



THE ROLE OF BUSINESS INCUBATORS IN DRIVING ECO-INNOVATION BY START-UPS: A DESCRIPTIVE-SURVEY STUDY

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Abstract

Purpose. This study investigates the role of business incubators (BIs) in fostering the development of eco-innovations by incubated start-ups. By examining how BIs integrate sustainability into their incubation practices and facilitate open innovation (OI) processes, it explores the overlooked intersection between incubation, OI, and eco-innovation.

Design/methodology/approach. The research employs a descriptive survey design based on a sample of Italian BIs. Data were collected through structured questionnaires administered in 2024.

Findings. The results reveal that BIs are increasingly fostering a sustainability-oriented culture and supporting eco-innovation, although such practices remain at an early stage of development. By acting as OI intermediaries, BIs facilitate knowledge and technology transfer across innovation ecosystems, contributing to more robust and sustainable networks. Nonetheless, incubated start-ups do not yet fully exploit networking services, suggesting either a lack of consolidated strategies and expertise or that the diffusion of OI in Italy is still in progress.

Practical and social implications. The findings suggest that BI managers should strengthen sustainability-oriented policies and enhance OI support to make incubation processes increasingly competitive. Start-up managers should leverage BIs' networks to overcome resource constraints, particularly in developing eco-innovations. Policymakers are encouraged to provide incentives, training, and dedicated funding to reinforce BIs' role in fostering sustainable innovation ecosystems.

Originality of the study. This study contributes to the emerging debate on the interplay between OI and eco-innovation by conceptualizing BIs as sustainability-oriented OI intermediaries. It advances understanding of how incubation practices shape sustainable innovation ecosystems and provides empirical evidence from the Italian context, where the diffusion of the OI paradigm remains limited.

1. Introduction

In an era marked by escalating environmental challenges, the pursuit of sustainable development has become a global priority. Central to this effort is the concept of eco-innovation, encompassing new products, processes, and services that mitigate environmental impacts and enhance resource efficiency (Kemp & Pearson, 2007). The imperative for eco-innovation is reinforced by tightening regulatory pressures, evolving consumer preferences, and the competitive advantages it affords pioneering firms (Parrilli et al., 2023; Putu Aditya et al., 2025; Sun et al., 2023; Zairbani & Jaya Prakash, 2025; Zighan et al., 2024). Within this context, start-ups, characterized by agility, creativity, and risk tolerance, play a pivotal role in developing and deploying eco-innovative solutions (Hojnik & Ruzzier, 2016; Nuthalapati et al., 2020). However, despite these intrinsic advantages, start-ups often face significant barriers in transforming innovative ideas into viable market offerings, primarily due to constraints in financial resources, specialized expertise, and established networks (Spender et al., 2017). These limitations underscore the need for robust external support mechanisms.

Against this backdrop, business incubators (BIs) play a fundamental role. They assist early-stage ventures through tailored support services, including shared infrastructure, strategic mentoring, business monitoring, and advisory programs, thereby creating a structured environment conducive to innovation and growth (Aernoudt, 2004; Hackett & Dilts, 2004). In recent years, their contribution to sustainable transitions and the promotion of eco-innovation has attracted growing scholarly attention (Gliedt et al., 2018). BIs provide a wide range of services, spanning strategic guidance, technical consulting, resource mobilization, and market entry support, that are essential for overcoming the structural barriers faced by eco-innovative start-ups (Kanda et al., 2018).

The literature on BIs remains relatively recent and evolving, with several gaps still evident (Sohail et al., 2023). In particular, the role of BIs in the development of eco-innovations has received limited empirical attention (e.g., Carvalho et al., 2018; Sultana & Turkina, 2023), as has the broader study of sustainable innovation within start-ups (e.g., Sahili & Barrales-Molina, 2024). Accordingly, this research seeks to address the following question:

RQ₁: How do business incubators facilitate the development of eco-innovation by start-ups?

Moreover, BIs are increasingly recognized as innovation intermediaries (Conroy et al., 2023) facilitating the adoption of open innovation (OI) practices by incubated firms through targeted networking services (Hansen et al., 2000; Scillitoe & Chakrabarti, 2010; Soetanto & Jack, 2013). The OI paradigm emphasizes the strategic use of both inbound and outbound

knowledge flows to accelerate innovation and expand commercialization opportunities (Chesbrough, 2003). For start-ups, engaging in OI practices is crucial to offset internal resource limitations by leveraging external knowledge, expertise, and partnerships (Bereczki, 2019; Pastore et al., 2020; Spender et al., 2017). This aspect is particularly relevant for eco-innovation, given its complexity, high risk, and elevated development costs (e.g., Jaffe et al., 2005; Mukherjee et al., 2024; Rennings, 2000). BIs thus connect start-ups with external actors, such as established firms, universities, and research centers (external innovation networks), and foster collaborations among incubated firms themselves (internal innovation networks) (Bøllingtoft & Ulhøi, 2005; Soetanto & Jack, 2013).

Despite increasing attention, research on BIs as OI intermediaries remains limited (Leitão et al., 2022; Theodoraki et al., 2022). These organizations often adopt OI principles in an informal and unstructured manner (Cirule & Uvarova, 2022), highlighting the need for further investigation into how BIs can effectively facilitate OI adoption among start-ups (Leitão et al., 2022). Furthermore, the relationship between OI and eco-innovation is still underexplored, as the two constructs have largely evolved as distinct research domains (Lippolis et al., 2023; Urbinati et al., 2023). In addition, limited research has examined OI collaborations between start-ups and other organizational actors, such as SMEs (Mercandetti et al., 2017) or large firms (Barile et al., 2024). Existing OI studies predominantly focus on large, high-tech firms (Albats et al., 2020; Dubouloz et al., 2021; Presenza, 2015; Sabando-Vera et al., 2022). Based on these research gaps, the following question is proposed:

RQ₁: How do business incubators foster the adoption of open innovation processes by start-ups?

To address these research questions, a descriptive-survey study was conducted on a sample of Italian BIs.

This paper contributes to the growing literature at the intersection of OI and eco-innovation by highlighting the role of BIs as sustainability-oriented OI intermediaries. It further enriches current understanding of how incubation mechanisms influence the development of sustainable innovation ecosystems, offering empirical insights from Italy, where OI practices are still not widely established.

