Università degli Studi di Ferrara

DOCTORAL COURSE IN
ENVIRONMENTAL SUSTAINABILITY AND WELLBEING
CYCLE XXXVIII

COORDINATOR Prof. Elisa Bolchi

Towards a National Framework for Sustainable Startups: Insights from the Italian Innovation Ecosystem

Scientific/Disciplinary Sector (SDS) SECS-P/02

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Year 2022/2025

Abstract

The aim of this thesis is to investigate how sustainability, innovation, and inclusion are articulated, interpreted, and operationalized within the Italian startup ecosystem. It adopts a multidisciplinary research method integrating textual, bibliometric, and survey-based analyses to construct a comprehensive framework for assessing the contribution of innovative startups to the United Nations Sustainable Development Goals (SDGs).

The first chapter employs a large-scale text analysis of more than 9,000 Italian "innovative startups" registered in the *Registro delle Imprese*. Using a custom SDG keyword dictionary and natural language processing (NLP) techniques, the study maps the diffusion of sustainability-related discourse across sectors and regions, distinguishing "green" from "non-green" startups. Statistical comparisons reveal that sustainability-oriented firms exhibit distinctive economic and organizational profiles, particularly in terms of R&D intensity and human-capital composition.

The second chapter moves to the academic domain, conducting a bibliometric analysis of 984 peer-reviewed articles on sustainable startups published between 2015 and 2025 in *Scopus*. Through co-citation, co-authorship, and keyword co-occurrence networks (VOSviewer), it identifies the intellectual structure and thematic evolution of the field. Four main clusters emerge—sustainable business models, circular economy and eco-innovation, entrepreneurial ecosystems, and impact measurement — highlighting both the interdisciplinarity and fragmentation of research on sustainability-oriented entrepreneurship.

The third chapter complements these macro-level findings with original micro-level evidence from a national survey of 1,000 Italian startups conducted in partnership with FORMAT RESEARCH SRL. It analyses how founders perceive and enact sustainability within their strategies, governance, and innovation practices. Descriptive, comparative, cluster and econometric analyses reveal a heterogeneous but coherent landscape where sustainability functions as both a moral compass and a competitive resource. The results show significant correlations between environmental orientation, R&D investment, and gender diversity in leadership, suggesting that inclusiveness and innovation reinforce rather than compete with sustainability objectives.

Taken together, the three studies provide an integrated, multi-layered understanding of sustainable entrepreneurship in Italy—linking discourse, scholarship, and practice. The thesis contributes theoretically by framing sustainability as a signaling and legitimation mechanism within emerging entrepreneurial ecosystems, and empirically by proposing replicable tools for assessing firms' alignment with the SDGs. Policy implications highlight the need for tailored instruments that strengthen the institutional, financial, and cultural conditions enabling startups to act as key drivers of a sustainable transition.

Italian translation

L'obiettivo di questa tesi è indagare come la sostenibilità, l'innovazione e l'inclusione vengano articolate, interpretate e concretamente applicate all'interno dell'ecosistema delle startup italiane. Il lavoro adotta un approccio di ricerca multidisciplinare che integra analisi testuali, bibliometriche e basate su un questionario, al fine di costruire un quadro complessivo per valutare il contributo delle startup innovative al raggiungimento degli Obiettivi di Sviluppo Sostenibile (SDGs) delle Nazioni Unite.

Il primo capitolo applica un'analisi testuale su larga scala a oltre 9.000 "startup innovative" italiane registrate nel Registro delle Imprese. Utilizzando un dizionario di parole chiave legate agli SDGs e tecniche di natural language processing (NLP), lo studio mappa la diffusione del linguaggio della sostenibilità nei diversi settori e territori, distinguendo le startup "green" da quelle "non green". Le analisi statistiche evidenziano come le imprese orientate alla sostenibilità presentino profili economici e organizzativi distintivi, in particolare per quanto riguarda l'intensità di R&S e la composizione del capitale umano.

Il secondo capitolo effettua un'analisi bibliometrica di 984 articoli scientifici sottoposti a revisione paritaria, pubblicati tra il 2015 e il 2025 su Scopus e dedicati al tema delle startup sostenibili. Attraverso reti di co-citazione, co-autorship e co-occorrenza di parole chiave elaborate con VOSviewer, vengono identificate la struttura intellettuale e l'evoluzione tematica del campo di ricerca. Emergono quattro principali cluster — modelli di business sostenibili, economia circolare ed eco-innovazione, ecosistemi imprenditoriali e valutazione dell'impatto — che mettono in luce al tempo stesso l'interdisciplinarità e la frammentazione degli studi sull'imprenditorialità orientata alla sostenibilità.

Il terzo capitolo analizza le evidenze provenienti da un'indagine nazionale condotta su un campione di 1.000 startup italiane in collaborazione con Format Research Srl. L'analisi esplora come i fondatori percepiscono e attuano la sostenibilità all'interno delle proprie strategie, pratiche di governance e processi di innovazione. Le analisi descrittive, comparative econometriche e di clustering delineano un panorama eterogeneo ma coerente, in cui la sostenibilità emerge come driver etico e al tempo stesso come risorsa competitiva. I risultati mostrano correlazioni significative tra orientamento ambientale, investimenti in R&S e diversità di genere nella leadership, suggerendo che inclusione e innovazione si rafforzano reciprocamente piuttosto che competere con gli obiettivi di sostenibilità.

Complessivamente, i tre capitolo cercano di offrire una comprensione integrata e multilivello dell'imprenditorialità sostenibile in Italia, mettendo in relazione linguaggio, conoscenza scientifica e pratica imprenditoriale. La tesi contribuisce sul piano teorico interpretando la sostenibilità come meccanismo di segnale e legittimazione all'interno degli ecosistemi imprenditoriali emergenti, e sul piano empirico proponendo strumenti replicabili per misurare l'allineamento delle imprese agli SDGs. Le implicazioni di policy sottolineano la necessità di strumenti mirati in grado di rafforzare le condizioni istituzionali, finanziarie e culturali che permettono alle startup di agire come attori chiave della transizione sostenibile.

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Introduction

In the past decade, sustainability has shifted from being a peripheral concern to a central dimension of economic and industrial transformation. As societies confront climate change, resource scarcity, and social inequality, the imperative for a transition toward more sustainable models of production and consumption has intensified. Within this context, startups—young, innovation-driven, and flexible organizations—have emerged as crucial agents of change. They possess unique characteristics that allow them to experiment, pivot, and scale solutions to environmental and social challenges more rapidly than traditional firms. At the same time, their contribution to sustainable development remains understudied and often underestimated, particularly in national ecosystems such as Italy's, where entrepreneurship is shaped by strong institutional and cultural specificities.

The Italian Startup Act (Decree-Law No. 179/2012) established a distinct legal category for "innovative startups", positioning them at the core of Italy's modernization strategy. By reducing bureaucratic barriers and providing fiscal incentives, the Act aimed to stimulate a new generation of enterprises capable of combining technological innovation with competitiveness and sustainability. More than 12,000 firms have registered under this scheme, offering an unprecedented opportunity to study how entrepreneurial activity interacts with policy frameworks, institutional environments, and global agendas such as the United Nations Sustainable Development Goals (SDGs). Despite this potential, systematic knowledge about the sustainability orientation of Italian startups is still limited. While large corporations are now routinely assessed for their environmental, social, and governance (ESG) performance, the same cannot be said for early-stage ventures, which often lack standardized reporting mechanisms. Startups communicate their identity primarily through language—mission statements, registry descriptions, and online self-presentations—making textual data a powerful yet underutilized source for understanding how they conceptualize sustainability. Moreover, academic research on sustainable startups remains fragmented, with few attempts to integrate textual, bibliometric, and behavioural data into a coherent national framework.

This thesis addresses these gaps by developing an integrated, multi-method approach to understanding how sustainability is framed, disseminated, and enacted within the Italian startup ecosystem. It combines three complementary analytical perspectives—linguistic, scientific, and empirical—to capture the phenomenon at multiple levels.

The first chapter uses natural language processing (NLP) and a dictionary of SDG-related keywords to analyse over 9,000 firm descriptions from the national *Registro Imprese*. This chapter investigates how Italian startups linguistically align with the UN 2030 Agenda, identifies which SDGs are most frequently referenced, and explores whether sustainability-oriented startups differ in their economic performance. By linking textual data with financial indicators from the AIDA database, it provides a novel view of how sustainability discourse translates into measurable outcomes.

The second chapter shifts from firms to the literature production. It examines how scholars have conceptualized sustainable entrepreneurship through a bibliometric analysis of 984 peer-reviewed articles published between 2015 and 2025. Using VOSviewer, it visualizes the evolution of research clusters, identifying dominant themes such as circular economy, eco-innovation, and social entrepreneurship. This mapping highlights both the intellectual maturity and the fragmentation of the field, helping to position the present work within broader scientific debates.

The third chapter presents original micro-level data from a large-scale questionnaire conducted with FORMAT RESEARCH SRL on over 1,000 Italian startups. The survey investigates entrepreneurs' perceptions, practices, and challenges concerning sustainability, innovation, and inclusion. Through descriptive statistics, comparative analysis (green vs. non-green startups), and cluster analysis, this chapter reveals the heterogeneity of sustainability orientations across firms, sectors, and regions. The findings suggest that environmental orientation and inclusiveness are positively associated with R&D intensity, innovation capacity, and, in some cases, economic performance.

Taken together, the three chapters form a coherent empirical and theoretical framework for understanding sustainable entrepreneurship in Italy. The thesis advances the idea that sustainability in startups operates not merely as a strategic objective but also as a signalling and legitimation mechanism—a way through which young firms navigate uncertainty, attract resources, and build institutional credibility. This interpretative lens connects institutional theory, signalling theory, and the resource-based view, illustrating how external pressures, narrative framing, and internal capabilities interact in shaping sustainability-oriented behaviour.

1. Mapping SDGs in Italian Startups: A Text Analysis Approach

1.1. Introduction

In recent years, startups have increasingly emerged as central actors in processes of economic and social transformation, due to their innovative capacity, flexibility, and responsiveness to emerging trends. These characteristics make startups key agents not only of digitalization, but also of sustainability-oriented transitions (Schaltegger et al., 2016; Audretsch et al., 2021). At the global level, the United Nations' Sustainable Development Goals (SDGs), adopted in 2015, provide a comprehensive agenda to address some of the most pressing environmental, social, and economic challenges. While the role of established corporations in implementing the SDGs has been widely examined, the contribution of startups remains comparatively underexplored.

Within the Italian context, startups have gained relevance since the introduction of the national regulatory framework for "innovative startups" in 2012. This legal category aims to promote entrepreneurship through tax incentives, administrative simplifications, and dedicated support mechanisms. Despite this strong policy emphasis, it is not yet entirely clear whether, and to what extent, Italian innovative startups integrate sustainability considerations and SDGs into their activities and strategic orientations.

The aim of this chapter is to investigate how Italian innovative startups position themselves with respect to the SDGs by analysing the textual self-descriptions provided in the Registro Imprese database. In doing so, the chapter offers a structured overview of how SDGs are distributed across the Italian startup ecosystem. A text analysis approach is adopted, supported by a custom dictionary of SDG-related keywords. Based on this analysis, startups are classified according to their sustainability orientation, distinguishing between "green" and "non-green" firms. In a second stage, the economic and financial performance of these two groups is compared, to assess whether sustainability orientation is associated with distinctive outcomes.

Despite the growing emphasis on sustainability-oriented entrepreneurship, limited empirical evidence exists on how sustainability is interpreted and operationalized by innovative startups, particularly in terms of their strategic narratives and economic implications. This gap is especially relevant in contexts such as Italy, where policy frameworks explicitly promote innovative entrepreneurship and sustainability-related objectives. While innovative

startups represent only a very small fraction of the Italian productive system—characterized by approximately 4.3 million firms, the vast majority of which employ fewer than ten workers—this chapter does not assume that startups play a preponderant role in aggregate employment or output dynamics. Rather, startups are analysed as early-stage organizational forms operating under conditions of high uncertainty, experimentation, and turnover. In a productive system marked by frequent entry and exit, innovative startups can be interpreted as sites of variation and selection, where new technological and organizational solutions are tested, even if only a minority of them ultimately scale up. The focus of this chapter is therefore qualitative rather than quantitative and aims to understand how sustainability-oriented narratives and strategies emerge within this specific segment of the entrepreneurial ecosystem. In this sense, this chapter addresses the following research questions:

RQ1: How do Italian innovative startups refer to the United Nations Sustainable Development Goals (SDGs) in their textual self-descriptions?

RQ2: Which SDGs are most frequently represented across startup descriptions, and how are they distributed across sectors?

RQ3: Is startups' sustainability orientation (i.e. green versus non-green) associated with differences in economic and financial performance?

Furthermore, this chapter contributes to the literature on entrepreneurship and sustainability by applying natural language processing (NLP) tools to a large-scale dataset of Italian startups. It also enriches our understanding of how the global agenda of the SDGs is interpreted and localized within a specific entrepreneurial ecosystem, namely Italy. Finally, it provides policymakers and investors with evidence-based insights into the economic characteristics of sustainability-oriented startups.

Before proceeding, it is important to clarify how the concept of innovation ecosystem is used in this chapter. In the innovation ecosystem literature, ecosystems are commonly defined as configurations of interacting actors, organizations, and institutions that jointly enable knowledge creation and innovation (e.g., de Vasconcelos Gomes et al., 2018). However, rather than being treated as a fully modelled network of interacting actors, the innovation ecosystem is adopted here in a contextual and institutional sense. Innovation is understood as emerging within a shared environment shaped by regulatory frameworks, cognitive norms, and dominant narratives. Due to data availability constraints, the empirical analysis intentionally focuses on firm-level evidence.

More specifically, the innovation ecosystem is conceptualized as the institutional and discursive setting in which Italian innovative startups operate, shaped by national policies such as the Italian Startup Act and by global frameworks such as the Sustainable Development Goals. Within this context, startups strategically articulate their identity, objectives, and orientation through textual self-descriptions. These narratives are interpreted as observable traces of how firms position themselves within the broader ecosystem and seek legitimacy and resources under conditions of uncertainty. Accordingly, this chapter does not aim to measure ecosystem interactions directly, but rather to analyse how startups interpret and reproduce ecosystem-level priorities—such as technological innovation and sustainability—at the firm level. In this sense, the ecosystem perspective informs the theoretical framing of the study, while the empirical analysis remains intentionally firm-centred. Empirically, this implies that startup self-descriptions are analysed not only as firm-level characteristics, but also as outcomes of ecosystem-level incentives, narratives, and legitimacy pressures.

1.2. Conceptual background

Consistently with this contextual interpretation of the innovation ecosystem, the following section reviews the literature on startups, innovation, institutions, and sustainability, with particular attention to how entrepreneurial behaviour is shaped by uncertainty, legitimacy-seeking, and institutional environments.

1.2.1. Theoretical Framework

1.2.1.1. Startups and Contemporary Entrepreneurship

In the last two decades, startups have come up as a unique organizational form among entrepreneurs. Although people commonly use the word “startup” for all kinds of new businesses, scholars are now leaning towards associating it with a particular kind of young company that is characterized by innovation, scalability, and uncertainty (Ries et al., 2011; Blank, 2013). Despite of small and medium sized enterprises (SMEs) which often seek to establish a stable position within an existing market, startups seek to grow as quickly as possible, introducing new business models, disrupting existing ones with technology or creating entirely new markets (Shane et al., 2000).

The concept of startup is based on the idea, firstly proposed by Schumpeter (1934), according to the fact that entrepreneurs must create new combinations of resources, disrupting the pre-existing industries and markets. In this sense, the role of entrepreneurs in recognising opportunities and acting upon them under conditions of uncertainty has been explored in many later studies (Shane et al., 2003). Startups can

therefore be seen to institutionalise entrepreneurial activity. They are temporary organisations established to find and exploit business models that can be scaled up (Blank 2013).

Some characteristics distinguish startups from other types of organisations, as flat organisational structures, an iterative approach to business model development and a willingness to learn from failure (Ries 2011). Startups are also characterised by their use of lean startup methodology. This involves creating minimum viable products (MVPs) and testing them on customers to validate assumptions about the market. Feedback from customers is then used to update the business model and improve the product. Startups may therefore be seen as learning organisations (Cavalcante et al., 2014, Ghezzi et al., 2020).

Some scholars demonstrated the link between the share of technology and net employment growth originates from young, high-growth firms (Haltiwanger et al., 2013; Guzman et al., 2016). Through their contribution, startups also act as character of structural change: they accelerate digital transformation, drive industrial diversification, and introduce new organizational and cultural paradigms (Autio et al., 2018). In this sense, they represent a form of experimental capitalism (Nightingale et al., 2014), where new ideas are continuously tested and selected through market processes.

Startups are also considerable as symbol of innovation, risk and youthful energy in the modern economy, as well as disruption and creativity (Kuratko et al., 2017).

The emergence of entrepreneurial ecosystems—commonly defined as networks of interacting actors such as institutions, investors, incubators, and universities (Isenberg, 2010; Stam, 2015)—has also contributed to shaping shared institutional conditions and dominant narratives that influence startup behaviour. Rather than seeing entrepreneurial activity as a purely individualistic act, the ecosystem perspective emphasizes the role of shared institutional conditions, support structures, and dominant narratives shaping startup behaviour (Roundy, 2017; Malecki, 2018). Not all startups are successful, however: most fail within the first few years of life (Stinchcombe at al., 1965; Yang et al., 2017). In this sense, a key challenge for research on startups is therefore understanding why some scale up while others do not (Haltiwanger et al., 2017). Because of their natural innovativeness on new technologies, startups are crucial in helping countries make the transition to a low-carbon economy. However, the pressures that they face – including having to meet investors' expectations – can make it difficult for them to focus on sustainability goals at the same time as striving to become economically viable (Bocken et al., 2016).

Startups are also important when it comes to achieving sustainability objectives such as those set out in the United Nations' Sustainable Development Goals (SDGs) (Cohen et al., 2007). While they have an important role to play in creating a more environmentally friendly and socially inclusive economy, they are also vulnerable to failure due to their short time horizons and reliance on investors.

1.2.1.2. The Role of Innovation and Uncertainty in Startup Dynamics

Entrepreneurs create novelty, they experiment under uncertainty and take on uncertain risks. Indeed, Knight (1921) identifies uncertain risk-taking as entrepreneurs' unique function. In this sense, startups embody this concept, creating new markets or developing new technologies. Their success depends on convincing investors, customers, and institutions that something that does not exist (or at least, does not exist yet) is valuable. Schumpeter (1934) takes this idea further, arguing that entrepreneurship drives economic evolution by introducing five types of innovations: products, processes, markets, supplies, and organisations. By doing so, they disrupt existing monopolies and create temporary new ones – a process he called creative destruction. In this view, entrepreneurship is not just running a small business; it also means reshaping what already exists. They do this through radical innovation. So, while small firms might compete with larger ones by being cheaper or more flexible, startups aim to transform the market in some way. From a Schumpeterian perspective, innovation is inherently a process of creative destruction, in which the creation of new products, technologies, and organizational forms is necessarily accompanied by the displacement or obsolescence of existing ones. Consequently, sustainability should not be interpreted as a purely additive outcome of innovation, but rather as the dynamic result of a trade-off between what is created and what is destroyed through innovative activity. This tension is particularly relevant when analysing sustainability-oriented entrepreneurship, as innovative startups may simultaneously contribute to new sustainable solutions while disrupting existing economic and social arrangements.

However, innovation does not occur as a single event; it is a dynamic process that involves continuous learning and adaptation. In evolutionary economics, innovation is seen because of bounded rationality: because they cannot know everything about the future, firms adopt routines that help them adapt to changing circumstances (Nelson et al., 1982). Startups embody this idea with their lean startup methods (Ries, 2011; Blank, 2013). They form hypotheses about products, test these hypotheses in the market, and change course based on

the results – often many times. So, innovation in startups is not just about technology; it is also organisational and cognitive (Teece, 2010). This may involve changing an existing business model or creating an entirely new one; developing new partnerships or collaborative structures; or altering how resources are allocated within the organisation (Foss et al., 2016).

Indeed, because startups are generally unencumbered by existing products or ways of working, they can combine knowledge in novel ways and then commercialise it (Foss et al., 2016). As Hannan et al., (1984) note, large organisations often find this difficult because they are limited by their existing commitments (a problem known as path dependence). Startups may therefore succeed not because they have more resources than established companies but because they can adapt more quickly – an advantage that disappears once the company becomes larger and more bureaucratic (Hannan et al., 1984). However, path dependence is not exclusive to large or incumbent firms. Small and medium-sized enterprises may also experience structural rigidities, particularly when facing major technological, market, or institutional disruptions. In this respect, differences between startups and other SMEs should be interpreted as differences of degree rather than of kind, with startups typically displaying higher flexibility but not being immune to lock-in effects.

Startups face many challenges that larger businesses do not. According to Aldrich et al., (1994), young companies encounter four types of uncertainty that older firms have either overcome or learned to navigate. These four are technological, market, organizational and institutional. In the startup world, technological uncertainty often relates to whether a product under development will work as intended or be feasible to manufacture. Market uncertainty exists because entrepreneurs cannot know in advance how much customers will pay for something that has never been sold before–or if they will buy it at all. Organizational uncertainty arises from having too few employees, too little money or too little experience. Finally, institutional uncertainty is created by the broader environment in which startups operate laws and regulations can change unexpectedly; cultural norms shift over time.

Aldrich and Fiol (1994) argue that startups can overcome these uncertainties by using "dynamic capabilities" such as sensing opportunities, seizing them through innovation and changing quickly when circumstances alter. Teece et al. (1997) add that these capabilities also help companies adapt to technological changes as well as shifts in their environment– for example, alterations in government rules or societal values. When a startup can combine

strategic flexibility with organisational learning it may create a temporary advantage over rivals by being first to market with an innovative product or service (Teece et al., 1997).

Christensen et al., (1997) note though that innovation also makes young companies vulnerable because it involves taking risks such as spending lots of money on research and development without knowing if there will be any returns. Startups are also likely to fail if they try to grow too fast in markets that are not ready for them or if they cannot find enough customers willing to pay high prices during early stages of their life cycle (Auerswald et al., 2003).

Moreover, young firms face a "liability of newness" (Stinchcombe, 1965) which means they have not yet had time to build trust with clients and partners nor establish routines for doing business. It is therefore important for them to create legitimacy by joining accelerators, forming alliances with other companies and promoting themselves using narratives that connect their activities to wider social trends (Suchman, 1995; Navis et al., 2011). Startups are institutions that manage uncertainty by exploring possibilities, iterating towards solutions and framing their activities in ways that appeal to others (Garud et al., 2014). This means they need more than just technological innovations to succeed—they also require discursive ones.

The environment in which startups are born, and grow is very important to how innovative they can be and how well they handle uncertainty. In fact, these two things–innovation and uncertainty–are closely connected to the rules, beliefs and habits of the society around them. Laws and regulations, availability of money, and attitudes towards risk and failure all help shape how uncertainty is perceived and dealt with by new businesses. Italy's Startup Act (Decree-Law No. 179/2012) created a national framework for supporting innovative startups.

1.2.1.3. Startups and the Sustainable Development Goals (SDGs)

When the UN Sustainable Development Goals (SDGs) were adopted in 2015, they set out an ambitious agenda for tackling some of the biggest challenges facing our planet: climate change, inequality and the need for more sustainable economic growth.

In this sense the SDGs did more than anything else was to change how different economic actors perceive their role in relation to one another and in the wider world. Instead of seeing themselves simply as competitors or isolated players, the Goals have helped to create a shared language around issues of sustainability that can be used by businesses of all types—from multinational corporations to small startups.

Governments and large businesses have taken the lead when it comes to implementing and reporting on their progress towards the SDGs. Recent contributions have begun to explore the role played by smaller enterprises, particularly startups (Muñoz & Cohen, 2018). They do this by employing unique approaches characterized by creativity, problem-solving, and taking risks that other business types might find too dangerous. As a result, they can contribute significantly to global development — on both a large scale and in very specific places.

Startups can also help deliver the specific SDGs set out by the United Nations for 2030 through cleantech businesses working on affordable, clean energy (SDG7) or agritech ventures fighting hunger through better farming methods (SDG2). Edtech firms promoting quality education (SDG4) and Medtech businesses ensuring good health and wellbeing (SDG3) are two more cases in point.

Shepherd et al., (2011) show how ventures are characterized such as these as part of the "sustainable entrepreneurship" movement where economic potential is combined with an interest on social and environmental needs. These companies do not only focus on profit-making alone, but they believe that aside from that they should also contribute positively to the society. Circular economy methods, renewables and inclusive practices are common features too, but such entrepreneurs have an added headache most others do not.

Entrepreneurship and SDGs can be said to have a mutual relationship from a conceptual standpoint, such that entrepreneurial innovation propels sustainability agenda through new options for managing intricate issues while at the same time it receives a normative rational for guiding business operations that create value but in a socially just manner which again then leads back to sustainability proposition.

Entrepreneurship promotes the development of a sustainable society; a view that has prompted scholars (e. g., Belz et al., 2017) to perceive startups as potential key drivers for bridging global issues at community level through innovative approaches.

Therefore, besides detecting SDG references within startup communication, this chapter must empirically measure what types of goals are being selected vis-à-vis their growth outcomes and sectors emphasis; an issue that if addressed could shed light on recent empirical research wonders.

1.2.1.4. The Role of Eco-Innovation in Sustainable Entrepreneurship

Eco-innovation is important in startups for two reasons: firstly, it is an opportunity for entrepreneurship; by tackling issues related to resource, (i.e. garbage and energy), entrepreneurs can create innovations or enter new markets with such innovations, secondly, it helps in gaining acceptance by society or customers because eco-innovative startups comply with institutional requirements on environment conservation and sustainable development (Horbach et al., 2012). This dual role reveals the larger conflict within sustainable entrepreneurship concerning the identification of chances versus ethical duty (Patzelt et al., 2011). Certain organizational and strategic characteristics are very common with eco-innovative startups. For example, they usually have a strong mission orientation whereby they embed environmental values within the core of their identity and hence brand themselves as such (Hockerts et al., 2010). It is also known for intensive research and development activities that are carried out mostly in collaboration with higher learning institutions and research centres, as well as having faith in specialized investors like green venture capital funds. On top of that networking is very important because through it, these startups may tap into complementary resources available through partnerships and alliances while also mitigating the risk posed by technological uncertainty (Hojnik et al., 2017).

Theoretically speaking, eco-innovation can be explained using several different theories. According to the resource-based view (RBV), environmental resources like knowledge of clean technologies or environmentally friendly materials are distinctive competencies that result in a competitive advantage (Hart, 1995). Then institutional theory views eco-innovation as a response to external driving factors like policy measures, societal demands for corporate environmental responsibility and overall compliance with norms of behaviour (DiMaggio et al., 1983; Berrone et al., 2013). To conclude, the evolutional theory of innovation states that eco-innovative processes follow a cumulative and path dependent pattern with many of them being influenced by technological experimentation and feedback learning (Nelson et al., 1982). Eco-innovation, although promising, presents certain difficulties. First, new enterprises seeking to protect the environment usually must endure lengthy periods before they are fully developed, require more capital investment and face with demand that is not guaranteed (Hellström, 2007). Adoption in the market may also be slowed down due to lack of proper facilities, consumers not believing it or other technologies being better. On top of that, these eco-innovations create social value in the form of reduced emissions or garbage that cannot be monetized immediately, thus posing a problem where private incentives do not match with public value (Rennings, 2000). Such obstacles

underscore the significance of favourable ecosystems, which may encompass policies, finances as well as networking to reduce costs and promote spreading.

Therefore, sustainable entrepreneurship involves eco-innovation as both a cause and effect. This sustainability-oriented innovation equips new ventures to translate the SDGs particularly relevant for clean energy (SDG 7), sustainable consumption and production (SDG 12), as well as climate change mitigation and adaptation (SDG 13). Nonetheless, it also indicates that sustainability is a driver for innovation that creates various kinds of offerings in the market and business models. In this regard, eco-innovation forms the technological edge of entrepreneurship towards sustainable development, where even small and resource-constrained startups have the potential to make a significant impact.

1.2.2. Institutional Framework

1.2.2.1. The Italian Startup Act and the National Ecosystem

In 2012, Italy adopted a comprehensive legislative framework that explicitly sought to foster the creation and growth of a domestic startup ecosystem. This framework, established through Decree-Law No. 179 of 18 October 2012, soon came to be known as the "Italian Startup Act" (ISA), provided the definition of "innovative startup". This legislation has emerged from a broader recognition that Italy's economic stagnation and productivity gap could not be addressed solely through traditional industrial policy. Instead, structural renewal required the creation of a new class of enterprises—small, agile, and technology–oriented—that could act as catalysts of modernization (Criscuolo et al., 2014; Grilli et al., 2015). From an economic perspective it aimed to create an environment where new businesses could thrive — by cutting red tape, offering tax breaks to investors and making it easier for companies to raise venture capital. Legally, innovative startups, were defined as "young, high-tech companies with strong growth potential and therefore elements of Italian industrial policy" had to be companies no older than five years, with less than €5 million in annual revenue that operated in tech-related sectors. In addition, to qualify as innovative they had to meet at least one of three criteria:

It incurs R&D expenses equal to at least 15% of the greater of the cost and total value of production;

Employ highly qualified personnel (at least one-third PhDs, PhD students or researchers, or at least two-thirds with a master's degree);

Be the owner, depositary or licensee of at least one patent or the owner of registered software.

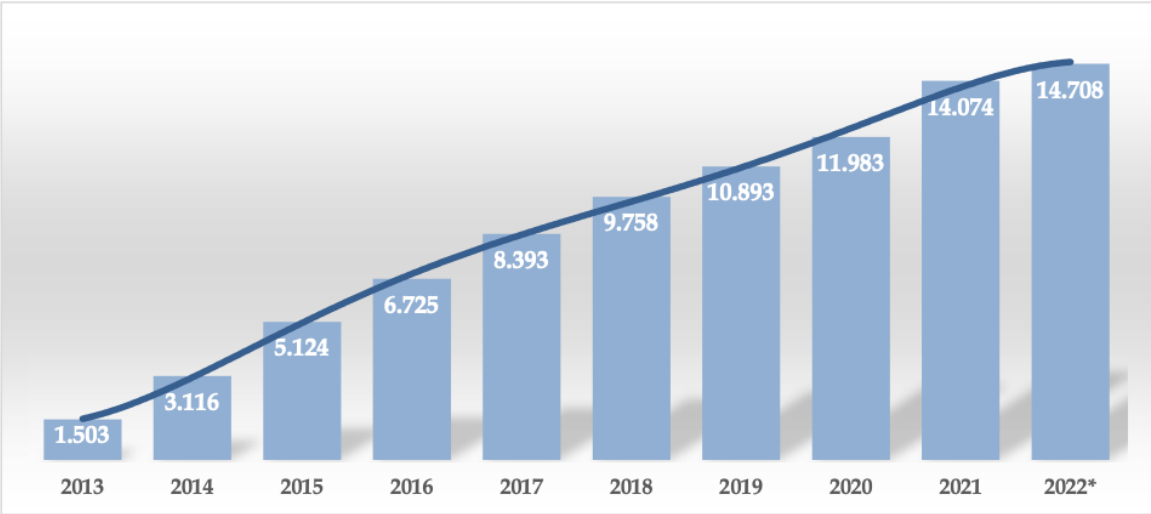

Figure 1.1: Trend in the number of innovative startups 2013–2022 Source: MIMIT

These firms were then given access to a range of incentives including tax breaks, funding and exemptions from certain legal requirements (Decree-Law No. 179 of 18 October 2012). Over time, other complementary programs have been introduced — such as Smart&Start Italia, Italia Startup Visa (for foreign entrepreneurs wanting to set up shop) and "innovative SMEs" (which provide support beyond the initial startup phase).

From a policy perspective, the Italian Startup Act exemplifies a shift from industrial policy to innovation policy. It prioritizes the creation of enabling environments over direct subsidies and promotes an ecosystem logic where universities, accelerators, venture capital, and public institutions co-evolve. By institutionalizing innovation within a legal framework, it has fostered not only firm creation but also legitimacy - an essential factor in overcoming the "*liability of newness*" (Yang et al., 2017). Startups, in turn, have responded by embedding innovation and sustainability in their self-definitions, often invoking global narratives such as the UN Sustainable Development Goals (SDGs) to enhance credibility and attract investors.

1.2.3. Methodological Background

1.2.3.1. Data-Driven and Text-Based Approaches in Entrepreneurship Research

There has been a shift in entrepreneurship research towards the use of data-driven and computational approaches to study entrepreneurial behaviour in broad terms. Although earlier methods using questionnaires, face-to-face communications or even few cases analysis gave deep understanding on why individuals act in certain ways and how businesses functioned at that level; they lacked extendibility and could hardly be repeated (Davidsson et al., 2012). Entrepreneurship scholars can now utilize digital

platforms that provide open databases and employ sophisticated analytical tools, all of which facilitate empirically grounded research on a larger scale (Gentzkow et al., 2019; von Krogh, 2022).

Text analysis has emerged as a promising approach in the realm of research on new ventures. Startups produce a large quantity of textual data that is hard to manage. This data includes things like mission statements, websites, pitch decks and registry descriptions — all of which offer insights into how entrepreneurs see themselves, what they want to achieve and what kinds of innovations they are pursuing (McKenny et al., 2018). Textual analysis, using both natural language processing (NLP) techniques and dictionaries, lets researchers quantify complex concepts like entrepreneurial orientation, sustainability or market positioning based on such texts (Gentzkow et al., 2019; Hannigan et al., 2019). For many startups there are no conventional measures of environment, social and governance (ESG) or sustainability performance. This makes text analysis particularly useful since it can tap into the qualitative data contained in linguistic self-descriptions– often the only information available about the company's goals and values.

Previous research has demonstrated that these patterns can be used to predict success reveal strategies for gaining legitimacy (Navis et al., 2011) or track how sustainability concepts spread across entrepreneurial ecosystems (Horne et al., 2019). And by combining textual data with numeric indicators, studies can maintain both computational scale and theoretical richness. These mixed methods approach help bridge gaps between quantitative and qualitative perspectives on ventures– for example by showing how meaning, identity and innovation intersect during entrepreneurship (Allison et al., 2017). Text analysis, therefore, may be useful in augmenting the traditional performance indicators and providing alternative measures of the strategies adopted by companies. This change in methodology shows that entrepreneurship has undergone a big change in knowledge. Today, people view entrepreneurs as individuals who create meaning and not just as economic agents of making sense. Economic actors who engage in entrepreneurial activity create narratives that help them to be accepted in various social groups and acquire resources.

In this study, the above approach is implemented by looking at what Italian innovative startups write about themselves in the Registro Imprese. Through natural language processing (NLP) techniques and a specially designed dictionary of keywords related to the Sustainable Development Goals (SDGs), the paper attempts to determine whether these young firms orient themselves towards sustainability and if it affects their

economic results. It adds to an increasing amount of research that uses textual information for studying the linkage between entrepreneurship and certain societal objectives.

1.3. Research Design and Approach

This chapter, through statistical analysis and natural language processing (NLP), seeks to find out whether Italian startups' official activity descriptions are environmentally friendly. This study considers the fact that textual data can be used to ascertain an organization's character, planned course of action and moral standpoint with increasing effectiveness than before. The combination of these two techniques facilitates an investigation into whether and how much Italian innovative startups contribute towards the achievement of the sustainable development goals (SDG) as proposed by the United Nations. This is because there is growing awareness that text data can provide valuable but overlooked clues on organisational identity, strategy and values.

It follows an approach that is consistent with the computational social science and entrepreneurship analytics trends, which suggest incorporating data from wide-ranging, unstructured sources alongside traditional surveys (Gentzkow et al., 2019; von Krogh, 2022). Such methods prove very effective for startups that do not follow normal reporting procedures seen in more mature firms but are still able to record their positioning strategy linguistically through language (Navis et al., 2011).

