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SUSTAINABLE OPEN INNOVATION BETWEEN LARGE COMPANIES AND STARTUPS

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ABSTRACT : In the contemporary business landscape, the complexity and seriousness of the global issues faced by our society have reached a turning point. Strong multilateral initiatives are needed in order to address the *Grand Challenges* of our times. Sustainable Open Innovation, characterised by collaborative practices between different partners, driven by sustainability, and transcending the firm's innovation boundaries, can represent an extremely valuable asset to solve these challenges.

This thesis investigates the dynamics of Sustainable Open Innovation between large companies and startups, aiming to elucidate the collaborative process, highlighting the main reasons behind the adoption of Open Innovation mechanisms, as well as presenting the main benefits, challenges and opportunities inherent in such a remarkable innovation approach. Grounded in a multidisciplinary theoretical framework encompassing innovation management, open innovation, sustainability, and finally the interrelation between open innovation and sustainability, this qualitative study employs a mixed-methods approach, through both an inductive and deductive reasoning, and combining semi-structured interviews and secondary data to shed light on the subject matter. The objective of this research is to provide theoretical and practical implication to the recent topic of Sustainable Open Innovation, with a specific focus on effective OI collaborations between large companies and startups.

The findings contribute to both theory and practice by advancing our understanding of how large companies and startups can collaborate to foster innovation that is not only profitable and economically viable for both partners, but also socially and environmentally responsible. The results are summarised by taking into account the key research questions addressed in this study, aiming at providing insights on the discussed topic. In the end, this study provides practical recommendations for managers and entrepreneurs seeking to leverage Open Innovation for sustainable development goals.

KEYWORDS: Innovation, Open Innovation, Sustainability, Sustainable Open Innovation, Startups, Large companies

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1 INTRODUCTION

The first chapter of this master's thesis includes an overview of the study with its practical and theoretical implications. First, the background of the study will be presented. Secondly, the research questions, the main objectives, as well as the research gaps, will be outlined, along with the delimitations of the study. Finally, the main concepts and definitions will be mentioned.

1.1 Background of the study

In these extraordinary hard times, the complexity and seriousness of the global issues faced by our society have reached a turning point: global pandemics, wars, famine, climate change, biodiversity, only to name a few, represent serious and complex issues which impact our everyday existence and will probably continue to affect future generations, unless an immediate collective action is taken by all members of society.

In a popular article titled *"Tackling Grand Challenges Pragmatically"*, Ferraro et al. (2015) firstly coined the word Grand Challenges, by referring to the major critical issues faced by humanity nowadays, with significant global implications. In that study, the authors called for a pragmatic multilateral and coordinated approach to address these challenges. In fact, such *Grand Challenges* are characterized by an increased degree of complexity and uncertainty, especially those related to the transition to sustainable development. As a result, the same great challenges demand that businesses, public institutions, and the whole society start to significantly increase the level of collaboration in order to implement innovative, sustainable solutions and drive the transition to sustainable development. Fostering collaboration among experts from different fields, bringing together professionals with diverse perspectives, as well as involving and engaging all the relevant stakeholders, can lead to a more comprehensive and effective solutions, rather than acting independently (Dahlander and Wallin, 2020). In 2015, the

United Nations created the 2030 Agenda for Sustainable Development, and its 17 Sustainable Development Goals (SDGs) represent an urgent call for action by all countries to cooperate in order to solve the world's biggest problems (United Nations, 2024). Addressing the issue of climate change, in particular, appears to be paramount for the transition to sustainable development. The traditional linear "take-make-dispose" economic model is no longer sustainable in the long term, and it's reaching its physical limitations (Ellen MacArthur Foundation, 2013). Companies in various industries have a great impact on the environment: continuous extraction and use of finite resources and waste production affect the environmental and social sustainability, causing big impacts on biodiversity, CO2 and GHG emissions, and to a broader extent, contributing to climate change (Ellen MacArthur Foundation, 2013). The new "sustainable" paradigm, which is so strongly advocated by numerous international organizations, government bodies and policy makers, as well as society in its broadest sense, requires a structural change of perspective, through a multilateral effort involving both individuals, companies, industries, institutions and countries, by implementing radical shifts in societal values, norms, and behaviours (Chizaryfard et al., 2020).

In this paper, I argue that multilateral collaboration for innovation is paramount for advancing the transition to sustainable development, thanks to a more effective and rapid implementation of innovative, sustainable solutions. In particular, collaborations between large, established companies and early startups, through the systematic use of Open Innovation, can be extremely beneficial for that purpose. Open innovation (OI), originally, refers to the "use of purposive inflows and outflows of knowledge to accelerate internal innovation" (Chesbrough, 2003). Later the concept has evolved to refer to a higher degree of collaboration between several stakeholders, and the range of applications is quite broad and can fulfil diverse purposes. I argue that OI between large companies and startups is crucial for implementing innovative, sustainable solutions due to its ability to foster collaboration, leverage diverse perspectives, putting together complementary resources, and addressing each part's necessities and objectives in a more effective way. Sustainable development, in fact, requires rapid and transformative

innovations to address urgent environmental, social, and economic issues. With this regard, OI can be functional in speeding up the development and implementation of sustainable solutions, by allowing a collaborative environment with the sharing of knowledge, technologies, and resources. Such a collaborative innovation model recognizes that both large companies and startups have unique strengths, resources, and capabilities that can be mutually beneficial (Chesbrough, 2003).

Overall, OI plays a pivotal role in fostering a collective and dynamic approach to tackle the complex challenges associated with sustainable development. Opening up the innovation processes can facilitate and accelerate the implementation of sustainable solutions, with positive benefits for all the partners involved. However, OI is still poorly embraced by companies, and there is a limited, yet successful, amount of case studies which show the tangible benefits of such a different approach to innovation. Moreover, when the new approach is in place, it is not exactly clear why both parties decide to collaborate and synergize (Dahlander and Wallin, 2020). The quest for the reasons behind the adoption OI models in both large companies and startups, as well as the presentation of the benefits as well as challenges of this innovative approach, can represent a significant case study for speeding up the adoption of the OI practice among different organisations.

In conclusion, the *Grand Challenges* presented by serious issues such as climate change and the growing concern of international organizations towards sustainability demand a strong paradigm shift in the domain of innovation management, through a more effective collaboration between different stakeholders under the larger domain of OI. With this regard, OI initiatives between large companies and innovative startups can result in a more effective implementation of groundbreaking innovations, and fostering the creation of new value.

1.2 Research questions and objectives

The importance of Open Innovation for a more effective implementation of creative, sustainable solutions is now being recognized by several companies, institutions, and governments. However, many companies still struggle to understand the benefits of opening up their innovation models, by using a more collaborative approach to innovation, in order to leverage potentially beneficial partnerships with innovative organisations, leading to the implementation of sustainable solutions. Understanding the dynamics of SOI, and the core factors and motivations to pursue a SOI approach, can be beneficial for bringing up a larger "case for Open Innovation" and eventually speeding up the OI processes driven by sustainability-

In this study, the following research questions will be addressed:

1. ***Why do large established companies and startups collaborate through a Sustainable Open Innovation approach?***

2. ***Which are the main benefits, as well as the barriers and challenges of an effective implementation of Open Innovation between large companies and startups?***

In summary, the core focus of the research is to investigate the main factors for implementing Open Innovation for sustainable development, or Sustainable Open Innovation, which involves different kind of collaborations between large established companies and early startups, with an in-depth analysis of the key success factors as well as the main challenges and barriers faced by both players in implementing SOI. The answers to the previous research questions will contribute to the existing, non-abundant, literature on the topic of Sustainable Open Innovation.

Regarding the objectives of this study, the author aims, in general terms, to investigate the dynamics of SOI within both large companies and startups. Firstly, by analysing the

reasons behind the choice of collaborating through a general OI paradigm, and secondly by evaluating the positive factors and benefits, as well as challenges and issues of SOI collaborations between large companies and startups.

Therefore, this thesis presents two main purposes. Firstly, to investigate the key drivers of the decision of implementing SOI internally, by analysing the company's motivation to pursue SOI as a new strategic approach to innovation driven by sustainability. Specifically, the focus will be on the reasons behind the partnerships between large, established companies and startups. The second main objective is to analyse the benefits as well as the challenges for an effective collaboration between large established companies and startups. It is therefore interesting to explore the multifaceted relationship between these two stakeholders which, apparently, couldn't be more different from each other in terms of size of the business, agility, business models and resources available.

The objectives supporting the RQs are divided into theoretical and empirical objectives. The study has the following theoretical objectives:

1. To analyse the existing literature related to Open Innovation, the role of Open Innovation in fostering sustainable development, and the key features of Open Innovation from the perspectives of both large companies and startups.
2. To analyse the existing literature related to sustainability, with its most relevant aspects as well as issues to consider, in order to understand its role in shaping innovation-
3. To analyse the current literature on the interaction between the two themes of Open Innovation and sustainable development, hence investigating the recent concept of Sustainable Open Innovation which has not extensively examined in the literature.

Furthermore, the study presents the following empirical objectives:

1. To analyse the core motivations for implementing Open Innovation in both large established companies and early startups, with real case studies to serve as a concrete example.
2. To analyse critical elements and success factors, as well as the potential challenges for effective collaborations between large companies and startups, under the domain of Open Innovation.

The practical contribution of this study aims at building up a case study for SOI, by summarizing the key positive elements of SOI as a method that can provide multiple benefits for both large companies and startups. The main idea is that such a collaborative approach to innovation can lead to the implementation of innovative, sustainable solutions in a quicker and more effective way, which in turn can provide a larger impact on society and the environment.

Finally, by following these objectives, and after analysing the current literature on the presented topics, a theoretical framework will be created in order to understand the role of OI for the adoption of sustainable solutions. However, given that the study is in large extent exploratory, with the aim of building new insights and results in a lacking theory on the topic, the theoretical framework will only be presented at the end of the findings section. The empirical objectives will be achieved through collection of primary and secondary data, coupled with the execution of a qualitative analysis through the application of a mixed approach, with elements of deductive and inductive reasoning.

1.3 Research Gaps

Both the concepts of Open Innovation and Sustainable Development are not completely unknown in the literature. Quite the contrary, if taken from a singular perspective, they are both well-established fields of research, especially regarding Open Innovation. Both

theories are quite relevant in the actual business environment, as the call for multilateral collaboration has been growing in popularity in these past decades (Dahlander and Wallin, 2020).

In recent years, sustainability has become a popular concept promoted by the EU and many organisations worldwide. However, there is still little and vague scientific research on the intersection between OI and sustainability. Despite the potential and large emphasis, over the years, of the OI concept, little is known about the interaction and integration of the two themes. Specifically, the concept of Sustainable Open Innovation is not widely discussed in the literature (Bogers et al., 2020).

Furthermore, within the research area of OI, there is still a relatively unexplored field, and studies examining collaborative innovation between startups and large companies, particularly from the perspective of startups, are still almost non-existent (Usman, Vanhaverbke, 2017). The investigation of the dynamics of the collaborations between large companies and startups can provide interesting insights in this field of research. In addition to this, there is not a broad literature on the motivations and factors behind the adoption of OI practices between large, structured companies and startups.

In the broad area of innovation management, so far research has focused predominantly on competencies and capabilities of single firms to achieve competitive advantage through application of sustainability principles. Yet, little attention has been paid to understanding the role of cross-sectoral collaboration, through OI, for advancing sustainable development. In fact, as mentioned before, although the concepts of OI and sustainability have been raising in popularity in the literature, there is a gap in research regarding their combination, and specifically regarding OI between large companies and startups in the context of Sustainable Open Innovation (Bogers et al., 2020).

In summary, a potential research gap exists in the literature, in particular regarding the topic of Sustainable Open Innovation, specifically between large companies and startups,

which is the focus of this study. An investigation into such topics can also serve as a guide to practitioners and non practitioners in order to evaluate the role and importance of OI for implementing sustainable solutions.

1.4 Delimitations of the study

Several delimitations have been identified in this study, starting with the identification of the research problem, the research question, and the objectives. In fact, this study's context has been restricted to align with its defined scope. For instance, the focus on OI for sustainability, or Sustainable Open Innovation, is determined by the significant nature of the topic, as well as for its actual importance in today's global scenario, as outlined in the introduction section.

Starting with the theoretical framework, an important delimitation can be found within the structure followed by the author. As the purpose of the study is to analyse the key drivers and the main aspects of OI between large companies and startups, a comprehensive structure was created to best serve this objective. Starting with the role of OI and its evolution, both in large companies and startups, it then became appropriate to study the dynamics of OI between large companies and startups, therefore deep diving into the core of the research. Finally, the topic of SOI is presented in light of the interrelation between OI and sustainability. Given the little evidence on the topic of SOI, the author needed to focus more on the key dynamics of OI, with more emphasis on the OI dynamics between large companies and startups, while only at the end presenting the relatively new concept of SOI with a real case example presented in the literature.

In addition, a strong delimitation can be found in the limited geographical application of the presented case studies, as only Italian companies were selected and analysed for the purpose of this study. The results could not be generalised as each market has unique characteristics that may impact the motivations to pursue OI approaches, like for instance the characteristics of the environment in which organisations operate, external

incentives in pursuing cross-collaborations between different stakeholders, both pecuniary and non-pecuniary benefits, and the differences in innovation culture across organisations in different markets (Chesbrough et al., 2014). Furthermore, both Italgas and Snam, the two large Italian companies selected for the case study, belong to the energy sector, where the dynamics of OI can significantly differ from other industries. Comparisons of results are therefore limited due to the sectorial application of these results. In fact, the energy sector in Italy is frequently in the spotlight due to increased external pressures on reducing costs, foster sustainability, and lower public participation. The specific situation could therefore represent a limitation in the following generalisation of the results.

As for the methodology employed for collecting and analysing empirical data, an exploratory approach will be utilized to show the dynamics of Sustainable Open Innovation between large companies and startups, with real case studies. The study will employ a qualitative method, incorporating various data sources and methods to ensure the research's validity, reliability, and credibility. Both primary and secondary data will be collected using mainly an inductive approach, with a primary focus on the elaboration of semi-structured interviews within the selected companies. The semi-structured format allows for adaptability in framing questions based on the responses of the interviewees. The sources of secondary data, including textual and non-textual documents, surveys, and datasets, will be utilized to gain a comprehensive understanding of the contextual background of the companies presented in the case study, and will serve as complementary to the primary data. An important delimitation is, therefore, given by the choice of the methods, which is obviously limited to a specific research methodology, in this case represented by the exploratory, qualitative study.

1.5 Main concepts and definitions

Establishing a clear understanding of the main concepts and definitions is paramount to laying a solid foundation for the study. For this reason, this paragraph presents the core

concepts incorporated in this study as well as the main definitions in order to facilitate a clearer comprehension of the subject matter:

INNOVATION – "a *process that an individual or organization undertakes to conceptualize brand new products, processes, and ideas, or to approach existing products, processes, and ideas in new ways"* (Will Purcell, 2019)

OPEN INNOVATION – *"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model"* (Chesbrough et al., 2014)

STARTUPS – *"A startup is a temporary organization designed to search for a repeatable and scalable business model"* (Steve Blank, 2010)

LARGE COMPANY – "*company employs more than 250 persons, with a yearly turnover that exceeds 50m euro or a total yearly financial statement that exceeds 43m euro"* (European Commission, 2016).

SUSTAINABLE DEVELOPMENT – "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (UN Brundtland Commission, 1987).

SUSTAINABLE OPEN INNOVATION – "*a distributed innovation process which is based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model, thereby contributing to development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (*Bogers et al., 2020)

1.6 Structure of the study

This study is comprised of 5 chapters.

The first chapter serves as general introduction, offering a contextual background of the study by identifying the research gap that the thesis intends to address. It outlines the research questions and objectives of the study, as well as the main concepts and delimitations presented in the literature review.

Chapter 2 encompasses a comprehensive review of the literature, divided into different sub topics. Starting with the Open Innovation paradigm, its main mechanisms and development over the years, the following section deals with the main contributions on the startups subject, followed by an investigation of the role of OI within startups. Subsequently, the focus is on Open Innovation between large companies and startups. Finally, the sub chapters of sustainability and sustainable open innovation are presented

In Chapter 3, the methodology employed for analysing the gathered data will be elucidated. Initially, the research design will be outlined, followed by a depiction of the data collection process and the considered case study. Subsequently, the investigative process will be scrutinized to affirm the study's quality.

Moving to Chapter 4, this section will conduct an analysis of the empirical results, aiming to address the empirical questions and align with the objectives outlined in the introductory chapter. The goal is to establish a connection between the previously developed theoretical framework and the empirical findings. Additionally, managerial implications will be assessed to formulate an empirical framework consistent with the discovered outcomes.

Chapter 5 serves as the conclusive chapter wherein the conclusion and summary are presented. Alongside this, limitations and suggestions for future studies will be delineated.

2 LITERATURE REVIEW

This chapter provides a detailed investigation of the literature regarding the Open Innovation (OI) paradigm and its connection with sustainability. Firstly, the study presents a broad overview of the literature regarding the role of innovation for fostering companies' business growth and competitive advantage, followed by an introduction of the concept of OI and its evolution over time, presenting the main studies and contributions. Subsequentially, the focus of the discussion is on the critical role of OI within both large companies and startups as a major contributor to addressing different innovation purposes. In particular, the sub chapter regarding startups will cover the role of OI in startups, despite poorly analysed in the existing literature, with the purpose of showing how OI can represent a decisive driver for overcoming the so-called initial *liabilities* of early startups. The consequent paragraph deals with the role of OI between large established companies and startups, the dynamics of the collaborations between both parties, along with the presentation of a successful case study. The second part of the literature review entails a discussion around the topic of sustainable development, with the presentation of the recent concept of sustainable open innovation (SOI). Starting with the topic of sustainable development and its importance for modern organizations, the focus will be lead on how OI can be linked with sustainability, and specifically how OI can be leveraged by companies for implementing sustainable innovation.

2.1 Open Innovation

This literature review starts with the topic of Open Innovation (OI), which emerged in the literature in the early 2000s as a new innovation paradigm that challenges the conventional innovation models within organisations, by promoting multilateral collaboration, sharing of ideas, and co-creation processes beyond the internal organisational boundaries (Chesbrough, 2003). This study entails a comprehensive

exploration of OI, aiming to discover its theoretical underpinnings and implications, as well as strategic and practical applications across various organizations. By exploring the multifaceted aspects of OI, this study aims to shed light on how organisations can leverage external collaboration to drive sustainable growth, adapt to modern fast-changing environment, and successfully thrive in the contemporary business landscape. Before presenting the concept of OI, a synthetic introduction to the role of innovation is provided, as an essential enabler to foster a sustained competitive advantage.

2.1.1 The critical role of innovation

Innovation can be defined as a "*process that an individual or organization undertakes to conceptualize brand new products, processes, and ideas, or to approach existing products, processes, and ideas in new ways"* (Will Purcell, 2019). Therefore, according to the author, innovation in business entails improving existing products or processes, or developing new products or processes. In practical terms, companies can pursue innovation in existing products and services, by making improvements, or through new business models, processes, and functions.

Innovating is critical for multiple reasons: it can allow a significant competitive advantage, it is often linked to business growth and efficiency improvement, as well as being a source of talent attraction and retention (IMD, 2023). Moreover, unexpected challenges are quite inevitable in the business landscape. Embracing innovation can position you ahead of the competition and foster the expansion of your company simultaneously, as well as allowing a great adaptability to overcome difficulties (Dahlander and Wallin, 2020).

According to Schumpeter (1942), innovation is fundamental for economic growth and business development. By coining the famous term *"creative destruction",* Schumpeter aimed at explaining how the process of innovation, often driven by disrupting ideas, products, and technologies, can lead to a destruction of the existing models and the

development of more efficient systems. According to the author, the two main principles of Creative Destruction are innovation and entrepreneurship, and the combination of the two aspects is considered to be critical in order to foster economic growth. Moreover, the author suggested that small entrepreneurial firms are sources of most innovations, as they are characterized by strong entrepreneurial spirit and willingness to take risks which can result in introduction of new ideas, technologies, and even business models.

According to Porter (1987), innovation is a key factor of success for organisations, and an effective management of innovation is critical for achieving and maintaining long-term competitive advantage. Porter also stressed the importance of differentiation through innovation, hence where companies aim to offer unique and innovative products or services, therefore creating a distinctive value proposition which can set a company apart from competition. Moreover, the author recognizes that innovation is fundamental for value creation. In fact, companies that innovate effectively can offer valuable solutions to meet customer needs far better than competitors.

In a popular article called *"You need an Innovation Strategy"*, Pisano (2015) stretched the importance of having an innovation strategy aligned with the general business strategy, in order to perform better in the long term. The author found a link between innovation and value creation, and the criticality of pursuing innovation which creates value. The author also presented a framework called *"The Innovation Landscape Map"*, which characterizes innovation based on two dimensions: the degree of technical changes, and the degree of business model changes. Each dimension of the matrix shows different types of innovation based on the two dimensions.

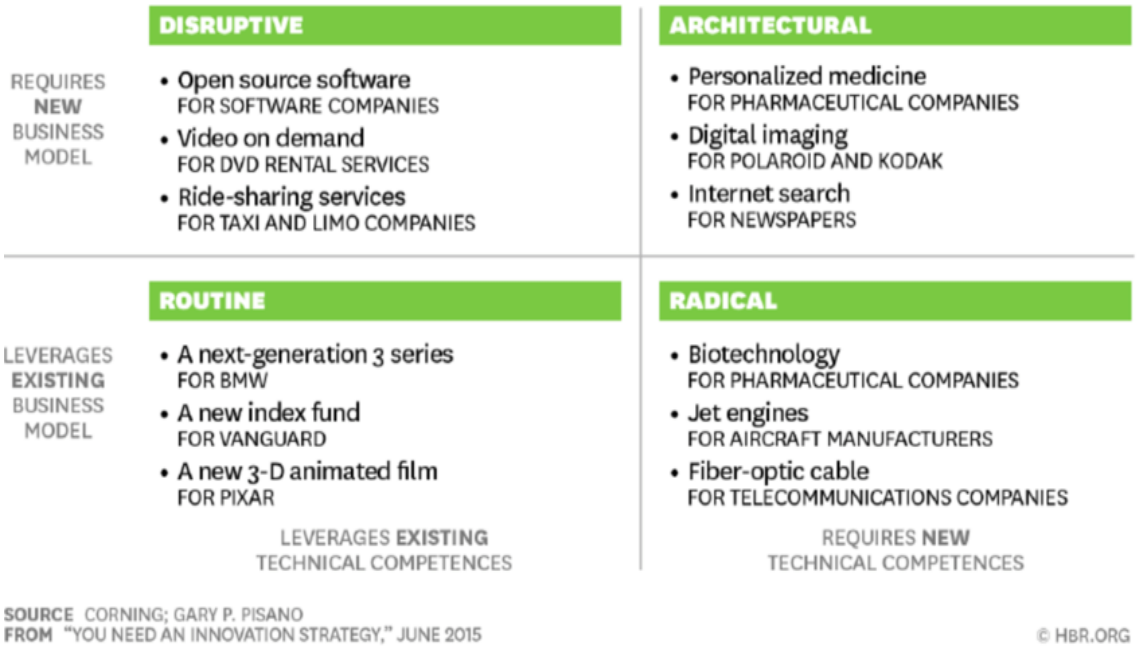

Figure 1. The Innovation Landscape Map (Pisano, 2015)

Figure 1 shows the four main innovation strategies, according to *The Innovation Landscape Map (Pisano, 2015). Routine innovation* is the lowest possible degree of innovation, built on the existing technological competences and in accordance with the existing business model. *Disruptive innovation* comes with a radically new business model, yet by leveraging on the existing technological competences. *Radical innovation*, instead, is built on the existing business model but requires radically new technical competences. This is mostly seen in high-tech, niche sectors where tech competences are fast-changing, and companies need constant investments in R&D. Finally, *architectural innovation* combines both technological and business model disruptions, and claimed as the most challenging innovations to pursue.

2.1.2 Closed and Open Innovation

The concept of Open Innovation (OI) was originally coined by Henry Chesbrough in his book *"Open Innovation: The New Imperative for Creating and Profiting from Technology"* (2003). Chesbrough defines open innovation as *"the use of purposive inflows and*

outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (p.1). The author also conceptualized the theme as a distributive innovation process involving intentional collaborations, across the organizational boundaries, for accelerating internal innovation. Initially the new OI paradigm aimed at challenging the existing closed innovation model of R&D, which was no longer sustainable and performant.

In the same book, Chesbrough provides the six principles of OI, in contrast with the principles of closed innovation (Figure 2).

Closed Innovation	Open Innovation
1 - All the smart people work in our organization.	1 - Not all the smart people work in our organization.
2 - To profit from R&D we have to discover, develop and supply everything ourselves.	2 - External R&D can create value for our organization.
3 - Only if we discover it will we manage to get it to market first.	3 - Internal R&D is needed to grasp that value.
4 - If our organization is the first to commercialize an innovation, we will beat our rivals.	4 - We have to be involved in basic research to benefit from it, but the discovery does not have to be ours.
5 - If we create the most and best ideas in our industry, we will win.	5 - If we make better use of external and internal ideas and unify the knowledge created, we will win.
6 - If we have full control over the innovation process our rivals will not be able to profit from our innovative ideas.	6 - We should optimize the results of our organization, combining the sale or licensing of our innovation with the purchase of external innovation processes whenever they are more efficient and economic.

Figure 2. Principles of closed innovation and open innovation (Chesbrough, 2003)

According to Chesbrough (2003), in fact, several factors led to the erosion of the *closed innovation* paradigm, namely globalization of the workplace, the availability of venture capital, and the creation of new forms of innovation (e.g. spin-offs) through special agreements between the agents, with the aim of fostering new ways of developing ideas and technologies outside the firm boundaries.

Over the years, several perspectives have emerged on the topic of OI which differ from the original concept coined by Chesbrough. For instance, the notion of *"open, distributed innovation"* coined by von Hippel (2005), deals with the distributed social division of labor, with a user-centric, democratized innovation in which different users can exchange knowledge and co-create innovative products or services, suggesting that innovation does not have to be limited to traditional internal R&D departments. In fact, the author challenged the traditional models of innovation where only producers and manufacturers were driving innovation processes.

Other authors introduced new perspectives on the topic of OI, as the notion of *"open source innovation"* presented by Raasch, Herstatt, and Balka (2010), or the term *"open collaborative innovation"* (Baldwin and von Hippel, 2011), which refers to the use of openly available information for innovation purposes, as *"public good"*.
On one hand, *Open source innovation* refers to a collaborative and transparent approach aimed at developing and sharing innovations by using a freely available source (as the underlying knowledge). Despite often associated with software development, has now expanded also towards business models. The main features of *Open source innovation* are transparency, free accessibility, and non-proprietary nature. *Open collaborative innovation* is more focused on the company strategic approach which includes external partners like customers, suppliers, research institutions, and other stakeholders which jointly create and develop new solutions. Among the others, knowledge sharing, cross-functional collaboration, and co-creation are the key elements of this sub-OI domain.

Despite further efforts in integrating the various theories on OI, there is still fundamental differences in the conceptualization of the theme. Following several critics to the traditional OI concept and these new theories on the topic, Chesbrough et al. (2014) propose a new definition of OI, with the objective of clarifying the traditional paradigm, and unifying future work in that area. According to the new definition, OI refers to *"a distributed innovation process based on purposively managed knowledge flows across*

organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model" (Chesbrough and Bogers., 2014).

Nowadays the concept of OI has evolved and can also include business model innovation, in new contexts that embrace communities and entire ecosystems. The widespread idea is that, if companies want to open their innovation boundaries to other parties, such as other firms, customers, research institutes and universities, even competitors, they should no more innovate within the traditional "closed innovation" approach. Embracing new ways of innovating, through OI, was found to be beneficial for companies in order to promote flowless innovation and sustain their competitive advantage over time (Dahlander and Wallin, 2020).

The core OI theory proposed by Chesbrough (2003), highlights three main OI models based on different knowledge flows:

- The *Outside-in* process, with inbound knowledge flow, involves a flow of external knowledge to improve the internal innovation of the company. The assumption of such a model is that an inbound of knowledge and technology from other actors is needed in order to overcome the internal lack of appropriate knowledge, hence furthering innovation. Traditionally, the outside-in process involves partnerships between suppliers and clients, but eventually other stakeholders can be part of it, such as research institutes or even competitors.

- The *Inside-out* process, with outbound knowledge flow, involves a transfer of ideas, technology and knowledge to the external environment. The idea behind the Inside-out process of OI is that companies might have internal innovation which does not add any specific value to the firm, or that such internal innovation might be functional for other firms. In this scenario, collaborations with external partners can represent a win-win situation.

- The *Coupled* process, with a combination of inbound and outbound flows, involves collaborations between companies or different stakeholders (suppliers, clients, research institutes, universities). The objective of the coupled OI process is to develop and adopt innovation by following a co-creation approach, which is fundamental for creating shared value between the participants (Galvagno and Dalli, 2014).

By analysing the three main models of OI presented by Chesbrough, it appears clear that the OI process is dynamic and can vary across organizations, depending on the objectives, the delimitations, and the industry. Some companies may emphasize certain mechanisms over others, depending on their needs, objectives, and resources.

The drivers behind the decision to implement OI models can vary across organisations and industries. First of all, acquiring innovations from external origins involves a two-step process: companies initially need to identify external outlets of innovation, and subsequently integrate those innovations into the organization. According to Bogers and West (2012), companies might acquire tangible innovations, technological inventions, or expertise, market insights, components, or any other valuable information to foster their innovation efforts. Among the factors influencing the use of external innovation sources, the need for internal elements like research and development capabilities and complementary assets play a significant role (Spithoven & Teirlinck, 2010). Over the years, and thanks to the rising availability of information and communication technologies, and the role played by the Internet, the process of searching for innovation coming from external sources has become almost costless. Among the mechanisms that can be exploited to favour the use of external sources of innovation, encouraging external partners with effective incentives plays a relevant role, be it in the form of monetary or non monetary incentives, as well as by creating structured mechanisms and procedures that offer a foundation for external participants to generate and potentially distribute innovations.

Securing innovation from external sources typically involves explicit contractual agreements and licensing arrangements, which offer enhanced opportunities for exploring technology. However, the effectiveness of licensing or other methods of knowledge acquisition relies on factors like the robustness of the intellectual property protection system (Chesbrough, 2003b). The acquisition of innovation from external sources may occur through obtaining knowledge or technology, or by acquiring the suppliers of innovation.

Integrating innovations into the typical R&D activities of the firm is the second, challenging step after having identified and acquired external innovations, and usually requires a fitting culture in the organisation as well as specific tech capabilities to integrate innovations from external sources. With this regard, organizational culture is fundamental in the ability of an organization to be able to effectively profit from external sources of innovation. Overcoming the so-called *"not invented here"* attitude is not easy at all. According to Dogson et al. (2006), there is a need of strong cultural changes to embrace innovation from external sources in order to allow collaboration with partners, and this is mostly true for large organizations with successful internal innovation areas, which might be less keen on enlarging their innovation processes outside their boundaries. Nevertheless, there is definitely more to integration than simply cultural considerations. Firms, in fact, possess specific processes and systems that can either promote or discourage the utilization of external innovation sources.

Ceccagnoli et al. (2009) claimed that obtaining innovations externally has the potential to alter the firm's R&D competencies, influencing both direct and indirect aspects. On one hand, the resources dedicated to acquiring innovations from external channels might directly diminish the resources allocated for internal innovation. On the other hand, external sourcing has the capacity to enhance the internal R&D capabilities of the firm.

Finally, commercializing innovations is paramount in the OI paradigm. In fact, a key difference between the new Chesbrough's paradigm and earlier studies of external use of innovation is focused on how firms can profit from innovations. Alignment to the firm's business model is therefore the "new" requirement of such innovations. As presented before, Chesbrough (2003) specifies that *"Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model."* Therefore, in the original view of OI, there must be inclusion and alignment of the innovation with the firm's business model, along with a clear commercialization strategy.

Among the main motivations to pursue open innovation mechanisms, Chesbrough and Crowther (2006) discovered that minimizing costs was considered a "secondary" incentive. Cost reduction is indeed a less common objective in comparison to enhancing innovation outputs and acquiring external knowledge. Research has also shown that there is a positive link between financial performance and getting external sources of innovation. However, some studies concluded that relying on external innovation sources led to a decline in profitability due to the fact that the rising costs associated with external collaborations surpassed the incremental value creation.

2.2 Startups

This chapter provides firstly an overview of the startups phenomenon, and subsequentially in relation to open innovation. In fact, OI and Startups are two concepts that are closely related. By embracing OI, startups can benefit from external resources, expertise, and access to markets, in a mutual collaborative relationship and opportunites with established companies, research institutes, and other startups.

Steve Blank's (2010) widely recognized definition of a startup characterizes it as *"a business entity, in the form of a company, a partnership, or a temporary organization, that is established with the prime objective of designing and establishing a sustainable*

and scalable business model". Blank is also acknowledged for his development of the Customer Development methodology, which centres around adopting customer-centric strategies for the establishment and expansion of startups.

One of the most popular masterpieces of the literature regarding startups is represented by the *"The Lean Startup"* developed by Eric Ries (2011), which provides a scientific approach for the creation and management of startups, by accelerating product development and go-to-market process. In the current rapidly changing environment, it provides practical insights and a strategic as well as systematic approach to building and scaling startups.

According to Ries (2011), the key principles of the lean startup methodology include:

1) