Open Innovation, knowledge management can become an asset for firms to promote sustainable innovations, which affects organizational sustainability (Lopes et al., 2017). Nevertheless, in spite of the opportunities that Sustainability-Oriented Innovation can bring for firms, it can cause complexity (i.e., managerial challenges in incorporating internal and external resources and achieving multidimensional objectives for sustainability targets beyond generating only revenues) that calls for changes in innovation resources and capabilities to solve the associated challenges (Behnam & Cagliano, 2019). Behnam and Cagliano (2019) showed that it is crucial for firms to adopt

Sustainability-Oriented Innovation to strengthen their exploration and exploitation capabilities with a clear direction and to unify the incorporation of internal and external resources, rather than relying mainly on R&D and knowledge formalization that only considers systemized maintenance and reactivating knowledge.

Strategic direction has enabled the innovation process through five significant organizational aspects, namely the integration of sustainability performance metrics in product development, search heuristics that support radical sustainability solutions, technology super-scouting throughout the value chain, harnessing the benefits of Open Innovation, and championing the value chain to build demand for radical sustainable product innovations (Kennedy et al., 2017). Yun et al. (2019) by developing an Open Innovation model to promote serial entrepreneurs indicated that an Open Innovation strategy can play the role of a crucial motivator for serial entrepreneurs. In addition, they revealed that to trigger sustainable serial entrepreneurs of Open Innovation, a balance between complexity and emergence is needed. Melander (2018) emphasized the importance of knowledge management in collaborating with external partners and internal stakeholders to combine external and internal capabilities. Moreover, in addition to well-known partners such as customers and universities, increased collaboration with NGOs and intermediaries could be beneficial for firms to support simultaneously achieving economic and sustainability innovation goals due to their positive correlation (Rauter et al., 2019).

The existing literature highlights uncertainty about whether Open Innovation actually promotes sustainability (Milana & Ulrich, 2022), which confirms the need for investigating contextual factors enabling both practices and strategies for Sustainability-Oriented Innovation. For instance, Milana and Ulrich (2022) in a study on Open Innovation practices in firms to unfold the sustainability dimensions showed that compared to large, incumbent firms, smaller firms are more prompt to develop sustainable technologies, and university entrepreneurship acts as a significant enabler of sustainable innovations. Furthermore, the authors showed that R&D activities in relation to the development of radical innovations, whether internally performed or in-licensed, are critical predictors for sustainability. Roh et al. (2021) revealed that government support and intellectual property rights in firms, as a knowledge-based competency of firms, including patent applications, utility model and trademark rights, and design registration, can highly influence green process innovation and green product innovation at the firm level, while Open Innovation plays a mediating role between each. The rationale behind comes from several factors as outlined by Roh et al. (2021), including (i) firms achieved intellectual property rights as internal resources participate more positively in Open Innovation activities to explore external knowledge, (ii) the legal protection system of intellectual property rights reduces the Open Innovation risks and supports its technological

innovation activities, and (iii) the government support provides firms opportunities to learn and understand the various Open Innovation aspects and interact with various institutions and firms that seek the improvement of green innovation.

Sustainable Open Innovation

Companies developing Sustainability-Oriented Innovation show a similar orientation towards the adoption of the Open Innovation approach both in terms of how they engage stakeholders and involve customers, and the innovation capabilities they develop, along with the Open Innovation process. These two aspects are depicted in Figure 6 and further detailed hereafter.

Stakeholder Engagement

The supportive role of stakeholder engagement in innovation efforts acts as an enabler to increase the capability of firms in developing Sustainability-Oriented Innovation through employing a wide range of external knowledge (Ghassim & Bogers, 2019). This is due to the fact that innovation for sustainability requires firms to engage with external stakeholders to gain social legitimacy, deal with complex issues, and access various expertise and skills (Watson et al., 2018). In the context of Open Innovation, stakeholder engagement is construed as a dynamic capability that is able to manage differences between external stakeholders and reinforce their respective resource bases (Watson et al., 2018). In this regard, managing sustainable innovation should take into account that interactions with stakeholders can significantly influence the sustainability impact and outcome (Arnold, 2017). However, developing eco-innovations using Open Innovation faces many challenges due to the complexity of achieving the dual goals of environmental and economic value creation, simultaneously, in a multi-stakeholder network (Garcia et al., 2019). Hence, more effective engagement of governmental agencies, NGOs, and regulators along with suppliers, customers, and other partners is required (Garcia et al., 2019). In an econometric estimation, De Marchi (2012) highlighted that environmentally-innovative firms can collaborate on innovation more than other innovative firms with external partners. This may be because environmental innovators have more intense R&D cooperation compared to other innovators, which might lead to higher interdependencies with external partners, and also, environmental innovators differ from other innovators in terms of implementation of R&D effort on a continuous basis (De Marchi, 2012).