The article is structured as follows. After this introduction, a section outlines the theoretical background underpinning the study. The third section illustrates the applied methodology and describes

the reference sample. The fourth section presents the main findings, which are then discussed in the fifth section. Finally, the article concludes by highlighting the key implications and outlining the main limitations of the research.

2. Theoretical Background

2.1 BIs

BIs are typically described as organizations that provide shared workspace, business support services, and networking opportunities to early-stage ventures (Bergek & Norrman, 2008). More specifically, the incubation process has been described as an interactive developmental mechanism aimed at encouraging entrepreneurial initiative and supporting start-ups in the creation of innovative products, while also providing a range of complementary services such as managerial support, access to finance, legal advice, operational expertise, and market access (Aernoudt, 2004). BIs have progressively evolved over time in response to changing economic and technological contexts. The literature commonly identifies three main waves in the historical development of incubation programs (Mian et al., 2016). The first wave (until the 1980s) focused on job creation and economic restructuring, offering affordable space and basic shared services to start-ups. The second wave (1980s-1990s) expanded BI offerings to include value-added services such as mentoring, skills development, and networking, while the first Internet-based virtual incubation models also began to emerge. The third wave (since the 2000s) is characterized by mixed-use science parks and the rise of accelerators linked to the digital economy, such as Y Combinator¹, which provide cohort-based, time-limited programs with a strong emphasis on mentoring and preparing public pitches to attract investors. Therefore, according to Abduh et al. (2007), the services offered by BIs can be grouped into three main categories: (i) Facility-related services; (ii) Counselling and business support services; (iii) Access to networks. Among the various typologies proposed in the literature, Grimaldi and Grandi (2005) classify BIs into four main categories: (i) Business Innovation Centers (BICs): created in 1984 by a European Commission initiative, BICs mainly provide foundational support such as workspace, information on funding opportunities, administrative assistance, and visibility; (ii) University Business Incubators (UBIs): affiliated with universities, UBIs foster the creation, integration, and dissemination of new scientific and technological knowledge. Services often include academic consultancy, access to libraries and laboratories, R&D resources, and technology transfer

¹ Y Combinator is one of the world's most prominent start-up accelerators located in San Francisco, California.

programs (Mian, 1996); (iii) Independent Private Incubators (IPIs): established by private investors or investor groups, IPIs often acquire equity stakes in start-ups to accelerate their growth. They are commonly referred to as accelerators, focusing on ventures that have already started operations and require additional capital or know-how; (iv) Corporate Private Incubators (CPIs): set up by large corporations to support the development of new business projects emerging from internal initiatives (e.g., intrapreneurship) that cannot be pursued within the parent organization.

Ownership and origin patterns vary by type: BICs and UBIs are generally non-profit, established by public institutions to promote local economic growth, while IPIs and CPIs are private and profit-oriented. Furthermore, UBIs and CPIs often host projects originating within their parent organizations, whereas BICs and IPIs primarily support external ventures.

2.2 The Role of BIs in Start-up Eco-Innovation

Eco-innovations are characterized by their ability to reduce environmental risks, pollution, and other negative impacts associated with resource use, when compared to conventional alternatives (Kemp & Pearson, 2007). Eco-innovation is a highly complex concept, and, at present, there exists no universally accepted definition in the literature (Zairbani & Jaya Prakash, 2025). The development of eco-innovations is particularly well-suited to start-ups, as these emerging ventures operate in dynamic and highly competitive environments (Pichlak & Szromek, 2022). Start-ups' inherent organizational flexibility allows them to implement environmentally innovative practices more readily, due to flatter hierarchies and less rigid structures (Nuthalapati et al., 2020). Moreover, start-ups are fundamentally oriented toward innovation, emphasizing problem-solving and a willingness to take risks (Hojnik & Ruzzier, 2016), which naturally supports the pursuit of eco-innovative solutions. Therefore, eco-innovation can provide start-ups with a distinctive competitive edge, setting them apart from established competitors (Guleria & Kaur, 2022). However, start-ups often encounter substantial challenges in developing and commercializing innovations due to their small size and limited resources, knowledge, and capabilities (Spender et al., 2017). This becomes even more evident in the context of eco-innovation development, given its complexity, risk, and high development costs (e.g., Jaffe et al., 2005; Mukherjee et al., 2024; Rennings, 2000). Therefore, start-ups aiming to develop eco-innovations face unique barriers, including high initial capital costs, uncertain cash flows, and challenges in securing funding from traditional investors (Mukherjee et al., 2024).

Given these substantial challenges, innovation intermediaries such as BIs (Conroy et al., 2023) play a crucial role in supporting eco-innovation development by start-ups (Mukherjee et al., 2024). Innovation intermediaries are widely discussed in the innovation management literature and, more recently, have increasingly attracted attention in the sustainability transitions literature as well (Gliedt et al., 2018). According to Kanda et al. (2018), these organizations support the development of eco-innovations by start-ups through a wide range of practices, including: (i) forecasting and roadmapping, by helping firms identify promising eco-innovations and define strategic directions; (ii) information gathering and dissemination, through the collection and sharing of technical and market knowledge via seminars and digital tools; (iii) prototyping and piloting, by providing testbeds to validate environmental benefits and reduce risks; (iv) technical consulting, offering expertise on energy and material efficiency; (v) resource mobilization, by facilitating access to financial, human, and knowledge resources; (vi) commercialization, supporting market entry for eco-innovations; (vii) branding and legitimation, enhancing reputation and social acceptance; and (viii) networking and partnerships, fostering collaboration among firms, universities, and research centers to overcome innovation barriers. This latter point is crucial, given the innovation barriers that typically characterize start-ups. Therefore, start-ups should adopt OI practices to overcome these constraints by engaging with external entities and organizations (Bogers, 2011; Primario et al., 2024; Spender et al., 2017).

2.3 BIs as OI Intermediaries

The OI paradigm emphasizes firms' intentional use of both inbound and outbound knowledge and technology flows to accelerate internal innovation processes and broaden opportunities for external commercialization of innovations (Chesbrough et al., 2006; Chesbrough, 2003). The literature identifies several variants of OI (e.g., Chesbrough & Bogers, 2014; Chesbrough, 2003; Gassmann & Enkel, 2004): (i) Outside-in (or inbound) OI, where firms acquire knowledge from external sources; (ii) Inside-out (or outbound) OI, where firms transfer knowledge externally; and (iii) Coupled OI, which combines the two previous processes and allows for the development of strategic R&D networks.