1.3.1. Dataset and Data Collection

For this research we focused on the data extracted from Registro Imprese platform, the database managed by the Italian Chambers of Commerce. The analysis focused on companies registered as "*innovative startups*," a legal category introduced by Decree-Law No. 179/2012 (Italian Startup Act). As mentioned above, this legislation was established with the aim of promoting the creation and growth of highly innovative companies and provides a standardized and data-rich information base that is ideal for empirical research. The Register of Innovative Startups is a public archive, updated regularly, which provides access to a wide range of descriptive and administrative information. Among these, a relevant section dedicated to the Company's purpose, where each firm freely describes its main activity. This field is at the base of the study, as it reflects how startups define themselves, their strategic positioning, and areas of innovation from an internal perspective.

The dataset covers the period 2019–2023 (November) is composed by a total of 9,037 startups, after excluding records with missing, incomplete, or invalid descriptions.

Within the Registro Imprese platform, a startup must upload its official company profile, which includes:

- the company name;
- the tax code;
- the relevant Ateco code;
- the legal information (province of registered office, website, etc.);
- the text description of the activity .

To obtain the entire dataset, it was necessary to develop a custom Python script. Through an API client and dedicated access keys, the script enabled the automatic extraction of all publicly available data from the official portal, aggregating it into a single, structured dataset, ensuring systematic and reproducible collection, and eliminating the risk of omissions or errors typical of manual downloads.

Furthermore, since the Registro Imprese does not provide economic and financial data, it was necessary to integrate performance indicators.

Using the tax codes already collected, every startup was cycled from AIDA – Bureau van Dijk, an authoritative source of company financial statements and data. The main economic and financial indicators (e.g., turnover, ROI, EBITDA, number of employees, and net profit) were extracted from AIDA and associated with each startup.

The two data sets – the descriptive one based on the register and the financial one – were then merged, after a cleaning and normalization process to ensure consistency of information. The resulted dataset was the combination of qualitative (textual and categorical) and quantitative (economic, financial, and dimensional) data for each startup.

1.3.2. Text Preprocessing and Dictionary Construction

The decision to use the Sustainable Development Goals (SDGs) as an interpretative parameter stems from the need for a shared and internationally recognized conceptual framework to analyse the sustainability orientation of innovative startups. Introduced by the United Nations in 2015 as part of the 2030 Agenda, the SDGs provide a common language through which complex economic, environmental, and social phenomena can be translated into comparable analytical categories (Horne et al., 2020; Confraria et al., 2024). In this sense, the SDG framework helps to move beyond a narrowly defined economic–financial interpretation of firm performance, offering instead a broader interpretative lens capable of

capturing both the value orientation and the project dimension of new entrepreneurial ventures. Through the semantic association between startup activity descriptions and the 17 SDGs, it becomes possible to assess the extent to which Italian startups are oriented towards areas consistent with sustainability principles, such as low-impact technological innovation or social inclusion.

Nevertheless, the construction of a vocabulary capable of coherently mapping corporate texts onto the SDGs is affected by several methodological and linguistic challenges. Italian startups primarily describe their activities in Italian; however, these descriptions frequently include English terms, technical jargon, and neologisms typical of innovation-oriented discourse. This linguistic hybridization complicates the establishment of a univocal "green" lexicon, as the same terms may assume different meanings depending on context (e.g. "energy", "smart", "sustainable", "digital transformation"). Moreover, many expressions associated with the SDGs do not lend themselves to straightforward translation, thus requiring a careful semantic reconciliation between the terminology used in international policy frameworks and the language adopted by firms.

The use of the SDGs as an analytical tool also entails a strong interdisciplinary dimension. The SDGs transcend traditional disciplinary boundaries, positioning themselves at the intersection of economics, sociology, environmental sciences, public policy, and innovation studies. Their application to the startup domain therefore represents not merely a classificatory exercise, but also an attempt to integrate multiple analytical perspectives in the interpretation of entrepreneurial phenomena. On the one hand, the SDG framework enables an understanding of firm activities in relation to sustainability and social inclusion principles. On the other hand, its operational translation through textual and semantic analysis introduces methodological elements drawn from computational linguistics and data-driven approaches. Accordingly, this research adopts a mixed methodological perspective that combines policy analysis, computational text analysis, and sectoral–economic analysis to provide a comprehensive reading of the Italian innovation ecosystem.

The mapping procedure was implemented through a two-step process. In a first phase, an algorithm associated textual keywords with specific SDGs by drawing on a custom dictionary developed for this study. In a second phase, the automatically generated associations were validated through qualitative human assessment, ensuring that the assigned SDGs were consistent with the actual meaning of the startup descriptions. This validation process helped to limit the risk of false positives and to increase semantic accuracy. By combining automated computational techniques—advantageous for handling

large datasets—with interpretative human judgement, the approach balances scalability and analytical reliability.

Within this research, the SDG framework performs multiple functions. It reconciles theoretical requirements with the practical needs of data analysis and interpretation, and, more importantly, allows the analysis to move beyond a purely keyword-based corpus linguistics approach. In this sense, the SDGs are used to construct a system of meaning capable of capturing the complex and evolving vocabulary through which startups articulate their business ideas and strategic orientations. Through the association between startups and SDGs, the analysis can capture existing sustainability orientations and to construct an index that goes beyond the measurement of sustainability strategies or policies already implemented by firms, potentially revealing an underlying sustainability imaginary reflected in the linguistic representation of their business models.

The corpus screening relies on a custom dictionary of SDG-related keywords, specifically developed for this study. The full dictionary, including the complete list of keywords associated with each SDG, is reported in Appendix A. The SDG framework is therefore not employed as a simple keyword-matching device, but as a semantic structure that organizes startup narratives into a coherent system of meaning. Keywords are interpreted within their textual context and systematically validated through manual screening, to ensure consistency between the extracted terms and the intended SDG themes.

1.3.3. Analytical Strategy

Consistently with the literature on environmental and sustainable entrepreneurship (e.g. Schaltegger et al., 2016), startups referring to at least one environmental or resource-related SDG are classified as "green startups" in the empirical analysis. The empirical analysis was divided in three stages, combining text-based techniques with quantitative analyses.

1) Descriptive and frequency analysis: a semi-automatic text classification approach was first adopted. This let us match specific lexical patterns from the startup descriptions with the United Nations' 17 Sustainable Development Goals (SDGs). This process allowed for the identification of the SDGs most frequently addressed by Italian startups as well as the extent to which they address multiple goals simultaneously.

2) Correlation analysis among SDGs: the Spearman rank-order correlation coefficients between pairs of SDGs were calculated and visualized via a heatmap, showing some positive and close correlation between specific SDGs.

3) Comparative and inferential analysis: by combining SDG with sectoral classifications, we were able to conduct comparative and inferential analyses. This enabled us to identify and distinguish startups which could be categorized as "green" because of their focus on sustainability from those which are not "green" or sustainable oriented. SDGs 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 12 (Responsible Consumption and Production), 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land) were all categorised as “environmental” related, and startups mentioning these goals were subsequently classed as “green” by default. To assess whether differences in economic performance across startup groups are statistically significant, we employed two-sample t-tests for independent means. This approach compares the mean values of financial indicators between categories of the Sustainability Orientation Index (SOI). Given the large sample size and approximately normal distribution of standardized indicators, the t-test provides a robust and interpretable measure of difference in central tendency. While more complex multivariate models could be adopted, the t-test is appropriate for the exploratory nature of this study and ensures comparability with previous research on startup performance (Grilli et al., 2015; Serio et al., 2020). A set of descriptive statistics and t-tests were carried out to compare the performance of green vs non-green startups in terms of Revenues, ROI, ROE, ROS and EBITDA.

1.4. Results

As mentioned above, this chapter presents an empirical analysis of a dataset of 9,037 innovative Italian startups registered in the Business Register over the period 2019-2023. Using textual analysis, the SDGs contained in the descriptive variables available for each startup have been detected and codified. Hence, on one side, we are interested in investigating how many and which SDGs are included in the business rationale of innovative startups. Given the large number of objectives potentially pursued by each company, a second issue addressed is whether some SDGs co-occur more frequently than others. Finally, we aim at checking whether firms with different levels of green orientation exhibit significant diversities in terms of their financial and economic performance.

To address these questions, the chapter unfolds along three main sections. Firstly, it deals with the distribution of SDGs in our dataset. Secondly, it assesses the relationships between all the variables included in the analysis by computing a correlation matrix. Finally, t-tests are used to see if there are any statistically significant differences between startups with high and low levels of green orientation in their economic and financial performance.

1.4.1. Distribution of SDGs in Startup Descriptions

We performed a textual analysis of the descriptions of the 9,037 innovative Italian startups included in our dataset. With this analysis, we were able to determine which of the Sustainable Development Goals (SDGs) were specifically referred to in the entrepreneurial objectives of these companies. The text analysis reveals that approximately the 52% of the startups in the dataset explicitly reference at least one SDG.

We counted the occurrences of the 17 SDGs in startup descriptions and reported the results in Table 1.2, which reveals a highly skewed distribution. More than 46% of the total SDG occurrences relate to SDG 9 (Industry, innovation and infrastructure–5,044 occurrences, referred to by 2,892 firms – 32%), an overwhelming proportion reflecting both the explicit focus on technological innovation in our dataset selection and, presumably, the deep interconnections of industrial development with numerous SDGs. Narrowing down further, we found that SDG 9 clearly outnumbers other goals, with the second- and third-most frequent ones being Good Health and Well-being (SDG 3 – 11. 6%) and Quality Education (SDG 4 – 9. 3%).

It is also interesting to note that while the text analysis reveals an environmental motivation behind a relevant fraction of the startup initiatives (with SDGs 7, 12, and 13, Affordable and Clean Energy, Responsible Consumption and Production, and Climate Action, respectively, appearing between 3. 7% and 5% of the total occurrences), this seems to emerge particularly in connection to technological and industrial innovative goals. Rather, the same analysis exposes a generalized absence in startup narratives of reference to other SDGs, connected to the promotion of social justice, better institutions, or international cooperation (SDGs 5, 8, 10, 14, 16, and 17 each present in less than 1.8% of the cases). Startups are generally more responsive to such dominant socioeconomic mega-trends, whilst gender equality, reduced inequalities, and decent work and economic growth have only marginal significance at this early stage of these companies' lives.

Table 1.1 also highlights how Italian startups show by and large an attitude toward SDGs that is both multi-faceted and highly differentiated in terms of content and emphasis. This is demonstrated by several indicators. The median startup refers to at least one SDG (Count > 0). As shown by the statistic on the number of firms that, whilst mentioning the SDGs, only refer to one specific objective (3,655 out of 9,037 companies, or 40%), a relevant fraction of firms integrates different social objectives into their mission (around 13% of companies in our dataset refer to two or more SDGs; the value of 1. 16 for Variance for SDG 9 denotes strong polarization of this objective for many Italian startups). This result also reflects wide differences among mission contents.

SDG	Sum	% of total	Min	Max	Std Dev	Var	Count >0	% >0	Count >1	% >1
SDG 1	108	0.99	0	23	0,28	0,08	61	0,68	15	0,17
SDG 2	239	2.19	0	5	0,22	0,05	177	1,96	39	0,43
SDG 3	1265	11.57	0	14	0,60	0,36	771	8,53	258	2,85
SDG 4	1020	9.33	0	12	0,53	0,28	650	7,19	194	2,15
SDG 5	38	0.35	0	2	0,07	0,00	35	0,39	3	0,03
SDG 6	312	2.85	0	6	0,28	0,08	204	2,26	56	0,62
SDG 7	548	5.01	0	11	0,43	0,18	312	3,45	106	1,17
SDG 8	61	0.56	0	2	0,09	0,01	55	0,61	6	0,07
SDG 9	5044	46.15	0	10	1,08	1,16	2892	32,00	1153	12,76
SDG 10	158	1.45	0	9	0,22	0,05	100	1,11	26	0,29
SDG 11	474	4.34	0	8	0,33	0,11	322	3,56	93	1,03
SDG 12	528	4.83	0	10	0,40	0,16	310	3,43	118	1,31
SDG 13	409	3.74	0	10	0,31	0,10	267	2,95	88	0,97
SDG 14	58	0.53	0	6	0,11	0,01	43	0,48	7	0,08
SDG 15	289	2.64	0	3	0,21	0,04	243	2,69	40	0,44
SDG 16	180	1.65	0	4	0,16	0,03	160	1,77	15	0,17
SDG 17	199	1.82	0	4	0,18	0,03	163	1,80	26	0,29

Table 1.1: Descriptive statistical overview of the total thresholds for SDG matches.

From a geographical SDG distribution, the heatmap (Figure 1.2) highlights the orientation of Italian innovative startups toward the Sustainable Development Goals (SDGs). Milan, Rome, and Naples metropolitan areas have wide and varied SDGs engagements that cut across many sectors in line with their being the national centres of innovation having sectoral diverse and complex entrepreneurial environment. Sectoral categorizations (e.g., agritech, biotech, med-tech) are based on the combination of ATECO codes and dominant keywords emerging from startup self-descriptions. It seems that in such contexts, there is an embedding of the SDG activities across multiple

other sectors including but not limited to; health technology (SDG 3), education and e-learning (SDG 4), responsible consumption (SDG 12), as well as sustainable development goals related with cities (SDG 11). Conversely, smaller or regionally specialized provinces display niche patterns of sustainability orientation, often linked to their local economic fabric. For instance, provinces with a strong agricultural or agritech vocation show a higher concentration in SDG 2 ("Zero Hunger"), while those with active biotech or med-tech clusters emphasize SDG 3 ("Good Health and Well-being"). From a structural perspective, the relative uniformity of certain goals—such as SDG 9 ("Industry, Innovation and Infrastructure") and SDG 8 ("Decent Work and Economic Growth")—across most provinces points to their systemic nature in innovation-driven entrepreneurship. These SDGs act as foundational pillars around which more specific sustainability narratives are articulated.

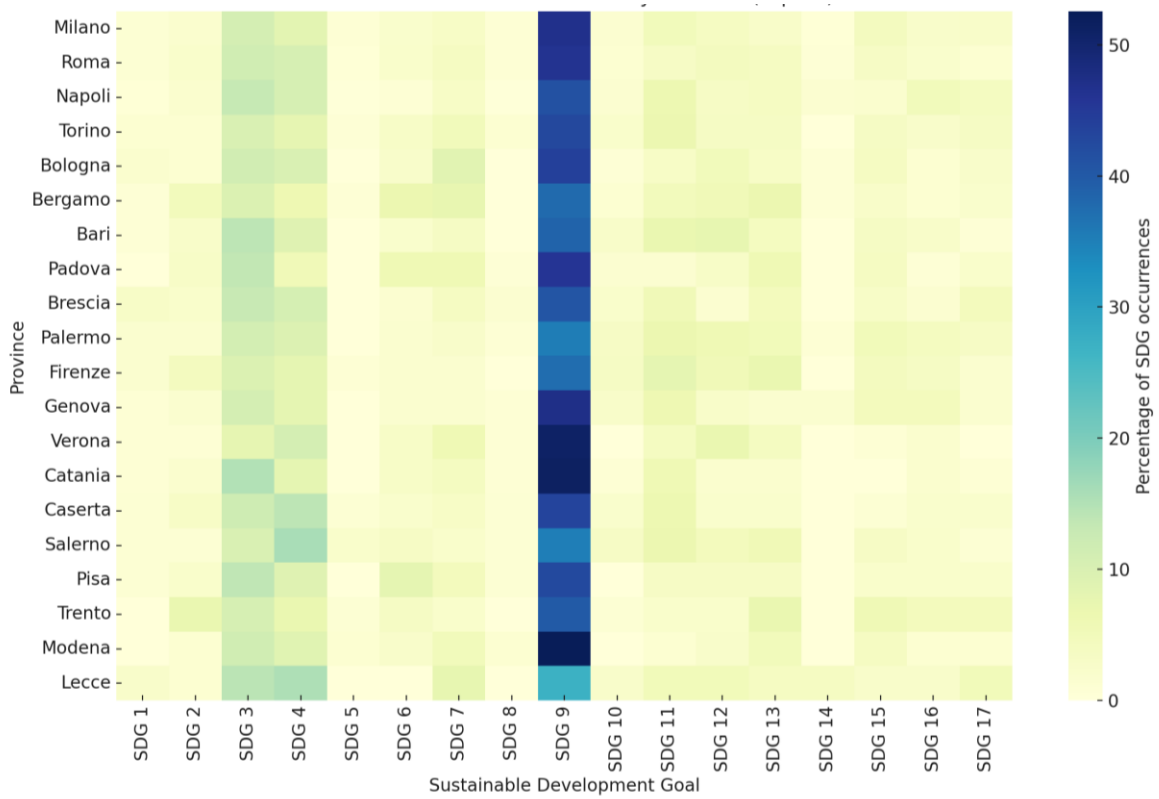

Figure 1.2: Number of SDGs occurrences by Provinces (Top 20). Note: figures report absolute counts. Differences across provinces may partly reflect the overall size of local startup populations.

To understand the correlation between the SDGs it was calculated a Spearman correlation matrix among the seventeen Sustainable Development Goals (SDGs), computed on the frequency of sustainability-related keywords identified within the activity descriptions of Italian innovative startups. The correlation structure provides insight into the semantic and thematic proximity of different SDGs within the

entrepreneurial narratives. Overall, the results reveal a pattern of selective and asymmetric associations, where only a few goals display strong mutual relationships, while most correlations remain low or moderate, suggesting a relatively narrow and specialized engagement with specific sustainability. This can show which SDGs are closely related to each other and tend to appear together. It can also show which SDGs are not closely related and tend to appear apart. Overall, the correlation coefficients show that there are only weak links between SDGs. This suggests that most startups focus on just one or a few SDGs rather than trying to address all of them. However, there are some interesting clusters of SDGs which appear together more often. SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) are all moderately correlated with each other ($r \approx 0.15–0.16$). This suggests that a lot of startups are working on technologies related to these goals, such as making resources more efficient, creating renewable energy sources and reducing carbon emissions. There is also a cluster of SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation) and SDG 15 (Life on Land) which are all related to the bioeconomy. This includes startups working on agritech, sustainable farming and circular food systems.

SDG 4 (Quality Education) and SDG 9 (Industry, Innovation and Infrastructure) have mild correlations with many other SDGs. This shows that education and innovation are important for achieving lots of the SDGs.

SDG 10 (Reduced Inequalities) is quite closely correlated with SDG 1 (No Poverty) ($r = 0.21$). This suggests that a lot of startups which aim to reduce poverty also aim to reduce inequalities. On the other hand, SDG 5 (Gender Equality) and SDG 16 (Peace, Justice and Strong Institutions) have weak correlations with other SDGs. This means they are less often mentioned alongside other SDGs in startup descriptions. This may be because there are fewer technologies or market incentives which can help achieve these goals compared to others like climate action or resource efficiency.

	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16	SDG 17
SDG 1	1	0.007	0.045	0.046	0.06	-0.014	-0.009	0.027	0.018	0.209	0.04	-0.002	0.013	-0.001	0.009	0.028	0.038
SDG 2	0.007	1	0.084	0.046	-0.009	0.106	0.054	-0.002	0.051	0	0.005	0.028	0.09	0.012	0.108	0.003	0.004
SDG 3	0.045	0.084	1	0.056	-0.001	0.027	-0.008	0.013	0.086	0.032	0	0.001	0.022	0.004	0.041	0.01	0.025
SDG 4	0.046	0.046	0.056	1	0.023	-0.007	0.002	0.073	0.111	0.075	0.014	0.02	0.009	0.053	0.066	0.089	0.034
SDG 5	0.06	-0.009	-0.001	0.023	1	0.012	-0.012	0.062	0.016	0.062	0.007	0.025	0.016	0.027	0.01	-0.009	0.044
SDG 6	-0.014	0.106	0.027	-0.007	0.012	1	0.095	0.013	0.01	-0.011	0.002	0.109	0.151	0.031	0.091	-0.012	0.003
SDG 7	-0.009	0.054	-0.008	0.002	-0.012	0.095	1	0.007	0.039	-0.02	0.04	0.066	0.161	0.004	0.051	-0.004	0.001
SDG 8	0.027	-0.002	0.013	0.073	0.062	0.013	0.007	1	0.038	0.031	0.043	0.034	0.014	0.007	0.018	0.009	0.02
SDG 9	0.018	0.051	0.086	0.111	0.016	0.01	0.039	0.038	1	0.036	0.065	0.024	0.033	0.054	0.04	0.076	0.07

SDG 10	0.209	0	0.032	0.075	0.062	-0.011	-0.02	0.031	0.036	1	0.07	-0.004	0.002	-0.002	-0.012	0.009	0.033
SDG 11	0.04	0.005	0	0.014	0.007	0.002	0.04	0.043	0.065	0.07	1	0.01	0.082	0.012	0.018	0.025	0.033
SDG 12	-0.002	0.028	0.001	0.02	0.025	0.109	0.066	0.034	0.024	-0.004	0.01	1	0.116	0.049	0.066	-0.019	0.037
SDG 13	0.013	0.09	0.022	0.009	0.016	0.151	0.161	0.014	0.033	0.002	0.082	0.116	1	0.026	0.068	0.008	0.057
SDG 14	-0.001	0.012	0.004	0.053	0.027	0.031	0.004	0.007	0.054	-0.002	0.012	0.049	0.026	1	0.042	-0.008	0.005
SDG 15	0.009	0.108	0.041	0.066	0.01	0.091	0.051	0.018	0.04	-0.012	0.018	0.066	0.068	0.042	1	-0.005	0.048
SDG 16	0.028	0.003	0.01	0.089	-0.009	-0.012	-0.004	0.009	0.076	0.009	0.025	-0.019	0.008	-0.008	-0.005	1	0.029
SDG 17	0.038	0.004	0.025	0.034	0.044	0.003	0.001	0.029	0.07	0.033	0.033	0.037	0.057	0.005	0.048	0.029	1

Table 1.2: Correlation matrix with correlated contingency coefficients

Italian innovative startups greatly differ in referring to SDGs in various ATECO sectors. Sectoral categorizations (e.g., agritech, biotech, med-tech) are based on the combination of ATECO codes and dominant keywords emerging from startup self-descriptions. In terms of geographical distribution, the highest concentration of agritech startups is observed in provinces such as Bologna, Verona, and Bari, while biotech and med-tech startups are primarily concentrated in Milan, Rome, and Turin. It was also found that the environment-related SDGs (7, 12, 13) as well as technology-related ones (9) are mentioned more frequently than the social (1, 5, 10) and institutional (16, 17) aspects of sustainable development in these enterprises of ATECO codes. Then SDG 9 appears as the most widely mentioned goal in all sectors. This finding is in line with the characteristics of the Startups operating in other ATECO sectors (see Figure 1.3) are more likely to link their activities to SDG 9 than to any other goal.

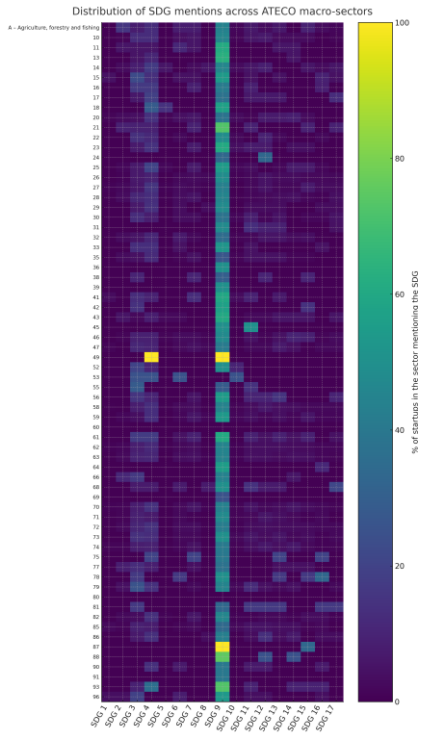

Figure 1.3: SDGs distribution across ATECO macro sectors

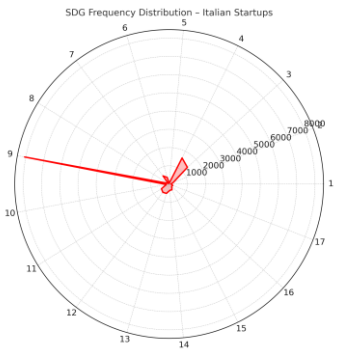

Figure 1.4: SDG Frequency distribution

This confirms previous studies stating that for startups technological innovation is a key aspect of sustainability. The relatively high presence of environmental SDGs (SDGs 7, 12, 13) in specific ATECO sectors (e. g., A – Agriculture, forestry and fishing; C – Manufacturing; D – Electricity and gas supply) suggests that startups tend to focus on environmental issues when these are closely related to the core of their business, that is when they are embedded in specific sectors and activities (Hockerts et al., 2010; Hojnik et al., 2016). In contrast, SDGs 1, 5, 10 are almost absent from all ATECO categories. This result shows that innovative startups hardly address poverty, gender inequality, and inequalities. SDGs 16 and 17 are also rarely mentioned. This is understandable, as these two SDGs concern matters (peace, justice, and institutional capacity) typically addressed by public institutions, NGOs, or other types of organizations. A key observation that emerges from our dataset is the small – but important – number of startups that fall under the agricultural sector (ATECO A). Although this sector accounts for the smallest proportion of our overall dataset, it is notable that SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) are among the most frequently mentioned goals. The importance of this group for sustainable development can be seen in the attention these startups give to issues like resource management, waste reduction and sustainable production systems.

One way to look at this is as an "agritech–sustainability" link in Italian startup activity: whereas the wider Italian startup scene is characterised by a strong focus on technological development (SDG 9), agritech startups are exceptional in their emphasis on environmental concerns.

From a theoretical point of view, our findings support existing research that suggests sustainability is often sector-specific (Cohen et al., 2007). They also show that while environmental considerations have become part of the Italian startup landscape, there is still limited attention paid to social or institutional goals such as SDG 5 (Gender Equality) or SDG 10 (Reduced Inequalities).

This implies a narrow focus on sustainability issues that could be expanded through dedicated policy interventions—perhaps by introducing gender or social cohesion targets into startup funding schemes. Overall, our results reveal a patchwork landscape in which environmental considerations are increasingly integrated into innovative startup activity, but in which a broader understanding of sustainability has yet to emerge fully. Further research will be needed to understand how different factors—sectoral trends, funding opportunities or institutional settings—may drive the growth of environmentally conscious startups in

Italy while encouraging a more multidimensional approach to sustainability among startups active in other sectors.

1.4.2. Performance Comparison: Green vs Non-Green Startups

We then investigate whether sustainability orientation is associated with differences in financial performance among Italian innovative startups. More precisely, the analysis explores whether startups that explicitly refer to sustainability—and to environmental sustainability—exhibit systematically different financial outcomes compared to neutral startups. This research question is motivated by existing evidence on large corporations documenting positive associations between sustainability orientation and firm performance and seeks to assess whether similar patterns emerge among young innovative firms.

To address this objective, a unique dataset was constructed by integrating text-based indicators of sustainability orientation with accounting and financial information obtained from official business registers. Sustainability orientation is captured through indicators derived from startup self-descriptions using SDG-related keywords, while financial performance is measured using accounting data extracted from the AIDA database. Financial indicators refer to the most recent year available for each firm, ensuring consistency across observations and minimizing missing values.

Financial performance is evaluated using a set of complementary indicators, namely sales revenues, EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization), ROI (Return on Investment), ROS (Return on Sales), and ROE (Return on Equity). These measures capture different dimensions of firm performance, including scale of operations (revenues), operating profitability (EBITDA), investment efficiency (ROI), operational efficiency (ROS), and returns to equity holders (ROE). To enhance comparability across firms, all performance variables are standardized using z-scores.

Sustainability orientation is summarized through the Sustainability Orientation Index (SOI), a categorical variable designed to capture the type and intensity of sustainability engagement at the firm level.

$$SOI_i = \begin{cases} 1 \; if \; startup \; i \; mentions \; at \; least \; one \; of \; the \; environemntally \; related \; SDGs \; (6{,}7{,}12{,}13{,}14{,}15) \\ 2 \; if \; startup \; i \; mentions \; only \; non-environemntal \; SDGs \\ 0 \; if \; startup \; i \; doesn't \; mention \; any \; SDG \; keyword \; in \; its \; description \end{cases}$$

In the case of multiple SDG references, firms are classified according to the most sustainability-intensive category, with priority given to environmental SDGs. The hierarchical sustainability variable is coded such that higher values correspond to a stronger sustainability orientation.

To assess whether sustainability orientation is associated with differences in financial performance, standardized performance indicators (ROI, ROS, and ROE) are compared across green-oriented, other SDG-oriented, and neutral startups using two-sample t-tests for independent means. This approach enables a transparent comparison of group-level performance outcomes and is consistent with the exploratory and descriptive nature of the analysis, without implying causal relationships or requiring a formal identification strategy. Alternative coding (e.g., reversed scales assigning higher values to non-environmental goals) were considered, but do not affect the substantive interpretation of the results.

The empirical results indicate systematic differences in financial performance across sustainability-oriented and neutral startups. Mean standardized values of ROI, ROS, and ROE are higher for sustainability-oriented firms compared to neutral startups. Moreover, green startups display slightly higher and more stable performance levels than startups oriented toward non-environmental SDGs, suggesting a comparatively stronger financial robustness among environmentally oriented ventures.

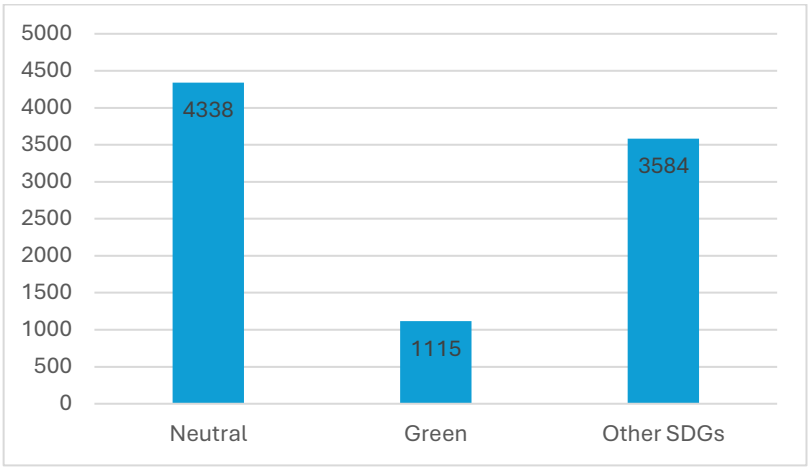

Figure 1.5: distribution of Startups

Startups were grouped (Figure 1.5) into three categories: green, other SDG-oriented, and neutral. The green group consisted of companies that mentioned at least one environmental SDG in their description. The other SDG group included businesses that mentioned social, educational or institutional SDGs but no environmental ones. Neutral companies did not reference any SDGs in their descriptions. These categories were used to do statistical analyses and regression tests on several profitability measures (ROI, ROS, ROE) that had been standardized. Since more than one comparison (Green versus Neutral, Other versus Neutral, and Green versus Other) was made, the Holm–Bonferroni method was used to adjust the p-values.

As shown in Table 1.3, average standardized financial indicators (Revenues, EBITDA, ROI, ROS) show only minor differences across SDG-based groups, with all means lying close to zero once standardized over the entire sample.

Specifically, Green startups - those associated with environmental SDGs (6, 7, 12, 13, 14, 15) - show slightly higher mean ROI and ROS values than Neutral firms, suggesting somewhat greater internal efficiency. Startups aligned with other non-environmental SDGs also exhibit modestly higher ROI, while Neutral startups tend to underperform marginally across all metrics. These gaps, however, are very small (less than 0.1 standard deviations) and accompanied by substantial within-group variability.

Pairwise t-tests between groups confirm that none of these differences is statistically significant after applying the Holm–Bonferroni correction for multiple comparisons. Before correction, ROI (Other SDGs > Neutral) and ROS (Green > Neutral) approached significance ($p \approx 0.03–0.04$), but these associations disappear once the adjustment for multiple testing is applied ($p\_adj > 0.09$). Thus, the apparent performance advantages are not robust at conventional significance levels.

From a conceptual standpoint, these findings indicate that alignment with the Sustainable Development Goals does not yield systematically higher financial performance among Italian innovative startups, at least in the short term.

Indicator	Group	Mean (z)	Std (z)	n	Significant differences (Holm–Bonferroni, $\alpha = 0.05$)
Revenues	Neutral	-0.006	0.91	4338	None
	Green	-0.043	1.06	1115	–
	Other SDGs	+0.021	1.08	3584	–
EBITDA	Neutral	+0.007	0.84	4338	None
	Green	-0.023	0.73	1115	–
	Other SDGs	+0.015	0.84	3584	–
ROI	Neutral	+0.010	1.00	4338	None ($p = 0.033$ before correction; $p\_adj = 0.099$)
	Green	+0.059	1.01	1115	–
	Other SDGs	+0.097	0.99	3584	–
ROS	Neutral	-0.015	1.00	4338	None ($p = 0.039$ before correction; $p\_adj = 0.117$)
	Green	+0.058	0.95	1115	–
	Other SDGs	+0.038	1.02	3584	–

Table 1.3: Descriptive statistics (z-scores) and t-tests across SDG-based startup groups. The table reports standardized means (z), standard deviations, and sample sizes for each group (Neutral, Green, and Other SDGs) across four financial indicators. Pairwise t-tests reveal no statistically significant differences at $\alpha = 0.05$ after Holm–Bonferroni correction, based on the corrected classification (N = 1,115 Green startups).

Nevertheless, the slightly positive direction of ROI and ROS among sustainability-oriented firms may hint at more efficient or resilient business models, potentially reflecting intangible benefits such as stakeholder trust, innovation capability, or operational optimization.

Overall, the evidence supports a nuanced interpretation: while sustainability alignment does not guarantee superior outcomes, it may be associated with modest efficiency advantages that are economically relevant but not statistically distinct within this sample. Future research could further refine the empirical analysis by adopting measures of sustainability depth and breadth, in line with the framework proposed by Laursen and Salter (2006), to capture more nuanced patterns of strategic engagement across firms.

1.4.3. Interpretation and Discussion of Findings

The previous results have outlined how Italian startup ecosystem participants perceive the relationship between sustainability and innovation. This offers an analysis of the United Nations' Sustainable Development Goals (SDGs) in startup self-descriptions from both a qualitative textual analysis perspective and a quantitative financial analysis perspective. This two-sided analysis reveals a general involvement with the SDGs that is both characteristic of, and limited by, the business environment in which these companies operate.

Notably, SDG 9 (Industry, Innovation and Infrastructure) was the most mentioned goal across all startups self-descriptions; nearly one-third of all startups referenced this goal in some form. Given the legal and institutional environment in which Italian startups operate, as defined by the Italian Startup Act, this finding is not entirely unexpected. Startups are encouraged to frame their activities within a narrative of technological advancement and industrial development to both attract investors and demonstrate to government authorities that their businesses conform to the specific requirements outlined in the law. Startups in Italy have been observed to focus their sustainability efforts mainly on technological and environmental issues, such as those addressed in SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). Social and institutional goals like SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities) and SDG 16 (Peace, Justice, and Strong Institutions) are less commonly pursued. This might be because they require more resources and partnerships than startups typically have. It also could reflect an understanding that such goals are important for society, but not necessarily relevant to the businesses these startups are building. SDGs 6, 7, 12 and 13 are all related to the environment and are often mentioned together by Italian startups. This suggests an increasing interest in eco-innovation and using technological

advancements to make products and services more environmentally friendly. In addition, these four SDGs are interconnected. Improving performance in one area can help improve performance in another. For example, making something more energy efficient might also reduce carbon emissions or create less waste. An analysis of financial results shows that companies focused on sustainability do not grow faster than others. Those that concentrate on environment and climate issues have higher ROS (return on sales) than non-sustainability-oriented companies, while those working towards social goals such as education have higher ROI (return on investment).

From a resource-based view (RBV), these capabilities can be seen as intangible assets. They help companies perform better and compete more effectively in the long term. While the financial rewards might not be huge right away, having these capabilities ensures they stay legitimate, attractive to investors, and adaptable in an ever-changing environment. The study also shows how new companies can get an advantage by making use of something known as the 'liability of newness'. This means that because they are young and small, startups find it hard to be taken seriously or get access to resources that might be available to older or larger businesses. However, if they can show they are committed to sustainability – by linking themselves to things like the Sustainable Development Goals (SDGs) – then this could give them an edge when it comes to making contacts or getting funding. Our findings also suggest that although environmental sustainability has been adopted by only a few Italian startups – mainly those in high-tech sectors, and then only partially due to limits on resources – where it has been adopted, this has helped them perform better over time.

This supports the idea that for companies of any age or size, innovation and sustainability can work well together: innovations can provide ways to meet sustainability challenges while sustainability gives innovations a direction and purpose that helps them stand out from competitors.

We also found some useful lessons for policymakers. For example, one way to build on the success of the Italian Startup Act could be to give more support to those startups that show they are working towards specific SDGs or which have SDG-related targets in their business plans. This could be done through government funding schemes, incubators that help new businesses get established, or incentives for investors who back companies with an interest in sustainability. By providing such support, policymakers might also encourage more startups to focus on social and institutional SDGs (which were underrepresented in our sample).

1.5. Conclusions

This chapter examined the connection between Italian innovative startups and the United Nations Sustainable Development Goals (SDGs). Based on this combined analysis, we tried to highlight: (1) To what degree are Italian startups involved with SDGs (2) Which specific goals do they mention most often and is there any pattern to this (3) If the focus on environmental sustainability is associated with better economic and financial performances. We find that while a large proportion (52%) of startups mention SDGs in their descriptions, only a small part of them (12%) is associated to the green SDGs. The ones they most often talk about are those related to innovation (SDG 9), education (SDG 4) and health (SDG 3). By contrast, goals that deal with social issues (SDGs 5, 10, 16 and 17) are hardly mentioned at all.

A thematic analysis shows that one SDG dominates all others: SDG 9 (Industry, Innovation and Infrastructure). This reflects the fact that many Italian startups see themselves as contributors to sustainable development mainly because they are innovative. However, there is also a group of environmental SDGs (6, 7, 12 and 13) that appear together in a pattern we can call an eco-innovation cluster. Startups operating in this space tend to specialize in areas like agritech and cleantech. By contrast, digital and service-based startups rarely mention environmental SDGs when they describe themselves.

Our overall conclusion is that, while a lot of Italian startups say they support SDGs, only some are really committed to sustainable development—and these tend to be found in specific sectors.

About the financial performances, basing on the results, we highlighted that rather modest differences between sustainable and non-sustainable startups. When comparing startups aligned with the Sustainable Development Goals (SDGs) to those without any explicit sustainability orientation, no statistically significant differences emerge in terms of revenues or EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortisation). This suggests that sustainability orientation does not necessarily translate into faster growth or larger business size. However, small performance tendencies can still be observed. Startups associated with non-environmental SDGs (for instance, those related to education, health, or social inclusion) show slightly higher average ROI (Return on Investment), whereas startups focused on environmental or “green” SDGs tend to exhibit marginally higher ROS (Return on Sales). Although these differences are not statistically significant after correcting for multiple comparisons, they point to a potential link between sustainability orientation and greater internal efficiency in resource utilization and operational management.

Overall, the evidence indicates that sustainability-oriented startups are not necessarily larger or faster-growing but may be slightly more efficient or resilient in how they convert revenues into profits and investments into returns. Given the descriptive and exploratory nature of the empirical analysis, the results should be interpreted as systematic associations rather than causal effects. Issues related to endogeneity and self-selection cannot be fully addressed within the present framework, as more aggressive or strategically oriented firms may be both more likely to articulate sustainability-related narratives and to achieve superior performance outcomes. Future research based on longitudinal data and richer firm-level controls could further investigate these mechanisms.

1.6 Limitations and Implications

The study has some limitations that should be acknowledged. First, the analysis relies on the official textual descriptions that startups upload to the *Registro Imprese*. These descriptions are not designed for research purposes: they vary in length, style, and quality, and may not fully reflect the real strategic orientation or sustainability practices of the firms. As a result, the linguistic patterns captured through the SDG dictionary represent how startups *communicate* about sustainability rather than a direct measure of their *actual* environmental or social impact.

Second, the classification of startups according to the Sustainable Development Goals (SDGs) depends on a manually curated dictionary. Although the dictionary was validated and refined through qualitative checks, some semantic ambiguity remains—especially because of the mix of Italian and English terminology and the use of innovation-related buzzwords that may overlap across SDGs. This limits the precision with which each goal can be identified and introduces potential noise into the categorization process.

Third, the financial data used for comparison refer to a relatively short period (2019–2023), and many startups in the sample are still in their early stages. Their economic and financial results are therefore volatile and may not yet capture the long-term effects of sustainability orientation on firm performance.

Despite these limitations, the study offers important contributions. It demonstrates how computational text analysis can be applied to national startup registers to derive insights on sustainability orientation at scale. By systematically mapping the SDGs within thousands of Italian startups, it provides a first empirical picture of how the global 2030 Agenda is interpreted and localized within a specific entrepreneurial ecosystem. Moreover, even if no

strong statistical differences in performance emerged, the research shows that sustainability-oriented startups display slightly higher efficiency indicators—suggesting that sustainability and innovation may reinforce each other in subtle but meaningful ways.

From a broader perspective, the study underscores the value of using text-based data as a complementary source of evidence for policy evaluation and for understanding emerging entrepreneurial trends. It thus opens the door for future research using more refined linguistic models, longitudinal analyses, or cross-country comparisons to explore the evolving link between entrepreneurship and sustainable development.

References

- Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. *Academy of Management Review, 19*(4), 645–670.
- Allison, T. H., McKenny, A. F., & Short, J. C. (2017). The effect of entrepreneurial rhetoric on microlending investment: An examination of the warm-glow effect. *Journal of Business Venturing, 32*(6), 693–706.
- Asgari T, Daneshvar A, Chobar AP, Ebrahimi M, Abrahamyan S. Identifying key success factors for startups with sentiment analysis using text data mining. *International Journal of Engineering Business Management*. 2022;14.
- Auerswald, P. E., & Branscomb, L. M. (2003). Valleys of death and Darwinian seas: Financing the invention-to-innovation transition in the United States. *Journal of Technology Transfer, 28*(3–4), 227–239.
- Autio, E., Nambisan, S., Thomas, L. D. W., & Wright, M. (2018). Digital and spatial affordances and the genesis of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal, 12*(1), 72–95.
- Belz, F. M., & Binder, J. K. (2017). Sustainable entrepreneurship: A convergent process model. *Business Strategy and the Environment, 26*(1), 1–17.
- Bengtsson, F., Alfredsson, E., Cohen, M., Lorek, S., & Schroeder, P. (2018). Transforming systems of consumption and production for achieving the SDGs. *Sustainability Science, 13*(6), 1533–1547.
- Berrone, P., Fosfuri, A., Gelabert, L., & Gomez-Mejia, L. R. (2013). Necessity as the mother of 'green' inventions: Institutional pressures and environmental innovations. *Strategic Management Journal, 34*(8), 891–909.
- Blank, S. (2013). Why the lean startup changes everything. *Harvard Business Review, 91*(5), 63–72.
- Bocken, N. M. P., & Short, S. W. (2016). Towards a sufficiency-driven business model. *Environmental Innovation and Societal Transitions, 18*, 41–61.
- Cavalcante, S. (2014). Designing business model change. *International Journal of Innovation Management, 18*(3), 1450018.
- Christensen, C. (1997). *The innovator's dilemma.* Harvard Business School Press.
- Cohen, B., & Winn, M. (2007). Market imperfections, opportunity and sustainable entrepreneurship. *Journal of Business Venturing, 22*(1), 29–49.
- Confraria, H., Ciarli, T., Noyons, E., (2024) Countries' research priorities in relation to the Sustainable Development Goals, *Research Policy*, Volume 53, Issue 3,

- Criscuolo, C., Gal, P., & Menon, C. (2014). The dynamics of employment growth: New evidence from 18 countries. *OECD STI Policy Papers, 14*.
- Davidsson, P., & Gordon, S. R. (2012). Panel studies of new venture creation: A method-focused review. *Small Business Economics, 36*(3), 255–276.
- DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited. Isomorphism in Organizational Fields'*American Sociological Review, 48*(2), 147–160.
- Foss, N. J., & Saebi, T. (2016). Fifteen years of research on business model innovation. *Journal of Management, 43*(1), 200–227.
- Gavrilenko, E., Khosmood, F., Rastad, M., & Moghaddam, S. A. (2023). Improving Startup Success with Text Analysis. *arXiv preprint arXiv:2312.06236*.
- Garud, R., Gehman, J., & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy, 43*(7), 1177–1188.
- Gentzkow, M., Kelly, B., & Taddy, M. (2019). Text as data. *Journal of Economic Literature, 57*(3), 535–574.
- Ghezzi, A. (2020). How entrepreneurship changes business models. *Long Range Planning.*
- Grilli, L., & Murtinu, S. (2015). New technology-based firms in Europe: Market and policy challenges. *Journal of Technology Transfer, 43*(1), 1–8.
- Guzman, J., & Stern, S. (2016). The state of American entrepreneurship. *NBER Working Paper, 22095*.
- Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review, 49*(2), 149–164.
- Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986–1014.
- Hellström, T. (2007). Dimensions of environmentally sustainable innovation. *Sustainable Development, 15*(3), 148–159.
- Hockerts, K., & Wüstenhagen, R. (2010). Greening Goliaths versus emerging Davids. *Journal of Business Venturing, 25*(5), 481–492.
- Hojnik, J., & Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature *Environmental Innovation and Societal Transitions, 19*, 31–41.
- Hojnik, J., Ruzzier, M., & Manolova, T. S. (2017). Internationalization and economic performance: The mediating role of eco-innovation. *Journal of Cleaner Production, 171*, 1312–1323.

- Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact. *Ecological Economics, 78*, 112–122.
- Horne, J., Recker, M., Michelfelder, I., Jay, J., Kratzer, J., (2020) Exploring entrepreneurship related to the sustainable development goals - mapping new venture activities with semi-automated content analysis, *Journal of Cleaner Production*, Volume 242,
- Isenberg, D. (2010). How to start an entrepreneurial revolution. *Harvard Business Review, 88*(6), 40–50.
- Knight, F. H. (1921). *Risk, uncertainty and profit.* University of Chicago Press.
- Kuratko, D. F., Morris, M. H., & Schindehutte, M. (2017). Understanding the dynamics of entrepreneurship. *Small Business Economics, 49*(1), 1–17.
- Navis, C., & Glynn, M. A. (2011). Legitimate distinctiveness and the entrepreneurial identity. *Academy of Management Review, 36*(3), 479–499.
- Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change.* Harvard University Press.
- Nightingale, P., & Coad, A. (2014). Muppets and gazelles. *Industrial and Corporate Change, 23*(1), 113–143.
- Patzelt, H., & Shepherd, D. A. (2011). Recognizing opportunities for sustainable development. *Entrepreneurship Theory and Practice, 35*(4), 631–652.
- Rennings, K. (2000). Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecological Economics, 32*(2), 319–332.
- Ries, E. (2011). *The lean startup.* Crown Business.
- Roundy, P. (2017). Hybrid organizations and the logics of entrepreneurial ecosystems. *International Entrepreneurship and Management Journal, 13*(4), 1221–1237.
- Saura, J. R., Palos-Sanchez, P., & Grilo, A. (2019). Detecting indicators for startup business success: Sentiment analysis using text data mining. *Sustainability*, *11*(3), 917.
- Schumpeter, J. A. (1934). *The theory of economic development.* Harvard University Press.
- Serio, R. G., Dickson, M. M., Giuliani, D., & Espa, G. (2020). Green production as a factor of survival for innovative startups: Evidence from Italy. *Sustainability, 12*(22), 9464.

- Shepherd, D. A., & Patzelt, H. (2011). The new field of sustainable entrepreneurship. *Entrepreneurship Theory and Practice, 35*(1), 137–163.
- Stinchcombe, A. (1965). Social structure and organizations. In *Handbook of organizations* (pp. 142–193).
- Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review, 20*(3), 571–610.
- Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43*(2–3), 172–194.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development.* UN.
- von Krogh, G. (2022). Artificial intelligence in organizations: New opportunities for phenomenon-based theorizing. *Academy of Management Discoveries, 8*(2), 153–161.
- Yang, T., & Aldrich, H. E. (2017). The liability of newness revisited. *Social Science Research, 63*, 36–53.

Appendix

Vocabulary used for text analysis

SDG	Description	Keywords
1	No Poverty	povertà; inclusione sociale; disuguaglianze economiche; welfare; microcredito; microfinanza; financial inclusion
2	Zero Hunger	fame; insicurezza alimentare; agricoltura; food security; nutrizione; alimentare sostenibile; agritech; precision farming; idroponica; vertical farm
3	Good Health & Well-being	salute; sanità; medicale; medicina; biomedico; farmaceutico; diagnostica; telemedicina; benessere; mental health; e-health; dispositivo medico; biotech
4	Quality Education	istruzione; educazione; formazione; formativo; formativi; edtech; didattica; life long learning; alfabetizzazione
5	Gender Equality	parità di genere; pari opportunità; gender equality; women empowerment; femminile; diversity & inclusion; violenza di genere
6	Clean Water & Sanitation	acqua; idrico; depurazione; potabilizzazione; wastewater; acque reflue; irrigazione; water treatment
7	Affordable & Clean Energy	energia rinnovabile; fotovoltaico; solare; eolico; geotermico; idroelettrico; biomassa; efficienza energetica; smart grid; accumulo; batterie; idrogeno; hydrogen
8	Decent Work & Economic Growth	lavoro dignitoso; turismo sostenibile; sicurezza sul lavoro; gig economy; microimpresa; occupazione; crescita economica
9	Industry, Innovation & Infrastructure	manifattura avanzata; iot; robotica; automazione; ai; intelligenza artificiale; machine learning; blockchain; 5g; cyber physical; materiali avanzati; infrastrutture
10	Reduced Inequalities	disuguaglianze; inclusione; migranti; accessibilità; accessibility; disabilità; equità; coesione sociale
11	Sustainable Cities & Communities	città; urbano; mobilità; smart city; trasporto pubblico; housing; sicurezza urbana; resilienza urbana; tutela patrimonio; biciplan; urbanistica; rigenerazione urbana

12	Responsible Consumption & Production	consumo responsabile; produzione responsabile; economia circolare; riciclo; riuso; riutilizzo; eco design; ecodesign; packaging sostenibile; life cycle assessment; lca; waste management; rifiuti
13	Climate Action	clima; cambiamento climatico; decarbonizzazione; emissioni; co2; ghg; net zero; carbon footprint; adattamento; mitigazione
14	Life Below Water	mare; oceano; blue economy; pesca sostenibile; acquacoltura; biodiversità marina; marine litter; plastiche in mare
15	Life on Land	biodiversità; foresta; bosco; suolo; land restoration; agroforestazione; habitat; ecosistema; riforestazione
16	Peace, Justice & Strong Institutions	giustizia; legaltech; anticorruzione; diritti umani; privacy; cybersecurity; pa digitale; pubblica amministrazione; e-government
17	Partnerships for the Goals	cooperazione; sdg; agenda 2030; alleanze; multi-stakeholder; impact investing; esg; csr; partnership

2. Mapping the Research Landscape of Sustainable Startups: A Bibliometric Perspective

2.1. Introduction

The role of startups in modern economic and social systems has become increasingly important over the past two decades. As young, innovation-driven companies, startups are in a privileged position to both develop and scale innovative solutions to socially important challenges, which include climate change, sustainable development, and environmental protection. Among SMEs, startups are playing an important role in advancing the SDGs (Bocken, 2015; Horne et al., 2020; Trautwein, 2021). In this sense, startups are crucial economic actors in driving sustainable transition thanks to their unique characteristics and capabilities. A key aspect is their intrinsic capacity for innovation (Sehnem et al., 2022) which can generate new technologies, innovative products, and services that address pressing environmental and social challenges (Trautwein, 2021).

At the same time, the academic debate on sustainability and entrepreneurship has expanded considerably, particularly since the adoption of the United Nations Sustainable Development Goals (SDGs) in 2015. Considering this, sustainability has become a pillar of corporate strategy, with almost all large companies having a vice president-level executive with the word “sustainability” in their title. Most large companies now have explicit public statements on sustainability policy and claim to apply a “triple bottom line” that considers the company's financial, environmental, and social performance (Elkington, 1998).

At the heart of this are sustainable startups, i.e., early-stage companies that integrate environmental and social value creation into their business models. Research on circular startups, for example, highlights how these companies rely on hybrid growth strategies and shows that circular startups, like other hybrid organizations, are engaged in both commercial activities and impact scaling activities (Han et al., 2023).

To better understand the correlation between sustainability and startups, this chapter applies a bibliometric approach to systematically analyze academic output on sustainable startups. In this sense, bibliometric analysis has become increasingly popular in the social sciences, as it allows for the quantitative mapping of large bodies of literature and the identification of intellectual structures through the analysis of citations, co-citations, and co-occurrences (Donthu et al., 2021). Compared to traditional narrative or systematic literature reviews, bibliometrics provides greater

transparency and replicability, while enabling the visualization of research clusters, collaboration networks, and thematic trends. These characteristics make bibliometrics ideally suitable for interdisciplinary and emerging fields such as sustainability-oriented entrepreneurship, where the literature embraces different domains (economics, social sciences, environmental studies) as well as is constantly evolving.

The analysis was based on data from Scopus, one of the most comprehensive databases of peer-reviewed literature, covering the period 2015-2025. This time is particularly relevant as it coincides with the global spread of the SDGs and the intensification of academic interest in sustainable business models. The focus is limited to journal articles in the fields of business, economics, and social sciences, written in English and published in the final stage, to ensure both rigor and comparability. In this way, the study seeks to provide a clear overview of the subject. The purpose of this bibliometric study is not to provide a normative assessment of the "best" journals, authors, or theories in the field of sustainable startups, nor to replace critical scholarly judgment with purely quantitative indicators. Rather, the objective is to offer a structured and replicable mapping of the academic landscape in which the phenomenon of sustainable startups is embedded. In this sense, the bibliometric analysis serves three complementary functions.

First, it provides a systematic overview of the scientific production on sustainable startups. Second, through network-based techniques, it helps reconstruct the intellectual structure of the field.

Third, it provides an analytical framework clarifying which concepts and lines of research are most central to the literature on sustainable startups. Accordingly, bibliometrics is employed here as a complementary tool, aimed at framing and contextualizing the empirical analysis that follows, rather than as a substitute for theoretical interpretation.

This chapter is structured around the following research questions (RQs):

- ◊ **RQ1:** Which are the main publishing trends in the literature on sustainable startups over the last decade?
- ◊ **RQ2:** Which countries, institutions, authors, and journals have been the most proactive and most influential in this area?
- ◊ **RQ3:** Which thematic clusters and schools of thought emerge from the co-occurrence and co-citation analyses?

◊ **RQ4:** What research gaps and possible future directions can be identified through this bibliometric mapping?

In this regard, the chapter seeks to offer several contributions. First, it provides a structured overview of the intellectual landscape of research on sustainable startups, highlighting how the field has evolved in terms of volume, geography, and disciplinary scope. In addition, it identifies the most influential actors—authors, journals, institutions, and countries—that have contributed most to the debate, thus providing a reference point for scholars approaching the field. Third, it also identifies the conceptual clusters and thematic directions that currently dominate the literature, such as sustainable business models, the circular economy, and eco-innovation. Finally, by highlighting gaps in the research, the chapter provides possible avenues for future research, emphasizing how further studies could help to highlight the correlation between sustainability and startups.

2.2. Methodology

The bibliometric analysis presented in this chapter is based on data downloaded from Scopus, one of the largest and most widely used databases of peer-reviewed academic publications. Scopus is generally preferred to Web of Science (WoS) in social and management sciences because of its broad coverage and robust metadata, which make it particularly well suited for large-scale mapping activities (Mongeon & Paul-Hus, 2015). Bibliometric analysis has emerged as a widely recognized methodology for mapping the intellectual structure of scientific fields and identifying research trends. Unlike traditional narrative or systematic reviews, which rely heavily on limited synthesis, bibliometric methods permit quantitative, replicable, and transparent analysis of large bodies of literature (Zupic & Čater, 2015; Donthu et al., 2021). This objectivity makes bibliometrics increasingly popular for consolidating fragmented research domains and assessing the dynamics of scientific knowledge. Through techniques such as co-citation, bibliographic coupling, co-authorship, and keyword co-occurrence analysis, bibliometrics allows for the visualization of knowledge networks and the identification of thematic clusters that structure a given subject area (Donthu et al., 2021).

The use of bibliometric approaches is also beneficial for new and inter-disciplinary fields, like sustainable entrepreneurship and green startups, in which literature can be scattered over several as well as diverse disciplines, journals, as well as theory bases.

With the unification of descriptive statistics as well as network analysis, bibliometric approaches offer a macroscopic visualization of publication trends as well as a microscopic comprehension of a research area's intellectual bases as well as patterns of collaborative working relationships (Dontu et al, 2021a,Verma and Gustafsson, 2020). It also enables the discovery of new trends and knowledge gaps that inform subsequent research directions (Donthu, Kumar, Pandey, & Lim, 2021a; Verma & Gustafsson, 2020). Furthermore, unlike meta-analyses or systematic reviews, bibliometric methods provide larger and more objective perspectives using large-scale bibliographic databases rather than interpretation (Aguinis, Pierce, Bosco, Dalton, & Dalton, 2011; Snyder, 2019). In addition, improvements to databases such as Scopus and Web of Science, along with visualization software such as VOSviewer and Gephi, have made bibliometric studies more accessible and analytically robust (van Eck & Waltman, 2010; Aria & Cuccurullo, 2017). After all, bibliometric analysis allows for a more in-depth assessment of disciplinary development, giving researchers a strategic framework to see where their contributions fit into an ever-growing knowledge base (Donthu, Kumar, & Pattnaik, 2020b; Wallin, 2005).

2.2.1. Database selection

The dataset for this bibliometric study was extracted exclusively from Scopus, a choice made deliberately and in line with established methodological practices in bibliometric and science-mapping research within the social sciences. Comparative studies have consistently shown that Scopus provides broader and more balanced coverage of peer-reviewed journals in business, management, economics, and social sciences than Web of Science, particularly for interdisciplinary topics such as sustainability and innovation (Mongeon & Paul-Hus, 2015).

Compared to alternative sources, Scopus offers structured and high-quality metadata, including standardized information on authors, affiliations, citations, keywords, abstracts, and subject categories. These features are essential for conducting network-based analyses such as co-citation, co-authorship, and keyword co-occurrence, which form the backbone of bibliometric mapping and performance analysis (Cobo et al., 2011; Zupic & Čater, 2015). Moreover, Scopus allows data export in structured formats (e.g., CSV, BibTeX, RIS), ensuring full compatibility with established bibliometric software such as VOSviewer and Bibliometrix and thereby enhancing transparency and replicability (Aria & Cuccurullo, 2017; Donthu et al., 2021).

Although Google Scholar provides wider coverage in terms of document volume, its inclusion of non-peer-reviewed materials, inconsistencies in metadata quality, limited transparency of indexing criteria, and vulnerability to duplication significantly reduce its suitability for systematic and replicable bibliometric analyses (Harzing & Alakangas, 2016). For these reasons, Google Scholar is generally considered inappropriate for network-based bibliometric techniques that rely on standardized and reliable bibliographic information.

Finally, methodological guidelines recommend the use of a single high-quality database—rather than merging multiple sources—when the objective is to map intellectual structures and thematic patterns, as database integration often introduces noise, duplication, and distortions in citation networks (Zupic & Čater, 2015; Donthu et al., 2021). Accordingly, the exclusive use of Scopus represents a trade-off that prioritizes methodological rigor, comparability, and analytical robustness over sheer coverage, while maintaining sufficient disciplinary breadth for the purposes of this study.

2.2.2. Query design and refinement

The approach to data collection was divided into several stages: the process began with a broad search, to which restrictions were gradually applied to obtain a comprehensive and relevant final dataset. The initial query included several terms commonly associated with entrepreneurship and sustainability:

TITLE-ABS-KEY (startup* OR "start-up*" OR entrepreneurship OR "new venture*") AND TITLE-ABS-KEY ("sustainable development" OR "SDGs" OR "eco-innovation" OR "circular economy" OR "green economy" OR "sustainab*" OR "green")

This broad search, without any time or disciplinary restrictions, yielded a total of 11,124 articles. While this confirmed the relevance of the topic, it also revealed the need for a more focused scope, as many of these articles only marginally concerned about startup. In the second step, the query was refined to focus specifically on "*startup**" and "*start-up**" as keywords, removing the more general terms "*entrepreneurship*" and "*new venture*", which often generated noise by retrieving papers outside the intended scope. This change significantly reduced the dataset to 3.248 articles, being more coherent with the research focus.

In the last step, further filters were then used to retain quality and relevance:

- Years of publication: 2015–2026, to make the comparison congruent with the onset of the SDGs (2015) as well as encapsulate the largest phase in sustainable entrepreneurship literature expansion.
- Paper typoplogy: only articles, excluding conference papers, book chapters, and reviews to maintain comparability.
- Source: journals, in order not to incorporate non-peer-reviewed sources.
- Language: English only since it happens to be the leading language of academic publications internationally.
- Publication stage: only “final” articles without "in press" items for stability of bibliographic data.
- Field areas: “Business, Management and Accounting” (BUSI), “Economics, Econometrics and Finance” (ECON), and “Social Sciences” (SOCI) since they contain the areas of disciplines that relate more closely than any other areas to startup and sustainability research.

The application of these restrictions has provided the following query TITLE-ABS-KEY (startup* OR start-up*) AND TITLE-ABS-KEY(green OR sustainability OR "sustainable development" OR "SDGs" OR "eco-innovation") AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"ECON") OR LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"ENVI")) AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (LANGUAGE,"English")) AND (LIMIT-TO (PUBSTAGE,"final")) resulted in a final dataset of 1.119 articles, which constitutes the basis for the subsequent descriptive and network analyses.

2.2.3. Inclusion and exclusion criteria

The criteria for inclusion and exclusion were defined ex-ante to ensure methodological transparency and replicability. Specifically, articles were included if they met all the following conditions:

- Explicit mention of startups (*startup**, *start-up**) in title, abstract, or keywords.
- Explicit mention of sustainability-related concepts (e.g., *sustainable development*, *SDGs*, *eco-innovation*, *circular economy*, *green economy, green*).
- Published between 2015 and 2026.
- Peer-reviewed journal article in English.
- Indexed in Scopus within the selected subject areas (BUSI, ECON, SOCI).

- Articles were excluded if:
- They mentioned startups only at marginal level (e.g., as part of a list of organizational forms without specific analysis).
- They were published in languages other than English.
- They were conference papers, editorials, book chapters, or review articles.

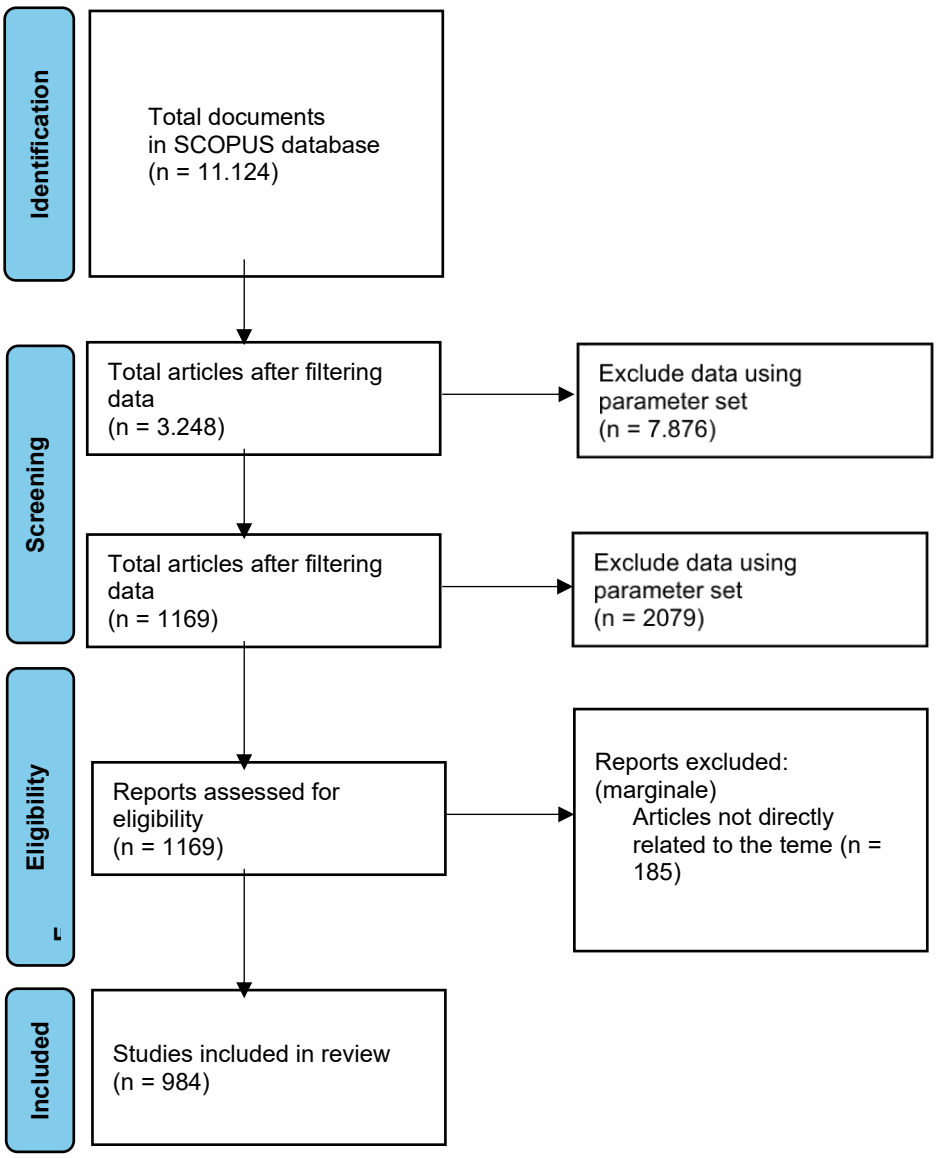

Figure 2.1: PRISMA Flow Diagram for systematic reviews

To enhance the transparency of the research design, the article screening process was documented following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021). In this sense, PRISMA has emerged as the international standard for ensuring transparency and completeness in systematic reviews, providing a structured framework that improves both clarity and replicability. Its flow chart is broadly used across disciplines to provide a structured framework that enhances both clarity and replicability (Liberati et al., 2009).

Figure 2.1 presents the PRISMA flow diagram summarizing the stages:

1. **Identification**: 11.124 records retrieved from the initial query.
2. **Screening**: restriction to *startup* and *start-up* reduced the dataset to 3,248 records.
3. **Eligibility**: application of filters (years, language, document type, subject areas, publication stage) resulted in 1.119 articles.
4. **Inclusion**: final dataset of 984 articles for bibliometric analysis.

The analysis combined basic statistical tools with VOSviwer software to ensure both descriptive rigor and advanced network visualization.

- Excel was used during the early stage of the analysis, to track publication trends by year, map contributions at the national level, rank the most important journals and authors, and then filter downloaded content. In addition, it enabled the use of pivot tables and bar charts, which facilitated the visualization and interpretation of large data sets, providing a clearer view of temporal and geographical patterns. In this sense, although Excel is not a specialized bibliometric tool, it is commonly used during the initial stages of analysis due to its versatility and ability to effectively manage structured metadata (Zupic & Čater, 2015).

- VOSviewer was used to conduct the network-based analyses, (including keyword co-occurrence, author and source co-citation, and co-authorship networks at both individual and country levels). VOSviewer is widely recognized as one of the most powerful and user-friendly tools for creating and visualizing bibliometric maps, thanks to its capacity to process large datasets and generate clear and interpretable visualizations of bibliographic networks (van Eck & Waltman, 2010; Waltman et al., 2010). Compared to other software such as CiteSpace or Gephi, VOSviewer is specifically optimized for bibliometric mapping and has been widely applied in research on management, entrepreneurship, and sustainability (Chen, 2017). Its clustering techniques and distance-based visualization algorithms permit the identification of thematic clusters and topic structures with high accuracy and readability (Cobo et al., 2011; Donthu et al., 2021).

In this sense, the combination of Excel for data collection and preliminary analysis and VOSviewer for mapping and creating maps and cluster links is a well-established

practice, as it offers rigor in data analysis on the one hand and transparency and clarity in the reporting of processed data on the other.

2.2.4. Justification of methodological choices

Several methodological decisions were made deliberately to balance comprehensiveness and focus, in line with established practices in bibliometric research. Each choice is justified both theoretically and methodologically, to ensure transparency, rigor, and alignment with the research objectives of this thesis.

1. Database: as mentioned before, Scopus was chosen between the other available datasets due to its breadth, and compatibility with bibliometric tools. In addition, if compared to Web of Science, Scopus provides a larger number of journals in management and social sciences, thereby enhancing coverage and representativeness (Mongeon & Paul-Hus, 2016; Aghaei Chadegani et al., 2013), useful to conduct the interdisciplinary analyisis. On the other hand, even if Google Scholar provides a broader coverage, its inclusion of non-peer-reviewed material and inconsistent metadata quality make it less reliable for systematic bibliometric analyses (Harzing & Alakangas, 2016;).

2. Period (2015-2026): the decision to start the analysis period in 2015 was determined by the publication, in the same year, of the United Nations Sustainable Development Goals (SDGs), which are considered worldwide as the basis for the debate on sustainability. In this sense, the inclusion of previous years (e.g., the 2000s), although it would have provided a larger sample size, would have potentially generated results that were far from the research objective. Furthermore, the inclusion of a previous period, which did not coincide with the boom in startups and sustainable startups in particular - would have provided less relevant results from a research perspective. The publication period in question should therefore be identified as between 2015 and September 2025.

3. Thematic areas (BUSI, ECON, SOCI): these thematic categories were selected to make the research interdisciplinary, without however generating results that were inconsistent with the research questions. Therefore, categories of journals belonging to business, economics, and social sciences were considered. On the

other hand, although engineering and environmental science journals often publish research on sustainable technologies, they rarely address the entrepreneurial and organizational aspects that are central to this study, as was also evident during the determination and streamlining of the Scopus dataset. Considering this, in the field of study focused on economics, social sciences, and business sciences, it is in line with the recommendations of bibliometric studies that aim to outline conceptual rather than purely technical fields (Zupic & Čater, 2015; Donthu et al., 2021).

4. Document type (journal articles): only peer-reviewed journal articles were included. Therefore, conference proceedings, reviews, book chapters, and similar items, although potentially useful for research purposes, were excluded due to their heterogeneous peer review standards and limited reliability in tracking citations. Journal articles, on the other hand, represent the most stable and comparable unit of analysis in bibliometric research, as they are consistently indexed and cited in all databases. Finally, only "final stage" articles were included (Cobo et al., 2011; Paul & Criado, 2020).

5. Language (English): the analysis was limited to publications in English. Although this choice inevitably excludes research published in other languages, English remains the dominant language in academic publications, particularly in management and economics. In contrast, the inclusion of articles in other languages would have created discrepancies in the analysis of co-occurrence and keywords, reducing the comparability and thus compromising the reliability of the study.