González-Moreno et al. (2019), in a study on the relationship between firms' interactions with stakeholders to develop different types of eco-innovations, showed that coordination challenges and bounded rationality explain an inverted U shape in the connection of breadth of external knowledge sources and the propensity to develop eco-process innovations. Furthermore, a strong direct effect of external knowledge on the success of green innovation, which tends to be larger for green than for

non-green innovation, was highlighted by Stucki and Woerter (2022). Conducting an empirical analysis of green enterprises to explore the effect of customer involvement on green innovation, Ma et al. (2022) outlined that customer involvement and boundary-spanning capability have a positive correlation, customer involvement has a positive impact on green innovation, and there is a positive correlation between boundary expansion force and environmental protection innovation. Therefore, to implement external involvement, firms should better devote resources to more effectively using the knowledge and information of customers (Zhao et al., 2018). Besides, in addition to firm-oriented green innovation, firms need to consider customer-oriented green innovation to increase their performance (Woo et al., 2014) since customer demand positively moderates the effects of creativity enhancement and innovation intensity on eco-innovation strategy (Liao & Tsai, 2019).

Innovation capabilities

To convert knowledge into new products and services, processes, and business models, firms need innovation capabilities (Siqueira & Pitassi, 2016). Siqueira and Pitassi (2016) outlined four capabilities of firms to drive Open Innovation, including networking, competence mapping, relational, and desorptive capabilities. The capabilities of companies to apply Open Innovation practices while focusing on Sustainability-Oriented Innovation are aligned with the Open Innovation capability-based framework proposed by Lichtenthaler and Lichtenthaler (2009). In their Open Innovation capability-based framework, Lichtenthaler and Lichtenthaler (2009) identified six 'knowledge capacities', namely inventive, absorptive, transformative, connective, innovative, and desorptive capacity, as a firm's critical capabilities to manage internal and external knowledge in Open Innovation processes. Both internal knowledge processes (e.g., knowledge creation or exploitation) and external innovations play vital roles in Open Innovation, and the necessity of integrative perspectives for the firms to build strongly on external transactions to extend their internal bases is highlighted in the literature (Behnam et al., 2018; Behnam & Cagliano, 2019; Lichtenthaler & Lichtenthaler, 2009).

When it comes to Sustainability-Oriented Innovation, the Open Innovation capabilities of the firm must conform to the particular sustainability context that the firm has considered (Behnam et al., 2018). Technological development and R&D address only a part of the change towards sustainability, hence, firms should also establish sustainability-related research and enhance their sustainability-oriented learning processes (Müller & Siebenhüner, 2007). Nevertheless, among the three main pillars of sustainability, namely economic, social, and environmental, the environmental aspect has been the most considered one in the available literature (Garcia et al., 2019; Naruetharadhol et al., 2021), and more attention is devoted to sustainable products (Melander, 2018) than sustainable processes in the organization (Roh et al., 2021). Hence, the lack of an integrative approach to simultaneously consider

all three aspects within the innovative firm is felt. This is while this topic is of significant importance as adding sustainability approaches to the traditional open innovations in a business may require reinforcing or adjusting some of its innovation capabilities (Behnam & Cagliano, 2019).

An innovative framework and a research agenda

This section provides and discusses the proposed framework and summarizes the central issues and the key research gaps at the intersection between Open Innovation and Sustainability-Oriented Innovation in a research agenda.

Open Innovation and Sustainability-Oriented Innovation intersections: the proposed framework

Building on the results presented above, in this section, we propose a framework aiming at offering a comprehensive understanding of the relationships between Open Innovation and Sustainability-Oriented Innovation, both in the case where the Open Innovation approach acts as an enabler of Sustainability-Oriented Innovation (i.e., *Open Sustainable Innovation*), and in the case where the research analyzes how companies developing Sustainability-Oriented Innovation also adopt the Open Innovation approach (i.e., *Sustainable Open Innovation*). The proposed framework, shown in Figure 7, merges and synthesizes the results of the systematic literature review, also previously depicted and summarized in both Figures 5 and 6. As shown in Figure 7, there are five main aspects framing the relationships between Open Innovation and Sustainability-Oriented Innovation, including (i) inbound and outbound Open Innovation practices, (ii) Open Innovation strategies, (iii) internal and external contextual factors, (iv) stakeholder engagement, and (v) innovation capabilities. In this regard, while the first three aspects belong to the *Open Sustainable Innovation* perspective, the last two ones address the *Sustainable Open Innovation* perspective. These ascpects are presented hereafter.

(i) Inbound and Outbound Open Innovation practices. Although the need for firms to search for knowledge outside their boundaries for developing Sustainability-Oriented Innovation has been highlighted in litearture (Li-Ying et al., 2018), very few studies analyze the ability of the same firms to absorb knowledge coming from outside, hence highlighting the critical role played by the absorptive capacity (Lichtenthaler & Lichtenthaler, 2009). Especially when dealing with the inbound open innovation practice, firms must screen their external environment to search for technological innovation and knowledge that can be exploited internally, and not exclusively rely on in-house R&D activities. Although the absorptive capacity is recognized by scholars as a major driver for internalizing external know-how and driving firms' competition (Spithoven et al., 2010), little

attention has been however paid by scholars to how firms develop and leverage absorptive capacity for developing sustainable innovations. In parallel, when reflecting on the outbound open innovation (or inside-out) practice, firms must reveal and sell their technologies to the external environment. In this case, they need to develop a specific capability to manage knowledge outflows, i.e., the desorptive capacity (Müller-Seitz, 2012). In the context of Sustainability-Oriented Innovation, it is not clear how firms develop and leverage the desorptive capacity to license or commercialize Sustainability-Oriented Innovation patents, i.e., "patents that refer to Sustainability-Oriented Innovation concepts" (Ponta et al., 2022), and how they can help firms to generate a higher economic performance than traditional, non-Sustainability-Oriented Innovation patents.

In addition, existing research highlights how firms may benefit from external partnering and external sourcing for improving their sustainable innovation performance (Zhang & Chen, 2022). Indeed, collaborating with an appropriate partner with environmental expertise, for example, can allow firms to exploit new technological innovation or knowledge, which is useful for the development of sustainable innovations (Melander, 2018). However, from the conducted systematic literature review in this research does not emerge standardized criteria that firms can leverage to scout and select the best partners for developing sustainable innovations. In other words, management scholars are called to explore in future studies the existence of methods and approaches for stakeholders' involvement and management to facilitate the transition pathway of firms towards Sustainability-Oriented Innovation.

Moreover, although partnering with external stakeholders may benefit firms in properly developing sustainable innovations (Melander, 2018; Zhang & Chen, 2022), the organizational modes of collaboration linked to specific types of Sustainability-Oriented Innovation developed by firms are still under-researched. We call future studies to investigate which typologies of organizational modes of collaboration, such as outsourcing, research contracts, joint ventures, merger, and acquisitions, can be considered the most suitable for developing different typologies of sustainable innovations, such as either green products, or green processes, as well as sustainable business models. Accordingly, we call for future studies to investigate if the traditional procedures for selecting the appropriate organizational mode of collaboration when a firm is aimed to implement Open Innovation (Chiesa & Manzini, 1998) may differ in the peculiar context of Sustainability-Oriented Innovation.

(ii) Open Innovation strategies. The existing studies in the Open Innovation literature acknowledge the role that Open Innovation strategies (i.e., acquiring, sourcing, selling, and revealing) play in positively affecting firms' eco-innovation performance (Dahlander & Gann, 2010). In particular, the research highlights how this performance can be pragmatically translated into eco-products and/or eco-process innovations, as a result of the individual actions implemented by the innovation

managers. This notwithstanding, the motivational factors characterizing the individuals in charge of implementing an Open Innovation strategy for a Sustainability-Oriented Innovation is still a debated topic, which deserves further investigation. This research gap is especially true when analyzing the Open Innovation strategies characterized by outbound open innovation practices combined with non-pecuniary mechanisms, i.e., a revealing strategy. In this regard, it is very much difficult to investigate the reasons why some managers implement revealing strategies compared to other ones. Furthermore, the difficulty significantly increases when analyzing the motivational factors for implementing a revealing strategy enabling a Sustainability-Oriented Innovation (Suhada et al., 2021). Further theoretical and empirical research in this context is thus worth to be conducted.

(iii) Internal and external contextual factors. We recognize the need for further theoretical and empirical research on the role that internal and external contextual factors can play in enabling both Open Innovation practices and strategies for Sustainability-Oriented Innovation (Milana & Ulrich, 2022). Indeed, both internal or firm-related, and external or industry-related, contextual factors may positively influence the creation of an organizational environment able to allow for the development of valuable Sustainability-Oriented Innovation as a result of the Open Innovation process.

As far as the internal contextual factors are concerned, while the existing research recognizes the enabling role of knowledge management within firms to promote sustainable innovations (Lopes et al., 2017), further research is required to better understand how knowledge is created and absorbed into the firm and then combined with the firm knowledge base. In addition, existing research recognizes the need for firms to innovate the endowment of their resources and capabilities while developing Sustainability-Oriented Innovation (Behnam & Cagliano, 2019). This notwithstanding, further studies are required to investigate the core resources and capabilities needed for the Open Innovation process that can effectively support the development of sustainable innovations.

As for the external contextual factors, current research extensively reckons the role of governmental institutions in supporting the development of Sustainability-Oriented Innovation, for example, through sustainability-oriented directives packages (European Commission, 2019). The policy action is aimed to create a favorable environment and a responsible political agenda for the transition of firms to a more sustainable pathway of their Open Innovation process while removing barriers and limitations affecting its development process (Roh et al., 2021). However, future contributions should investigate more the influence that political initiatives and regulatory frameworks play in the development of green process innovation and green product innovation by firms. For example, a set of standardized indicators that firms may use to measure the degree to which their Open Innovation process contributes to the development of sustainable innovations could be developed and proposed.

(iv) Stakeholder Engagement. It is interesting to note how firms developing sustainable innovations share some similarities in the way they engage stakeholders and involve their customers in their Open Innovation process. The existing research highlights how the intensity of the collaboration between firms and external stakeholders is higher when developing sustainable innovations rather than traditional innovations (Cloutier et al., 2020). In addition, the existing studies recognize a positive role played by customers if much more involved in the Open Innovation process for developing Sustainability-Oriented Innovation (Kennedy et al., 2017). Accordingly, firms developing sustainable innovations, compared to firms developing non-sustainable innovations, spend much more effort in engaging the stakeholders and involve more their customers in their innovation activity (Goodman et al., 2017). Nevertheless, potential avenues for future research that still deserve further investigation include: first, how these firms engage with the external stakeholders and how customers are involved in the Open Innovation process; second, in which phases of the Open Innovation process they contribute more; and third, which are the main activities these actors performed for supporting the firms.

(v) Innovation Capabilities. Finally, existing literature highlights the need for firms to explore and exploit innovation capabilities with a clear direction (Behnam et al., 2018; De Marchi & Grandinetti, 2013), as well as to unify the integration of internal and external technological innovation and knowledge rather than relying mainly on conventional R&D and knowledge formalization (Müller & Siebenhüner, 2007; Rauter et al., 2019). However, which kinds of innovation capabilities firms developing sustainable innovations through the implementation of the Open Innovation approach need to develop, as well as how they are developed, and eventually with whom they are developed, remain a strong research gap in the current study discussing the relationships between Open Innovation and Sustainability-Oriented Innovation.

Research Agenda

Despite the insightful findings emerging from the systematic literature review, which also allowed to provide the final framework and to bring into light relevant information at the intersections between the framework dimensions, major research gaps and questions remain to be explored and answered while investigating the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*. In this vein, having synthesized the provided insights through the comprehensive systematic review conducted in this research, Table 2 provides potential emerging and promising questions to be addressed in future research. The proposed formulated questions have a double objective. First, they are aimed at identifying the main open issues in the debate on the relationships between Open Innovation and Sustainability-Oriented Innovation. Second, they are aimed at inspiring

scholars and researchers in future works to go deeper into the main aspects characterizing the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*.

Conclusions, limitations, and avenues for future studies

This paper contributes to the discussion around the debate about sustainability issues related to business and innovation activities of firms (Hsu & Chang, 2017; Wagner & Blom, 2011). It particularly addresses the management literature by reviewing the research at the intersection between Open Innovation and Sustainability-Oriented Innovation, to assess the interplay between these two relevant topics. By doing so, we especially add to the current academic debate in the innovation management literature that has more recently delved into the Open Innovation practices and strategies for developing Sustainability-Oriented Innovation (Rauter et al., 2017). Building on the hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation*, which have been used as a theoretical guide to conducting the systematic literature review, we have framed the relationships between Open Innovation and Sustainability-Oriented Innovation by proposing an innovative framework. Building on this framework, we have finally identified the central issues and the key research gaps, which deserve further investigation by future studies.

The findings of our research offer a significant contribution to the studies investigating both how firms develop sustainable innovations by implementing an Open Innovation approach (Behnam & Cagliano, 2019), as well as which are the key aspects that unite these firms while implementing Open Innovation practices and strategies for sustainable innovations (Behnam et al., 2018). Indeed, we delve into this literature stream, by showing the Open Innovation practices and strategies that firms adopt to develop Sustainability-Oriented Innovation, such as the absorption of external knowledge and the partnering with external stakeholders with environmental expertise, as well as the Open Innovation-related characteristics that firms developing sustainable innovations have in common, such as stakeholder engagement, customer involvement, and development of innovation capabilities. In this context, the debate on the role played by internal (or firm-related) and external (or industry-related) contextual factors in enabling Open Innovation practices and strategies for Sustainability-Oriented Innovation remains a critical aspect to be further studied (Milana & Ulrich, 2022). This issue may particularly add to the research studying the enabling factors that support the development of sustainable innovations by firms. However, through conducting the current systematic literature review, we were not able to differentiate how SMEs develop sustainable innovations through the implementation of Open Innovation compared to their counterparts, i.e., large, incumbent firms. Since we are aware that several differences may exist (Bendig et al., 2022). Besides, since a systematic

process has been conducted to capture relevant articles to the topic, some pieces of research that address green technologies without explicitly referring to them as eco-innovation (Natalicchio et al., 2018) might have been neglected in this review, which calls for future studies and further research efforts.

In addition, our study offers a significant contribution to managers and practitioners operating in the fields of Sustainability-Oriented Innovation and Open Innovation, who can use the proposed framework to find an instrument for designing Open Innovation strategies and practices aimed at developing Sustainability-Oriented Innovation. Moreover, our research agenda may support them in thinking about these Open Innovation strategies and practices in accordance with particular aspects characterizing the hybrid perspectives of *Open Sustainable Innovation* – such as the development of the absorptive capacity and the desorptive capacity, as well as the search of core resources and capabilities, for Sustainability-Oriented Innovation – and *Sustainable Open Innovation* – such as the engagement of stakeholders and the involvement of customers also addressing the development of innovation capabilities for Sustainability-Oriented Innovation. Methodologically, the rationale behind conducting the current review relies on the analysis of archival data from a systematic literature review. Hence, our results must be confirmed through the usage of a wider sample of techniques. For example, many of the research gaps that we have highlighted in the research agenda, and especially those addressing the 'how' questions, may be filled in future studies by using the inductive approach characterizing either the single case study or the multiple case study analysis. In this regard, case studies are useful for exploring specific theoretical issues that lack adequate empirical evidence, as in the case of the role that Open Innovation can play in the development of Sustainability-Oriented Innovation.

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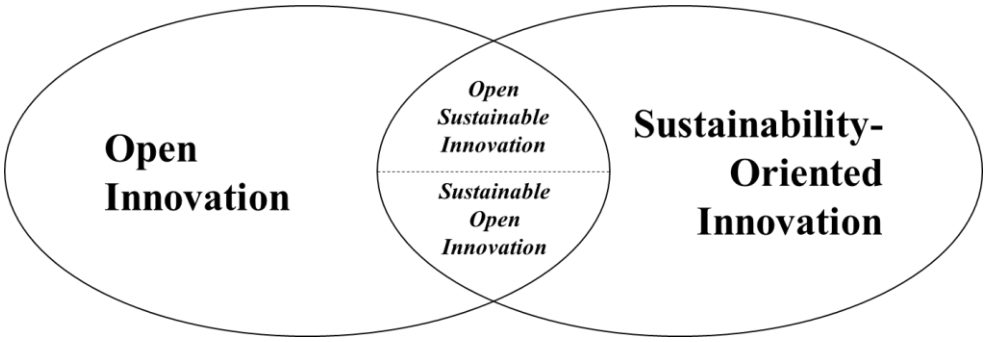

Figure 1. Hybrid perspectives of *Open Sustainable Innovation* and *Sustainable Open Innovation.*

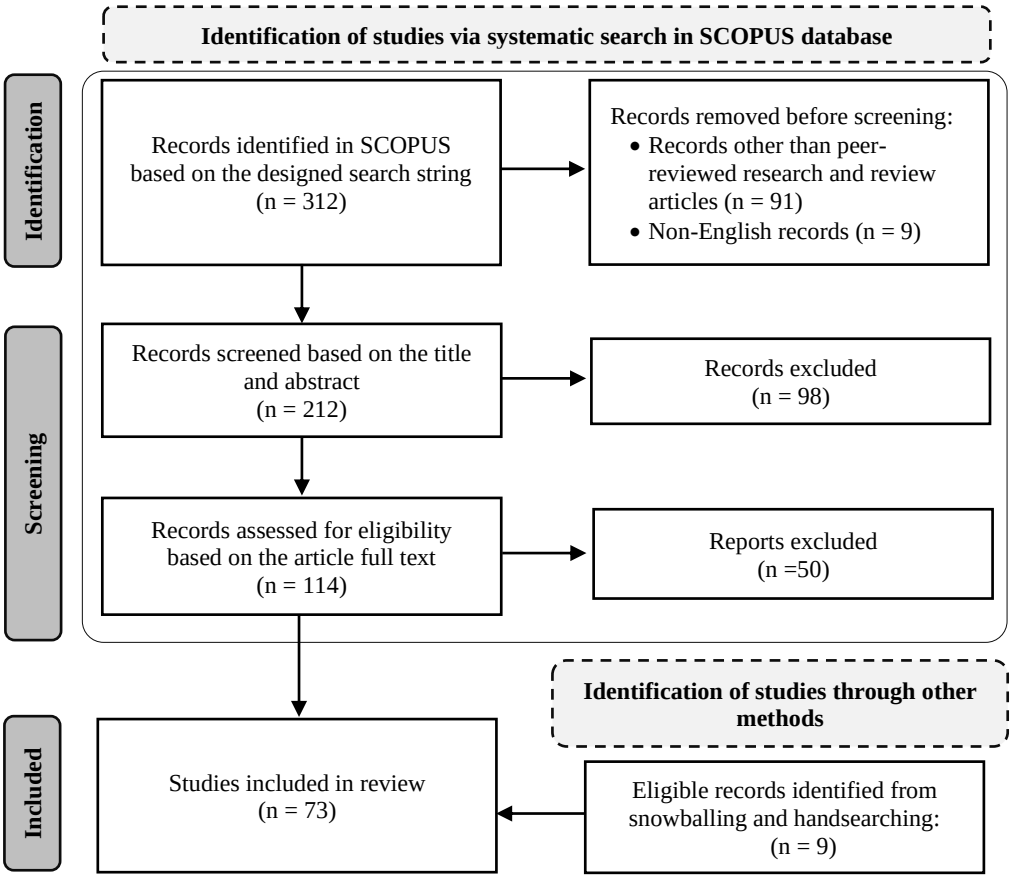

Figure 2. Data collection process based on PRISMA framework (adapted from Page et al., 2021).

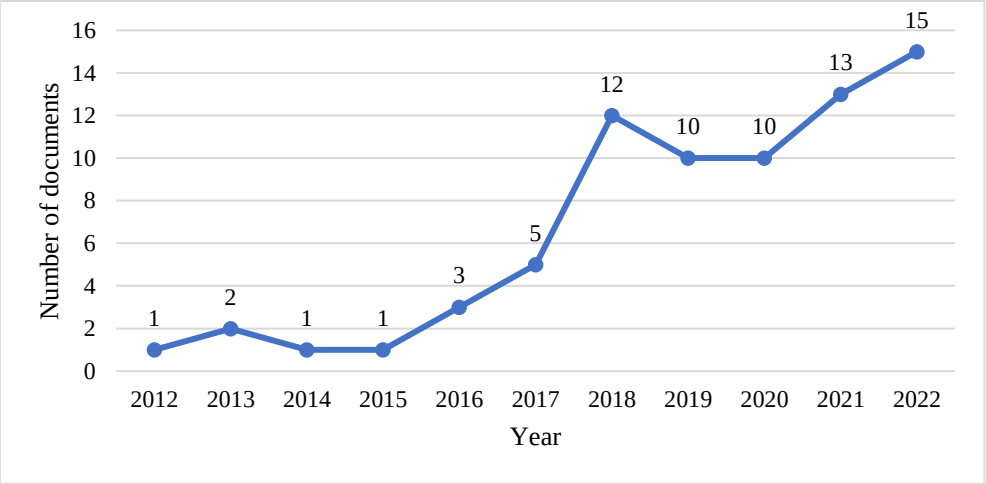

Figure 3. Historical series of published articles in the Open Innovation and Sustainability-Oriented Innovation research domains.

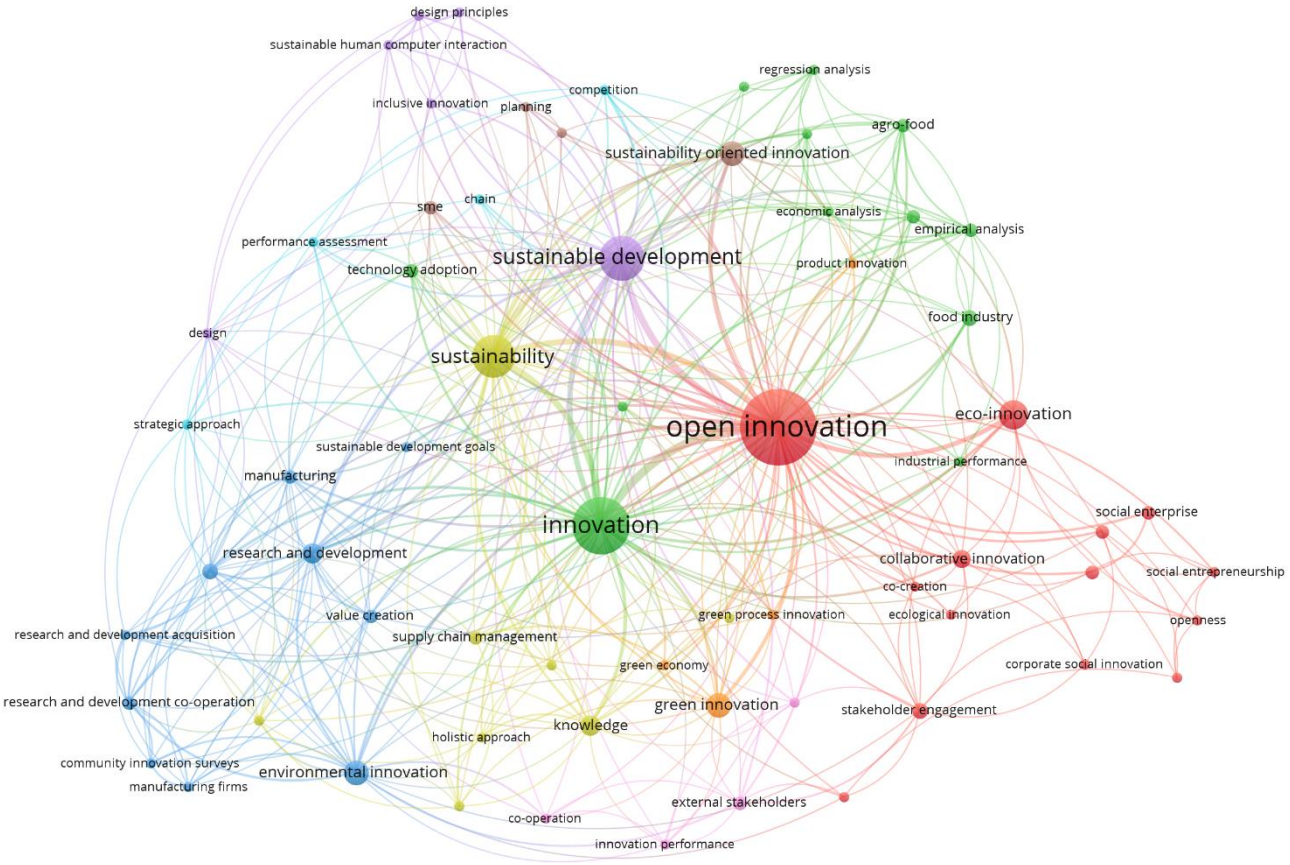

Figure 4. Co-occurrence network of keywords in the Open Innovation and Sustainability-Oriented Innovation research domains.

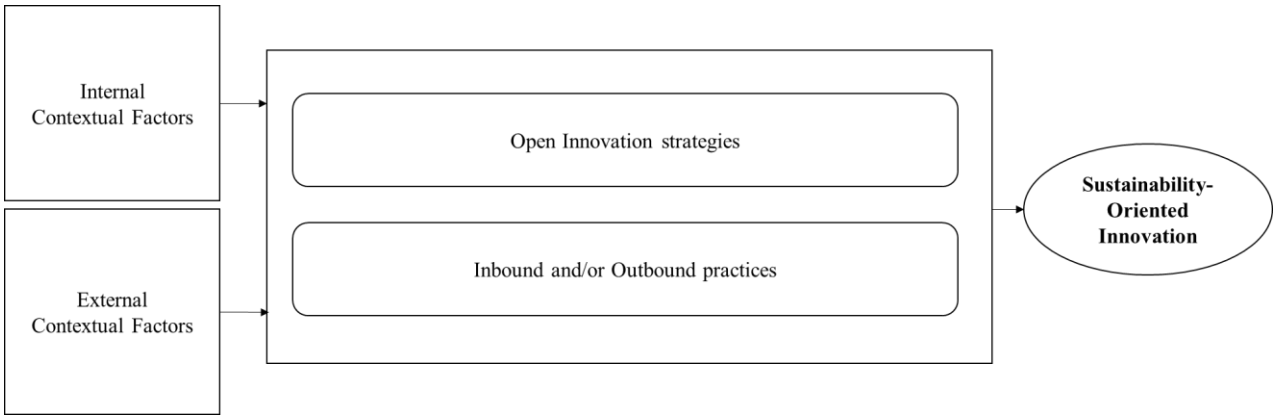

Figure 5. Results of the systematic literature review built onto the hybrid perspective of *Open Sustainable Innovation*.

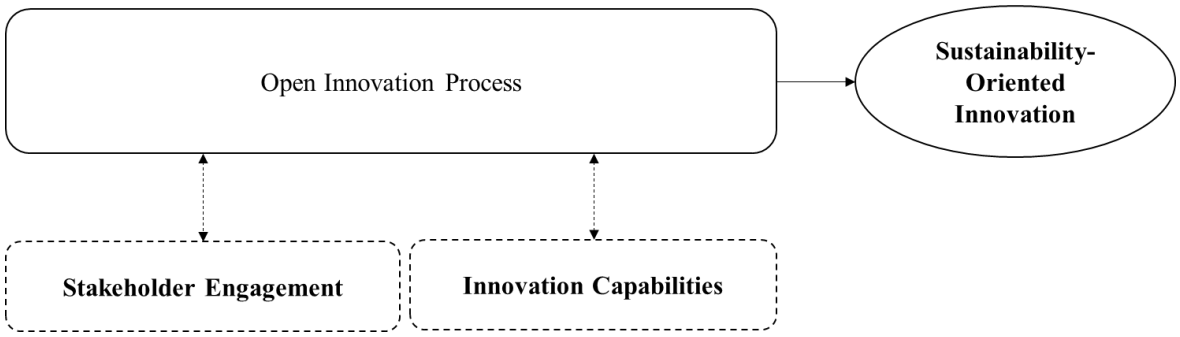

Figure 6. Results of the systematic literature review built onto the hybrid perspective of *Sustainable Open Innovation*.

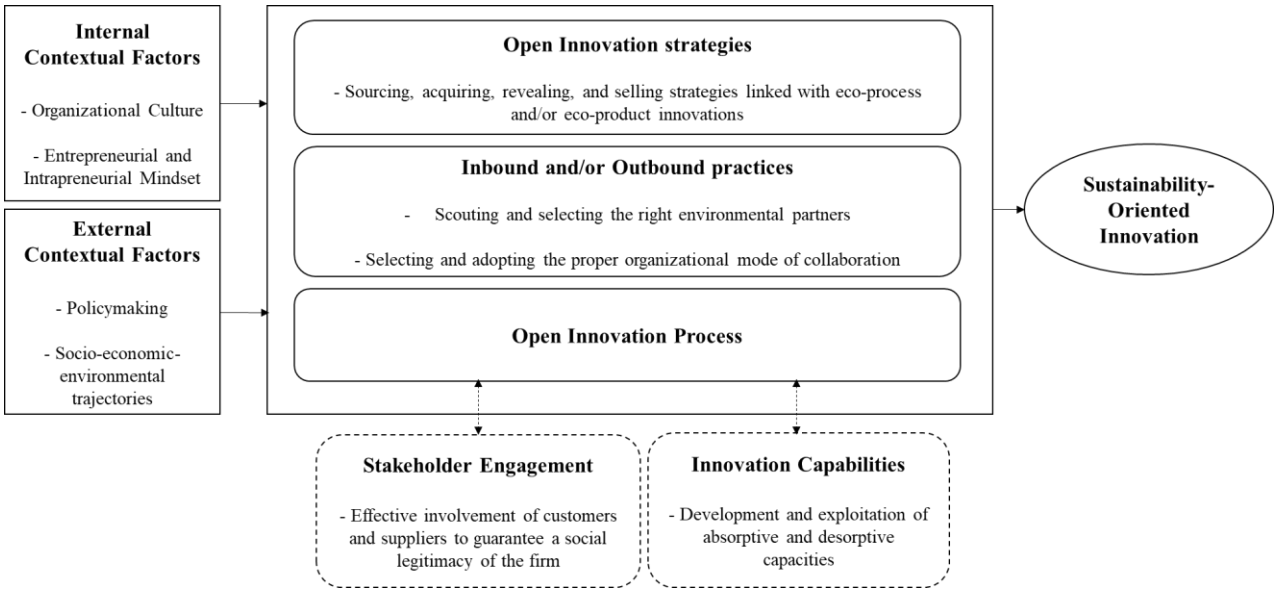

Figure 7. An innovative framework framing the relationships between Open Innovation and Sustainability-Oriented Innovation.

Table 1. Overall inclusion and exclusion criteria in the data collection process.

	No.	Criteria	Reason
Inclusion	1	Publication in journals	Research and review articles published in journals are mainly peer-reviewed and significantly contribute to the literature.
	2	Language	Articles published in English have wider coverage and accessibility.
Exclusion	1	Perspective	Articles lacking any clarification on the role of Open Innovation as an enabler of Sustainability-Oriented Innovation, or any explanation of whether firms developing Sustainability-Oriented Innovation also followed the OI approach were excluded, as they did not provide adequate information to achieve the research objectives.
	2	Generalization of the results	Articles focused on a firm operating in a single industry and in a single country were excluded to ensure the generalizability of the findings.
	3	Unit of analysis	Articles whose unit of analysis was not the firm were excluded, as they could not support achieving the objectives of this research.

Table 2. Emerging and promising questions for future research.

Framework dimension		Emerging and Promising Research Questions
Open Sustainable Innovation		
Inbound and Outbound Open Innovation practices		• How do firms develop and leverage the absorptive capacity and the desorptive capacity for Sustainability-Oriented Innovation? • How do firms scout and select their partners for developing sustainable innovations? • What are the best typologies of collaborations that can be performed by companies for developing sustainable innovations?
Open Innovation strategies		• How do firms implement Open Innovation strategies for enhancing the development of sustainable innovations? • Which are the motivational factors that push firms' managers to implement an Open Innovation strategy for a Sustainability-Oriented Innovation? • Which are the motivational factors that push firms' managers to implement a revealing strategy for a Sustainability-Oriented Innovation, compared to an acquiring, a sourcing, or a selling strategy?
Contextual Factors	*Internal*	• How do firms create and absorb knowledge for promoting sustainable innovations? • How do firms innovate the endowment of their resources and capabilities while developing Sustainability-Oriented Innovation? • What core resources and capabilities are required by firms in the Open Innovation process to support the development of sustainable innovations?
	External	• What role do political initiatives and regulatory frameworks play in fostering a more sustainable pathway of firms' Open Innovation process? • How do policy actions remove barriers and limitations affecting the effectiveness of the Open Innovation process for Sustainability-Oriented Innovation? • What is the best set of indicators firms may adopt to measure the degree to which their Open Innovation process contributes to the development of sustainable innovations?
Sustainable Open Innovation		
Stakeholder Engagement (External)		• How do firms developing sustainable innovations engage with external stakeholders? • How are customers involved by firms developing sustainable innovations in their Open Innovation process? • In which phases of the Open Innovation process external stakeholders and customers do contribute more, and with which activities?

Innovation Capabilities (Internal)	• Which kinds of innovation capabilities are developed by firms developing sustainable innovations through the implementation of the Open Innovation approach? • How are innovation capabilities developed by firms developing sustainable innovations through the implementation of the Open Innovation approach? • With whom are innovation capabilities developed by firms developing sustainable innovations through the implementation of the Open Innovation approach?