BIs play a pivotal role in fostering OI among their incubated start-ups by offering targeted networking services (e.g., Hansen et al., 2000; Scillitoe & Chakrabarti, 2010; Soetanto & Jack, 2013). Such services encourage inter-firm collaboration, facilitate knowledge sharing, and support the establishment of technological and market partnerships (Hansen et al., 2000).

Through these mechanisms, BIs enable start-ups to connect with external actors, such as SMEs, large firms, and universities (external innovation networks), while simultaneously enhancing knowledge exchange among incubated firms themselves (internal innovation networks) (Bergek & Norman, 2008; Bøllingtoft & Uhløi, 2005; Cirule & Uvarova, 2022; Soetanto & Jack, 2013). In this context, BIs act as enablers of OI practices, supporting start-ups in externalizing their innovation processes and engaging with external knowledge sources (Chesbrough & Brunswicker, 2014; Cirule, 2022; Hansen et al., 2000; Soetanto & Jack, 2013; Van De Vrande et al., 2009). Specifically, networking activities are particularly important because they support start-ups in acquiring external resources and knowledge to develop their innovations (inbound OI), as well as in transferring or commercializing their technology to external partners and markets (outbound OI). Moreover, BIs help start-ups overcome several barriers that can hinder the adoption of OI practices (Cirule & Uvarova, 2022), such as limited knowledge and time constraints (Weingarden & Raes, 2022). Networking opportunities offered by BIs have therefore become a key factor influencing start-ups' decisions to join a particular incubation program (Ruping & von Zedtwitz, 2001). Finally, given that OI has been identified as a key mechanism for addressing emerging technological trends and international policy agendas, such as the Sustainable Development Goals (SDGs) for the 2015-2030 period (Bogers et al., 2018), BIs, acting as OI intermediaries, may represent a critical organizational mechanism for fostering eco-innovation and contributing to broader sustainability transitions.

3. Methodology

This study adopts a survey research method, which is widely employed to collect data while ensuring a defined level of statistical accuracy (Rea & Parker, 1992; Rossi et al., 2013). Specifically, we adopted a descriptive-survey design, as its primary purpose is to assess the extent of a phenomenon and to capture its distribution within a given population, particularly in contexts where existing knowledge on the topic is still limited (Dubin, 1978; Malhotra & Grover, 1998; Wacker, 1998).

3.1 Data Sample

The research was conducted in Italy, a country where the culture of OI is still relatively underdeveloped (European Commission, 2024). In this context, the role of BIs can be strategic in fostering the diffusion of this paradigm. Specifically, the investigation was carried out on a sample of

BIs, consisting of all certified BIs officially recognized by the Ministry of Enterprises and Made in Italy and listed in the Italian Business Register² (Registro delle Imprese) as of March 4, 2024. This choice allowed us to test our research questions on those BIs that, due to their higher quality standards and services, are presumably more inclined to promote innovation. Indeed, Article 25, paragraph 5, of Italian Decree-Law No. 179 of October 18, 2012, converted with amendments by Law No. 221 of December 17, 2012, specifies that a certified BI of innovative start-ups must meet a series of specific requirements outlined in the same article: (i) possess facilities, including physical spaces, suitable for hosting innovative start-ups, such as areas dedicated to testing, experimentation, or research; (ii) have equipment appropriate to the activities of start-ups, including ultra-broadband Internet access, meeting rooms, and machinery for tests, trials, or prototypes; (iii) be managed or directed by individuals with recognized expertise in business and innovation and maintain a permanent technical and managerial consulting structure; (iv) maintain regular collaborations with universities, research centers, public institutions, and financial partners engaged in activities and projects related to innovative start-ups; (v) demonstrate adequate and proven experience in supporting innovative start-ups. Following the approach and methodology applied by Cavallo et al. (2020) and Sansone et al. (2020), a number of non-certified BIs was also included to provide a more comprehensive overview of the incubation ecosystem and to capture relevant practices occurring beyond certified incubation programmes. These BIs were identified using secondary sources available online. In particular, lists compiled by PNI-Cube³, Italia Startup Association⁴, and Startup Geeks⁵ were considered. Subsequently, a purposive sampling strategy was adopted to retain only non-certified BIs that were most actively engaged in the paradigms of OI and eco-innovation. To this end, an analysis of secondary sources was conducted, including institutional documents of the BIs (specifically, their regulations and, where available, activity reports), websites, and press coverage. The analysis focused on the presence of dedicated sections or information on OI and sustainability, retaining only those BIs that met the following three strict inclusion criteria:

2 The list of certified Italian BIs is available at the following link: <https://startup.registroimprese.it/isin/static/startup/index.html?slideJump=33>.

3 PNICube, the Italian association that brings together BIs and business plan competitions, provides an updated list of Italian BIs at: <https://www.pnicube.it/associati>

4 Italia Startup, a non-profit association that supports and represents the Italian start-up ecosystem, provides a list of Italian BIs at: <https://innovup.net/soci/>

5 Startup Geeks is an Italian BI and pre-accelerator supporting start-ups through online programs, mentorship, and a dedicated community, and provides a list of BIs at: <https://www.startupgeeks.it/incubatori-acceleratori-startup-in-italia/#post-content-elementor>

(1) tenant selection strategy (sustainable focus): explicit prioritization of start-ups whose projects address sustainable challenges or develop sustainable technologies.

(2) service provision (OI orientation): formal provision of networking and collaboration activities aimed at fostering knowledge exchange and joint initiatives among incubated start-ups as well as between these start-ups and external actors (e.g., corporations, research institutions, and other ecosystem stakeholders), thereby supporting OI processes.

(3) institutional mission (sustainability commitment): explicit references within the BI's mission, vision, official regulations, or public reports that emphasize a strategic commitment to environmental and social sustainability.

For both certified and non-certified BIs, no distinction was made between public or private nature; all types were considered in order to provide an extensive and detailed analysis of the phenomenon. Therefore, all 63 certified BIs were included, and 37 non-certified BIs were selected based on the aforementioned purposive criteria.

3.2 Data Collection

An invitation to participate in the survey was sent to 100 BIs. The survey was administered to individuals holding key strategic or operational roles within the BIs, specifically CEOs, Operations Directors, or Innovation Managers. These roles were selected because they possess comprehensive knowledge of the BI's strategic orientation toward sustainability, the specific incubation services provided, and the management of OI networks. 9 questionnaires could not be delivered due to incorrect contact information. Consequently, 91 questionnaires were successfully administered to the target respondents. At the end of the process, a total of 23 valid responses were received, corresponding to a response rate of 25.27%. Of the 23 respondents, only 20 disclosed their identity and thus provided information directly linked to the identification of the BI (e.g., geographical location). The majority of organizations that agreed to participate in the study are located in Southern Italy (39.13%), while 17.39% are based in Central Italy and 30.43% in Northern Italy. For the remaining 13.04%, no information is available due to the anonymity of BIs. Furthermore, the majority of the organizations that took part in the survey are private BIs (52.17%). Public BIs account for 26.09% of the respondents, while public-private BIs represent 8.70%. In this case as well, information is unavailable on the remaining 13.04%.

The study was conducted through the administration of a questionnaire for BIs, designed using the "Google Forms" platform. All participants were

given the opportunity to remain anonymous, ensuring that any sensitive information could be withheld from inclusion in the paper. The survey consisted of 12 closed-ended questions. Where appropriate, the option “*Other*” was provided, allowing respondents to freely supply an alternative answer if none of the proposed categories applied. Some of the questions allowed respondents to select one or more response options, others were dichotomous (Yes/No), and still others were designed to measure specific phenomena using a four or five-point Likert scale. The survey opened with a brief description of the study and its underlying rationale, as well as a set of practical instructions for completing the questionnaire. Some questions were adapted based on two previous studies conducted by Auricchio et al. (2014) and by Cirule & Uvarova (2022). The first section of the questionnaire included questions aimed at gathering information on the ability of BIs to foster the development of eco-innovations among their incubated start-ups. The second section focused on collecting data regarding the capacity of BIs to act as OI intermediaries. Data collection took place between March and September 2024. Before the actual administration of the questionnaire, a pilot test was conducted with four colleagues from the same department, in order to evaluate and refine the survey design and question wording, as well as to identify potential sources of bias (Dillman, 2013; Forza, 2002). Table 1 provides an overview of the variables included in the questionnaire, along with their respective modalities. For each modality, the table reports the main descriptive statistics, distinguishing between certified and non-certified BIs⁶.

⁶ As noted in Section 3.2, three of the 23 BIs did not disclose their identity, preventing their classification as either certified or non-certified.

Tab.1. Questionnaire variables and descriptive statistics

Variables	Modalities	Statistics			
Selection criterion (Five-point Likert ⁷)			All BIs (n=23)	Certified BIs (n=10)	Non-certified BIs (n=10)
	<i>Characteristics of the Business Idea</i>				
	Potential of the business idea	Mean	4.26	4.40	4.20
		SD	(0.86)	(0.84)	(0.92)
		MIN	2	3	2
		MAX	5	5	5
		Median	4	5	4
	Quality of the business idea	Mean	4.13	4.40	3.80
		SD	(0.92)	(0.70)	(1.14)
		MIN	2	3	2
		MAX	5	5	5
		Median	4	4,5	4
	Characteristics of the entrepreneurial team	Mean	4.52	4.60	4.40
		SD	(0.85)	(0.70)	(1.07)
		MIN	2	3	2
		MAX	5	5	5
		Median	5	5	5

⁷ A five-point Likert scale was used in line with Auricchio et al. (2014) to capture nuanced differences in the importance of selection criteria for incubated start-ups.

	Technological content of the business idea	Mean	3.39	3.30	3.40
		SD	(0.78)	(0.95)	(0.70)
		MIN	2	2	2
		MAX	5	5	4
		Median	3	3	3.5
	Environmental sustainability orientation	Mean	3.74	4.10	3.60
		SD	(0.86)	(0.88)	(0.84)
		MIN	2	3	2
		MAX	5	5	5
		Median	4	4	4
	Social sustainability orientation	Mean	3.74	3.90	3.90
		SD	(0.81)	(0.88)	(0.57)
		MIN	2	3	3
		MAX	5	5	5
		Median	4	4	4
	<i>Financial Resources Available and Project Development Stage</i>				
	Project development stage	Mean	2.70	2.50	3.00
		SD	(1.15)	(1.27)	(1.15)
		MIN	1	1	1
		MAX	5	5	5
		Median	3	2	3
	Availability of debt financing	Mean	2.43	2.70	2.20
		SD	(0.79)	(0.82)	(0.79)
		MIN	1	2	1
		MAX	4	5	3
		Median	2	2,5	2
	Availability of equity financing	Mean	2.65	2.80	2.50
		SD	(0.93)	(0.79)	(1.18)
		MIN	1	2	1
		MAX	4	4	4
		Median	3	3	3
	<i>Factors in Common with the BI</i>				
	Link between the start-up and a BI's partner organization	Mean	2.78	2.80	2.90
		SD	(1.17)	(1.14)	(1.37)
		MIN	1	1	1
		MAX	5	4	5
		Median	3	3	2.5

	Consistency with the business area in which the BI operates	Mean	3.22	3.40	3.10
		SD	(1.35)	(1.17)	(1.66)
		MIN	1	2	1
		MAX	5	5	5
		Median	4	3,5	4
Commitment in Promoting Sustainability Culture among Incubated Start-ups <i>(Four-point Likert⁸)</i>		Mean	3.21	3.40	3.20
		SD	(0.52)	(0.52)	(0.42)
		MIN	2	3	3
		MAX	4	4	4
		Median	3	3	3
Services Promoting Sustainability among Incubated Start-ups	Policy requiring incubated start-ups to adopt sustainability criteria	(% of BIs providing service)	26.09%	40.00%	20.00%
	Financial support for incubated start-ups making significant sustainability investments		39.13%	50.00%	30.00%
	Structured integration of sustainability criteria in the selection phase		69.57%	90.00%	70.00%
	Technical support for incubated start-ups developing sustainable products or services		95.65%	100.00%	100.00%
	Consulting and training on implementing strategic sustainability policies		65.22%	80.00%	60.00%
	Organization of events or workshops on sustainable entrepreneurship and eco-friendly practices		73.91%	90.00%	80.00%
	Collaboration with external actors to promote sustainability		91.30%	100.00%	80.00%
	Periodic monitoring of environmental and social impact of incubated start-ups		43.48%	50.00%	50.00%

8 A four-point Likert scale was used, providing a clearer forced-choice assessment without a neutral midpoint, which is suitable for evaluating perceptions or opinions (Chyung et al., 2017).

Eco-innovation strategic perspective	Revisionist view	(% of BIs agreeing)	91.30%	100.00%	100.00%
	Adaptation view		8.70%	0.00%	0.00%
	Traditionalist view		0.00%	0.00%	0.00%
Propensity to adopt practices fostering OI among start-ups	Always	(% of BIs)	78.26%	90.00%	80.00%
	Rarely		21.74%	10.00%	20.00%
	Never		0.00%	0.00%	0.00%
Actions supporting OI	Technical /Financial Support	(intensity level) ⁹	50.73%	63.33%	53.33%
	Training and Mentoring Programs		72.05%	81.43%	68.57%
	Networking		64.78%	64.00%	68.00%
Future investment plans of BIs in OI	Yes, to a significant extent	(% of BIs)	60.87%	80.00%	50.00%
	Yes, to a minor extent		26.09%	20.00%	40.00%
	No plans		13.04%	0.00%	10.00%
BI's opinion on the level of utilization of networking services by incubated start-ups (Four-point Likert ⁷)		Mean	3.09	3.10	3.20
		SD	(0.42)	(0.32)	(0.42)
		MIN	2	3	3
		MAX	4	4	4
		Median	3	3	3

Source: Authors' elaboration

⁹ Intensity level = number of selected options out of the total options available for each category

4. Findings

4.1 BIs' engagement in eco-sustainability practices

The analysis of selection criteria reveals that BIs adopt a multidimensional approach in evaluating start-ups, balancing traditional business-oriented parameters with emerging sustainability-related aspects. Specifically, 69.57% reported effectively structured integration of sustainability criteria into the analysis and selection of start-ups. Adoption was higher among certified BIs (90%) than among non-certified BIs (70%). Table 2 presents the importance attributed by BIs to the main selection criteria shown in Table 1. The final evaluation was assigned based on the mean scores reported in Table 1 (calculated using a five-point Likert scale) as follows: from 1 to 2 (low level), from 2 to 3 (medium-low level), 3 (medium level), from 3 to 4 (medium-high level), and from 4 to 5 (high level).

Tab.2. Start-up selection criteria adopted by BIs

Selection criterion	Final assessment		
	All BIs (n=23)	Certified BIs (n=10)	Non-certified BIs (n=10)
<i>Characteristics of the Business Idea</i>			
Potential of the business idea	High	High	High
Quality of the business idea	High	High	Medium/High
Characteristics of the entrepreneurial team	High	High	High
Technological content of the business idea	Medium/High	Medium/High	Medium/High
Environmental sustainability orientation	Medium/High	High	Medium/High
Social sustainability orientation	Medium/High	Medium/High	Medium/High
<i>Financial Resources Available and Project Development Stage</i>			
Project development stage	Medium/Low	Medium/Low	Medium
Availability of debt financing	Medium/Low	Medium/Low	Medium/Low
Availability of equity financing	Medium/Low	Medium/Low	Medium/Low
<i>Factors in Common with the BI</i>			
Link between the start-up and a BI's partner organization	Medium/Low	Medium/Low	Medium/Low
Consistency with the business area in which the BI operates	Medium/High	Medium/High	Medium/High

Source: Authors' elaboration

Overall, high importance is attributed to several aspects of the business idea, including its potential, quality, and the characteristics of the entrepreneurial team. Medium-to-high importance is assigned to the technological content of the project, as well as to its level of social and environmental sustainability orientation, with both factors receiving an identical average score. This result suggests that BIs increasingly regard sustainability not as a peripheral feature, but as a criterion comparable to technology in shaping the attractiveness of entrepreneurial projects.

Conversely, medium-to-low importance is instead attributed to other factors, such as the project's stage of development and the availability of financial resources in the form of debt or equity. Similarly, the existence of links with the BI's partner organizations does not strongly influence the selection of start-ups, whereas greater relevance is given to the coherence of the project with the business area in which the BI operates. This indicates that BIs are less concerned with immediate financial readiness or pre-existing relational capital, focusing instead on the long-term coherence of the project with their own strategic domain.

When distinguishing between certified and non-certified BIs, the overall importance levels are largely similar. Exceptions include the quality of the business idea, for which non-certified BIs assign medium-to-high rather than high importance, the project development stage, for which non-certified BIs assign a medium level, compared to a medium-low level for certified BIs, and the level of environmental sustainability orientation, for which certified BIs assign a higher level than non-certified ones. The differences between certified and non-certified BIs reflect their distinct priorities and operational approaches. Certified BIs assign a higher importance level to the quality of the business idea, which could be due to their need to maintain strict performance standards entailed by their certified status. Regarding the project development stage, they assign a lower importance level, which may reflect a greater willingness to support projects at very early stages. Being more structured and better resourced, certified BIs may be less concerned with a project's early-stage maturity and more willing to incubate ideas from their inception. For the same reasons, they may also be better equipped to support eco-innovative start-ups, making environmental sustainability a strategic pillar rather than a mere *"plus"*.

Consistent with their selection criteria, BIs report a strong commitment to fostering a sustainability culture among the start-ups they support. Specifically, the majority (69.6%) indicate a moderate level of commitment, while 26.1% declare a high level of commitment. Only a small fraction (4.3%) report being slightly committed, and no BI indicates a lack of com-

mitment. Accordingly, the average level of commitment, calculated on a four-point Likert scale, is 3.21, with a relatively low standard deviation, indicating a consistent and broadly shared dedication to promoting sustainability among supported start-ups. When distinguishing between certified and non-certified BIs, some differences emerge. Among certified BIs, 40% report a high level of commitment and 60% a moderate level, resulting in an average commitment score of 3.40. Among non-certified BIs, 20% report a high level and 80% a moderate level, leading to a slightly lower average commitment score of 3.20. Although the difference is relatively small, certified BIs appear somewhat more inclined to promote a sustainability culture among their incubated start-ups.

Moreover, 26.09% of BIs have formal policies requiring incubated start-ups to adopt specific ecological practices, indicating that this aspect is still in its early stages. In detail, 40% of certified BIs report adopting such policies, compared to only 20% of non-certified BIs, confirming the previously observed trend. Additionally, 43.48% of BIs periodically monitor the environmental impact of their start-ups' activities, suggesting that this practice may expand in the coming years. In this case, certified and non-certified BIs show similar behavior, as 50% in each group report conducting such monitoring activities. Furthermore, 65.22% offer advisory and training services to support the strategic implementation of sustainability policies. In this regard, certified BIs (80%) exceed the percentage of non-certified ones (60%). While only 39.13% provide financial support for sustainability-related investments (50% among certified BIs compared to 30% among non-certified BIs), 95.65% offer technical support, such as access to laboratories, tools, and advanced technologies to develop and refine innovations (100% of both certified and non-certified BIs provide this service). Finally, 73.91% organize events or workshops on eco-sustainable entrepreneurship (90% among certified BIs and 80% among non-certified ones), and 91.30% collaborate with external organizations to foster a culture of sustainability among their incubated start-ups (100% of certified BIs compared to 80% of non-certified BIs). Overall, these results confirm the initial commitment of BIs to promote sustainability, highlighting a trend likely to accelerate in the coming years, with more organizations adopting formal sustainability policies and monitoring practices. In particular, this commitment is evident among both certified and non-certified BIs, although a slightly higher level of engagement emerges among certified BIs.

Finally, nearly all BIs (91.30%) agree with the "*Ecological Modernization*" theory (Jänicke, 2008; Zhu et al., 2012) and, consequently, with the "*revisionist view*" (Hermundsdottir & Aspelund, 2021), which posits that the adoption of eco-innovations should not be arbitrary or merely a reactive measure in response to new environmental regulations. Instead, it should

be strategically planned to maximize firm performance. In contrast, 8.70% of respondents believe that the development of eco-innovations is necessary only to comply with environmental regulations (*"adaptation view"*), and none of the BIs adopt the *"traditionalist view"*, which argues that developing such innovations entails only costs and provides no benefits to firms (Hermundsdottir & Aspelund, 2021). When distinguishing between certified and non-certified BIs, 100% of both groups agree with the *"revisionist view"*. These results underscore the generally positive perception of sustainability-related issues among BIs.

4.2 The role of BIs as OI intermediaries

The data collected indicate a strong commitment by BIs to promoting OI among their incubated start-ups, encouraging them to expand the boundaries of innovation. Specifically, 78.3% of BIs reported consistently adopting practices that foster the adoption of OI processes, while 21.7% reported doing so only rarely, and none declared never adopting such practices. More specifically, 90% of certified BIs reported consistently adopting these practices and only 10% doing so rarely. Among non-certified BIs, the share of those consistently adopting such practices decreases to 80%, while the proportion reporting rare adoption rises to 20%. Moreover, 60.9% reported planning substantial investments in OI, 26.1% indicated more limited plans, and only 13% stated that they had no plans in this regard. More specifically, 80% of certified BIs reported planning substantial investments, while the remaining 20% indicated more limited investment plans. Among non-certified BIs, the share planning substantial investments decreases to 50%, while 40% report more limited investment intentions and 10% state that they do not plan to make such investments in the future.

Specifically, BIs adopt targeted practices to foster the development of both internal and external innovation networks. Table 3 summarizes these practices, classifying them according to the type of activity (Technical/Financial Support; Training and Mentoring Programs; Networking) and the type of innovation network (internal or external).

Type of activity	External Innovation Network	Internal Innovation Network
<i>Technical/ Financial Support</i>	Access to financial and/or technical resources (e.g., testing laboratories) to facilitate the acquisition of external innovations and/or the development and commercialization of internal innovations	Provision of co-working spaces
<i>Training and Mentoring Programs</i>	Training and/or mentoring programs aimed at fostering a culture of openness and collaboration with external companies. Training and/or mentoring on technology transfer processes and intellectual property management. Support activities for drafting business plans and pitch decks to present innovations to potential partners and investors.	Training and/or mentoring programs on team building. Training and/or mentoring programs designed to foster a co-working culture among incubated start-ups.
<i>Networking</i>	Organization of networking events with universities, research centers, innovative firms, and potential investors. Consultancy services for the evaluation, selection, and integration of external innovations. Offering and dissemination of partnership programs with external companies, universities, and other institutions (e.g., call for start-ups, OI labs). Promotion of incubated start-ups through dedicated communication and marketing channels. Support in scouting activities for potential external partners. Development of an online platform enabling incubated start-ups to articulate innovation-related needs and challenges and to showcase their innovations, while allowing external firms to propose their innovations as potential solutions or to request innovations from the start-ups.	Organization of internal networking events to foster interaction and knowledge sharing among incubated start-ups. Organization of collaborative initiatives (internal co-creation projects or those promoted by partner organizations) among incubated start-ups on technological topics of shared interest, or aimed at joint participation in regional, national, and European funding schemes. Creation of a consortium of start-ups in which all members operate according to the principle of " <i>Peer Innovation</i> ". Development of online platforms or dedicated forums for the exchange of resources and knowledge among incubated start-ups.

Source: Authors' elaboration

A first set of practices revolves around technical and financial support, enabling start-ups to access resources such as laboratories and specialized facilities that facilitate the development and commercialization of internal innovations, as well as the integration of external ones. The provision of co-working spaces also serves as a key mechanism to nurture collaboration within the BI environment. The intensity with which BIs adopt these practices amounts to 50.73%. 63.33% of certified BIs report engaging in this type of support, while the percentage decreases to 53.33% among non-certified BIs. Second, training and mentoring programs are widely deployed to instill an OI mindset. Externally, these programs focus on technology transfer, intellectual property management, and the development of business plans and pitch decks to attract potential partners and investors. Internally, they target team building and the cultivation of a collaborative culture among start-ups sharing the incubation space. In this case, the intensity level is high, reaching 72.05%. When considering certified BIs, the percentage rises to 81.43%, while it stands at 68.57% for non-certified ones. This suggests a stronger level of engagement in this area among certified BIs. Finally, networking practices emerge as the most diversified and structured set of activities. Externally, BIs connect start-ups with universities, research centers, innovative firms, and investors through events, consultancy services, partnership programs, and communication platforms. They also support scouting activities and develop online platforms where start-ups and external firms can match innovation needs and solutions. Internally, networking initiatives foster interaction, knowledge sharing, and resource exchange among incubated start-ups, facilitated by events and dedicated online forums, collaborative co-creation projects, and the formation of consortia operating under a “*Peer Innovation*” approach. The intensity level with which BIs provide networking services amounts to 64.78%. In this area, certified and non-certified BIs show very similar levels, with a slightly higher percentage among non-certified BIs (68%) compared to certified ones (64%). These insights are particularly relevant, as they directly address the research gap concerning “*how*” BIs support OI among their start-ups. However, only 13.04% of the BIs surveyed reported that their start-ups fully and consistently exploit the networking services provided (10% among certified BIs and 20% among non-certified ones), while 82.61% stated that these services are used “*fairly sufficiently*” (90% for certified and 80% for non-certified BIs). Only 4.35% indicated a low level of utilization, and none reported no utilization. Accordingly, the mean perceived level of utilization, calculated on a four-point Likert scale, is 3.09 overall, 3.10 for certified BIs, and 3.20 for non-certified BIs. This finding aligns with the assumption that a culture of OI is still not deeply embedded within Italian firms.

Overall, a strong commitment by BIs to adopting practices that foster the implementation of OI processes among their incubated start-ups can

be highlighted. Specifically, the results show a higher level of engagement among certified BIs compared to non-certified ones, although both categories are, on average, highly committed in this regard.

5. Discussion

Sustainability principles are increasingly central to the strategic priorities of BIs. This shift is evident in the growing importance attributed to sustainability-oriented innovation projects during the start-up selection phase. BIs are also progressively adopting internal policies and practices that foster a sustainability-oriented organizational culture, embedding this approach as a foundational element in the business model development of incubated start-ups. Accordingly, they provide targeted support through consulting and training on sustainability, technical assistance, and the organization of related events. In doing so, BIs encourage start-ups to adopt sustainability proactively as a strategic lever, consistent with evidence that eco-innovation enhances firms' economic and financial performance (e.g., Appiah et al., 2025; Putu Aditya et al., 2025; Zairbani & Jaya Prakash, 2025). At the same time, they promote sustainability as an overarching vision and mindset, embedding it throughout organizational processes via a top-down approach. Therefore, the results of this study confirm the growing role of BIs as organizations supporting the development of eco-innovations by their incubated start-ups (Gliedt et al., 2018; Kanda et al., 2018; Mukherjee et al., 2024). Although these initiatives are still at a developmental stage, their relevance is expected to increase in the coming years, as sustainability is becoming intrinsically linked with the concept of start-ups itself. According to the Social Innovation Monitor (2024), the number of start-ups focused on sustainable innovation continues to grow steadily, suggesting that BIs must increasingly align with evolving market expectations by placing greater emphasis on sustainability.

The findings also highlight the active role of BIs as OI intermediaries (Conroy et al., 2023). Through networking services, BIs facilitate both internal and external innovation networks, enabling small firms to overcome constraints related to limited resources and knowledge (Bergek & Norman, 2008; Bøllingtoft & Ulhøi, 2005; Cirule & Uvarova, 2022; Soetanto & Jack, 2013). These services allow start-ups not only to transfer knowledge and technologies outward, thus supporting established firms in developing eco-innovations (outbound OI), but also to acquire external knowledge and technologies that accelerate and strengthen their internal eco-innovation processes (inbound OI) (Chesbrough et al., 2006; Chesbrough, 2003). Consequently, BIs' intermediation activities generate significant benefits for local innovation ecosystems by promoting collaboration among diverse actors and fostering eco-innovation development.

In this sense, BIs contribute to the emergence of “*sustainable innovation ecosystems*”, defined as dynamic networks of heterogeneous actors (e.g., firms, universities, research institutions, government bodies, and civil society organizations) that collaboratively generate innovations addressing major societal challenges while creating economic, environmental, and social value (Evans et al., 2017; Huy & Phuc, 2024; Stubbs & Cocklin, 2008). The growing scholarly attention to this topic underscores its novelty and increasing relevance in tackling contemporary global issues (Parahoo & Ayyagari, 2022).

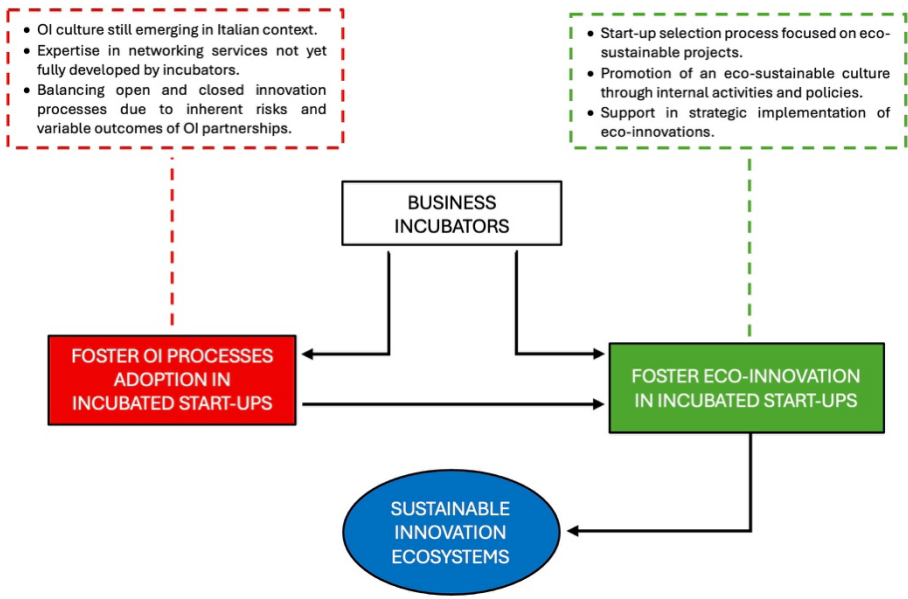
The results further indicate that certified BIs tend to be more committed to promoting a sustainability culture among their incubated start-ups, as well as to adopting practices that foster the implementation of OI processes. This outcome was somewhat expected, as certified BIs are required to comply with legally established quality standards and criteria, which generally translate into greater resources and a stronger organizational structure compared to non-certified BIs. However, it is important to underline that the difference is not particularly pronounced; non-certified BIs also demonstrate a substantial level of commitment to both sustainability and OI practices, confirming that engagement in these areas is widespread across the BI population.

However, incubated start-ups do not yet fully exploit the services offered by BIs, which may reflect a lack of established strategies and expertise or, more broadly, the still-limited diffusion of OI practices in Italy (e.g., European Commission, 2024). Indeed, Italian firms are notably affected by the “*Not-Invented-Here*” syndrome, a major barrier to OI adoption (Politecnico di Milano, 2024). This mindset leads companies to undervalue external ideas and products, perceiving them as inferior to those developed internally. While start-ups generally possess greater organizational flexibility and an inherent orientation toward innovation (Hojnik & Ruzzier, 2016; Nuthalapati et al., 2020), this cognitive barrier prevents them from fully leveraging the external networks provided by BIs. This opens an avenue for future research exploring the factors shaping firms’ perceptions and adoption of OI, particularly among incubated start-ups. Future studies could also provide guidelines and best practices to support BI managers in integrating the OI paradigm more effectively into incubation programs, as well as investigate start-ups’ satisfaction with networking services in the Italian context.

Finally, it is important to note that OI collaborations within innovation ecosystems do not always produce predictable outcomes, as results depend on multiple factors, including partner type, industry sector, relative bargaining power, and broader economic, institutional, cultural, and organizational contexts (e.g., Cricchio & Di Minin, 2025; Sears & Muhammad, 2024; Wallner-Drewitz & Menrad, 2011). Thus, the benefits of OI for eco-

innovation are heterogeneous and context-specific. Moreover, OI processes involve inherent risks, including relational challenges, coordination costs, and significant time and financial investments (Enkel et al., 2009). Excessive openness can increase managerial complexity, create dependence on external knowledge, and heighten the risk of losing control over critical resources such as expertise and intellectual property (Ben Arfi et al., 2018; Enkel et al., 2009; Triguero et al., 2022). Therefore, a balanced approach that combines open and closed innovation activities is essential to maximize the benefits of external collaboration while mitigating strategic and operational risks (Ben Arfi et al., 2018; Enkel et al., 2009). Figure 1 provides a graphical summary of the discussion.

Fig. 1. BIs as Drivers of Environmentally Sustainable OI



Source: Authors' elaboration

6. Conclusions

This study explores the role of BIs, also acting as OI intermediaries, in fostering eco-innovation among start-ups. The findings reveal that BIs are increasingly committed to promoting a sustainability-oriented culture within their incubated firms, making environmental engagement and related challenges central to their programs. Nevertheless, such practices remain at an early stage of development and require further time to become fully institutionalized. By functioning as OI intermediaries, BIs facilitate

knowledge and technology transfer between start-ups and other innovation ecosystem actors, thereby contributing to the creation of robust and sustainable ecosystems and accelerating the development of eco-innovations across stakeholders. Finally, considering the distinction between certified and non-certified BIs in the Italian context, both groups show a high level of commitment to environmental sustainability and OI practices, with certified BIs appearing slightly more engaged.

This research offers several implications.

From a theoretical perspective, this study makes multiple contributions to innovation management literature. First, it bridges three research streams that have largely evolved in parallel (business incubation, OI, and eco-innovation), thereby offering a more integrated perspective on how BIs foster open eco-innovation. Second, it addresses a specific theoretical gap concerning the *“how”* of OI intermediation. Rather than simply portraying BIs as facilitators, the study empirically identifies the mechanisms, ranging from internal co-creation networks to external technology transfer practices, through which BIs operationalize OI to help start-ups overcome resource constraints. Third, it contributes to the emerging debate on sustainable innovation ecosystems by showing how BIs orchestrate heterogeneous actors to accelerate eco-oriented innovation processes, thereby enriching ecosystem-level theorization.

From a managerial perspective, BI managers should integrate environmental sustainability criteria into start-up selection processes and provide tailored services that support sustainability. Such practices enhance the attractiveness of incubation programs, as an increasing number of start-ups are developing core businesses focused on environmental solutions (Social Innovation Monitor, 2024). Managers should also reinforce networking services, which are becoming critical components of incubation activities. In turn, start-up managers should actively exploit these networking opportunities to overcome resource and competence constraints through collaboration with external partners. This is particularly relevant for eco-innovation, which can serve as a strategic lever for achieving competitive advantage. Particularly, within the Italian framework, for non-certified BIs, specializing in eco-innovation and OI services can serve as a crucial differentiation strategy to attract high-potential start-ups. Conversely, certified BIs should leverage their institutional recognition and established networks to act as lead orchestrators in larger, sustainability-oriented OI ecosystems.

Policymakers should implement measures that strengthen local and national innovation ecosystems by offering incentives for collaborative eco-innovation practices among start-ups and established firms. They should also support the creation of platforms and networks that facilitate OI processes. Moreover, in the specific context of the Italian innovation ecosystem, policymakers could consider integrating specific sustainability

metrics into the legal requirements for granting or renewing the “*certified*” status, thereby institutionalizing green practices at the ecosystem level. Furthermore, targeted financial incentives and funding schemes should be designed for BIs that actively promote sustainability (especially for non-certified BIs aiming to upgrade their service portfolio towards green transition), thus fostering their development in this domain. Finally, investment in training and awareness programs on sustainability and OI is essential to nurture a more open, responsible, and sustainability-oriented innovation culture.

This study is not without limitations. First, it relies on a specific and bounded sample of Italian BIs; therefore, the findings are deeply tied to this geographical and institutional context and may not directly apply to different international ecosystems. To address this, future research should adopt a comparative approach, expanding the analysis to other European or global contexts. Second, the analysis captures only the perspective of BIs, excluding that of the incubated start-ups. Third, it adopts a descriptive-survey approach. Future research could employ qualitative methods (e.g., in-depth case studies) or quantitative ones (e.g., econometric models) to provide deeper insights into the dynamics examined. Fourth, the data are based on respondents’ self-perceptions; thus, complementary analyses using objective indicators of start-ups’ economic performance and environmental impact would offer a more comprehensive understanding.

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