6. These methodological decisions reflect the objective to provide a comprehensive overview of the literature on sustainable startups, while ensuring consistency, transparency, and methodological rigor. In this sense, the methodology used is in line with the now well-established standards of bibliometric research.

2.2.5. Trade-offs, journal reputation, and non-measurable dimensions

A well-known limitation of bibliometric approaches is that they tend to treat publication outlets symmetrically, implicitly if each journal carries the same epistemic weight. However, journal reputation, peer-review selectivity, and editorial strategies represent qualitative dimensions that cannot be fully captured by bibliometric indicators alone

(Moed, 2005; Wallin, 2005). As emphasized by the *Leiden Manifesto for Research Metrics*, quantitative indicators should support—but never replace—expert judgment, particularly when evaluating research quality and scientific influence (Hicks et al., 2015).

This aspect is particularly evident in highly prolific open-access journals, which tend to rank prominently in terms of publication volume while adopting editorial strategies based on high throughput and extensive use of special issues. Conversely, highly selective journals that deliberately limit publication volume may appear less central in quantitative rankings despite enjoying stronger reputational capital and long-term intellectual influence.

Rather than ignoring this issue, the present study explicitly acknowledges the trade-off between visibility-based metrics and qualitative academic judgment. Bibliometric indicators capture patterns of diffusion, thematic aggregation, and network centrality, but they do not provide a normative evaluation of scientific quality or theoretical depth. These non-measurable dimensions remain the domain of scholarly interpretation and disciplinary expertise (Moed, 2005). For this reason, bibliometric results are interpreted cautiously and contextualized within the broader literature on sustainable entrepreneurship. High publication volume is not equated with higher scientific quality, but rather with greater discursive presence within the field, reflecting how research topics circulate, consolidate, and gain visibility over time.

A similar trade-off applies to the selection of subject areas and language. Although sustainability-oriented entrepreneurship is inherently interdisciplinary, the analysis deliberately focuses on Business, Management and Accounting, Economics, and Social Sciences. This choice reflects the objective of capturing the organizational, economic, and institutional dimensions of sustainable startups, rather than their purely technical or engineering-related aspects. In bibliometric research, such disciplinary delimitation is considered appropriate when the aim is to map conceptual structures rather than technological trajectories (Zupic & Čater, 2015; Donthu et al., 2021).

Interdisciplinarity is therefore pursued within the social-scientific domain, ensuring conceptual coherence with the research questions addressed in this study, while still allowing for the integration of insights from sustainability science through cross-citations and thematic overlaps. A broader inclusion of technical fields could have increased heterogeneity but at the cost of interpretability and analytical focus. Likewise, limiting the analysis to English-language publications introduces a known linguistic and geographic bias, particularly favouring Anglo-American research. However, English

remains the dominant language of international scientific communication in management and economics, and its use ensures consistency in metadata, keyword structures, and citation practices—an essential requirement for reliable co-occurrence and network analyses (Mongeon & Paul-Hus, 2015; Zupic & Čater, 2015). The implications of these choices are explicitly acknowledged, and future research could extend the analysis through multilingual or region-specific bibliometric approaches.

2.3. Data Analysis

The following section presents the findings of the bibliometric study applied on the final set of 984 journal articles discussing the intersection of sustainability, startups, and adjacent concepts the Sustainable Development Goals (SDGs), the circular economy, as well as eco-innovation. In accord with established bibliometric research procedures, the study follows the two complementary axes on which the field gets organized as per usual procedures for bibliometric research (Zupic & Čater 2015; Donthu et al., 2021). To begin with, a descriptive viewpoint is taken, looking at the time dynamics of publication production, the geographic spread of research activity, and the concentration of publications at the level of journals, institutions, and authors. Descriptive bibliometrics has itself been used for many years for the purpose of charting the growth and diffusion of knowledge in scientific disciplines for scholars to acquaint themselves with productivity trends, prolific writers, and top-performing outlets (Pritchard, 1969; Moed, 2005; Aria & Cuccurullo, 2017). It is especially useful for new fields because it affords the macroscopic view of how the literature develops over time as well as over space (Broadus, 1987; Mongeon & Paul-Hus, 2016).

Second, the field's intellectual and collaborative structures are approached through relational perspective using keyword co-occurrence, co-citation, and co-authorship analyses. Relational bibliometric methods allow for the identification of knowledge networks for visualization as well as the identification of thematic clusters for the identification of the field's conceptual foundations as well as the social organization of science fields (White & McCain, 1998; van Eck & Waltman, 2010; Cobo et al., 2011). Keyword co-occurrence analysis has been generally accepted as an efficient way of extracting the thematic evolution of a field of research (Callon et al., 1991), whereas co-citation mapping aids in the identification of the field's intellectual roots as well as the inter-connections between seminal works (Small, 1973; Chen, 2017). In the same way, co-authorship analysis illuminates the mode of collaboration between scholars, between institutions as well as between countries for the identification of the social structure of the production of knowledge (Newman, 2001; Glänzel & Schubert, 2004).

By integrating both descriptive and relational approaches, this study offers a holistic mapping of the research domain, identifying its principal trends, clusters, and gaps. In this sense it not only enhances the interpretability of results but also aligns with best practices in bibliometric methodology for management and entrepreneurship research (Zupic & Čater, 2015; Donthu et al., 2021; Paul & Criado, 2020).

2.3.1. Temporal evolution of publications

The temporal distribution of publications shows a marked evolution in academic discourse on the topic of startups and sustainability over the last decade and a half. In the early period (2010-2015), scientific output was relatively limited, with an average of less than 20 articles per year. This can be interpreted as an early stage of the sector, in which only sporadic contributions explored the links between entrepreneurship and environmental or social sustainability. These early works often laid the conceptual foundations rather than producing cumulative empirical evidence, in the face of policies still in development, which could explain the relatively modest visibility of the topic at this stage.

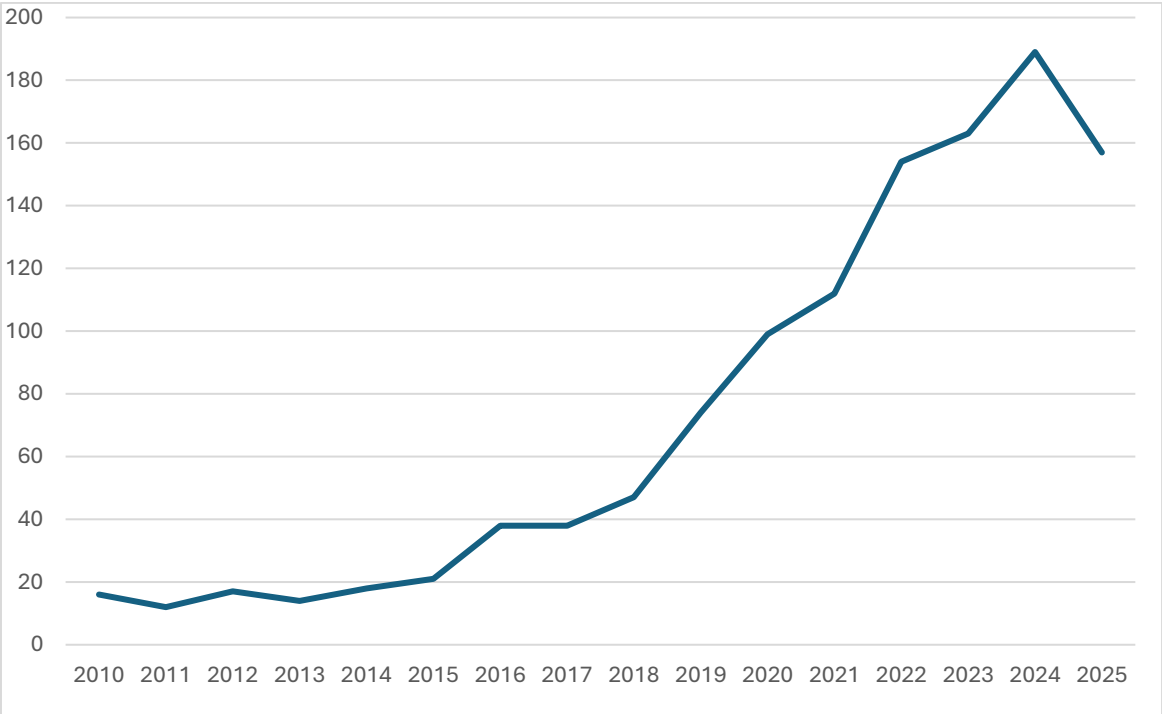

Figure 2.2: Growth pattern of sustainable startup literature in Scopus between 2015-2025

After 2016, there was an acceleration, with an increase in publications from 38 in 2016 to 74 in 2019. This increase coincides with the adoption and global dissemination of the United Nations Sustainable Development Goals (SDGs) in 2015, which provided a

unifying framework for research on sustainable entrepreneurship. The SDGs seem to have acted as a catalyst, stimulating academic output on startups as potential vehicles for sustainable transition.

The period 2020-2022 can be seen as a phase of consolidation and expansion. Annual publication output exceeds 90 publications, reaching a peak of 154 in 2022. This indicates that the research community has begun to recognize sustainable startups as a topic of interest in the field of entrepreneurship and innovation studies. The growing number of articles during these years also shows diversification in content, which includes bibliometric reviews, case studies, and analyses of one or more countries, among other things, helping to broaden the field of sustainable startups.

The last few years, from 2023 to 2025, also demonstrate this trend. In fact, with 163 articles in 2023, 189 in 2024, and 157 in September 2025, we can see signs of a further acceleration in academic productivity. This is not a random increase, but rather a sign that the study of sustainable startups has become a stable, prolific, and increasingly central research topic. The volume of publications also suggests an increase in academic interest, as more economics, social sciences, and business journals are devoting space to entrepreneurship studies focused on sustainability.

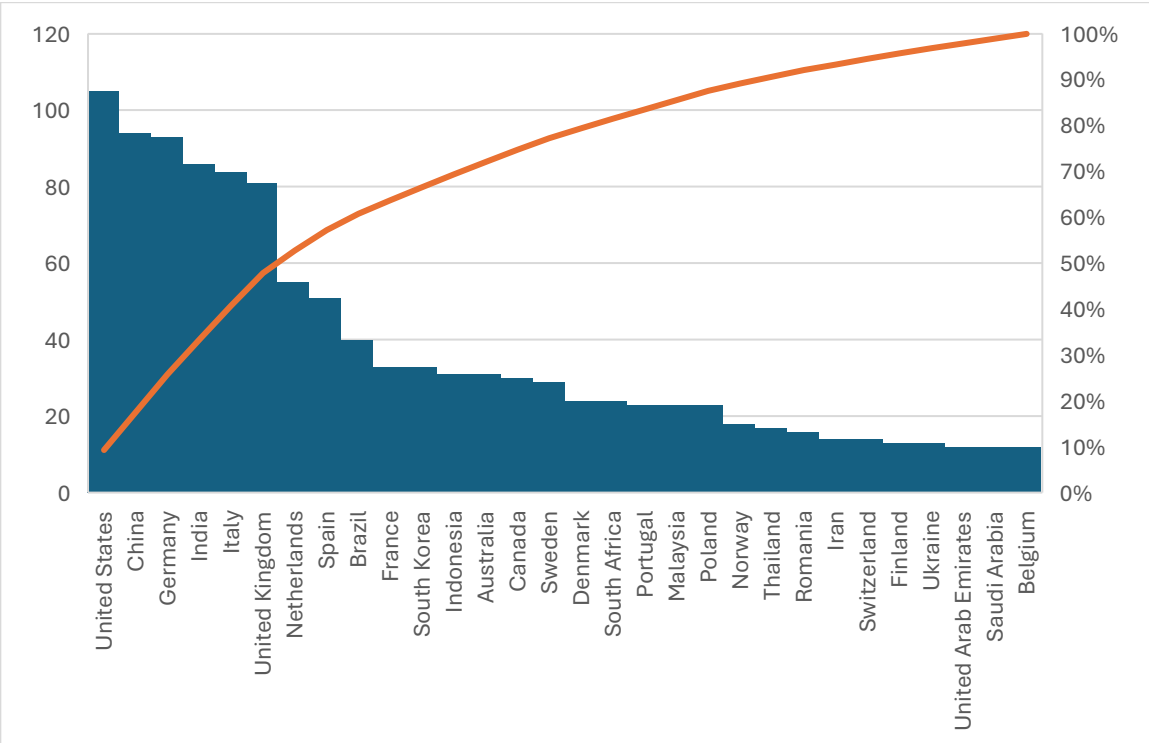

Figure 2.3: Geographical distribution of literature on sustainable startups in Scopus in the period 2015-2025

In terms of country publication and according to the 984-article dataset, the United States emerges as the top contributor with 105 articles (10.7%), followed by China with 94 articles (9.6%) and Germany with 93 articles (9.5%).

Then, India with 86 articles (8.7%), Italy with 84 articles (8.5%), and the United Kingdom with 81 articles (8.2%) also contribute significantly. In synthesis, the six countries share almost 55% of the articles, emphasizing their centrality within international research networks and their role in shaping dominant paradigms of scientific inquiry. The persistence of such concentration confirms earlier findings in the sociology of science, where a small number of countries function as "leaders" within the global knowledge economy, effectively setting research agendas and epistemic priorities.

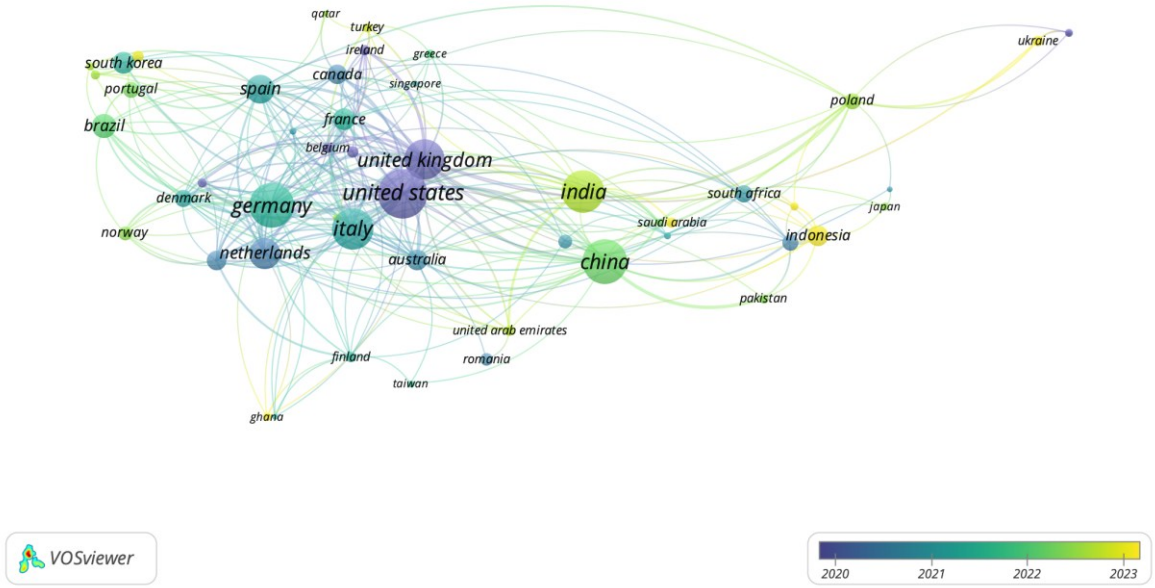

Figure 2.4: Co-author collaboration network by country on literature about sustainable startups in Scopus in the period 2015-2025

Regarding the map of the collaboration network between co-authors by country, based on the analysis of 984 documents indexed in the dataset, it is possible to highlight patterns of international collaboration that show how different countries group together and establish research links in the sector. In particular, the size of the nodes corresponds to the volume of publications associated with each country, while the thickness and intensity of the connecting lines indicate the strength of the links between co-authors. Distinct colours represent groups of countries that share relatively stronger intra-group collaborations, reflecting regional or thematic proximity (van Eck & Waltman, 2010;

Waltman et al., 2010). Once again, we can see how the United States emerges as the most important player, acting as a central hub connecting almost all other major nodes. Their position highlights the country's fundamental role in promoting global academic exchange and acting as a bridge between clusters. In this sense, the United States collaborates extensively with European countries such as the United Kingdom, Germany, France, Italy, and Spain, but also establishes strong links with Asian partners, particularly China, India, and South Korea. Despite of this, China also appears as important node in the map, in close relation to other Asian and emerging economies, such as Indonesia, Pakistan, Bangladesh, and South Africa. This cluster seems to underline the increasing relevance of South–South collaborations and the growing involvement of developing countries in international research.

As for European nations, it is easy to notice how the United Kingdom and Germany emerge as pivotal nodes holding firm bilateral and plurilateral relationships. Sweden, Denmark, Switzerland, and Norway are also showing the existence of regional connections reflecting both geographical neighbourhood and deep-rooted collaborative traditions within the European attitude towards cooperation. Italy and Spain suggest the existence of bridges between Europe on the one hand and the Americas on the other, bridging both the Americas for Europe towards the East, particularly towards the Americas. Finally, the map points out Poland and Ukraine as a somewhat autonomous couple, holding scarce links towards the broader network. In this respect, the nations of the Gulf region and the Middle East (e.g., Saudi Arabia, Kuwait, United Arab Emirates, Turkey) are linked both towards European nodes and towards Asian ones, reflecting their role towards being intercontinental region mediators. From the methodological viewpoint, the map showcases the diversity of worldwide cooperation and points out the existence of both leading hubs and peripheral players. Overall, whereas some nations (e.g., China, the United States, Germany) hold a leading role towards framing the general network structure, others join local, modest clusters, reflecting differences towards research capacity buildings, at large, towards international exposure.

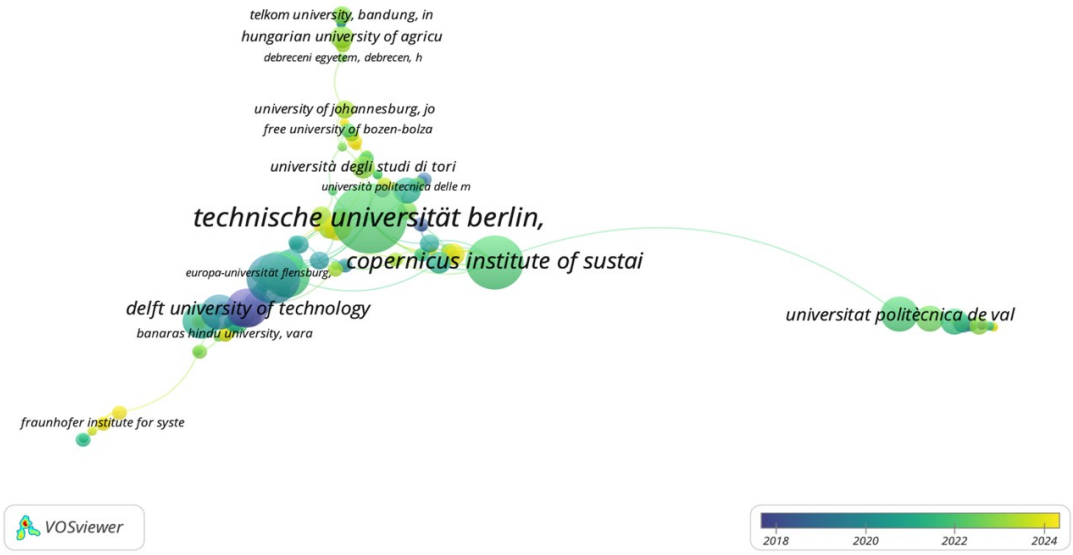

Figure 2.5: Co-authorship collaboration network by institutions on literature about sustainable startups in Scopus in the period 2015-2025

This trend is confirmed by the institutional co-authorship map generated through VOSviewer. In this sense it can be noticed a cohesive collaboration network among a set of European universities and research institutes, with temporal dynamics spanning from 2021 to 2024. The visualization reveals both the geographic clustering of institutions and their evolving research linkages in the domain of sustainability-oriented entrepreneurship and innovation.

The Technische Universitäten Berlin and the Copernicus-Institut des Nachhaltigen Developments (both based in Germany) clearly act as bridges between different institutions; as can be seen from the importance of the links, they play a key role in coordinating multi-institutional projects and transnational collaboration centers. Still within Germany, there is a very close national sub-cluster between the University of Oldenburg and Leuphana University in Lüneburg, characterized by long-standing collaborations in the field of sustainability science and entrepreneurship studies. Leuphana also has a particular research focus on transitions to sustainability and responsible innovation, which explains its close relationships with both national (Oldenburg) and international (Copernicus, TU Berlin) collaborators. The presence of the Technical University of Denmark within this sub-cluster describes a Nordic-German transnational relationship, likely linked to collaborative work on the circular economy, eco-innovation, and transition management.

Towards the right-side of the network, Universitat Politècnica de València appears as a separated yet interrelated actor. Connections with the Copernicus Institute and TU Berlin suggest being incorporated into wider European sustainability networks, such as EU-funded Horizon Europe or Erasmus+ research partnerships. That this node appears rather recent on the time-axis (green towards yellow, i.e., 2023–2024) confirms that it depicts newly growing partnerships, which adds credence towards the argument that Spanish institutions are getting increasingly active members of the sustainability-startup research landscape.

Temporal gradient (2021–2024) adds some more nuances. Old collaborations (blue hues) are seen between German institutions and the Copernicus Institute, which points at the deep history of such collaborations. newer collaborations (greenish-yellow hues) are clustered around the Universitat Politècnica de València, which points at expanding the EU-wide network southward and the progressive widening out of the landscape of collaborations. This points at a dynamic evolution: from a starting set of core German-Danish collaborations towards a widening out pan-European R&I ecosystem.

From a structural angle, the network exhibits a core-periphery setup, with TU Berlin and the Copernicus Institute being at the core, complemented by Leuphana and Oldenburg being local anchors, while newer additions like Valencia and Denmark shore up the periphery. This is a common structure for collaborative European research projects, which have a few experienced leaders undertake intellectual coordination while newer additions widen the spacial and disciplinary scope for such collaborations (Glänzel & Schubert, 2004; Hoekman et al., 2010). In general, the map depicts that institutional partnerships for sustainable entrepreneurship and eco-innovation are rooted in Central and Northern Europe but have expanded towards Southern Europe, paving a way for knowledge recombination and broader sustainability practice diffusion. The trend depicts not just the solidification of prior partnerships, but it also pictures the forging of new connections which might form the next decade's knowledge agenda for such work.

2.3.2. Author Collaboration and Thematic Structures

To further explore the intellectual and thematic structure of the field, Figures 5 and 6 present complementary bibliometric visualizations derived from the 984 documents analysed. The first map illustrates the co-author network between individual scholars, while the second depicts the co-occurrence of keywords, offering an in-depth view of conceptual domains and their evolution over time. Both techniques are well established

in bibliometric research and provide complementary perspectives on the social and intellectual organization of a field (Callon et al., 1991; van Eck & Waltman, 2010).

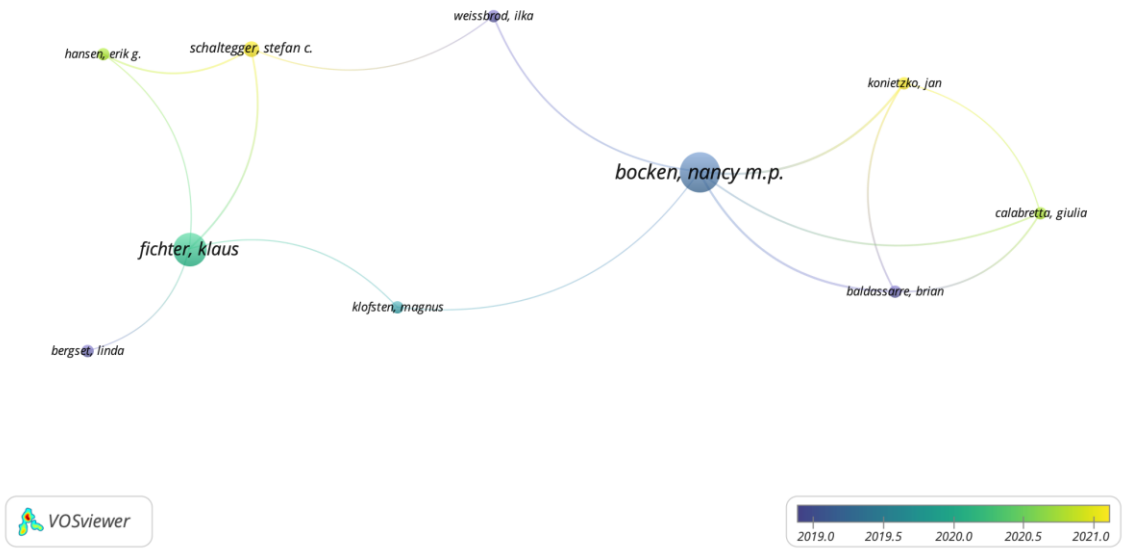

Figure 2.6: Co-authorship map of scholars between 2015 and 2025 (display 10 authors; threshold three articles).

According to the literature, the co-authorship network map (Figure 2.6) represents respectively different research group and scholars on sustainable startup during the period analysed. More in specific, Bocken, Nancy M. P., appears as the principal hub within this subfield. In co-authorship mapping, such a position typically reflects high degree and betweenness centrality—i.e., a scholar who both collaborates widely and connects otherwise weakly connected author groups (van Eck & Waltman, 2010; Waltman et al., 2010). The temporal color gradient (legend 2019-2021) indicates that many of Bocken's collaborations on the right-hand side of the map are comparatively recent (green-to-yellow), and several connections on the left-hand side are slightly earlier (blue-to-teal), suggesting a two stages collaboration pattern: earlier ties with sustainability entrepreneurship scholars and more recent ties with design- and innovation-oriented teams.

It can be noted that Bocken's strongest collaborations are with Calabretta, Baldassarre, Konietzko, and Jan. These authors show a cohesive team working for sustainability and collaborating repeatedly rather than through occasional pairings. The recent collaboration in this case (yellowish tones, which can be traced back to 2021 and beyond) involves a steady stream of joint publications on sustainable/circular business

models and experimentation, a reading that aligns with the broader literature on sustainable business model innovation (Boons & Lüdeke-Freund, 2013; Bocken et al., 2014). A central project group can therefore be assumed: high internal density (co-authors collaborating with each other, not just with the hub) and visible external outreach through the shared link with Bocken.

A cluster led by Fichter, Klaus, also occurs, which in turn is connected to Schaltegger, Stefan C., Hansen, Erik G., and Bergset, Linda, with an additional bridge from Klofsten, Magnus to Bocken. The color tones tend to be cool (2019-2020), indicating previous collaboration focused on sustainable entrepreneurship, incubation, and ecosystem perspectives. The link between Klofsten and Bocken is notable: it forms a cross-bridge between the entrepreneurship/eco-innovation cluster and the business model/design cluster, reinforcing Bocken's role as an intermediary between conceptual communities.

The relationship with Weissbrod, Ilka on the medium-high path continues Bocken's network towards sustainability assessment and impact measurement, with slightly lighter hues, indicating that this association perhaps acted as a stepping stone from assessment-analytical work towards subsequent design-orientation collaborations.

Considered in combination, such patterns characterize Bocken as a multi-cluster connector whose collaborations range (i) across sustainable business models/design-driven innovation, (ii) across sustainable entrepreneurship sustainability ecosystems, and (iii) across evaluation/impact areas, exactly the axes which have organized much of the literature developed recently. Examination of edge thinness (weakness of co-authorship) and node distance (collaboration in the VOSviewer layout corroborate three major inferences:

Unified subgroup founded on projects of design and circularity (Bocken-Calabretta-Baldassarre-Konietzko): compact connections, new findings, and prospective further

Entrepreneurship/transition cluster (Fichter with Schaltegger, Hansen, Bergset): strong history bases and conceptual impact, with quite old co-publications.

Bridge connections (Bridge of Bocken–Weissbrod; Bridge of Bocken–Klofsten): routes for knowledge recombination between the threads of design, entrepreneurship, and assessment

Methodologically, this landscape is a textbook example of a bridging-hub core-periphery network. These topologies frequently accompany field-shaping diffusion: innovations cultivated within the dense right-hand cluster (e.g., design methods, circular business experiments) diffuse easily through the hub to off clusters on the left (ecosystems/entrepreneurship) and, correspondingly, ideas developed there diffuse into

the original, dense, high-innovative-capability, high-change-velocity, high-competitive-pressure cluster on the right (design-for-sustainability, business model experiments). Pragmatically, the map identifies at least two places for future interlinking: (a) deeper interlinking between design-for-sustainability approaches and entrepreneurial acceleration/scaling ideas; (b) closer interlinking of impact measurement methods with business model experiments, to make evidence on effects more robust and legitimation impacts more robust.

Finally, two caveats for the reader of the thesis: (i) visual salience of nodes is a function of thresholds (minimum co-authorship thresholds, time window), so omitting or small nodes don't necessarily mean absent of influence overall; and (ii) time colouring spans about 2019–2021, so quite recent collaborations outside of that window might be underrepresented. Keeping those caveats in view, the map nonetheless gives a clear, empirically based picture of a triadic intellectual structure—design/circularity, entrepreneurship/ecosystems, and impact/assessment—tied together through one of the field's most active intermediaries.

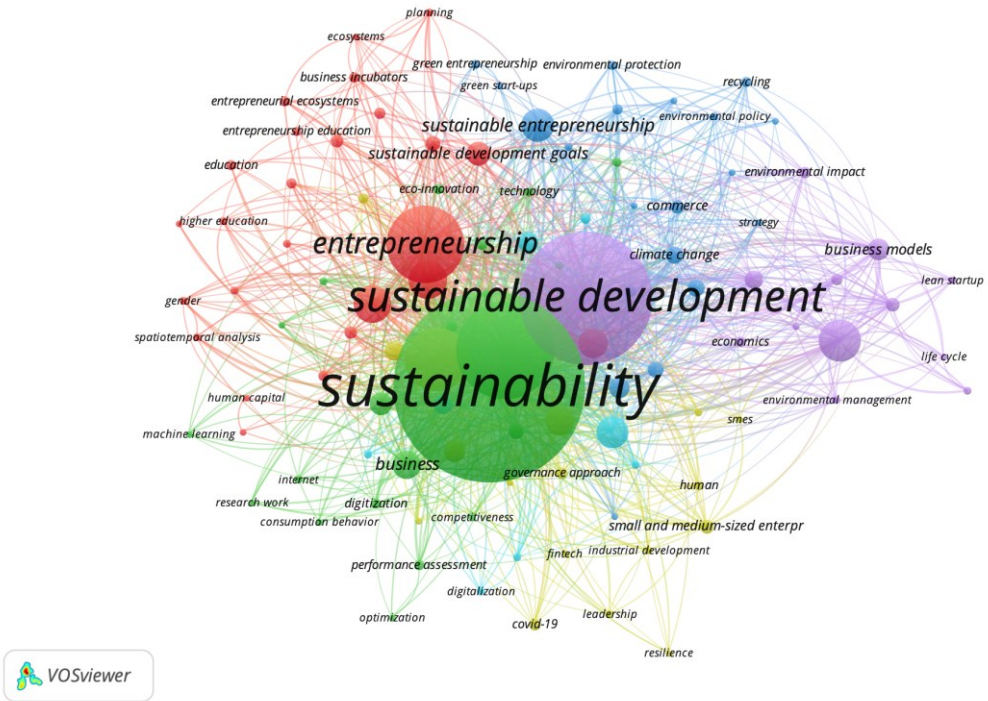

Figure 2.7: Keyword co-occurrence overlay visualization

Figure 2.7 provides a complementary picture of the intellectual structure. First, following van Eck and Waltman (2010) and Zupic and Čater (2015), co-keyword analysis was conducted to identify the key themes in sustainable startup literature. Specifically, figure & shows 107 keywords, corresponding to 107 nodes and at least 9

times occurrence. With this regard, the term **"**sustainability**"** appears as the central and most frequent occurring term, occupying the core of the network and connecting to a wide range of related concepts. Surrounding sustainability, large nodes such as "innovation," "circular economy," "entrepreneurship," and "start-up(s)" delineate the principal thematic clusters that structure the research field. Temporal co-word analysis reveals the time when topics were at the height of their popularity, in particular green-yellow terms (like sustainability or sustainable development) appear to be more recent, instead more traditional topic in blue (like entrepreneurship).

Emerging themes such as artificial intelligence, digitization, and fintech are also visible, suggesting that technological change is increasingly integrated into debates on sustainability-oriented entrepreneurship. The keyword co-occurrence analysis also generated six distinct clusters, each representing a thematic pillar in the literature on startups and sustainability.

Cluster 1 (Red) concerns the theme of *entrepreneurship* and its multiple articulations in start-up ecosystems. It reflects the consolidation of entrepreneurship as a driver for sustainable development and as a vehicle for achieving broader societal objectives.

Cluster 2 (Green) is cantered on *sustainability and innovation*, where technological advances and strategic approaches converge. This cluster highlights the integration of digitalization, artificial intelligence, and eco-innovation into sustainability studies, marking the field's technological and managerial orientation.

Cluster 3 (Blue) focuses on *sustainable entrepreneurship and environmental issues*, emphasizing the interplay between ecological challenges (e.g., climate change, recycling) and investment logics. It underscores the dual financial and environmental dimensions that shape the global research agenda.

Cluster 4 (Yellow) reflects the intersection of *entrepreneurship, economic growth, and policy*. Here, economic development is tightly connected with governance and regulatory frameworks, with the inclusion of COVID-19 signalling responsiveness to global crises.

Cluster 5 (Purple) is structured around *sustainable development and circular economy*, highlighting business model innovation and systemic transitions. This cluster embodies the normative core of the field, pointing to the reconfiguration of business practices for long-term sustainability.

Cluster 6 (Cyan) addresses *start-up processes and stakeholder involvement*, with attention to decision-making, orientation, and sectoral applications such as agriculture.

It represents the micro-level of analysis, focusing on organizational and relational dynamics within entrepreneurial ecosystems.

Taken together, the clusters reveal a multidimensional intellectual structure: (1) entrepreneurial ecosystems, (2) eco-innovation and circular economy, (3) digitalization and agriculture, (4) renewable energy and climate change, (5) business model innovation, and (6) CSR and social entrepreneurship. The relative size of clusters suggests that ecosystem and sustainability-oriented themes dominate, but the presence of technology-specific and social responsibility clusters demonstrates the field's interdisciplinary character.

This distribution is consistent with the increasing pluralization of sustainability entrepreneurship research, which spans policy, technology, and organizational studies.

Cluster	Color	Words	Number of words
1	Red	entrepreneurship (117), start-ups (55), startups (53), startup (42), sustainable development goals (33), sustainable development goal (20), entrepreneurial ecosystem (17), knowledge (17), social entrepreneurship (15), corporate social responsibility (14), education (14), open innovation (14), business incubators (13), entrepreneurial ecosystems (13), entrepreneurship education (12), gender (11), higher education (11), regional development (11), planning (10), spatiotemporal analysis (10), university sector (10), ecosystems (9), human capital (9), sdgs (9), social capital (9)	25
2	Green	sustainability (312), innovation (150), business (40), strategic approach (31), artificial intelligence (20), alternative energy (15), green economy (14), performance assessment (14), digitization (13), eco-innovation (13), technology (12), waste management (12), green innovation (11), internet (11), technological development (11), technology adoption (10), competitiveness (9), consumption behavior (9), learning (9), machine learning (9), optimization (9), research work (9)	22
3	Blue	sustainable entrepreneurship (47), investment (28), climate change (24), investments (24), venture capital (21), commerce (19), sustainable innovation (16), developing countries (14), recycling (14), environmental protection (12), green entrepreneurship (12), environmental policy (10), finance (10), developing world (9), economic and social effects (9), environmental technology (9), government (9), green start-ups (9), industrial enterprise (9), institutional theory (9), strategy (9)	21
4	Yellow	entrepreneur (95), business development (41), economic growth (30), environmental economics (27), economic development (26), small and medium-sized enterprise (18), covid-19 (16), governance approach (16), policy making (13), human (12), environmental sustainability (11), industrial development (11), leadership (10), financial system (9), fintech (9), resilience (9), smes (9), theoretical study (9)	18
5	Purple	sustainable development (210), circular economy (60), business models (30), business model (25), business	13

		model innovation (19), environmental impact (15), sustainable business (15), economics (14), environmental management (11), circular business model (10), lean startup (10), life cycle (9), sustainable business model (9)	
6	Light blue	start-up (45), stakeholder (28), decision making (27), technological innovation (13), digitalization (11), entrepreneurial orientation (11), perception (11), agriculture (10)	8

Table 2.1: Cluster of words

Taken together, the six clusters illustrate both the maturity and diversification of the field. Large clusters, such as entrepreneurship and sustainability (clusters 1 and 2), indicate well-established areas, while smaller ones, such as the circular economy and stakeholder processes (clusters 5 and 6), reveal more specialized or emerging areas of study. The co-existence of these dynamics is a sign of a healthy and evolving research panorama, in which core concepts are well established, but new perspectives continue to emerge that redefine the intellectual contours of sustainable entrepreneurship.

2.3.3. Leading Journals, Contributors, and Articles

The analysis of the top 20 journals publishing on sustainable startups and related themes reveals a high concentration of output in leading Q1-ranked outlets, spanning business, management, economics, energy, and environmental science. This cross-disciplinary distribution underscores the inherently hybrid nature of the field, which bridges entrepreneurship and innovation studies with sustainability transitions, energy policy, and organizational research.

SOURCE	PUB	COUNTRY	SCOPE	Q (2024)	HI	TC	NP
Sustainability (Switzerland)	Multidisciplinary Digital Publishing Institute (MDPI)	CH	Computer Science; Energy; Environmental Science; Social Sciences	Q1	207	222186	150
Journal of Cleaner Production	Elsevier Ltd	UK	Business, Management and Accounting; Energy; Engineering; Environmental Science	Q1	354	183039	52
Business Strategy and the Environment	John Wiley and Sons Ltd	UK	Business, Management and Accounting; Environmental Science; Social Sciences	Q1	173	17347	25
Technological Forecasting and Social Change	Elsevier Inc.	US	Business, Management and Accounting; Psychology	Q1	209	41185	14
Small Business Economics	Springer Netherlands	NL	Business, Management and Accounting; Economics,	Q1	180	5500	7

			Econometrics and Finance				
Resources Policy	Elsevier Ltd	UK	Economics, Econometrics and Finance; Environmental Science; Social Sciences	Q1	138	28215	6
Journal of Open Innovation: Technology, Market, and Complexity	Elsevier B.V.	CH	Economics, Econometrics and Finance; Social Sciences	Q1	63	6292	6
Management Decision	Emerald Group Publishing Ltd.	UK	Business, Management and Accounting; Decision Sciences	Q1	138	3031	6
Applied Energy	Elsevier B.V.	UK	Energy; Engineering; Environmental Science	Q1	323	61246	6
International Small Business Journal	SAGE Publications Ltd	UK	Business, Management and Accounting	Q1	120	903	6
Environmental Innovation and Societal Transitions	Elsevier B.V.	NL	Energy; Environmental Science; Social Sciences	Q1	86	2115	4
Journal of Business Research	Elsevier Inc.	US	Business, Management and Accounting	Q1	292	46180	4
Energy	Elsevier Ltd	UK	Energy; Engineering; Environmental Science; Mathematics	Q1	274	107755	4
Research Policy	Elsevier B.V.	NL	Business, Management and Accounting; Decision Sciences; Engineering	Q1	301	5916	4
Industrial Marketing Management	Elsevier Inc.	US	Business, Management and Accounting	Q1	187	6638	4
Energy Policy	Elsevier B.V.	UK	Energy; Environmental Science	Q1	292	17600	3
Journal of Business Venturing	Elsevier Inc.	US	Business, Management and Accounting	Q1	235	1970	2
Journal of Business Ethics	Springer Netherlands	NL	Arts and Humanities; Business, Management and Accounting; Economics, Econometrics and Finance; Social Sciences	Q1	277	11031	2
Business Horizons	Elsevier Ltd	UK	Business, Management and Accounting	Q1	131	2034	2
International Journal of Entrepreneurial Venturing	Inderscience	CH	Business, Management and Accounting	Q3	29	93	2

Table 2.2: Top 20 Journals on startups

With 150 publications, an outstanding h-index of 207, and more than 222,000 citations, Sustainability (Switzerland) (MDPI) is the most prolific journal at the top of the list. Though it has occasionally been the focus of discussion regarding selectivity and perceived rigor, its open access model and multidisciplinary field (computer science, energy, environmental, and social sciences) make it a privileged platform for timely dissemination and wide visibility (Gusenbauer, 2019). With 52 contributions, a solid h-index of 354, and more than 183,000 citations, the Journal of Cleaner Production (Elsevier) maintains its standing as a top journal. Its emphasis on eco-innovation, green business models, and sustainable production systems accounts for its prominence in the field and serves as a strict benchmark for conceptual and empirical research at the intersection of technology and management.

Business Strategy and the Environment (Wiley), with 25 articles, stands out as a specialized business and sustainability journal and is widely recognized as one of the most influential outlets in the sustainable entrepreneurship domain. In the same way, *Technological Forecasting and Social Change* (Elsevier) plays a key role in bridging future-oriented innovation studies with sustainability research, providing a platform for foresight-driven analyses of startups and transitions.

Ranking also includes entrepreneurship-oriented journals such as Small Business Economics (Springer) and International Small Business Journal (SAGE), which highlight the integration of sustainable entrepreneurship into small business research, although their results remain relatively modest (7 and 6 publications, respectively). In particular, the Journal of Business Venturing, one of the most prestigious journals in the field of entrepreneurship, has only 2 contributions, demonstrating that, although sustainable startups are gaining ground, they remain underrepresented in high-level journals dedicated to entrepreneurship, as in this case.

Applied Energy, Energy Policy, and Energy, on the other hand, illustrate the importance of technical and policy-oriented research for sustainable startups, although these journals focus on energy and policy in the context of renewable energy, clean technologies, and the transition to a low-carbon economy. These journals have very high citation rates and h-indices, confirming their influence in shaping the global debate on energy and sustainability. In addition to this, Environmental Innovation and Societal Transitions publish content related to transition management and sustainability science.

Both generalist business and management journals also contribute to the domain. It's the case of the *Journal of Business Research* (Elsevier) and *Industrial Marketing Management*, which provide space for empirical studies on green startups and business model innovation. Also, *Management Decision* (Emerald) and *Business Horizons* (Elsevier) further show that mainstream management journals are increasingly open to sustainability-oriented entrepreneurship topics.

Finally, ethics and societal impact, in particular the *Journal of Business Ethics* (Springer), has published work on the normative foundations of sustainable entrepreneurship and the role of startups in advancing the UN Sustainable Development Goals. Though only 2 papers are included, the journal's very high h-index (277) reflects its broad disciplinary influence and relevance for research at the interface of business and society.

Overall, three key patterns emerge:

1. Sustainability and energy journals (e.g., *Sustainability*, *Journal of Cleaner Production*, *Applied Energy*), which together account for a large proportion of publications.
2. Entrepreneurship and management journals (*Journal of Business Venturing*, *Small Business Economics*, *Business Strategy and the Environment*), with on the the entrepreneurial studies domain.
3. Cross-disciplinary journals, with contributions in policy, foresight, ethics, and innovation management.

This distribution illustrates that sustainable startup research is both anchored in specialized sustainability journals and progressively penetrating the mainstream entrepreneurship and management literature, though not yet at the same scale. The strong presence of Q1-ranked outlets across all categories reflects the high academic legitimacy of the field, while the spread across multiple domains points to its interdisciplinary consolidation.

Title	Author(s)	Source	Published Year	Total Citations (TC)	TC per Year
Greening Goliaths versus emerging Davids - Theorizing about the role of incumbents and new entrants in	K.N., Hockerts, Kai N.; R., Wüstenhagen, Rolf	Journal of Business Venturing	2010	973	60, 8125

sustainable entrepreneurship					
The influence of personality traits and demographic factors on social entrepreneurship start up intentions	J.K., Hwee Nga, Joyce Koe; G., Shanmuganathan, Gomathi	Journal of Business Ethics	2010	510	31,875
Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges	B.V., Todeschini, Bruna Villa; M.N., Nogueira Cortimiglia, Marcelo Nogueira; D.C., De Menezes, Daniela Callegaro; A., Ghezzi, Antonio	Business Horizons	2017	420	46,66667
Experimenting with a circular business model: Lessons from eight cases	N.M.P., Bocken, Nancy M.P.; C.S.C., Schuit, Cheyenne S.C.; C., Kraaijenhagen, Christiaan	Environmental Innovation and Societal Transitions	2018	376	47
Rare earths supply chains: Current status, constraints and opportunities	A., Golev, Artem; M., Scott, Margaretha; P.D., Erskine, Peter D.; S.H., Ali, Saleem H.; G., Ballantyne, Grant	Resources Policy	2014	340	28,33333
Mapping out the sharing economy: A configurational approach to sharing business modeling	P., Muñoz, Pablo; B.D., Cohen, Boyd D.	Technological Forecasting and Social Change	2017	331	36,77778
A typology of circular start-ups: Analysis of 128 circular business models	M., Henry, Marvin; T., Bauwens, Thomas; M.P., Hekkert, Marko P.; J., Kirchherr, Julian	Journal of Cleaner Production	2020	319	53,16667
Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design	B., Baldassarre, Brian; G., Calabretta, Giulia; N.M.P., Bocken, Nancy M.P.; T., Jaskiewicz, Tomasz	Journal of Cleaner Production	2017	307	34,11111

Barriers to circular business model innovation: A multiple-case study	E., Guldmann, Eva; R.D., Huulgaard, Rikke Dorothea	Journal of Cleaner Production	2020	306	51
Sustainable venture capital - Catalyst for sustainable start-up success?	N.M.P., Bocken, Nancy M.P.	Journal of Cleaner Production	2015	296	26,90909
Born to be green: new insights into the economics and management of green entrepreneurship	P., Demirel, Pelin; C.C., Li, Cher Cher; F., Rentocchini, Francesco; J.P., Tamvada, Jagannadha Pawan	Small Business Economics	2019	276	39,42857
Smart city governance in developing countries: A systematic literature review	S.Y., Tan, Si Ying; A., Taeihagh, Araz	Sustainability (Switzerland)	2020	237	39,5
Developing sustainable business experimentation capability – A case study	I., Weissbrod, Ilka; N.M.P., Bocken, Nancy M.P.	Journal of Cleaner Production	2017	176	19,55556
Open innovation 4.0 as an enhancer of sustainable innovation ecosystems	J., Costa, Joana; J.C.O., Matias, João Carlos O.	Sustainability (Switzerland)	2020	176	29,33333
A (new) role for business – Promoting the United Nations' Sustainable Development Goals through the internet-of-things and blockchain technology	C.D., Villiers, Charl De; S.C., Kuruppu, Sanjaya Chinthana; D.M.P.P., Dissanayake, Dinithi M.P.P.	Journal of Business Research	2021	167	33,4
Sustainability-oriented business model development: Principles, criteria and tools	H., Breuer, Henning; K., Fichter, Klaus; F., Lüdeke-Freund, Florian; I., Tiemann, Irina	International Journal of Entrepreneurial Venturing	2018	156	19,5
User innovativeness and fintech adoption in indonesia	B., Setiawan, Budi; D.P., Nugraha, Deni Pandu; A., Irawan, Atika; R.J., Nathan, Robert	Journal of Open Innovation: Technology, Market, and Complexity	2021	154	30,8

	Jeyakumar; Z., Zoltan, Zeman				
New formulations of the 'energy hub' model to address operational constraints	R., Evins, Ralph; K., Orehounig, Kristina; V., Dorer, Viktor; S.C., Li, Song C.	Energy	2014	149	12,41667
Green technology innovation: Anatomy of exploration processes from a learning perspective	S., Wicki, Samuel; E.G., Hansen, Erik G.	Business Strategy and the Environment	2019	139	19,85714
The impact of entrepreneurship on economic, social and environmental welfare and its determinants: a systematic review	T., Neumann, Thomas	Management Review Quarterly	2021	137	27,4

Table 2.3: Top 2020 papers on startups

In accordance with bibliographic research practice, we then proceeded to analyse the 20 authors who contributed the most (Donthu et al., 2021). Hockerts & Wüstenhagen (2010), "Greening Goliaths versus Emerging Davids" is by far the most cited contribution (973 citations; 61 per year), providing a fundamental framework that distinguishes between established companies and startups in promoting sustainable innovation, and remains the starting point for theorizing sustainable entrepreneurship and is frequently cited in the literature on management, policy, and sustainability. To complement this, Hwee Nga & Shanmuganathan (2010) (510 citations) connect social entrepreneurship to personality and demographics, emphasizing the role of individual -level antecedents in shaping startup intentions, thus linking entrepreneurship studies to psychology and ethics.

In subsequent years, there has been a sharp increase in highly cited contributions devoted to sustainable business models and the circular economy. Todeschini et al. (2017) (420 citations), for example, analyse sustainable business models in the fashion industry, offering one of the first in-depth studies of the specific dynamics of the sector that promote or hinder sustainability in business contexts. Bocken et al. (2018), "Experimenting with a Circular Business Model" (376 citations), and Henry et al. (2020), "A Typology of Circular Startups" (319 citations), which have established themselves as central references in the literature on circular entrepreneurship, combining empirical case studies with a systematic classification

of business model archetypes. These works have contributed decisively to defining the methodological and conceptual lexicon of so-called "circular startups."

At the same time, several contributions have focused on barriers, challenges, and enablers of circular innovation. Guldmann et al. (2020) (306 citations) investigate barriers to innovation in circular business models, while Baldassarre et al. (2017) (307 citations) link the design of sustainable business models with user-driven innovation processes. These studies highlight a growing trend towards integrating design thinking, co-creation with users, and the circular economy in startup contexts. From a financial and ecosystem perspective, Bocken (2015) (296 citations) on sustainable venture capital, Demirel et al. (2019) with "Born to Be Green" (276 citations), emphasize the structural and institutional dimensions of green entrepreneurship, highlighting the link between startup success, financing mechanisms, and policy incentives. These contributions reinforce the idea that sustainable entrepreneurship requires not only individual initiative at the micro level, but also supportive infrastructure and favourable conditions at the macro level.
Furthermore, Muñoz & Cohen (2017), "Mapping the Sharing Economy" (331 citations), place startups within the broader landscape of collaborative consumption and digital business models, while Tan & Taeihagh (2020) (237 citations) highlight the role of governance in smart cities, linking sustainable entrepreneurship to broader urban sustainability agendas. More recent contributions, such as Villiers et al. (2021) (167 citations), relate digital technologies—particularly IoT and blockchain—to the United Nations Sustainable Development Goals, representing the convergence between digitalization and sustainability that is redefining the field today.

From a methodological point of view, Weissbrod & Bocken (2017) (176 citations) and Breuer et al. (2018) (156 citations) contribute by developing frameworks and tools for sustainable experimentation and business model development, respectively, reinforcing the importance of methodological innovation in advancing this literature. Similarly, Costa & Matias (2020) (176 citations) explore open innovation 4.0, emphasizing the ecosystemic nature of sustainable innovation.

In terms of thematic evolution, three major waves are observable:

1. Foundational theorization (2010–2014) – Focus on incumbents vs. startups, personality traits, resource constraints (Hockerts & Wüstenhagen, Hwee Nga & Shanmuganathan, Golev et al.).

2. Business model and circularity (2015–2020) – Surge of empirical and conceptual contributions on sustainable and circular business models (Bocken, Baldassarre, Henry, Guldmann).
3. Digitalization and systemic integration (2019–2021) – Emergence of works linking startups with digital tools, smart cities, fintech, and the SDGs (Villiers et al., Tan & Taeihagh, Setiawan et al.).

Collectively, the top articles reveal that sustainable startup research is simultaneously grounded in theoretical foundations and increasingly future-oriented, incorporating business models, circular economy, financing, and digital transformation. The coexistence of entrepreneurship journals (*Journal of Business Venturing*), management outlets (*Journal of Cleaner Production, Business Horizons*), and technical/policy journals (*Resources Policy, Energy*) underscore the interdisciplinary nature of the field.

Author	ScopusID	h-index	Publications	Total Citations	PY start
N.M.P., Bocken, Nancy M.P.	24328581100	64	11	1597	2015
R., Wüstenhagen, Rolf	55970726900	34	1	973	2010
K.N., Hockerts, Kai N.	6505979814	24	1	973	2010
K., Fichter, Klaus	6602873863	18	9	667	2015
J., Kirchherr, Julian	57189004023	34	7	543	2020
G., Shanmuganathan, Gomathi	35272965600	1	1	510	2010
J.K., Hwee Nga, Joyce Koe	36196596900	11	1	510	2010
B., Baldassarre, Brian	57193409119	13	3	505	2017
M.P., Hekkert, Marko P.	6602626379	61	5	451	2020
G., Calabretta, Giulia	35786957200	14	2	429	2017
A., Ghezzi, Antonio	24831905500	39	2	427	2017
D.C., De Menezes, Daniela Callegaro	57208771341	6	1	420	2017
M.N., Nogueira Cortimiglia, Marcelo Nogueira	23093331600	24	1	420	2017
B.V., Todeschini, Bruna Villa	57195364407	3	1	420	2017
M., Henry, Marvin	57211926087	5	3	380	2020
C., Kraaijenhagen, Christiaan	57200817030	2	1	376	2018
C.S.C., Schuit, Cheyenne S.C.	57225138352	3	1	376	2018
B.D., Cohen, Boyd D.	7402977055	23	2	360	2017

P., Muñoz, Pablo	56494242900	27	2	360	2017
S.H., Ali, Saleem H.	11439396200	30	1	340	2014

Table 2.4: Top 20 Authors on startups

The analysis at the author level offers a privileged insight into intellectual leadership and collaboration dynamics in the field of sustainable entrepreneurship and green startups. The main contributors show an interesting combination: on the one hand, the pioneers who laid the theoretical foundations of the sector; on the other, more recent and prolific scholars who have fostered its growth with empirical research on circular business models, sustainable innovation, and sustainability-oriented design.

At the center of the network is Nancy M. P. Bocken, the most influential and prolific author, with 11 publications since 2015, an h-index of 64, and over 1,500 citations in this dataset. Her studies range from sustainable business models to experimentation to circular entrepreneurship (Bocken et al., 2014; 2018). Frequent collaborations with Brian Baldassarre, Giulia Calabretta, and Cheyenne Schuit have given rise to a solid core of research focused on design and innovation. Her central position reflects not only the volume of publications, but also her role as a "connector" between different sub-areas of sustainability research.

In contrast, Rolf Wüstenhagen and Kai Hockerts stand out as founding theorists: both authors of a single, but fundamental contribution, the famous Greening Goliaths versus Emerging Davids (2010, 973 citations. Another prominent author is Klaus Fichter, with nine publications since 2015, an h-index of 18, and over 650 citations. His work focuses on entrepreneurial ecosystems, sustainability-oriented innovation, and business model experimentation, often in collaboration with Henning Breuer and Florian Lüdeke-Freund. His work represents the German-speaking tradition in sustainable entrepreneurship studies, capable of connecting management and innovation.

Starting in 2017–2020, a new generation of scholars has made significant contributions. Julian Kirchherr (7 publications, 543 citations) and Marko P. Hekkert (5 publications, 451 citations; overall h-index 61) are very active in studies on the circular economy and transitions, with Kirchherr's (2020) typologies of circular startups now widely cited. Brian Baldassarre (3 publications, 505 citations), Giulia Calabretta (2 publications, 429 citations),

and Antonio Ghezzi (2 publications, 427 citations) have brought an interdisciplinary perspective related to design and innovation

The number of citations accumulated by these authors clearly shows how they are helping to define the frontier of research. Alongside them are isolated but highly influential works. Joyce Koe Hwee Nga and Gomathi Shanmuganathan (2010, 510 citations) have authored a now classic study on personality traits and social entrepreneurial intentions. Similarly, Bruna Todeschini, Marcelo Nogueira Cortimiglia, and Daniela Callegaro De Menezes (2017, 420 citations) published a pioneering article on sustainable business models in the fashion industry, demonstrating how sector-specific studies can contribute to the evolution of the field. Although their output is more limited, these works are now considered essential references.

Among the emerging authors, Marvin Henry (3 publications, 380 citations), author of circular startup typologies, and Cheyenne Schuit and Christiaan Kraaijenhagen (both with 376 citations), who collaborate with Bocken on experimental projects and case studies, stand out. Also noteworthy are Pablo Muñoz and Boyd Cohen (360 citations each), who stand out for their contributions on the sharing economy and sustainable entrepreneurship: their mapping of the sharing economy (2017) is now one of the most cited and influential works of recent years.

From an author-level analysis, three main groups can be distinguished. The first group, represented by Hockerts and Wüstenhagen, defined the fundamental concepts of the field through a limited number of seminal works. The second group, comprising Bocken, Fichter, Kirchherr, and Hekkert, has consistently expanded the literature with influential contributions on business models, circular startups, and transition pathways. The third group, consisting of Todeschini, Baldassarre, Calabretta, Muñoz, and Cohen, has enriched the field with high-impact thematic and sectoral studies, often the result of interdisciplinary collaborations that link conceptual and empirical perspectives.

Overall, this configuration reflects the dynamics of a young and interdisciplinary research field: a few central figures, such as Bocken, coexist with a broader constellation of isolated but highly cited contributions. It is precisely the interaction between seminal works and collaborative clusters that has shaped the evolution of knowledge on sustainable entrepreneurship.

3. Conclusions

This chapter dives into a thorough bibliometric analysis of the research surrounding sustainable startups, mapping out the key intellectual, geographic, and thematic dimensions of this field from 2015 to 2025. By going through the research questions we outlined at the beginning, we've managed to stitch together a somewhat fragmented body of knowledge and set up a solid base for the empirical sections coming up in this thesis.

Publication trends (RQ1). The findings show a noticeable increase in academic work on sustainable startups. Before the United Nations rolled out the Sustainable Development Goals (SDGs) in 2015, most contributions were all over the place and mostly theoretical. But starting around 2016, we saw a significant rise in publications that reached a steady state by about 2020, coinciding with a stronger focus on sustainability in global policies and business strategies. This shift indicates that sustainable startups have moved from the sidelines of academic discussions to becoming a central focus in sustainability and entrepreneurship research. They're being recognized more for their role in driving ecological and social change.

Geographic, institutional, and journal distribution (RQ2). The production of knowledge is a bit uneven geographically but is becoming more diverse. Places like the United States, China, and some leading European countries, including Germany and the UK, are emerging as major hubs. While North America and Europe have provided a lot of the theoretical groundwork, Asian countries and emerging markets are offering valuable insights tailored to their contexts, especially in areas like energy, agriculture, and inclusive innovation. On the institution side, a strong European network led by TU Berlin and Leuphana University has steadily expanded to include institutions from Southern Europe, like Universitat Politècnica de València. The analysis of authorship reveals a two-tier structure: early theorists like Hockerts and Wüstenhagen, whose 2010 piece is still a key reference, share the stage with consolidators such as Bocken, Fichter, Kirchherr, and Hekkert, who have expanded the field through ongoing discussions on circular business models and transition studies. When it comes to journals, the range of publications clearly shows the interdisciplinary nature of the field—*Sustainability* and *Journal of Cleaner Production* lead in terms of volume, while journals like *Business Strategy and the Environment* and *Small Business Economics* are helping to cement sustainable startup research within mainstream management and entrepreneurship literature.

Intellectual and thematic clusters (RQ3). Our co-occurrence and co-citation analyses uncovered six main thematic areas: (i) entrepreneurial ecosystems and support structures; (ii) eco-innovation and circular economy; (iii) digitalization and changes across sectors (with agriculture, fintech, and smart cities standing out); (iv) renewable energy and fighting climate change; (v) innovative sustainable business models; and (vi) social entrepreneurship and corporate responsibility. This fragmentation underscores the interdisciplinary character of the field, but it also highlights a growing convergence around sustainability as a shared framework. Concepts like the circular economy and sustainable business models are becoming crucial links that connect various research streams, indicating that a common conceptual language and intellectual agenda is starting to take shape—an essential development for the maturation of the field.

Research gaps and future directions (RQ4). There are still significant gaps to address. Even though sustainable startups are getting more attention in management and entrepreneurship journals, they're somewhat underrepresented in top publications like *Journal of Business Venturing* and *Entrepreneurship Theory and Practice*. This points to a chance for a deeper theoretical integration of sustainable entrepreneurship with traditional entrepreneurship studies. Another ongoing issue is the absence of standardized methods for measuring the environmental and social impacts of startups, which hinders comparability and weakens their relevance to policy. Crafting solid, replicable metrics could help bridge this divide. Additional research could investigate how digital transformation intersects with green entrepreneurship—especially the roles of AI, blockchain, and fintech in scaling sustainable startups—as well as the contributions of emerging economies as testing grounds for frugal and inclusive innovation. These avenues could significantly broaden both the conceptual and empirical scope of the field.

All in all, the findings illustrate a field that has rapidly progressed from theoretical discussions to empirical research. Sustainable startup research today is characterized by a high level of interdisciplinarity, geographic diversity, and a growing link with broader conversations on sustainability and innovation systems. The evidence suggests that these startups are no longer just minor players; they're increasingly recognized as crucial drivers of systemic change, linking technological advancement to social issues.

On a wider scale, sustainable startups wear two hats. On the micro level, they're innovators, trying out new technologies, business models, and organizational styles. On the macro level, they act as catalysts for structural change, helping to reshape industries and push forward

global sustainability goals. The academic literature mirrors this dual role, weaving together detailed case studies of entrepreneurial practices with overarching analyses of policy structures, innovation ecosystems, and pathways to transition.

In conclusion, this chapter not only lays out a structured overview of the scholarly output on sustainable startups but also pushes the field forward by clarifying its intellectual boundaries, highlighting key players, and pinpointing critical gaps. By providing a clear and replicable bibliometric map, it strengthens the methodological foundation of sustainability entrepreneurship research and creates a stepping stone for future studies. It's both a summary of past and present scholarship and a launchpad for a forward-thinking research agenda that aligns more closely with the urgent sustainability challenges of the twenty-first century.

References

- Aghaei Chadegani, A., Salehi, H., Yunus, M. M., Farhadi, H., Fooladi, M., Farhadi, M., & Ale Ebrahim, N. (2013). A comparison between two main academic literature collections: Web of Science and Scopus databases. Asian Social Science, 9(5), 18–26.
- Aguinis, H., Pierce, C. A., Bosco, F. A., Dalton, D. R., & Dalton, C. M. (2011). Debunking myths and urban legends about meta-analysis. Organizational Research Methods, 14(2), 306–331
- Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975
- Baldassarre, B., Calabretta, G., Bocken, N. M. P., & Jaskiewicz, T. (2017). Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design. Journal of Cleaner Production, 147, 175–186
- Bocken, N. M. P. (2015). Sustainable venture capital—Catalyst for sustainable start-up success? Journal of Cleaner Production, 108(A), 647–658
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. Journal of Cleaner Production, 65, 42–56
- Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. Journal of Cleaner Production, 45, 9–19
- Broadus, R. N. (1987). Toward a definition of "bibliometrics". Scientometrics, 12(5–6), 373–379
- Callon, M., Courtial, J. P., & Laville, F. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research. Scientometrics, 22(1), 155–205
- Chen, C. (2017). Science mapping: A systematic review of the literature. Journal of Data and Information Science, 2(2), 1–40
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. Journal of the American Society for Information Science and Technology, 62(7), 1382–1402

- Demirel, P., Li, C. C., Rentocchini, F., & Tamvada, J. P. (2019). Born to be green: New insights into the economics and management of green entrepreneurship. Small Business Economics, 52(4), 759–777
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research, 133, 285–296
- Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. Journal of Business Research, 109, 1–14
- Elkington, J. (1998). Cannibals with forks: The triple bottom line of 21st century business. New Society Publishers.
- Glänzel, W., & Schubert, A. (2004). Analysing scientific networks through co-authorship. In Handbook of Quantitative Science and Technology Research (pp. 257–276). Springer
- Guldmann, E., & Huulgaard, R. D. (2020). Barriers to circular business model innovation: A multiple-case study. Journal of Cleaner Production, 243, 118160
- Han, J., Wu, J., Chen, C., & Yang, J. (2023). Circular startups and hybrid growth strategies: Exploring the dual logic of impact and profit. Journal of Cleaner Production, 387, 135956
- Harzing, A. W., & Alakangas, S. (2016). Google Scholar, Scopus and the Web of Science: A longitudinal and cross-disciplinary comparison. Scientometrics, 106(2), 787–804
- Henry, M., Bauwens, T., Hekkert, M. P., & Kirchherr, J. (2020). A typology of circular start-ups: Analysis of 128 circular business models. Journal of Cleaner Production, 245, 118528
- Hicks, D., Wouters, P., Waltman, L., de Rijcke, S., & Rafols, I. (2015). The Leiden Manifesto for research metrics**.** Nature, 520, 429–431.
- Hockerts, K., & Wüstenhagen, R. (2010). Greening Goliaths versus emerging Davids—Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. Journal of Business Venturing, 25(5), 481–492
- Horne, J., Jansson, J., & Roud, V. (2020). Sustainable entrepreneurship and innovation ecosystems. Technological Forecasting and Social Change, 157, 120054
- Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses. PLoS Medicine, 6(7), e1000097

- Mongeon, P., & Paul-Hus, A. (2015). The journal coverage of Web of Science and Scopus: A comparative analysis. Scientometrics, 106(1), 213–228
- Moed, H. F. (2005). Citation analysis in research evaluation. Springer
- Muñoz, P., & Cohen, B. (2017). Mapping out the sharing economy: A configurational approach to sharing business modeling. Technological Forecasting and Social Change, 125, 21–37
- Newman, M. E. J. (2001). The structure of scientific collaboration networks. Proceedings of the National Academy of Sciences, 98(2), 404–409
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71
- Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? International Business Review, 29(4), 101717
- Pritchard, A. (1969). Statistical bibliography or bibliometrics? Journal of Documentation, 25(4), 348–349
- Sehnem, S., Provensi, D. C., da Silva, R., & Pereira, S. C. F. (2022). Green startups and the sustainable transition: An overview. Journal of Cleaner Production, 363, 132548
- Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. Journal of the American Society for Information Science, 24(4), 265–269
- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333–339
- Trautwein, C. (2021). Startups for sustainability: The role of entrepreneurial innovation in the green transition. Sustainability, 13(8), 4223
- Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538
- Verma, S., & Gustafsson, A. (2020). Investigating the emerging COVID-19 research trends in the field of business and management: A bibliometric analysis approach. Journal of Business Research, 118, 253–261
- Wallin, J. A. (2005). Bibliometric methods: Pitfalls and possibilities. Basic & Clinical Pharmacology & Toxicology, 97(5), 261–275

- White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. Journal of the American Society for Information Science, 49(4), 327–355
- Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. Organizational Research Methods, 18(3), 429–472

3. Empirical Evidence from the Italian Startup Ecosystem: Survey-Based Insights on Sustainability, Innovation and Inclusion

3.1. Introduction

While the previous chapters have examined sustainability-oriented entrepreneurship through the lens of secondary and textual data -first by analysing how startups linguistically align with the Sustainable Development Goals (SDGs), and subsequently by mapping the intellectual structure of academic research on sustainable and innovative entrepreneurship - the present chapter moves from the conceptual to the empirical level.
It focuses on first-hand evidence collected directly from Italian innovative startups, thereby shifting the analytical perspective from an external and discursive dimension to an internal and behavioural one.

The main objective of this chapter is to capture the perceptions, motivations, and self-reported practices that characterize startups operating within the Italian innovation ecosystem. Attention is devoted to understanding how these firms integrate sustainability, innovation, and inclusion within their strategic and organisational dynamics, and how such orientations manifest in their everyday decisions, structures, and collaborations.
This approach allows for an in-depth exploration of how sustainability-driven entrepreneurship is enacted "from within" - that is, as a lived organisational practice rather than a merely rhetorical or policy-related construct.

Unlike the text analysis carried out in Chapter 1 and the bibliometric investigation presented in Chapter 2 - which together provided a macro-level understanding of sustainability narratives and academic framings - this chapter adopts a micro-analytical and actor-centred perspective. It examines how entrepreneurs interpret themselves and prioritise and operationalise sustainability and innovation in their business models (Podsakoff et al., 2016). Through this lens, sustainability is treated not only as a normative principle but also as a potential source of strategic differentiation, social legitimacy, and competitive advantage within the evolving institutional landscape of Italian entrepreneurship.

A survey-based methodology has been selected as the most suitable instrument to capture the subjective, perceptual, and behavioural dimensions of entrepreneurial action that cannot be adequately identified through textual or financial datasets alone. The survey provides primary data on the structural features, innovation patterns, and inclusion practices of

startups, allowing for the systematic comparison of sustainability-oriented and non-sustainability-oriented startups.
This empirical design thus complements and extends the findings of the previous analytical phases, offering a multidimensional and grounded understanding of how sustainability and innovation co-evolve at the firm level.

Specifically, the chapter seeks to identify the common patterns and distinctive traits that together delineate what may be called the "*typical Italian startup"*. The expression "typical Italian startup" is used here as a heuristic label, referring to the most frequently observed configurations within the sample, rather than to a statistically representative or average firm. This approach is consistent with a population-based perspective, which emphasizes heterogeneity and diversity over the identification of a single representative entity.
This involves analysing not only the tangible aspects of entrepreneurial activity - such as size, sector, and R&D investment - but also the intangible and attitudinal dimensions that reflect how startups perceive their role within broader economic, social, and environmental transitions.
By exploring these interconnections, the study aims to shed light on the interplay between entrepreneurial orientation, institutional pressures, and innovation capabilities in shaping the sustainability profile of emerging firms.

Accordingly, this chapter addresses the following research questions:

- ◊ **RQ1.** What profiles of startups emerge within the Italian innovation ecosystem according to their orientation toward sustainability, innovation, and inclusiveness?
- ◊ **RQ2.** How does sustainability orientation influence entrepreneurs' perceptions of the national business environment and their strategic decisions?
- ◊ **RQ3.** What relationships exist between gender diversity, innovation practices, and sustainability within startups?

By combining descriptive and inferential statistical analyses with exploratory techniques such as cluster analysis, the chapter aims to construct a multidimensional taxonomy of Italian startups.
In this chapter, the concept of innovation ecosystem is adopted in a contextual and meso-level sense, rather than as a fully modelled system of interacting actors. Drawing on the innovation ecosystem literature (de Vasconcelos Gomes et al., 2018), the ecosystem is

understood as the institutional, regulatory, and cognitive environment within which startups operate, including policy frameworks, knowledge infrastructures, and territorial conditions. Due to data availability constraints, the empirical analysis remains intentionally firm-centred. However, startups' behaviours and outcomes are interpreted as emerging from population-level dynamics shaped by ecosystem-level incentives and constraints, rather than as the result of isolated firm-level agency.

3.2. Methodological Framework

The conceptual framework of this chapter deepens the analytical logic underlying the empirical investigation of sustainability-oriented entrepreneurship. Moving beyond macro-level mappings of discursive and intellectual structures, the chapter focuses on the micro-foundations of entrepreneurial behaviour, examining how startups internalize, operationalize, and enact sustainability principles within their organizational and strategic configurations.

This micro-analytical perspective is essential for capturing the heterogeneity of entrepreneurial practices that cannot be inferred from textual or bibliometric analyses alone (Podsakoff et al., 2016). By observing firms directly, the analysis connects institutional narratives of sustainability with the managerial and behavioural mechanisms through which entrepreneurial value is created, legitimized, and sustained over time.

From a theoretical standpoint, the analysis is grounded in two complementary yet analytically distinct perspectives.

First, the Resource-Based View (RBV) (Barney, 1991; Peteraf, 1993) provides an interpretive lens through which sustainability and innovation can be understood as strategic resources and dynamic capabilities (Teece et al., 1997). In this view, firms that effectively integrate environmental and social objectives into their business models can develop a resource bundle that are valuable, rare, inimitable, and non-substitutable - thereby creating long-term competitive advantage (Hart, 1995; Aragón-Correa et al., 2003). Sustainability-driven entrepreneurship, in this sense, is not merely a moral or regulatory response but a manifestation of strategic proactivity and organizational learning (Hall et al., 2010).

Startups, particularly in emerging ecosystems, often navigate a dual imperative: achieving economic viability while conforming to institutionalized discourses of sustainability and inclusion (Delmas et al., 2008; Bansal, 2005). This theoretical strand underscores that environmental and social strategies are not purely endogenous choices but are also responses

to institutional isomorphism and the pursuit of legitimacy within their reference fields (Suchman, 1995).

Integrating these two perspectives allows for a multi-level analytical model that captures both internal dynamics - resource allocation, innovation processes, team composition - and external contingencies - ecosystem support, regulatory structures, and cultural norms - that collectively influence how startups position themselves in the Italian innovation landscape. In this dual framework, sustainability and inclusion are conceptualized as interdependent and co-evolving dimensions of entrepreneurial responsibility rather than as isolated attributes (Muñoz et al, 2018; Hörisch et al., 2015). They reflect how entrepreneurial firms simultaneously *respond to* and *shape* their institutional environment, translating global sustainability logics into localized practices that balance innovation-driven competitiveness with social and environmental accountability (York et al., 2016). It is important to clarify that, within an evolutionary and Schumpeterian perspective, institutional change should not be attributed to the agency of single firms, particularly in the case of startups, which are small by definition. Rather, the shaping of the institutional environment emerges as a population-level outcome, resulting from the cumulative behaviour of heterogeneous firms over time. Accordingly, this chapter adopts a population-thinking approach, focusing on patterns of diversity, variance, and differentiated trajectories, rather than on the notion of a representative firm.

Methodologically, the chapter adopts a survey-based empirical design to capture perceptual, behavioural, and structural dimensions of startups operating within the Italian ecosystem. This approach is well-established in entrepreneurship research for its ability to link subjective managerial orientations with organizational outcomes (Aguinis et al., 2017). The survey instrument enables the quantitative assessment of constructs such as innovation intensity, collaboration patterns, inclusion policies, and sustainability commitments - providing a multidimensional dataset suitable for comparative and exploratory analyses, including clustering and non-parametric testing (Ketchen et al., 1996).

By identifying and characterizing the structural, behavioural, and value-based configurations that define distinct types of startups, the chapter provides an empirical typology of the "*Italian startup prototype*" - a composite representation of the configurations that dominate Italy's evolving innovation landscape. In doing so, the analysis contributes to a richer understanding of how emerging ventures internalize sustainability as a guiding logic, transforming institutional pressures into strategic resources and embedding social and

environmental purpose into their competitive positioning (Schaltegger et al., 2011; Muñoz et al., 2018).

3.3. Survey and Variable Structure

The survey, conducted during the period July - October 2025, represents the core empirical instrument of this research. It was designed to explore, through direct self-reported questions, the multidimensional nature of innovative startups in Italy - integrating structural, behavioural, and perceptual information. The approach follows the consolidated survey structures in entrepreneurship and management research, where survey-based data are employed to capture individual and organizational attitudes, to provide update data (Podsakoff et al., 2016). The design of the instrument was informed by prior studies on sustainability-oriented entrepreneurship and innovation management (Cohen et al., 2007; George et al., 2016). It operationalizes the key constructs identified in the previous chapters - sustainability, innovation, entrepreneurial context, and inclusion - through measurable indicators. The questionnaire consists of five thematic sections, each corresponding to one analytical dimension of the research. The survey, submitted through FORMAT RESEARCH SRL - a research institute operating since 1992 in Italy and Europe, specialized in corporate investigations - generated a dataset composed by 1000 valid observations and over one hundred variables, covering quantitative, categorical, and ordinal data. The variables, grouped into five analytical categories, corresponding to the questionnaire's structure, are described as below:

Section	Dimension	Variables
1	General Information	*Region, Province, Year of foundation, Revenues, Number of employees, % women, % R&D staff*
2	Sustainability and SDGs	*Green orientation, Impact (social, economic, environmental), SDGs pursued*
3	Innovation	*R&D investment (% turnover), Barriers to innovation, Collaborations with universities, Type of innovation introduced*
4	Entrepreneurial Context	*Motivations for founding, Perception of the Italian environment, Access to support instruments*
5	Gender Diversity and Inclusion	*% women in founding team, % women in managerial roles, Gender policies, Diversity measures*

All variables were subjected to data cleaning and normalization with the aim of ensure consistency across responses. Missing values were treated through pairwise deletion or mean substitution, depending on the analysis type.
Ordinal variables (e.g., Likert scales 0–5) were coded numerically, while categorical variables were transformed into dummy variables for subsequent statistical testing, providing a multidimensional representation of the Italian startup ecosystem.
The questionnaire consists of five thematic sections, each corresponding to one analytical dimension of the research.

1. General Information

   This section collects structural variables such as ATECO sector, year of foundation, size, turnover class, and qualification as 'innovative startup'. These variables control for structural heterogeneity (Delmar et al., 2004).

2. Sustainability Orientation

   It measures sustainability through green orientation (yes/no/in part) and 0–5 scales for social, economic, and environmental impact, linked to the SDGs (Cohen et al., 2007; Dean et al., 2007; Schaltegger et al, 2011).

3. Innovation

   Covers R&D investment, collaborations, patents, and innovation incentives, capturing input–output dimensions of innovation (Schumpeter, 1934; Bocken et al., 2014).

4. Entrepreneurship and Barriers

   Investigates founders' motivations, perceived obstacles, and evaluation of the Italian entrepreneurial ecosystem (Urbano et al., 2013).

5. Gender Diversity and Inclusion

   Assesses gender composition and diversity policies, examining how inclusion relates to innovation (Díaz-García et al., 2013; Foss et al., 2019; Østergaard et al., 2011).

Due to the anonymity of the questionnaire, it was not possible to obtain financial information on individual participants, even though external datasets (e.g. AIDA). In the subsequent analyses, the dataset was used to:

- Conduct a descriptive analyse of the main dimensions (e.g., main characteristics of the Italian startups);
- Perform comparative tests between groups of startups (e.g. green vs non-green);
- Implement exploratory multivariate techniques, including cluster analysis, to identify underlying profiles and define the empirical traits of the "typical Italian startup".

The survey-based analysis relies on a sub-sample of innovative startups drawn from the proprietary database of Format Research, which was used as the sampling frame for the diffusion of the survey. Format Research was responsible for contacting firms included in its dataset and for administering the survey. The author did not perform any discretionary selection of firms. Participation in the survey was voluntary, implying that the final sample reflects a two-stage selection process: an initial selection based on the coverage of the Format Research database, followed by firms' self-selection into participation. As a consequence, the survey results should be interpreted as representative of responding innovative startups within this data frame, rather than of the entire population of Italian firms. Accordingly, the empirical analysis adopts a cautious and exploratory interpretative stance, focusing on associations and patterns observed within the sample.

3.4. Analytical Strategy

The analytical framework developed for this chapter follows a progressive and multilevel approach, combining descriptive, comparative, and exploratory analyses.
Given the multidimensional structure of the dataset and the heterogeneity of the variables, the analytical process aims to move gradually from simple observation of trends to the identification of typologies and patterns that describe the Italian startup ecosystem. The objective is not only to quantify the diffusion of sustainable and innovative behaviours but also to understand how these features coexist and interact across different entrepreneurial dimensions -economic, social, organizational, and cultural. In doing so, the chapter seeks to empirically delineate the profile of the "*typical Italian startup*", as well as to uncover clusters of firms that share similar combinations of characteristics and orientations.

3.4.1. Descriptive Analysis

The first step consisted of a descriptive analysis of the key dimensions of the sample. This included general characteristics such as the year of foundation, number of employees, R&D intensity, gender composition of founders and managers, and the number of legal requirements satisfied under the Decreto-Legge 179/2012 for innovative startups.

The descriptive statistics (mean, standard deviation, minimum, and maximum) provided a first overview of the structural features of the Italian innovation ecosystem analysed, highlighting heterogeneity in firm size, maturity, and resource orientation.

The analysis also included:

- Frequency distributions for categorical variables (e.g., green orientation, gender policies, types of innovation);
- Measures of central tendency and dispersion (mean, median, standard deviation) for quantitative variables such as year of foundation, number of employees, and percentage in R&D;
- Geographical mapping of startups across Italian provinces, developed using *QGIS* (Quantum Geographic Information System), to visualize the spatial concentration of green-oriented and innovation-driven startups.

The mapping process involved the creation of choropleth and proportional-symbol maps**,** which illustrate the distribution of startups across Italian regions and macro-areas. This spatial representation supports the statistical evidence with an immediate visual dimension, highlighting patterns of concentration and regional asymmetries - particularly in the localization of sustainability-oriented firms. This stage was essential to provide an overview of the sample composition and to identify territorial and sectoral trends that later informed the comparative and clustering analyses.

3.4.2. Comparative Analysis

The second analytical phase explored the relationships between sustainability, innovation, and inclusion, testing whether specific orientations or characteristics were statistically associated.

Given the non-normal distribution of most variables, non-parametric tests were applied to ensure robustness.

The analyses included:

- Kruskal-Wallis H tests, to assess whether the distributions of quantitative or ordinal variables differ among *non-green*, *partially green*, and *green* startups.
- Dunn's post-hoc tests (with Bonferroni correction), to identify which group pairs exhibit significant differences.
- Spearman rank correlations, to explore monotonic relationships among continuous or ordinal variables (e.g., between the percentage of women in leadership and perceived social impact).

This comparative phase provided the statistical foundation for the subsequent cluster analysis, highlighting which variables differentiate startups in structural and behavioural terms.

3.4.3. Cluster Analysis: Identifying Startup Profiles

The third analytical phase employed cluster analysis to identify groups of startups that share similar characteristics in terms of sustainability orientation, innovation practices, and inclusion policies.

Cluster analysis is a powerful exploratory technique suitable for heterogeneous and multidimensional datasets, allowing for the discovery of natural groupings without predefined assumptions (Ketchen et al., 1996).

In this regard, the procedure was carried out as follows:

Variables selection: Variables were selected from the sustainability, innovation, and gender diversity sections of the survey, including:

– Green orientation (yes / in part / no);
– Social, economic, and environmental impact (scores 1–5);
– Percentage of R&D personnel and presence of innovation investments;
– Collaborations with universities or research centres;
– Gender-related measures (e.g., percentage of women in founding and managerial roles).

These variables jointly capture the environmental, technological, and social dimensions of startup behaviour.

Data preprocessing: Continuous variables were standardized using z-scores to prevent differences in scale from distorting cluster formation. Categorical variables (e.g., "green orientation") were transformed into dummy variables prior to normalization, ensuring consistent distance computation across mixed data types.

Clustering method: A hierarchical agglomerative clustering (Ward's method, based on squared Euclidean distance) was first applied to determine the optimal number of clusters. Subsequently, a K-means refinement was performed to maximize internal cohesion and external separation. This two-step approach balances statistical rigour with interpretability (Kaufman et al., 2009).

Cluster validation: The silhouette coefficient and inspection of cluster centroids were used to evaluate the quality and interpretability of the resulting groups. Cluster stability was also verified through multiple random initializations to ensure robustness of the final partitioning. Descriptive statistics for each cluster were then examined to construct meaningful profiles.

Results and interpretation: The analysis produced two main typologies in both the general and sustainability-focused subsets:
– In the general sample, four clusters emerged;
– Within the sustainability-oriented subset, five further clusters were identified.

This dual clustering approach provides both a macro-level typology of the Italian startup ecosystem and a micro-level differentiation within sustainability-oriented entrepreneurship. All clustering procedures were implemented in Python (using the scikit-learn library for standardization, hierarchical clustering, and K-means optimization), ensuring replicability and analytical precision. Summary tables and comparative visualizations were subsequently produced in Excel to enhance readability and integration into the final dissertation.

3.5. Analysis of the survey

3.5.1. Descriptive Analysis

Building upon the methodological framework presented before, this section reports the empirical results derived from the survey. The analyses are organized in four main stages: descriptive statistics, comparative analysis, correlation analysis, and cluster identification. Together, these results provide an integrated view of how sustainability, innovation, and inclusion characterize Italian innovative startups.
The geographical distribution of Italian innovative startups shows a clear concentration in a few key urban and economic hubs. The province of Milan (MI) emerges as the dominant center, hosting 125 startups, followed by Rome (RM) with 67, and Turin (TO) with 48. Other provinces with notable concentrations include Bologna (BO), Florence (FI), Bari (BA), Padua (PD), Verona (VR), and Brescia (BS), each ranging between 24 and 37 startups. This pattern reflects the broader geography of innovation in Italy, which is polarized around major

metropolitan and university-centered regions in the North and Center, where access to venture capital, research institutions, and industrial clusters is higher. The residual presence of startups in other provinces indicates a certain level of diffusion of innovative activity, albeit on a smaller scale.

Figure 3.1: Distribution of startups interviewed by province.

About the revenues distribution, most startups report an annual turnover of less than €2.5 million, accounting (approximately 984 firms), whereas only a small fraction exceeds this threshold. Specifically, 7 startups fall within the €2.5–10 million range, and just 4 startups report revenues between €10 and €150 million.

This strong skew toward the lower end of the revenue spectrum highlights the early-stage and small-scale nature of most innovative startups in Italy. It suggests that while the ecosystem is characterized by a high degree of entrepreneurial dynamism, it remains largely composed of micro- and small enterprises still in the process of consolidating their market presence and scaling operations.

Variable	Mean	Std Dev	Min	Max
Year of fundation	2020.7	3.38	1995	2025
Number of employees	6.14	7.33	1	60
% R&D employees	47.47	38.23	0	100
% women founders	1.64	0.76	1	4

% women leadership roles	1.66	0.8	1	4
Requirements Dlgs met	1.23	0.46	1	3

Table 3.1: Descriptive analysis of the dataset. Note: variables relating to female representation are coded on a scale of 1–4, where 1 = 0%, 2 = <50%, 3 = >50%, 4 = 100%.

Table 3.1 presents the descriptive statistics for the main structural and organizational variables of the startups in the sample. The average year of foundation is approximately 2020.7 (SD = 3.38)**,** indicating that most firms were established within the past five years and therefore belong to a relatively young entrepreneurial cohort. The earliest foundation year (1995) and latest (2025) highlight some heterogeneity, yet the distribution remains concentrated around the recent policy and funding initiatives supporting innovation. The average number of employees is 6.14 (SD = 7.33), ranging from 1 to 60, which confirms that many firms qualify as micro-enterprises, though a few have reached a modest growth stage. The percentage of R&D employees shows substantial variability (Mean = 47.47%, SD = 38.23), reflecting different strategic orientations: while some startups devote most of their workforce to research and development, others remain more commercially or operationally focused.

With respect to gender composition, the mean scores for women founders (Mean = 1.64, SD = 0.76) and women in leadership roles (Mean = 1.66, SD = 0.80) suggest that female participation remains limited. These values, on a 1–4 scale, correspond roughly to categories between “low” and “moderate” representation, underscoring a persistent gender imbalance within the Italian innovation ecosystem.

Finally, the average number of legal requirements met under the Decreto-Legge 179/2012 equals 1.23 (SD = 0.46), with a maximum of 3, indicating that most startups comply with the minimum legal criteria for innovative status, but only a minority satisfy multiple qualifying conditions.

These descriptive results portray a young, small-scale, and R&D-oriented entrepreneurial landscape, characterized by pronounced heterogeneity in technological focus and persistent gender gaps in governance and founding teams.

Requirements	**% Startup**
R&D expenditures≥15%	63.5%
Personale altamente qualificato	48.2%
Brevetto o software registrato	9.7%

Table 3.2: % of Dlgs 179/2012 equirements satisfied

Table 3.2 illustrates the extent to which startups in the sample comply with the key legal requirements defined by the Decree Law 179/2012 for recognition as “innovative startups”.

Specifically, 63.5% of firms report R&D expenditures equal to or greater than 15% of total costs (Spese in R&S ≥15%), making this the most frequently satisfied criterion. This highlights a strong commitment to research and innovation activities as a central element of their business models.

A smaller, yet substantial share (48.2%) declares the presence of highly qualified personnel (*Personale altamente qualificato*), indicating that nearly half of the startups employ individuals with advanced degrees or specialized technical expertise. This confirms that human capital remains a critical factor in sustaining innovative capabilities within the ecosystem. By contrast, only 9.7% of startups report ownership of a registered patent or software (*Brevetto o software registrato*). This low percentage suggests that, while many firms engage in R&D activities, relatively few succeed in producing formalized intellectual property, possibly reflecting the early developmental stage of these ventures or the prevalence of innovation in non-technological domains (e.g., digital services, organizational innovation). The evidence indicates that Italian innovative startups primarily qualify for the legal status through R&D intensity and skilled human resources, while technological patenting remains a minority characteristic within the ecosystem.

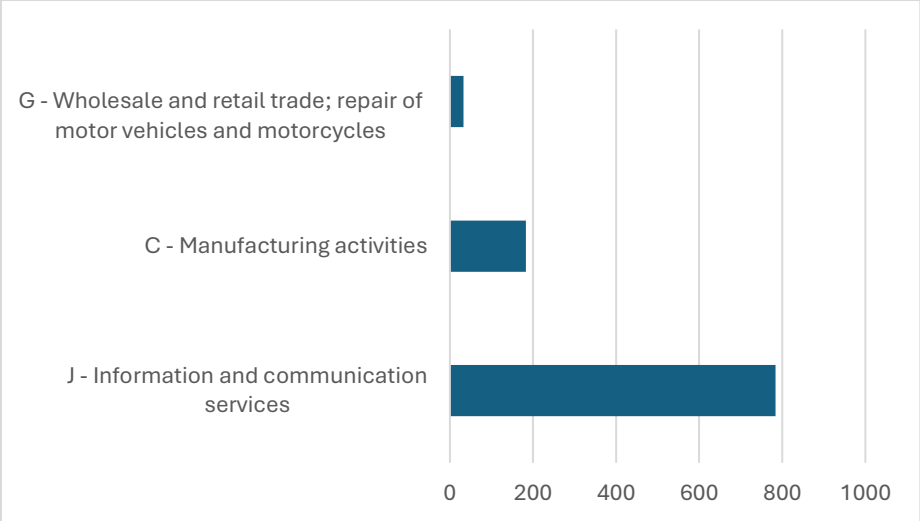

Figure 3.2: ATECO code distribution

The industrial composition of the surveyed startups reveals a marked concentration in a few core sectors of the Italian innovation landscape. The overwhelming majority, approximately 70% of the sample, operates under the "*J*" ATECO code, "*Information and Communication Services"*. This reflects the centrality of digital technologies, software development, and ICT-related activities in driving the country's innovation dynamics. The prominence of this sector aligns with broader European trends, where knowledge-intensive services constitute the backbone of new entrepreneurial ventures.

The "*C*" category, "*Manufacturing Activities",* accounts for roughly 18% of startups,

highlighting a smaller yet significant segment oriented toward product innovation and industrial technologies. These firms often integrate advanced production processes, design, and engineering competencies, bridging digital innovation with tangible outputs. Finally, a residual share of startups, around the 3%, belongs to the "*G*" sector, "*Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles"*. These firms represent a commercial extension of innovation, where new digital business models such as e-commerce and platform-based distribution intersect with traditional trade and repair activities.
It is also important to acknowledge that this sectoral configuration might, at least in part, reflect the composition of the sample provided by FORMAT RESEARCH, the institution that conducted the survey. If certain categories of startups-particularly those in ICT and digital services-were more represented in the original dataset, this could have influenced the observed distribution. Nevertheless, this potential sampling bias does not undermine the general validity of the findings, which remain consistent with the broader empirical evidence of a digital-intensive and service-oriented Italian startup ecosystem.

As part of the survey, all startups - regardless of their level of sustainability orientation - were asked to indicate which of the United Nations Sustainable Development Goals (SDGs) they actively pursue or consider relevant to their business activities. The question was designed to capture the extent to which the startup ecosystem aligns with the 2030 Agenda and to identify the specific sustainability domains most frequently integrated into entrepreneurial strategies.

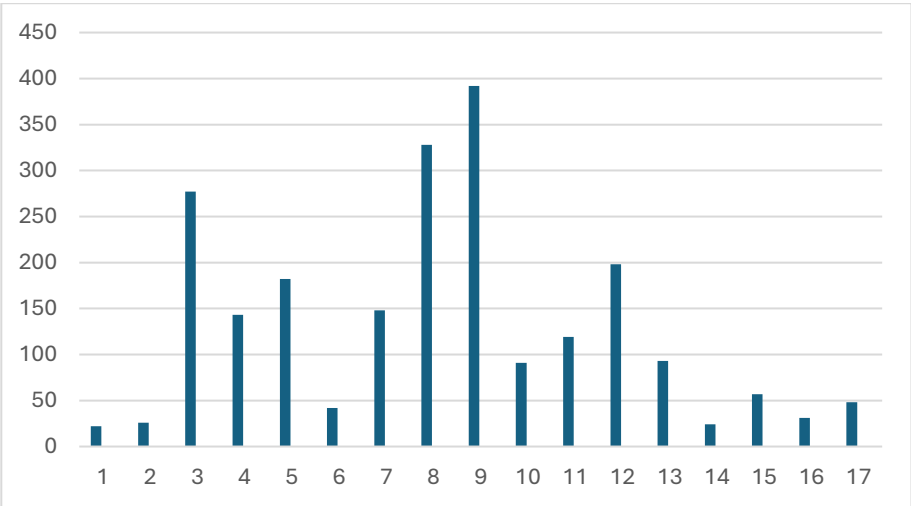

Figure 3.3: SDGs distributions

The distribution of responses reveals a clear concentration around a limited set of Sustainable Development Goals. Startups most frequently report engagement with Industry,

Innovation and Infrastructure (SDG 9), followed by Decent Work and Economic Growth (SDG 8) and Good Health and Well-being (SDG 3). These goals reflect an interpretation of sustainability closely aligned with innovation, market development, and the provision of socially valuable goods and services. Environmental goals such as Responsible Consumption and Production (SDG 12) and Affordable and Clean Energy (SDG 7) also display substantial frequencies, indicating growing attention to resource efficiency, circularity, and energy-related innovation. By contrast, SDGs emphasizing redistribution, poverty alleviation, and institutional dimensions—such as No Poverty (SDG 1), Zero Hunger (SDG 2), Reduced Inequalities (SDG 10), and Peace, Justice and Strong Institutions (SDG 16)—are selected far less frequently. Overall, the pattern suggests that Italian startups engage with the SDGs in a pragmatic and innovation-centered manner, prioritizing goals that are more readily compatible with technological development, competitiveness, and scalable business models, while the redistributive and institutional dimensions of the 2030 Agenda remain relatively marginal. The pattern indicates that Italian startups engage with the SDGs in a pragmatic and innovation-centered manner, focusing on objectives that align with competitiveness, digitalization, and environmental responsibility. This finding corroborates existing evidence (e.g., *Kraus et al., 2022; García-Sánchez et al., 2023*) showing that early-stage ventures tend to operationalize sustainability through technological and efficiency-based pathways**,** while the social dimension of the 2030 Agenda remains relatively marginal in entrepreneurial practice.

The correlation matrix (see Appendix) highlights the degree of association between the Sustainable Development Goals pursued by startups. In general, the coefficients are relatively low-mostly between 0.0 and 0.2 - indicating that the pursuit of individual SDGs tends to occur independently rather than in strongly interconnected clusters. This pattern confirms that startups often focus on specific sustainability objectives aligned with their technological or market domain, rather than pursuing comprehensive, multi-dimensional sustainability strategies. Nonetheless, a few moderate positive correlations emerge. The strongest relationships are observed between SDG 14 (Life Below Water) and SDG 15 (Life on Land) ($r = 0.24$), and between SDG 13 (Climate Action) and the same two environment-related goals ($r = 0.15–0.19$). This suggests that startups addressing environmental challenges tend to operate within an integrated ecological perspective, where the protection of ecosystems, biodiversity, and climate are treated as complementary aims. Similarly, SDG 4 (Quality Education) shows a modest correlation with SDG 5 (*Gender Equality*) ($r = 0.17$), reflecting the tendency of socially oriented startups to link education and inclusiveness in

their missions. A smaller positive link between SDG 5 and SDG 10 (*Reduced Inequalities*) (r = 0.15) reinforces this interpretation, indicating that equality-driven initiatives may share common underlying values. Conversely, correlations involving SDG 9 (*Industry, Innovation and Infrastructure*) - one of the most frequently selected goals - are weak or even slightly negative with several others (e.g., SDG 3, r = –0.20; SDG 4, r = –0.05). This pattern confirms that technological and innovation-focused startups tend to emphasize innovation and competitiveness rather than broader social or environmental synergies, supporting the view that sustainability is often pursued through specialized rather than holistic pathways**.** Overall, the correlation structure reveals that while Italian startups display diverse engagement with individual SDGs, their strategic orientations remain segmented and goal specific. Environmental SDGs cluster more coherently than social ones, reflecting a stronger conceptual and operational integration of ecological concerns. These findings are consistent with previous evidence that entrepreneurial ecosystems tend to engage with sustainability in a selective and innovation-centered manner**,** where interconnections among goals emerge primarily within environmental domains rather than across the full sustainability spectrum (Bansal et al., 2017).

3.5.2. Analysis of Green Startups

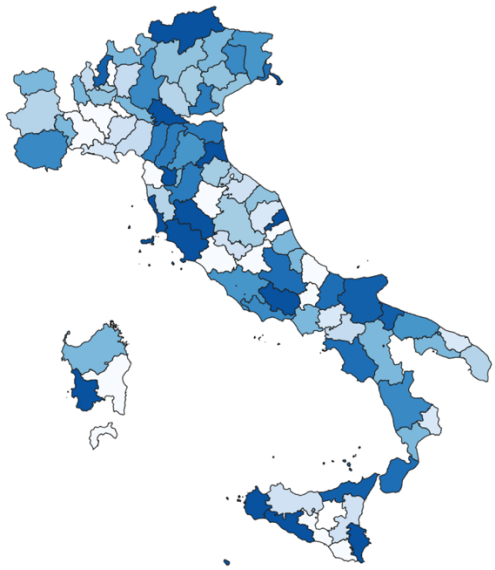

Figure 3.4: Distribution of startups classified as “green” across Provinces

As part of the survey, respondents were asked whether their startup could be considered *“green”*, that is, whether it integrates environmental sustainability as a central element of its business model by developing products, services, or technologies that reduce environmental impact or support the transition toward a sustainable economy. The question allowed for three possible responses: *yes*, *no*, and *partly*. Following the analytical framework

adopted throughout this study, both *yes* and *partly* answers were grouped under the "green-oriented" category, as they indicate a clear or emerging commitment to sustainability. Overall, 487 startups-representing a significant share of the total sample-declared themselves either fully or partially green. The resulting geographical distribution, visualized in the corresponding map, shows a marked territorial heterogeneity. Some provinces, such as Agrigento, L'Aquila, Bari, Aosta, and Ancona**,** exhibit notably high proportions of green startups, in certain cases reaching or exceeding 50% of local respondents. This pattern suggests that the integration of environmental sustainability is not limited to the most industrialized or urbanized contexts but also emerges in smaller or peripheral territories, where ecological awareness, regional incentives, or resource-based industries may stimulate sustainable entrepreneurship. Conversely, several provinces in Northern Italy-despite concentrating a higher absolute number of innovative startups-display lower relative shares of green-oriented firms, indicating that innovation there remains predominantly driven by technological or service-based objectives rather than environmental ones. This asymmetry reflects broader structural dynamics within the Italian innovation system, where sustainability-oriented entrepreneurship coexists with more traditional forms of digital or industrial innovation. To gain a deeper understanding of how startups conceptualize and implement sustainability, a specific focus was conducted on those that identified as partially green. Within this subgroup, 45 startups provided a textual explanation describing how sustainability is integrated into their business model. These open-ended responses offer valuable qualitative insights into the practices, strategies, and meanings associated with sustainability in entrepreneurial contexts - ranging from eco-efficient production processes and circular economy approaches to the adoption of renewable energy, waste reduction initiatives, or sustainable product design.

Words	**Frequency**
ambiente / ambientale	22
ridurre / riduzione	18
impatto	17
digital / digitale	15
carta	14
uso / utilizzare	12
energia / energetico	10
sostenibile / sostenibilità	9
risorsa / risorse	8

processo	8
green	7
efficienza	7
spreco / scarto	6
circolare / riutilizzo / riciclo	6
consumo / riduzione consumi	5
tecnologia / tecnologie	5
mobilità / spostamenti	4
emissioni / inquinamento	4
prodotto / produzione	4
virtualizzazione	3

Table 3.3: recurring words from the descriptive analysis of "partially green" startups.
Note: English translation of variables is provided in the Appendix

The textual analysis further substantiates and deepens the evidence emerging from the descriptive and geographical analyses. The most recurrent words - "*ambiente"*, "*ridurre"*, "*impatto"*, "*digitale"*, "*carta"*, and "*energia"* - suggest a conception of sustainability that is primarily pragmatic and operational, centered on waste reduction, energy efficiency, and process digitalization. The frequent use of terms such as "*digitale"*, "*carta"*, and "*virtualizzazione"* points to an understanding of environmental commitment as dematerialization, where sustainability is pursued through the replacement of physical processes with digital solutions. This reflects a vision of sustainability as eco-efficiency (Porter & van der Linde, 1995), in which technological innovation and resource optimization serve as the main vehicles for reducing environmental impact, rather than as catalysts for deeper systemic or social transformation. The presence of words related to "*circolarità"*, "*riutilizzo"*, and "*riciclo"* indicates an emerging awareness of broader sustainability paradigms, emphasizing the rational use of resources and the transition toward circular business models. However, expressions referring to social or ethical dimensions of sustainability - such as inclusion, community, or social value - remain largely absent. This linguistic pattern suggests that, within the discourse of Italian startups, sustainability is still conceived predominantly in environmental and technological terms, reflecting a stage of development in which ecological awareness is operational but not yet fully integrated into a holistic strategic framework.

These findings highlight the predominance of a technology-driven and efficiency-oriented narrative, consistent with the early stages of sustainable entrepreneurship, where firms tend to equate environmental responsibility with innovation and process optimization rather than with transformative change (Schaltegger et al., 2011). To complement the analysis of green orientation, startups that identified themselves as fully green or partially green were asked to indicate whether they actively pursued three types of impact - social, economic, and environmental - and, if so, to assess the perceived relevance of each on a scale from 0 ("not at all relevant") to 5 ("completely relevant"). This two-step structure ensures that the impact scores reflect only the evaluations of those startups that explicitly pursue each dimension, thus providing a more precise picture of the underlying orientations.

Group	Impact	N	Mean	SD	Min	Max
Overall (Green + Partially)	Social	316	3.84	1.17	0.0	5.0
	Economic	346	3.92	1.08	0.0	5.0
	Environmental	381	3.93	1.15	0.0	5.0
Fully Green	Social	278	3.86	1.18	0.0	5.0
	Economic	306	3.91	1.10	0.0	5.0
	Environmental	351	3.98	1.15	0.0	5.0
Partially Green	Social	38	3.74	1.11	2.0	5.0
	Economic	40	4.00	0.96	1.0	5.0
	Environmental	30	3.30	0.95	1.0	5.0

Table 3.4: Economic, social and environmental impacts and relevance scores by startup group Note: *N pursue* indicates the number of startups that explicitly declared pursuing each type of impact (i.e., answered "yes" to the corresponding question). *Mean, SD, Min,* and *Max* refer to the 0–5 scale of perceived relevance, computed only among startups that pursue that impact. All values are approx. to two decimals.

The results reveal that, within the group of green and partially green startups, the environmental dimension remains the most frequently pursued, with 381 firms declaring engagement in this area, followed by the economic (346) and social (316) dimensions. Nevertheless, the average perceived relevance of the three impacts is remarkably similar - around 3.9 on a five-point scale - suggesting that sustainability is viewed as a multidimensional yet still operational construct rather than a value-driven transformation. When comparing subgroups, fully green startups display higher consistency and intensity across all three dimensions, with the environmental impact achieving the highest mean score (3.98 ± 1.15). This pattern is consistent with their self-definition and indicates a more consolidated and systematic approach to sustainability integration. Conversely, partially green startups pursue each impact far less frequently and exhibit greater heterogeneity in

their assessments. Their economic impact attains the highest mean value (4.00 ± 0.96), while the environmental impact records a notably lower mean (3.30 ± 0.95). This asymmetry suggests that, for these firms, sustainability is often interpreted in terms of efficiency, competitiveness, and resource optimization, rather than as an explicit ecological mission. These findings confirm that, even among startups that identify as green, environmental considerations dominate the discourse in scope, but not necessarily in perceived importance once filtered by actual pursuit behaviour. The relative convergence of mean scores across dimensions highlights that sustainability practices in the Italian startup ecosystem remain functional and performance-oriented, with only the most mature firms aligning their environmental goals with strategic intent. This evidence supports the view that sustainable entrepreneurship often evolves from instrumental eco-efficiency toward more integrated triple-bottom-line models as ventures progress in their sustainability trajectory (Hockerts et al., 2010; Schaltegger et al., 2011). The following section combines this qualitative evidence with quantitative indicators - particularly the scores attributed by startups to the social, economic, and environmental impacts of their activities - to identify the areas where sustainability receives the greatest strategic emphasis. This integrative perspective allows for a more comprehensive understanding of how sustainability is both perceived and operationalized within the Italian startup ecosystem, linking territorial patterns to firm-level behaviours and values.

3.5.3. Comparative analysis

To explore structural and behavioural differences among startups with different sustainability orientations, a comparative profiling analysis was conducted. Startups were divided into three groups according to their self-assessed environmental orientation:

1. Fully Green (startups integrating environmental sustainability as a core strategic component);
2. Partially Green;
3. Non-Green (startups without explicit environmental integration).

The analysis combined descriptive statistics and cross-group comparisons, following a quantitative exploratory design commonly used in entrepreneurship and sustainability studies (e.g., Hockerts et al., 2010; Schaltegger et al., 2011).

Variable	Year of foundation	Number of employees	% R&D personnel	Startup Act requirements met	% women founders (1–4)	% women leadership (1–4)	Turnover < €2.5M	Diversity policy	Main ATECO sector	Main geographical area

Fully Green (mean)	2020,8	6,1	47,5	1,32	1,7	1,7	95.0%	39.8%	ICT & Manufacturing	North & Centre
Fully Green (SD)	3,4	7,3	38,2	0,46	0,8	0,8				
Fully Green (min)	1995	1	0	1	1	1				
Fully Green (max)	2025	60	100	3	4	4				
Partially Green (mean)	2021,1	5,9	42,1	1,21	1,6	1,6	96.8%	35.2%	ICT & Services	Centre
Partially Green (SD)	3,5	6,9	37,6	0,44	0,7	0,8				
Partially Green (min)	1999	1	0	1	1	1				
Partially Green (max)	2024	55	100	3	4	4				
Non-Green (mean)	2019,9	8,2	38,6	1,12	1,4	1,4	88.3%	24.6%	Trade & Services	South & Islands
Non-Green (SD)	3,7	9,1	35,9	0,41	0,6	0,7				
Non-Green (min)	1998	1	0	1	1	1				
Non-Green (max)	2024	75	100	3	4	4				

Table 3.5: Comparative profile of startups by sustainability orientation

Partially green startups share several structural similarities with fully green ones but exhibit slightly lower R&D intensity (42.1%) and fewer Startup Act requirements met (1.21). This intermediate profile suggests a transitional stage of sustainability integration-where environmental or social commitment coexists with more conventional business orientations. By contrast, non-green startups tend to be larger and more established (8.2 employees on average, mean year of foundation = 2019.9) but display a weaker innovation and sustainability orientation. Their R&D share (38.6%) and compliance with innovation requirements (1.12) are both lower, confirming a more traditional entrepreneurial model. In terms of inclusion, the results show that green-oriented firms have slightly higher gender representation in both founding and managerial positions (mean category = 1.7 vs. 1.4 for non-green) and are more likely to adopt formal diversity policies (39.8% vs. 24.6%). This indicates that sustainability orientation is often accompanied by broader social and governance awareness, aligning with multidimensional conceptions of responsible innovation.

From a sectoral perspective, green startups are heavily concentrated in ICT and manufacturing, reflecting their alignment with technological and process-based innovation. Non-green startups dominate in trade and services, areas where the environmental or innovation leverage is structurally lower. Geographically, green startups are mainly located

in Northern and Central Italy, confirming the spatial polarization of innovation and sustainability within more developed regional ecosystems. The evidence depicts sustainability-oriented startups as smaller, research-driven, and inclusion-sensitive firms, positioned at the frontier of digital and green innovation. However, their limited scale and early-stage market positioning underscore the ongoing challenge of translating sustainable innovation into economic consolidation - a dynamic typical of nascent green entrepreneurship ecosystems (Hockerts et al., 2010; Schaltegger et al., 2011).

Variable	H statistic	p-value	n	q-value (BH)
Foundation year	22.77	< 0.001	1000	0.00023
% R&D staff	13.95	< 0.001	1000	0.00674
Bureaucracy	13.61	< 0.001	1000	0.00674
Number of employees	13.22	< 0.001	1000	0.00674

Table 3.6: Results of the Kruskal–Wallis H tests across levels of green orientation.

Then, Kruskal–Wallis results confirm that only a limited set of structural and innovation-related variables (*Year of foundation, % R&D staff, Bureaucracy, Number of employees*) significantly differ across the three levels of green orientation.

Green-oriented startups tend to be younger (more recently founded), more research-intensive, and characterized by larger teams, suggesting that sustainability orientation is particularly salient among dynamic and growing ventures. The significant difference in *R&D employment share* reinforces the idea that environmentally oriented firms embed sustainability within a broader innovation strategy, leveraging knowledge creation as a key competitive factor. Interestingly, the variable related to *bureaucracy* also differs across groups, with greener firms perceiving regulatory and administrative processes as less obstructive. This could indicate higher managerial sophistication or greater adaptability in navigating institutional requirements. These findings depict green startups as younger, more research-driven, and organizationally more mature, supporting the view that sustainability and innovation co-evolve within the Italian startup ecosystem.

3.5.4. Clustering analysis

To better understand the latent structure of the startup ecosystem, a two-stage clustering analysis was conducted. The first clustering was applied to the entire sample of companies, with the aim of identifying recurring structural and organisational profiles.

The second analysis focused exclusively on startups that defined themselves as green or partially green, to explore the different internal trajectories of sustainability-oriented

entrepreneurship. In both cases, a K-Means partial clustering approach was adopted, after standardising the quantitative variables using z-scores to avoid distortions due to different measurement scales. The optimal number of clusters was determined using the silhouette index, supplemented by the interpretative consistency of the resulting types.

Cluster	Number of employees (mean)	Foundation year (mean)	% R&D staff (mean)	% Women (mean)	Bureaucracy (mean)	N
1	10.9	2019.2	39.4	37.1	3.1	245
2	6.5	2017.0	24.2	34.8	3.5	230
3	16.3	2015.4	31.8	43.9	2.7	248
4	4.1	2020.3	15.6	29.2	3.9	277

Table 3.7: Profiles of startup clusters

To uncover the structural and strategic heterogeneity of the Italian innovative startup ecosystem, a K-Means clustering analysis was conducted using quantitative indicators of firm structure and innovation capability. The selected variables included the number of employees, foundation year, the percentage of R&D staff, the share of women in managerial roles, and the perceived level of bureaucratic barriers. All variables were standardized after median imputation, and the optimal number of clusters was determined using the silhouette criterion on a representative subsample, yielding a four-cluster solution that was subsequently extended to the full dataset. The resulting clusters capture distinct organizational archetypes within the startup population. One group includes young, research-intensive ventures characterized by relatively larger and more gender-diverse teams. A second cluster aggregates more established firms with moderate R&D engagement and stable organizational structures. A third cluster comprises smaller, early-stage firms with limited R&D and managerial resources, while the fourth represents intermediate configurations, balancing elements of innovation intensity and structural maturity. The analysis demonstrates that Italian startups are not homogeneous but instead exhibit clear patterns along dimensions of scale, innovation orientation, and human capital composition. These patterns suggest that the evolution of startups within the ecosystem follows multiple trajectories - some emphasizing technological sophistication and internal development, others stability and consolidation - highlighting the multidimensional nature of innovation-driven entrepreneurship. To further explore the heterogeneity within sustainability-oriented ventures, a K-Means clustering was performed on the subsample of startups that declared themselves either green or partly green. The analysis relied on the same standardized indicators of firm structure and innovation capacity (size, foundation year, R&D employment share, gender composition, and bureaucratic burden).

Cluster	Number of employees (mean)	Foundation year (mean)	% R&D staff (mean)	% Women (mean)	Bureaucracy (mean)	N
1	12.4	2018.6	43.7	38.2	2.8	117
2	7.1	2016.9	27.3	41.0	3.4	112
3	4.3	2020.1	18.5	29.7	3.8	98
4	15.7	2015.2	32.1	45.4	2.5	113
5	9.8	2017.3	22.9	36.6	3.0	118

Table 3.8: Profiles of green and partly-green startup clusters

The optimal number of clusters, determined through the silhouette criterion, was found to be five, revealing a nuanced internal differentiation among environmentally oriented firms. The results indicate the coexistence of several sustainability-driven archetypes. One cluster groups young, high-R&D startups, representing proactive innovators that integrate environmental goals into technological development. A second cluster includes larger and more mature green firms, which appear to have institutionalized sustainability practices within stable organizational structures. A third cluster captures small, early-stage ventures where sustainability is likely driven by values and mission rather than formalized processes. The remaining clusters reflect intermediate profiles, such as firms with moderate R&D intensity or mixed managerial compositions, suggesting a gradual transition from awareness to operational integration of sustainability. The findings show that even within the subset of sustainability-oriented startups, sustainability is not monolithic. It manifests through multiple organizational pathways combining structural maturity, innovation orientation, and managerial diversity. These patterns reinforce the view that the green transition in entrepreneurship follows heterogeneous developmental logics, shaped by both strategic intent and resource constraints.

3.5.5. Profiling analysis

To complement the cluster analysis with a multidimensional interpretative layer, a set of composite indexes was developed to capture the structural, behavioural, and perceptual heterogeneity of the startups.

This approach follows established practices in organizational and innovation research, where multi-item indexes are used to summarise latent constructs such as innovation capability, network embeddedness, or social orientation (Zahra et al., 1995; Laursen et al., 2006; Spanos et al., 2001). Five indices were constructed - *Innovation*, *Networking*, *Financing*, *Inclusion*,

and *Perception* - plus a *Sustainability Orientation Index* for green and partly-green firm.
Each index aggregates multiple survey items referring to conceptually coherent dimensions and all variables were normalized to a 0-1 scale, ensuring comparability across heterogeneous measures (e.g., dichotomous, percentage, or Likert-scale items).
"*Yes/No*" responses were recoded as 1/0; intermediate options such as *"In progress"* were assigned 0.5; percentages were divided by 100; and ordinal scales were linearly rescaled. The indices therefore express the relative intensity of each dimension, with higher values indicating stronger innovation, collaboration, financial diversification, inclusion, or positive perception of the ecosystem.
This methodological choice aligns with the logic of synthetic performance indicators commonly employed in entrepreneurship and innovation studies to integrate different facets of organizational behaviour (Nardo et al., 2005).

Cluster	Innovation	Networking	Financing	Inclusion	Perception
1	0.62	0.54	0.48	0.51	0.57
2	0.43	0.39	0.41	0.46	0.44
3	0.58	0.50	0.55	0.63	0.61
4	0.36	0.33	0.37	0.41	0.39

Table 3.9: Profiles of startup clusters

The general profiling reveals a diversified structure of the Italian innovative startup ecosystem. By examining the mean values of the five indices across the four clusters identified in the previous analysis, it emerges that innovation intensity and networking capability tend to co-evolve: startups with stronger R&D engagement also exhibit more developed collaborative networks and a more favourable perception of the entrepreneurial environment. This group likely represents dynamic, opportunity-driven firms, capable of combining technological competences with relational openness. Conversely, clusters characterised by lower financing and networking scores correspond to younger or more resource-constrained startups, suggesting a liability of newness (Stinchcombe, 1965) and limited access to financial and institutional capital. The inclusion dimension appears moderately correlated with innovation, indicating that firms with greater organizational maturity tend to adopt more structured diversity and inclusion practices.
The profiling confirms that Italian startups cannot be considered a homogeneous category, but rather a set of distinct archetypes combining innovation, social orientation, and ecosystem perception in different ways - consistent with previous evidence on the multidimensional nature of early-stage entrepreneurial ecosystems (Acs et al., 2017; Spigel, 2017).

Cluster	Innovation	Networking	Financing	Inclusion	Perception	Sustainability
1	0.66	0.57	0.49	0.55	0.60	0.74
2	0.48	0.46	0.44	0.51	0.53	0.68
3	0.59	0.52	0.46	0.47	0.49	0.72
4	0.40	0.35	0.39	0.42	0.44	0.65
5	0.54	0.50	0.43	0.49	0.52	0.70

Table 3.10: Profiles of green / partly-green startup clusters

The profiling of the subsample of green and partially-green startups highlight a similarly heterogeneous internal structure.

Although these firms share a declared commitment to sustainability, the intensity and nature of their engagement vary substantially across clusters.

Startups with the highest Sustainability Orientation Index also display above-average scores in Innovation and Networking, suggesting a pattern of strategic sustainability, where environmental objectives are integrated with technological advancement and collaborative practices.

These "green leaders" align with the model of eco-innovative entrepreneurship described in the literature (Hockerts & Wüstenhagen, 2010), where sustainability acts as a driver of competitive differentiation. At the opposite end, clusters with lower values of the sustainability index are composed of smaller, younger firms with limited R&D resources and weaker network connections.

For these startups, sustainability appears as an aspirational or value-based orientation rather than an operational strategy - what Boons et al., (2013) - describe as *incipient sustainability integration*. Intermediate clusters exhibit balanced profiles, with moderate levels across all indices, representing transitional models in which sustainability is embedded but not yet fully institutionalised. In general, the results reinforce the view that sustainability-oriented entrepreneurship is a plural phenomenon, unfolding through multiple trajectories that reflect differences in resources, strategic intent, and ecosystem embeddedness. Beyond their descriptive function, the indices employed in this section were constructed following a standardized normalization and aggregation procedure consistent with composite indicator methodology (Nardo et al., 2005). Each index was validated through internal consistency checks and correlation analysis, confirming that the selected items coherently capture their intended construct (e.g., innovation intensity, inclusion orientation).

Although the indices are unweighted to preserve transparency, their interpretive reliability was ensured by cross-verifying the patterns emerging from the descriptive and clustering analyses.

This integrated approach allows the profiling framework to serve not only as a summary of

multidimensional patterns but also as an interpretative bridge between quantitative clustering and the conceptual dimensions of sustainability-oriented entrepreneurship.
Hence, the profiling analysis provides a synthetic yet theoretically grounded tool for characterizing the heterogeneity of startups and mapping their relative positions along the continuum from conventional to sustainability-driven innovation.

3.6. Econometric Analysis

The econometric analysis relies on a set of variables designed to capture the structural, organisational and technological characteristics that previous literature identifies as central to sustainability-oriented entrepreneurship. The dependent variable, green orientation, is operationalised as a binary indicator distinguishing startups that self-report a fully or partially green mission from those that do not. Binary codification is consistent with prior studies that conceptualise environmental commitment as a discrete strategic positioning choice rather than a continuous scale (Hockerts et al., 2010; York et al., 2010).

3.6.1. Variables and Measurement

The dependent variable, GREEN_BIN_D, is a binary indicator equal to 1 for startups declaring a fully or partially green mission and 0 otherwise. Independent variables are then grouped into three main categories:
1) Structural firm characteristics:
- YEAR_FOUND: year of establishment;
- SIZE_EMP: number of employees;
- PCT_GRAD: percentage of employees holding a university degree;
- PCT_RD_EMP: percentage of employees involved in R&D activities;
- PCT_WOMEN_EMP: share of female employees.

These variables capture age, scale and human capital composition, which are widely used in empirical research on eco-innovation and entrepreneurial behaviour (Horbach, 2008; Cainelli et al., 2013).

2) Technological and innovation-related indicators:
- INV_RD: dummy for R&D investment (1 = yes, 0 = no);
- INV_RD_INTENSITY: percentage of annual turnover devoted to R&D;
- INNOV_INTRO: dummy for introduction of a new product/process/service;
- UNIV_COLLAB: dummy for collaboration with universities or research centres.

These variables allow us to distinguish whether green orientation is driven by internal technological capabilities, innovation outputs or access to external knowledge (Demirel et al., 2010; Albort-Morant et al., 2016).

3) Organizational and institutional dimensions
- PUBLIC_INCENTIVES: dummy for receiving public support for innovation;
- GENDER_POLICY: dummy for the presence of formal gender-equality initiatives.

These dimensions capture the extent to which startups are embedded in supportive policy frameworks and adopt inclusive governance structures, both of which have been linked to stronger sustainability performance (Rennings, 2000).

3.6.2. Econometric Specification

The probability that firm i is green is modelled using a logistic regression model. Let $GREEN\_BIN\_D_i$ denote the binary indicator of green orientation for firm i. The specification is:

$$P(GREEN\_BIN\_D_i = 1) = \Lambda(\beta_0 + \beta_1 YEAR\_FOUND_i + \beta_2 SIZE\_EMP_i + \beta_3 PCT\_GRAD_i + \beta_4 PCT\_RD\_EMP_i + \beta_5 PCT\_WOMEN\_EMP_i + \beta_6 INV\_RD_i + \beta_7 INV\_RD\_INTENSITY_i + \beta_8 INNOV\_INTRO_i + \beta_9 PUBLIC\_INCENTIVES_i + \beta_{10} GENDER\_POLICY_i + \beta_{11} UNIV\_COLLAB_i),$$

where $\Lambda(z) = \exp(z) / (1 + \exp(z))$ is the logistic link function. Coefficients are estimated via maximum likelihood, and the analysis focuses on average marginal effects (AMEs), which express the change in the predicted probability of being green associated with a one-unit change in each covariate. This approach is consistent with best practice in interpreting non-linear probability models (Long et al., 2014).

3.6.3. National-Level Results

The logistic regression estimated on the full national sample of innovative identifies a coherent set of factors associated with the probability of being classified as green or partially green (1) or not green (0). The model is statistically significant (LLR p-value < 0.001) and displays a reasonable explanatory power for a behavioural outcome of this type. The results highlight the interplay between structural, organizational and relational dimensions in shaping environmental orientation within the Italian startup ecosystem.

A first relevant finding concerns firm age. The year of foundation carries a positive and significant effect, indicating that younger startups are more likely to adopt green orientations. This pattern is consistent with the idea that more recent entrepreneurial cohorts have been founded in a context in which sustainability has become a salient market expectation and a distinctive strategic positioning tool. Then, firm size exhibits a negative and significant marginal effect: smaller firms show a higher probability of being green. This result aligns with literature noting that micro-startups often adopt sustainability as part of their identity and value proposition, while larger firms—despite more resources—may be more path-dependent or commercially oriented. Smaller startups are more likely to be green, confirming the argument that small firms are often more agile, flexible and culturally cohesive in adopting environmental innovations (Schaper, 2002). The share of graduates among employees is negatively associated with green orientation, suggesting that sustainability-oriented startups may rely more on applied and hybrid skill sets than on highly formalised academic profiles (Cainelli et al., 2013).

Logistic Regression Coefficients

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
Intercept	-159.2531	44.477	-3.581	0.000	-246.425	-72.081
YEAR_FOUND	0.0787	0.022	3.575	0.000	0.036	0.122
SIZE_EMP	-0.0253	0.010	-2.510	0.012	-0.045	-0.006
PCT_GRAD	-0.0052	0.002	-2.592	0.010	-0.009	-0.001
PCT_RD_EMP	0.0049	0.002	2.481	0.013	0.001	0.009
PCT_WOMEN_EMP	8.2e-05	0.003	0.033	0.974	-0.005	0.005
INV_RD	-0.3537	0.206	-1.715	0.086	-0.758	0.050
INV_RD_INTENSITY	0.0030	0.003	1.198	0.231	-0.002	0.009
INNOV_INTRO	0.2502	0.163	1.536	0.125	-0.068	0.567
PUBLIC_INCENTIVES	0.2331	0.142	1.632	0.103	-0.046	0.509
GENDER_POLICY	0.6142	0.165	3.712	0.000	0.290	0.938
UNIV_COLLAB	0.4219	0.143	2.941	0.003	0.141	0.703

Marginal Effects (dy/dx)

Variable	Coefficient	Std.Err.	z	p-value	[2.5%	97.5%]
YEAR_FOUND	0.0182	0.005	3.661	0.000	0.008	0.028
SIZE_EMP	-0.0059	0.002	-2.539	0.011	-0.010	-0.001
PCT_GRAD	-0.0012	0.000	-2.626	0.009	-0.002	-0.000
PCT_RD_EMP	0.0011	0.000	2.511	0.012	0.000	0.002
PCT_WOMEN_EMP	1.9e-05	0.001	0.033	0.974	-0.001	0.001
INV_RD	-0.0820	0.048	-1.725	0.085	-0.175	0.011
INV_RD_INTENSITY	0.0008	0.001	1.202	0.229	-0.001	0.002
INNOV_INTRO	0.0580	0.038	1.543	0.123	-0.016	0.132
PUBLIC_INCENTIVES	0.0536	0.033	1.640	0.101	-0.010	0.118
GENDER_POLICY	0.1424	0.037	3.813	0.000	0.069	0.216

UNIV_COLLAB	0.0978	0.033	2.991	0.003	0.034	0.162

Table 3.11: Logistic regression estimating the probability of being classified as green or partially green (national sample).

Regarding human capital, the share of graduates shows a small but statistically significant negative effect. Although counterintuitive, this finding may indicate that highly educated teams gravitate toward business models that are more traditional or more commercially scalable, while sustainability-oriented startups may rely on hybrid, cross-disciplinary teams with different profiles. In contrast, the share of employees in R&D activities displays a positive and significant effect, suggesting that internal research capabilities support green orientation more than formal educational attainment does.

Technological variables present a mixed picture. R&D investment intensity and innovation introduction have the expected positive signs but do not reach conventional significance levels. This indicates that while technology and innovation matter for green strategies, they are not alone sufficient to explain green positioning. Similarly, access to public incentives for innovation shows a positive but non-significant effect: incentives may support innovation in general but are not systematically associated with environmental orientation.

Two organisational variables stand out. First, gender-equality policies exert a strong positive effect, in line with evidence that inclusive governance structures are systematically associated with better environmental and social performance (Bear et al., 2010; Boulouta, 2013). Second, collaboration with universities and research centres significantly increases the probability of being green, highlighting the role of external knowledge acquisition and absorptive capacity in driving eco-innovation (Albort-Morant, Leal-Millán & Cepeda-Carrión, 2016).

In summary, the full-sample results suggest that environmental orientation among Italian innovative startups is driven by a combination of youthfulness, small scale, internal R&D capability, inclusive governance, and knowledge collaboration, while purely technological investments or general innovation activity appear less decisive. The overall evidence underscores the multifaceted nature of sustainability adoption, rooted as much in organizational culture and external networks as in technological sophistication.

3.6.4. Regional Models

To account for territorial heterogeneity, the model is re-estimated separately for Italy's macro-areas (North-West, North-East, Centre, South and Islands). The results reveal distinct regional pathways towards sustainability.

Logistic Regression Coefficients

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
Intercept	-262.7789	109.081	-2.409	0.016	-476.574	-48.984
YEAR_FOUND	0.1298	0.054	2.406	0.016	0.024	0.236
SIZE_EMP	-0.0199	0.020	-0.997	0.319	-0.059	0.019
PCT_GRAD	-0.0024	0.004	-0.690	0.490	-0.009	0.004
PCT_RD_EMP	0.0054	0.004	1.542	0.123	-0.001	0.012
PCT_WOMEN_EMP	-0.0013	0.005	-0.256	0.798	-0.011	0.008
INV_RD	-0.4036	0.384	-1.050	0.294	-1.157	0.350
INV_RD_INTENSITY	-0.0024	0.005	-0.446	0.655	-0.013	0.008
INNOV_INTRO	0.2923	0.311	0.940	0.347	-0.318	0.902
PUBLIC_INCENTIVES	0.0160	0.266	0.060	0.952	-0.506	0.538
GENDER_POLICY	0.5274	0.307	1.719	0.086	-0.074	1.129
UNIV_COLLAB	0.5744	0.265	2.165	0.030	0.054	1.094

Marginal Effects (dy/dx)

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
YEAR_FOUND	0.0298	0.012	2.497	0.013	0.006	0.053
SIZE_EMP	-0.0046	0.005	-1.003	0.316	-0.013	0.004
PCT_GRAD	-0.0006	0.001	-0.692	0.489	-0.002	0.001
PCT_RD_EMP	0.0012	0.001	1.566	0.117	-0.000	0.003
PCT_WOMEN_EMP	-0.0003	0.001	-0.256	0.798	-0.003	0.002
INV_RD	-0.0925	0.088	-1.057	0.290	-0.264	0.079
INV_RD_INTENSITY	-0.0006	0.001	-0.447	0.655	-0.003	0.002
INNOV_INTRO	0.0670	0.071	0.945	0.345	-0.072	0.206
PUBLIC_INCENTIVES	0.0037	0.061	0.060	0.952	-0.116	0.123
GENDER_POLICY	0.1209	0.069	1.752	0.080	-0.014	0.256
UNIV_COLLAB	0.1317	0.059	2.233	0.026	0.016	0.247

Table 3.12: Logistic regression results for startups located in the North-West macro-area.

In the North-West (297 observations), the model is globally significant but has modest explanatory power ($R^2 \approx 0.054$), which is typical for behavioural outcomes. Two factors clearly stand out. First, the year of foundation has a positive and statistically significant effect: younger startups are more likely to be green or partially green. The marginal effect suggests that ceteris paribus, each additional year (i.e. being founded more recently) increases the probability of being green by around 3 percentage points. Second, collaboration with universities or research centres is a strong predictor:

collaborating startups show an increase of about 13 percentage points in the probability of being green, with a statistically significant marginal effect. Gender-equality policies display a positive and nearly significant influence, indicating that inclusive organisational practices tend to co-occur with environmental commitment, although the effect does not reach conventional levels of significance at 5%. By contrast, R&D-related variables, innovation introduction, and public incentives do not appear to play a major role in this macro-area (Stam, 2015).

Logistic Regression Coefficients

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
Intercept	-82.7093	73.246	-1.129	0.259	-226.270	60.851
YEAR_FOUND	0.0409	0.036	1.128	0.259	-0.030	0.112
SIZE_EMP	-0.0254	0.017	-1.507	0.132	-0.058	0.008
PCT_GRAD	-0.0107	0.004	-2.734	0.006	-0.018	-0.003
PCT_RD_EMP	0.0076	0.004	1.946	0.052	-5.61e-05	0.015
PCT_WOMEN_EMP	0.0068	0.005	1.440	0.150	-0.002	0.016
INV_RD	-0.4531	0.400	-1.133	0.257	-1.237	0.330
INV_RD_INTENSITY	0.0132	0.006	2.217	0.027	0.002	0.025
INNOV_INTRO	0.0467	0.321	0.145	0.884	-0.583	0.676
PUBLIC_INCENTIVES	0.1075	0.288	0.374	0.709	-0.456	0.671
GENDER_POLICY	0.5668	0.340	1.669	0.095	-0.099	1.233
UNIV_COLLAB	0.5186	0.292	1.777	0.076	-0.053	1.091

Marginal Effects (dy/dx)

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
YEAR_FOUND	0.0090	0.008	1.138	0.255	-0.007	0.025
SIZE_EMP	-0.0056	0.004	-1.531	0.126	-0.013	0.002
PCT_GRAD	-0.0024	0.001	-2.880	0.004	-0.004	-0.001
PCT_RD_EMP	0.0017	0.001	1.996	0.046	3e-05	0.003
PCT_WOMEN_EMP	0.0015	0.001	1.460	0.144	-0.001	0.004
INV_RD	-0.1001	0.088	-1.143	0.253	-0.272	0.072
INV_RD_INTENSITY	0.0029	0.001	2.290	0.022	0.000	0.005
INNOV_INTRO	0.0103	0.071	0.145	0.884	-0.129	0.149
PUBLIC_INCENTIVES	0.0238	0.064	0.374	0.708	-0.101	0.148
GENDER_POLICY	0.1253	0.074	1.700	0.089	-0.019	0.270
UNIV_COLLAB	0.1146	0.063	1.816	0.069	-0.009	0.238

Table 3.13: Logistic regression results for startups located in the North-East macro-area.

In the North-East (277 observations), the model is more robust ($R^2 \approx 0.084$; LLR p-value < 0.001) and reveals a more technologically driven pattern. The share of graduates exerts a negative and statistically significant effect: startups with a higher proportion of graduates are less likely to be green. Although counterintuitive, this result may indicate that highly

educated teams cluster in more conventional or growth-oriented business models rather than in sustainability-driven ventures. At the same time, both the share of employees engaged in R&D and R&D investment intensity show positive and statistically significant marginal effects. This implies that internal research capabilities and the intensity of R&D spending are important drivers of green orientation in this area, consistent with a productive structure rooted in advanced manufacturing and innovation. Gender-equality policies and collaboration with universities have positive but only borderline significant effects, suggesting that organisational and relational factors matter, but less strongly than the underlying technological capacity. This is consistent with capability-based models of eco-innovation in manufacturing-intensive regions (Horbach, 2008; Demirel et al., 2010). The negative effect of the graduate share may reflect a stronger reliance on practice-oriented technical skills rather than purely academic qualifications.

Logistic Regression Coefficients

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
Intercept	-181.7375	107.090	-1.697	0.090	-391.631	28.156
YEAR_FOUND	0.0901	0.053	1.700	0.089	-0.014	0.194
SIZE_EMP	-0.0269	0.025	-1.082	0.279	-0.076	0.022
PCT_GRAD	-0.0107	0.006	-1.845	0.065	-0.022	0.001
PCT_RD_EMP	0.0029	0.005	0.536	0.592	-0.008	0.014
PCT_WOMEN_EMP	-0.0073	0.007	-1.127	0.260	-0.020	0.005
INV_RD	-0.7437	0.514	-1.446	0.148	-1.752	0.264
INV_RD_INTENSITY	0.0102	0.008	1.286	0.198	-0.005	0.026
INNOV_INTRO	0.1486	0.379	0.392	0.695	-0.595	0.892
PUBLIC_INCENTIVES	0.7836	0.341	2.301	0.021	0.116	1.451
GENDER_POLICY	0.9292	0.397	2.342	0.019	0.152	1.707
UNIV_COLLAB	0.3896	0.342	1.141	0.254	-0.280	1.059

Marginal Effects (dy/dx)

Variable	Coefficient	Std. Err.	z	p-value	[2.5%	97.5%]
YEAR_FOUND	0.0196	0.011	1.750	0.080	-0.002	0.042
SIZE_EMP	-0.0058	0.005	-1.095	0.274	-0.016	0.005
PCT_GRAD	-0.0023	0.001	-1.909	0.056	-0.005	0.000062
PCT_RD_EMP	0.0006	0.001	0.538	0.591	-0.002	0.003
PCT_WOMEN_EMP	-0.0016	0.001	-1.141	0.254	-0.004	0.001
INV_RD	-0.1616	0.109	-1.476	0.140	-0.376	0.053
INV_RD_INTENSITY	0.0022	0.002	1.307	0.191	-0.001	0.006
INNOV_INTRO	0.0323	0.082	0.392	0.695	-0.129	0.194
PUBLIC_INCENTIVES	0.1703	0.070	2.433	0.015	0.033	0.308
GENDER_POLICY	0.2020	0.081	2.478	0.013	0.042	0.362
UNIV_COLLAB	0.0847	0.073	1.155	0.248	-0.059	0.228

Table 3.14: Logistic regression results for startups located in the Centre macro-area.

In the Central regions (184 observations), the configuration of determinants changes again, with institutional and organisational dimensions becoming central. The model is statistically significant ($R^2 \approx 0.099$), and the two most important predictors are public incentives and gender-equality policies. Startups that have benefited from public incentives for innovation are about 17 percentage points more likely to be green, according to the marginal effects. This points to a strong role of policy instruments in steering firms towards sustainability-related activities. Similarly, firms that implement gender policies show an increase of around 20 percentage points in the probability of being green, confirming the strong link between inclusive governance and environmental engagement. The year of foundation has a positive but only borderline significant effect, and the share of graduates is negatively associated with green orientation at the 10% level, in line with the pattern observed at national and North-Eastern level. R&D variables and innovation introduction do not significantly affect green orientation in this area. This configuration echoes work showing that policy instruments can effectively stimulate eco-innovation when combined with supportive organisational settings (Rennings, 2000).

Logit Regression Results

Variable	**coef**	**std err**	**z**	**P>|z|**	**[0.025 ; 0.975]**
const	-199.8103	93.126	-2.146	0.032	[-382.333 ; -17.287]
YEAR_FOUND	0.0986	0.046	2.141	0.032	[0.008 ; 0.189]
SIZE_EMP	-0.0393	0.023	-1.688	0.092	[-0.085 ; 0.006]
PCT_GRAD	0.0018	0.005	0.400	0.689	[-0.007 ; 0.011]
PCT_RD_EMP	0.0023	0.004	0.531	0.595	[-0.006 ; 0.011]
PCT_WOMEN_EMP	-0.0043	0.005	-0.817	0.414	[-0.015 ; 0.006]
INV_RD	0.0400	0.443	0.090	0.928	[-0.828 ; 0.909]
INV_RD_INTENSITY	-0.0024	0.007	-0.360	0.719	[-0.016 ; 0.011]
INNOV_INTRO	0.5091	0.353	1.443	0.149	[-0.182 ; 1.201]
PUBLIC_INCENTIVES	0.1481	0.297	0.498	0.618	[-0.434 ; 0.731]
GENDER_POLICY	0.6670	0.346	1.925	0.054	[-0.012 ; 1.346]
UNIV_COLLAB	0.2883	0.310	0.930	0.353	[-0.319 ; 0.896]

Marginal Effects

Variable	dy/dx	std err	z	P>|z|	[0.025 ; 0.975]
YEAR_FOUND	0.0221	0.010	2.215	0.027	[0.003 ; 0.042]
SIZE_EMP	-0.0088	0.005	-1.723	0.085	[-0.019 ; 0.001]
PCT_GRAD	0.0004	0.001	0.400	0.689	[-0.002 ; 0.002]
PCT_RD_EMP	0.0005	0.001	0.532	0.595	[-0.001 ; 0.002]
PCT_WOMEN_EMP	-0.0010	0.001	-0.822	0.411	[-0.003 ; 0.001]
INV_RD	0.0090	0.099	0.090	0.928	[-0.186 ; 0.204]
INV_RD_INTENSITY	-0.0005	0.002	-0.360	0.719	[-0.004 ; 0.002]
INNOV_INTRO	0.1141	0.078	1.467	0.142	[-0.038 ; 0.266]
PUBLIC_INCENTIVES	0.0332	0.066	0.499	0.618	[-0.097 ; 0.163]
GENDER_POLICY	0.1494	0.075	1.983	0.047	[0.002 ; 0.297]
UNIV_COLLAB	0.0646	0.069	0.936	0.349	[-0.071 ; 0.200]

Table 3.15: Logistic regression results for startups located in the South and Islands macro-area

In the South and Islands (242 observations), the model remains globally significant ($R^2 \approx 0.078$), although individual effects are somewhat weaker than in other areas. The year of foundation again has a positive and statistically significant effect: younger startups are more likely to be green, with an average marginal effect of about 2 percentage points per year. The number of employees has a negative and borderline significant effect, pointing to a tendency for smaller firms to be more environmentally oriented, in line with other macro-areas. The most salient organisational driver is gender-equality policies: startups that adopt such policies are roughly 15 percentage points more likely to be green, and this effect is statistically significant at the 5% level. By contrast, R&D-related variables, innovation introduction, public incentives, and collaboration with universities do not emerge as significant predictors in this macro-area, suggesting that green orientation here is more closely tied to firm demography (youth and smaller size) and organisational culture than to formal technological or institutional supports.

Taken together, these regional models show that there is no single, uniform "Italian" pattern of green orientation among startups. Instead, different macro-areas are characterised by distinct configurations of drivers:

- In the North-West, green orientation is mainly associated with younger firms embedded in university networks, with inclusive organisational practices playing a supporting role.
- In the North-East, it is primarily sustained by internal R&D capabilities and investment intensity, while higher educational attainment of the workforce does not automatically translate into greener strategies.
- In the Centre, environmental orientation is strongly linked to public support mechanisms and gender-equality policies, indicating a policy- and governance-driven pathway to sustainability.
- In the South and Islands, green startups tend to be younger, smaller, and more inclusive in terms of internal policies, while technological and institutional variables appear less decisive.

These heterogeneous patterns underscore the importance of adopting territorially differentiated policy approaches: promoting green entrepreneurship in Italy requires recognising and leveraging the specific structural, institutional, and cultural conditions of each macro-area rather than assuming a one-size-fits-all model.

3.6.5. Sectoral Models

The sample is split into two broad sectoral groups in order to preserve statistical power and interpretability, given the limited number of observations in several narrowly defined sectors. The selected groups represent sectors with markedly different innovation and sustainability logics, allowing for a parsimonious comparison without excessive fragmentation of the data. To disentangle sector-specific mechanisms, the analysis further stratifies the sample by ATECO codes, focusing on two major groups: C+G (manufacturing, wholesale/retail trade, and vehicle repair) and J (information and communication services).

Logit Regression Results

Variable	coef	std err	z	P>|z|	[0.025 ; 0.975]
const	-222.1487	166.369	-1.335	0.182	[-548.226 ; 103.929]
YEAR_FOUND	0.1098	0.082	1.334	0.182	[-0.052 ; 0.271]
SIZE_EMP	-0.0296	0.022	-1.370	0.171	[-0.072 ; 0.013]
PCT_GRAD	-0.0014	0.005	-0.306	0.760	[-0.011 ; 0.008]

PCT_RD_EMP	0.0140	0.005	2.843	0.004	[0.004 ; 0.024]
PCT_WOMEN_EMP	-0.0043	0.006	-0.760	0.447	[-0.015 ; 0.007]
INV_RD	-0.5539	0.466	-1.189	0.234	[-1.467 ; 0.359]
INV_RD_INTENSITY	0.0080	0.007	1.157	0.247	[-0.006 ; 0.021]
INNOV_INTRO	0.2511	0.381	0.659	0.510	[-0.496 ; 0.998]
PUBLIC_INCENTIVES	0.2192	0.331	0.662	0.508	[-0.430 ; 0.868]
GENDER_POLICY	0.8242	0.429	1.920	0.055	[-0.017 ; 1.665]
UNIV_COLLAB	0.4773	0.344	1.387	0.166	[-0.197 ; 1.152]

Marginal Effects

Variable	**dy/dx**	**std err**	**z**	**P>|z|**	**[0.025 ; 0.975]**
YEAR_FOUND	0.0219	0.016	1.354	0.176	[-0.010 ; 0.054]
SIZE_EMP	-0.0059	0.004	-1.391	0.164	[-0.014 ; 0.002]
PCT_GRAD	-0.0003	0.001	-0.306	0.759	[-0.002 ; 0.002]
PCT_RD_EMP	0.0028	0.001	3.051	0.002	[0.001 ; 0.005]
PCT_WOMEN_EMP	-0.0009	0.001	-0.764	0.445	[-0.003 ; 0.001]
INV_RD	-0.1107	0.092	-1.202	0.229	[-0.291 ; 0.070]
INV_RD_INTENSITY	0.0016	0.001	1.169	0.242	[-0.001 ; 0.004]
INNOV_INTRO	0.0502	0.076	0.661	0.508	[-0.099 ; 0.199]
PUBLIC_INCENTIVES	0.0438	0.066	0.664	0.507	[-0.085 ; 0.173]
GENDER_POLICY	0.1647	0.083	1.980	0.048	[0.002 ; 0.328]
UNIV_COLLAB	0.0954	0.068	1.409	0.159	[-0.037 ; 0.228]

Table 3.16: Logistic regression results for startups operating in ATECO sectors C and G (manufacturing, trade, and motor vehicle repair).

The sectoral analysis reveals that the determinants of green orientation vary substantially across different domains of economic activity, indicating that sustainability-driven

entrepreneurship does not follow a uniform logic but is shaped by sector-specific organisational, technological and cultural conditions.

For firms operating in ATECO C and G (manufacturing, wholesale/retail trade, and vehicle repair), the main predictor of green orientation is the share of employees engaged in R&D activities, which displays a strong and statistically significant effect in both the logit model and marginal effects. This suggests that, within more traditional and operationally intensive sectors, environmental commitment is closely linked to the presence of internal technical capabilities, rather than to formal innovation inputs or external collaborations. The marginal significance of gender-equality policies indicates that an inclusive organisational climate may complement these capabilities, but the effect remains secondary. Other technological, institutional and structural variables—including R&D investment intensity, innovation introduction, public incentives, and university collaboration—do not significantly influence the probability of belonging to a green-oriented startup in this group. Overall, the C+G sectors appear to follow a capability-based pathway, where sustainability emerges primarily from the internal knowledge base of the firm (Cainelli et al., 2013; Demirel et al., 2010). Gender-equality policies also show a positive effect, suggesting that inclusive governance can complement technical capacity in fostering green strategies.

Logit Regression Results

Variable	Coef.	Std. Err.	z	P>|z|	[0.025	0.975]
const	-152.7406	46.719	-3.269	0.001	-244.308	-61.173
YEAR_FOUND	0.0755	0.023	3.264	0.001	0.030	0.121
SIZE_EMP	-0.0219	0.011	-1.918	0.055	-0.044	0.000
PCT_GRAD	-0.0059	0.002	-2.602	0.009	-0.010	-0.001
PCT_RD_EMP	0.0028	0.002	1.267	0.205	-0.002	0.007
PCT_WOMEN_EMP	0.0023	0.003	0.809	0.418	-0.003	0.008
INV_RD	-0.2665	0.235	-1.136	0.256	-0.726	0.193
INV_RD_INTENSITY	0.0022	0.003	0.633	0.527	-0.005	0.009
INNOV_INTRO	0.2114	0.184	1.151	0.250	-0.149	0.571
PUBLIC_INCENTIVES	0.2028	0.161	1.257	0.209	-0.114	0.519
GENDER_POLICY	0.5906	0.183	3.229	0.001	0.232	0.949
UNIV_COLLAB	0.3532	0.162	2.176	0.030	0.035	0.671

Marginal Effects

Variable	dy/dx	Std. Err.	z	P>|z|	[0.025	0.975]
YEAR_FOUND	0.0176	0.005	3.346	0.001	0.007	0.028
SIZE_EMP	-0.0051	0.003	-1.935	0.053	-0.010	0.000
PCT_GRAD	-0.0014	0.001	-2.646	0.008	-0.002	-0.000

PCT_RD_EMP	0.0006	0.001	1.272	0.204	-0.000	0.002
PCT_WOMEN_EMP	0.0005	0.001	0.811	0.418	-0.001	0.002
INV_RD	-0.0621	0.054	-1.140	0.254	-0.169	0.045
INV_RD_INTENSITY	0.0005	0.001	0.634	0.526	-0.001	0.002
INNOV_INTRO	0.0493	0.043	1.154	0.248	-0.034	0.133
PUBLIC_INCENTIVES	0.0473	0.037	1.261	0.207	-0.026	0.121
GENDER_POLICY	0.1376	0.042	3.315	0.001	0.056	0.219
UNIV_COLLAB	0.0823	0.037	2.201	0.028	0.009	0.156

Table 3.17: Logistic regression results for startups operating in ATECO sector J (information and communication services).

In contrast, startups classified under ATECO J (information and communication services) follow a markedly different pattern. Here, the strongest determinants are gender-equality policies and collaboration with universities or research centres, both of which show robust and significant effects. These results underscore that in ICT industries, where knowledge flows, organisational culture and relational assets are critical, sustainability tends to emerge from governance structures and external knowledge networks rather than from internal technological capacity alone. The positive effect of the year of foundation confirms that younger digital firms are more likely to adopt a green orientation, reflecting generational shifts in values and strategic positioning. Additionally, firm size displays a borderline negative effect, suggesting that smaller ICT firms tend to engage more readily in sustainability-oriented models. By contrast, formal R&D indicators do not significantly predict green orientation in this sector, highlighting that environmental engagement in digital services is shaped more by cultural and relational dimensions than by technological intensity (Rennings et al., 2011).

the comparison between ATECO C+G and ATECO J confirms that sectoral context fundamentally shapes the mechanisms through which sustainability emerges. Traditional sectors display a technically driven model, where internal R&D capabilities constitute the primary differentiator, whereas ICT industries follow a value- and network-driven model, where inclusiveness, collaborative linkages and organisational culture act as the main levers. These findings reinforce the view that promoting sustainable entrepreneurship requires sector-sensitive policy approaches, acknowledging the differentiated pathways through which green orientation manifests across the productive structure.

3.6.6. Discussion of the results

Across the national, regional and sectoral models, three complementary mechanisms underpin the green orientation of Italian innovative startups. First, a knowledge-driven

sustainability pathway emerges in advanced innovation ecosystems and ICT sectors, where external collaboration and dynamic capabilities are central (Albort-Morant et al., 2016).
Second, a technology-driven pathway characterises manufacturing and production-oriented regions, where internal R&D capacity and specialised technical workforces are the main differentiators of green firms (Horbach, 2008; Cainelli et al., 2013). Third, a governance-driven pathway appears in areas where institutional incentives and inclusive organisational practices, especially gender-equality policies, are the most powerful predictors of green orientation (Bear et al., 2010).
These findings confirm that sustainable entrepreneurship is not a monolithic behavioural domain, but a set of context-specific trajectories shaped by the interaction of technological capabilities, organisational culture, policy frameworks and territorial ecosystems (Hockerts et al, 2010; York et al., 2010; Rennings et al., 2011).
The evidence suggests that policy interventions should be tailored to sectoral and regional conditions. In manufacturing and trade, support measures that strengthen internal R&D capacity and technical skills are likely to be most effective. In ICT and knowledge-intensive services, policies that foster inclusive governance, university-industry collaboration and network formation may yield higher returns. In structurally weaker regions, priority should be given to measures that reinforce organisational capabilities and support young, small firms in embedding sustainability within their business models. Overall, the econometric analysis demonstrates that green orientation among Italian innovative startups is the result of heterogeneous yet intelligible mechanisms. Recognising and leveraging this heterogeneity is crucial for designing effective strategies to advance sustainable entrepreneurship at both national and regional levels.

3.7. Conclusions

This chapter has provided an empirical and multidimensional overview of the Italian startup ecosystem, using survey-based data to explore how sustainability, innovation, and inclusion are enacted “from within” entrepreneurial organizations. The results reveal an ecosystem characterized by youth, small size, and high heterogeneity, where technological and digital innovation coexist with a gradually emerging sustainability orientation. From a structural perspective, most startups are micro-enterprises founded after 2020, concentrated in knowledge-intensive sectors such as ICT and manufacturing, and displaying a marked geographical polarization around Northern and Central regions. Their innovation model is predominantly research-driven: over 60% of firms invest more than 15% of turnover in R&D and rely on highly qualified human capital, though only a minority achieve formalized

intellectual property protection through patents or registered software.

In terms of sustainability, nearly half of the surveyed startups self-identify as green or partially green, indicating that environmental responsibility has become a relevant—though unevenly integrated—element of Italy's innovation landscape. However, the empirical evidence highlights that sustainability is still primarily operational and technology-based, focusing on energy efficiency, digital dematerialization, and process optimization rather than holistic social transformation. The textual analysis of open responses further confirms that ecological awareness remains pragmatic and innovation-oriented, reflecting an early stage of sustainable entrepreneurship. The comparative analyses demonstrate that green-oriented startups tend to be younger, smaller, and more R&D-intensive than non-green firms, suggesting that sustainability and innovation co-evolve within the ecosystem. These firms also display slightly higher inclusion scores, hinting at a nascent convergence between environmental and social responsibility. Conversely, non-green startups appear more established but less innovation-driven, often operating in traditional service sectors. The clustering and profiling analyses reinforce this multidimensional view: Italian startups do not constitute a homogeneous group but instead form distinct archetypes combining different mixes of innovation intensity, network embeddedness, financial diversification, and inclusion. Within the green subset, sustainability manifests through diverse trajectories—ranging from "eco-innovative leaders" integrating sustainability into strategic and collaborative practices to younger, resource-constrained firms where sustainability is still aspirational. In parallel, the econometric analysis enriches and strengthens these findings by identifying the specific structural, organisational, and relational factors that statistically predict the probability of being green. The national-level logit model confirms the central role of small size, younger age, and inclusive governance practices, with gender-equality policies emerging as one of the strongest predictors of environmental orientation. This reinforces the notion that sustainability in startups is tightly linked to organisational culture and internal values. Moreover, university collaboration significantly increases the likelihood of being green, underscoring the relevance of knowledge flows, network embeddedness, and absorptive capacity—a pattern consistent with the descriptive and clustering results. At the same time, formal educational intensity (PCT_GRAD) shows a negative association, suggesting that sustainability in early-stage ventures is driven more by applied, hybrid competences than by formal academic specialization.

The regional models further highlight how sustainability pathways differ across Italian territories. In the North-West, green orientation is largely driven by relational assets, particularly collaboration with universities. In the North-East, internal technological

capabilities—especially R&D personnel and investment intensity—constitute the strongest predictors, reflecting the region's manufacturing-intensive innovation system. In the Centre, sustainability is explained primarily by institutional and governance variables (public incentives and gender policies), while in the South and Islands, demographic and cultural features (youth and inclusiveness) dominate over technological determinants. These differences mirror the territorial diversity identified earlier, reinforcing the conclusion that sustainability evolves unevenly across Italy's entrepreneurial ecosystems. Sector-specific models based on ATECO codes complement this picture. In manufacturing and trade (C+G), green orientation is driven by R&D-related human capital, consistent with a capability-based pathway where environmental innovation depends on technical expertise. Conversely, in ICT and digital services (J), sustainability is linked to organisational values and relational infrastructures—gender equality, university collaboration, younger age, and small scale—confirming a culture- and network-driven logic. These results validate the earlier finding that sustainability is not a single phenomenon, but a set of differentiated trajectories shaped by sectoral and institutional contexts.

By addressing the three research questions formulated at the outset, the analysis has offered novel insights into the profiles, orientations, and interconnections that characterize sustainability-oriented entrepreneurship in Italy.

RQ1. Startups do not form a homogeneous group but constitute a constellation of organisational archetypes. The econometric evidence reinforces this point: different regions and sectors activate different mechanisms, illustrating that sustainability adoption depends on local ecosystems, technological regimes, and organisational capabilities.

RQ2. Sustainability-oriented startups display stronger ties with the innovation infrastructure (universities, research centres) and a greater ability to navigate institutional frameworks. The econometric findings confirm that collaboration and incentives matter, albeit unevenly across regions, and that sustainability shapes not only internal practices but also how startups engage with their external environment.

RQ3. The relationship between sustainability and inclusion, while modest, is robust across methods: gender-equality policies are consistently among the strongest predictors of green orientation. The econometric analysis therefore strengthens the conclusion that environmental and social responsibility, though distinct dimensions, tend to converge within the Italian startup ecosystem.

The results indicate that Italy is in a transitional phase. Sustainability is increasingly recognized as a source of differentiation and legitimacy but remains more frequently pursued through technological rather than social pathways. The coexistence of multiple entrepreneurial trajectories—from eco-innovative leaders to aspirational green ventures—illustrates the dynamic and evolving nature of sustainable entrepreneurship. Policy implications point to the need for territorially and sectorally tailored instruments capable of supporting the scaling-up of sustainable ventures, enhancing the diffusion of inclusive practices, and strengthening the alignment between innovation and sustainability agendas. Strengthening collaboration infrastructures, promoting inclusive organisational cultures, and supporting region-specific innovation capabilities appear to be essential levers for accelerating the transition toward a more sustainable and competitive entrepreneurial ecosystem.

3.8. Limitations and future research

As with any survey-based investigation, this study is subject to several limitations that should be acknowledged.

First, the analysis relies on self-reported data, which may be affected by perceptual biases or social desirability effects, particularly concerning sustainability and inclusion practices. Second, while the survey provides a large and diverse sample, it represents a cross-sectional snapshot of the Italian startup ecosystem at a specific point in time. Consequently, the findings capture associations rather than causal dynamics, limiting the ability to trace the temporal evolution of sustainability integration within firms.

Third, the operationalization of some constructs - such as inclusion or networking - was necessarily simplified to ensure comparability across respondents, which may have constrained the depth of analysis on these dimensions. Future research could address these limitations by integrating longitudinal data to examine how sustainability-oriented startups evolve over time, especially in relation to resource accumulation and scaling processes. Additionally, mixed-method approaches, combining quantitative indicators with qualitative interviews or case studies, would enable a more nuanced understanding of how entrepreneurs translate sustainability values into concrete organizational practices. Finally, comparative studies across countries or regional ecosystems could help contextualize the Italian case within broader European or global patterns, contributing to the refinement of theoretical models linking sustainability, innovation, and institutional environments in early-stage ventures.

References

- Acs, Z. J., Stam, E., Audretsch, D. B., & O'Connor, A. (2017). *The lineages of the entrepreneurial ecosystem approach*. Small Business Economics, 49(1), 1–10.
- Aguinis, H., Edwards, J. R., & Bradley, K. J. (2017). *Improving our understanding of moderation and mediation in strategic management research*. Organizational Research Methods, 20(4), 665–685.
- Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. Journal of Cleaner Production, 142(1), 379–392.
- Aragón-Correa, J. A., & Sharma, S. (2003). *A contingent resource-based view of proactive corporate environmental strategy*. Academy of Management Review, 28(1), 71–88.
- Bansal, P. (2005). *Evolving sustainably: A longitudinal study of corporate sustainable development*. Strategic Management Journal, 26(3), 197–218.
- Bansal, P., & Song, H.-C. (2016). *Similar but not the same: Differentiating corporate sustainability from corporate responsibility*. Academy of Management Annals, 11(1), 105–149.
- Barney, J. (1991). *Firm resources and sustained competitive advantage*. Journal of Management, 17(1), 99–120.
- Bear, S., Rahman, N., & Post, C. (2010). The impact of board gender diversity on corporate social responsibility. Journal of Business Ethics, 97(2), 207–221.
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). *A literature and practice review to develop sustainable business model archetypes*. Journal of Cleaner Production, 65, 42–56.
- Boons, F., & Lüdeke-Freund, F. (2013). *Business models for sustainable innovation: State of the art and steps towards a research agenda*. Journal of Cleaner Production, 45, 9–19.
- Boulouta, I. (2013). Hidden connections: The link between board gender diversity and corporate social performance. Journal of Business Ethics, 113(2), 185–197.
- Cainelli, G., Mazzanti, M., Environmental innovations, complementarity and performance: Evidence from production sectors. Research Policy, 42, 1595-1604.
- Cohen, B., & Winn, M. I. (2007). *Market imperfections, opportunity and sustainable entrepreneurship*. Journal of Business Venturing, 22(1), 29–49.

- de Vasconcelos Gomes, L. A., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). *Unpacking the innovation ecosystem construct: Evolution, gaps, and trends*. Technological Forecasting and Social Change*, 136*, 30–48.
- Dean, T. J., & McMullen, J. S. (2007). *Toward a theory of sustainable entrepreneurship: Reducing environmental degradation through entrepreneurial action*. Journal of Business Venturing, 22(1), 50–76.
- Delmar, F., & Shane, S. (2004). *Legitimating first: Organizing activities and the survival of new ventures*. Journal of Business Venturing, 19(3), 385–410.
- Delmas, M. A., & Toffel, M. W. (2008). *Organizational responses to environmental demands: Opening the black box*. Strategic Management Journal, 29(10), 1027 1055.
- Demirel, P., Kesidou, E. (2010). Stimulating different types of eco-innovation in the UK: Government policies and firm motivations. Ecological Economics, 70(8), 1546–1557.
- Díaz-García, C., González-Moreno, Á., & Sáez-Martínez, F. J. (2013). *Gender diversity within R&D teams: Its impact on radicalness of innovation*. Innovation, 15(2), 149–160.
- Foss, N. J., Lyngsie, J., & Zahra, S. A. (2019). *The role of external knowledge sources and organizational design in the process of opportunity exploitation*. Strategic Management Journal, 40(4), 759–782.
- George, G., Merrill, R. K., & Schillebeeckx, S. J. D. (2016). *Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development*. Entrepreneurship Theory and Practice, 44(5), 939–964.
- Hall, J. K., Daneke, G. A., & Lenox, M. J. (2010). *Sustainable development and entrepreneurship: Past contributions and future directions*. Journal of Business Venturing, 25(5), 439–448.
- Hart, S. L. (1995). *A natural-resource-based view of the firm*. Academy of Management Review, 20(4), 986–1014.
- Hockerts, K., & Wüstenhagen, R. (2010). *Greening Goliaths versus emerging Davids: Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship*. Journal of Business Venturing, 25(5), 481–492.
- Horbach, J. (2008). Determinants of environmental innovation—New evidence from German panel data. Research Policy, 37(1), 163–173.

- Hörisch, J., Johnson, M. P., & Schaltegger, S. (2015). *Implementation of sustainability management and company size: A knowledge-based view*. Business Strategy and the Environment, 24(8), 765–779.
- Kaufman, L., & Rousseeuw, P. J. (2009). *Finding groups in data: An introduction to cluster analysis*. Wiley.
- Ketchen, D. J., & Shook, C. L. (1996). *The application of cluster analysis in strategic management research: An analysis and critique*. Strategic Management Journal, 17(6), 441–458.
- Laursen, K., & Salter, A. (2006). *Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms*. Strategic Management Journal, 27(2), 131–150.
- Long, J. S., & Freese, J. (2014). Regression models for categorical dependent variables using Stata (3rd ed.). Stata Press.
- Muñoz, P., & Cohen, B. (2018). *Sustainable entrepreneurship research: Taking stock and looking ahead*. Business Strategy and the Environment, 27(3), 300–322.
- Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., & Giovannini, E. (2005). *Handbook on constructing composite indicators: Methodology and user guide*. OECD Publishing.
- Østergaard, C. R., Timmermans, B., & Kristinsson, K. (2011). *Does a different view create something new? The effect of employee diversity on innovation*. Research Policy, 40(3), 500–509.
- Peteraf, M. A. (1993). *The cornerstones of competitive advantage: A resource-based view*. Strategic Management Journal, 14(3), 179–191.
- Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2016). *Recommendations for creating better concept definitions in the organizational, behavioral, and social sciences*. Organizational Research Methods, 19(2), 159–203.
- Porter, M. E., & van der Linde, C. (1995). *Toward a new conception of the environment–competitiveness relationship*. Journal of Economic Perspectives, 9(4), 97–118.
- Rennings, K. (2000). Redefining innovation—Eco-innovation research and the contribution from ecological economics. Ecological Economics, 32(2), 319–332.
- Rennings, K., & Rammer, C. (2011). The impact of regulation-driven environmental innovation on innovation success and firm performance. Industry & Innovation. 18.

- Schaper, M. (2002). The challenge of environmental responsibility and sustainable development: Implications for SME and entrepreneurship academics. Radical Changes in the World: Will SMEs Soar or Crash?
- Schaltegger, S., & Wagner, M. (2011). *Sustainable entrepreneurship and sustainability innovation: Categories and interactions*. Business Strategy and the Environment, 20(4), 222–237.
- Schumpeter, J. A. (1934). *The theory of economic development*. Harvard University Press.
- Shane, S., & Venkataraman, S. (2000). *The promise of entrepreneurship as a field of research*. Academy of Management Review, 25(1), 217–226.
- Spanos, Y. E., & Lioukas, S. (2001). *An examination into the causal logic of rent generation: Contrasting Porter's competitive strategy framework and the resource-based perspective*. Strategic Management Journal, 22(10), 907–934.
- Spigel, B. (2017). *The relational organization of entrepreneurial ecosystems*. Entrepreneurship Theory and Practice, 41(1), 49–72.
- Stinchcombe, A. L. (1965). *Social structure and organizations*. In J. G. March (Ed.), *Handbook of organizations* (pp. 142–193). Rand McNally.
- Suchman, M. C. (1995). *Managing legitimacy: Strategic and institutional approaches*. Academy of Management Review, 20(3), 571–610.
- Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. European Planning Studies, 23
- Teece, D. J., Pisano, G., & Shuen, A. (1997). *Dynamic capabilities and strategic management*. Strategic Management Journal, 18(7), 509–533.
- Urbano, David & Alvarez, Claudia. (2013). Institutional dimensions and entrepreneurial activity: An international study. Small Business Economics.
- York, J. G., & Venkataraman, S. (2010). The entrepreneur–environment nexus: Uncertainty, innovation, and allocation. Journal of Business Venturing, 25(5), 449–463.
- York, J. G., O'Neil, I., & Sarasvathy, S. D. (2016). *Exploring environmental entrepreneurship: Identity coupling, venture goals, and stakeholder incentives*. Journal of Management Studies, 53(5), 695–737.
- Zahra, S. A., & Covin, J. G. (1995). *Contextual influences on the corporate entrepreneurship–performance relationship: A longitudinal analysis*. Journal of Business Venturing, 10(1), 43–58.

Appendix B

Correlation matrix between SDGs

SDG	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
SDG1	1.0	0.23	-0.0	0.08	0.04	0.04	0.01	0.01	-0.06	0.05	-0.06	-0.02	-0.02	-0.02	-0.04	-0.03	-0.0
SDG2	0.23	1.0	0.07	0.02	0.0	0.15	0.04	-0.01	-0.05	-0.01	-0.0	0.03	0.06	0.02	0.07	-0.03	-0.01
SDG3	-0.0	0.07	1.0	0.09	0.04	0.0	0.01	-0.06	-0.2	-0.07	-0.04	-0.13	-0.01	0.05	0.03	0.01	-0.01
SDG4	0.08	0.02	0.09	1.0	0.17	0.06	0.02	0.02	-0.05	0.04	-0.01	-0.08	-0.08	-0.05	-0.05	0.03	0.06
SDG5	0.04	0.0	0.04	0.17	1.0	0.1	0.04	0.14	0.01	0.15	-0.01	-0.04	-0.01	0.01	-0.0	0.02	-0.07
SDG6	0.04	0.15	0.0	0.06	0.1	1.0	0.14	-0.03	0.04	0.06	0.11	-0.0	0.05	-0.0	-0.01	-0.01	-0.0
SDG7	0.01	0.04	0.01	0.02	0.04	0.14	1.0	-0.09	-0.02	0.05	0.03	-0.04	0.02	-0.01	0.03	0.04	-0.01
SDG8	0.01	-0.01	-0.06	0.02	0.14	-0.03	-0.09	1.0	0.0	0.08	-0.01	0.04	-0.06	0.02	-0.1	-0.04	0.02
SDG9	-0.06	-0.05	-0.2	-0.05	0.01	0.04	-0.02	0.0	1.0	0.06	0.14	0.07	-0.0	-0.02	0.01	-0.01	0.04
SDG10	0.05	-0.01	-0.07	0.04	0.15	0.06	0.05	0.08	0.06	1.0	0.08	0.06	0.01	-0.05	-0.06	-0.04	0.01
SDG11	-0.06	-0.0	-0.04	-0.01	-0.01	0.11	0.03	-0.01	0.14	0.08	1.0	0.08	0.14	0.02	0.1	0.06	0.05
SDG12	-0.02	0.03	-0.13	-0.08	-0.04	-0.0	-0.04	0.04	0.07	0.06	0.08	1.0	0.08	0.05	0.12	0.01	0.04
SDG13	-0.02	0.06	-0.01	-0.08	-0.01	0.05	0.02	-0.06	-0.0	0.01	0.14	0.08	1.0	0.15	0.19	0.04	-0.02
SDG14	-0.02	0.02	0.05	-0.05	0.01	-0.0	-0.01	0.02	-0.02	-0.05	0.02	0.05	0.15	1.0	0.24	0.09	-0.0
SDG15	-0.04	0.07	0.03	-0.05	-0.0	-0.01	0.03	-0.1	0.01	-0.06	0.1	0.12	0.19	0.24	1.0	0.06	0.01
SDG16	-0.03	-0.03	0.01	0.03	0.02	-0.01	0.04	-0.04	-0.01	-0.04	0.06	0.01	0.04	0.09	0.06	1.0	0.01
SDG17	-0.0	-0.01	-0.01	0.06	-0.07	-0.0	-0.01	0.02	0.04	0.01	0.05	0.04	-0.02	-0.0	0.01	0.01	1.0

Table 3.3 translation

Words	**Frequency**
environment / environmental	22
reduce / reduction	18
impact	17
digital / digitalization	15
paper	14
use / utilization	12
energy / energy-related	10
sustainable / sustainability	9
resource / resources	8
process	8
green	7
efficiency	7
waste / scrap	6
circular / reuse / recycling	6
consumption / reduction of consumption	5
technology / technologies	5
mobility / transportation	4
emissions / pollution	4
product / production	4
virtualization	3

Survey translation

Business survey - the role of start-ups

Date:	10/07/2025
Research code:	2025-141UFE
Document:	Questionnaire Q02
Research methodology:	Cati/Cawi

The start-up ecosystem is playing an increasingly central role in economic development, innovation, the transition to sustainable business models and inclusion policies. However, several factors can influence start-ups' ability to innovate, grow and face market challenges. This questionnaire aims to analyse:

1 **The role of sustainability**: To examine whether and how 'green' start-ups differ from 'non-green' start-ups in terms of their approach to innovation and access to resources.

2 **The propensity for innovation:** Understanding the extent to which Italian start-ups invest in research and development, adopt new technologies and address the main barriers to innovation.

3 **Entrepreneurial challenges and opportunities**: Identify the main obstacles encountered by entrepreneurs in the start-up and growth phases of a start-up, as well as the most effective levers to support them.

4 **The impact of public policies and financing instruments:** Assessing the effectiveness of available incentives and the role of the regulatory and financial environment in the development of start-ups.

5 **Inclusion, diversity and gender equality:** Assess the presence of women in founding teams and management roles, the implementation of corporate policies for gender equality and diversity management, and the impact of diversity on innovation and the success of start-ups.

The information collected will provide a detailed picture of the current situation, offering useful insights for optimising policies to support innovation and entrepreneurship in Italy.

The questionnaire will take approximately 10 minutes to complete.

SECTION 1 - GENERAL INFORMATION

1.1 Please enter the following information:

- Town and municipality where the company has its registered office
- Turnover range
- Year of establishment
- ATECO code

1.2 Indicate the number of employees and their percentage composition in the years 2023-2024:

- Total number of employees in the company
- % Graduates
- % Employees engaged in research and development
- % of women

1.3 Which of the three requirements of Legislative Decree 2012 does it meet to be considered an innovative start-up? [multiple]

- It incurs research and development (R&D) expenses equal to at least 15% of the greater of the cost and total value of production;
- It employs highly qualified personnel (at least 1/3 PhDs, PhD students or researchers, or at least 2/3 with a master's degree);
- It is the owner, depositary or licensee of at least one patent or the owner of registered software.

SECTION 2 - THE ROLE OF SUSTAINABILITY

2.1 Is your start-up considered 'green', i.e. does it integrate environmental sustainability as a central element of its business model, developing products, services or technologies that reduce environmental impact or promote the transition to a sustainable economy?

- Yes
- No
- Partially (specify)

If yes/or partly D2.1 = 1 or 3

2.1.2 The term "impact" refers to the concrete and measurable effects generated by the startup's activity in three fundamental areas. What impacts does your startup pursue? [Multiple - one answer for each item Yes = 1 - No = 2]

1 **Social:** improvement of living conditions, inclusion, well-being of individuals and communities;

2 **Economic:** creation of economic value, jobs, competitiveness, growth;

3 **Environmental**: reduction of pollution, efficient use of resources, protection of ecosystems.

If D.2.1.2 = 1 (for each selected impact)

2.2 Assess the relevance of the impacts pursued on a scale of 0 to 5, where 0 = not at all relevant, 5 = completely relevant:

Social impact	0	1	2	3	4	5
Economic impact	0	1	2	3	4	5
Environmntal impact	0	1	2	3	4	5

ALL

2.3 Which of the following UN 2030 Agenda Goals are pursued or achievable by your start-up?

[Select up to 5 Goals from those listed (SDGs list)]

Presence/Absence - [Multiple of 5]

SDG	Objective	Brief Description
1	**End poverty**	**End poverty in all its forms everywhere.**
2	**End hunger**	**End hunger, achieve food security and promote sustainable agriculture.**
3	**Health and wellbeing**	**Good health and well- Ensure healthy lives and promote well-being for all at all ages.**
4	**Quality education**	**Ensure inclusive, equitable and quality education and learning opportunities for all.**
5	**Gender equality**	**Achieve gender equality and empower all women and girls.**
6	**Clean water and sanitation**	**Ensure availability and sustainable management of water and sanitation for all.**

7	**Affordable and clean energy**	**Ensure access to affordable, reliable, sustainable and modern energy for all.**
8	**Decent work and economic growth**	**Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.**
9	**Industies, innovation and infrastructures**	**Build resilient infrastructure, promote sustainable industrialisation and innovation.**
10	**Reduce inequality**	**Reduce inequality within and among nations.**
11	**Sustainable cities and communities**	**Make cities and human settlements inclusive, safe, resilient and sustainable.**
12	**Responsible consumption and production**	**Ensure sustainable consumption and production patterns.**
13	**Combat climate change**	**Take urgent action to combat climate change and its impacts.**
14	**Life below water**	**Conserve and sustainably use the oceans, seas and marine resources.**
15	**Life on land**	**Protect, restore and promote sustainable use of terrestrial ecosystems.**
16	**Peace, justice and strong institutions**	**Promote peaceful and inclusive societies, access to justice and effective institutions.**
17	**Partnerships for the goals**	**Strengthen the means of implementation and revitalise the global partnership for sustainable development.**

SECTION 3 - THE PROPENSITY FOR INNOVATION

ALL

3.1 What do you consider to be the main difficulty in innovation? [Single]

- Access to finance
- Bureaucracy
- Lack of talent
- Unresponsive market
- Other (please specify)

Only one difficulty Innovation Q3.1

3.1 How difficult do you think innovation is to pursue? (Rate on a scale of 0 to 5, where 0 = not difficult at all, 5 = very difficult). [Single]

- Access to funding
- Bureaucracy
- Lack of talent
- Unresponsive market
- Other (please specify)

ALL

3.2 Did you invest in R&D in the two-year period 2023-2024?

- Yes
- No

If yes (D3.2 = Yes)

3.2.1 - % of investment on turnover (numerical value from 1 to 100)

ALL

3.2.2 Do you have any future investments planned?

- Yes
- No

If yes (D3.2 = Yes)

- % planned on turnover (numerical value from 1 to 100)

3.3 Did you introduce any innovations in the two-year period 2023-2024?

Yes

No

If yes, D3.3=Yes

3.3.1 What do the innovations concern: [multiple]

- services and products
- services only
- process only

ALL

3.4. Is your company currently active in any of the following areas of the bioeconomy? (You may select more than one answer)

- Sustainable agriculture
- Bioenergy (e.g. biogas, biofuels)
- I Use of biomass or organic waste to produce new products or energy
- I Green chemistry/industrial biotechnology
- I Production of biodegradable or biobased materials
- I Circular economy (e.g. reuse, advanced recycling, industrial symbiosis)
- We are not active in the bioeconomy sector
- Other (please specify):

If no, D.3.4. = 7

3.4.1. Do you intend to develop projects or activities in this area in the next 3 years?

• Yes

• No

ALL

3.5 Do you collaborate with universities or research centres?

- Yes
- No
- Planned

If yes, D.3.5. = 1

3.5.1 In what way? [Multiple]

- Internships and/or work placements for students
- Industrial research contracts
- Joint research projects
- Other (specify)

ALL

3.6 Have you benefited from public incentives for innovation?

- Yes
- No

ALL

3.7 What sources of funding did your start-up use? [Multiple]

- Private investors,
- Public funds,
- Venture capital,
- Crowdfunding,
- Other (please specify),
- None

ALL

3.8 Did your start-up register any patents or intellectual property in the two-year period 2023-2024?

- Yes
- No
- Planned

SECTION 4 - ENTREPRENEURIAL CHALLENGES AND OPPORTUNITIES AND THE IMPACT OF PUBLIC POLICIES AND FINANCING INSTRUMENTS

4.1 What were your reasons for starting the start-up? [Multiple]

- Passion for innovation
- Economic independence
- Market opportunity
- Social impact
- Other (please specify)

4.2 What were the main difficulties you encountered in the initial phase? [Multiple]

- Bureaucracy
- Access to financing
- Finding talent
- Unresponsive market
- Other (please specify)

4.3 On a scale of 0 (very unfavourable) to 5 (very favourable), how favourable do you think the Italian context (entrepreneurial culture, regulation, ecosystem, access to capital) is to the creation and growth of new start-ups?

	0	1	2	3	4	5

4.4 What tools or resources would have been most useful in developing your startup more successfully? [Multiple]

- Mentorship
- Public incentives
- Training
- Investor network
- Other (please specify)

4.5 What skills do you consider essential for entrepreneurship? (max 3 choices)

Previous experience in the specific sector

- University or postgraduate level of education (Master's, PhD)
- Level of managerial skills
- Level of technical skills
- Level of leadership
- Communication and relationship management skills
- Strategic analysis skills
- Problem-solving skills level
- Other (please specify)

SECTION 5 - INCLUSION, DIVERSITY AND GENDER EQUALITY

5.1 Has the start-up adopted specific policies to promote gender equality and inclusion?

- Yes
- No
- Planned

5.2 What is the percentage of women/female entrepreneurs in the startup's founding team?

- 0%
- 1 to 50%
- 51% to 99%
- 100%

5.3 What percentage of women are in leadership roles in the start-up?

- 0%
- 1 to 50%
- 51% to 99%
- 100%

5.4 Are there policies in place to actively promote diversity in recruitment processes?

- Yes
- No
- Planned

If yes, 5.4=1

5.4.1 What measures are taken? [Multiple]

- Flexible working
- Smart working
- Equal opportunities in promotions
- Parenting support
- Mentoring programmes
- Other (please specify)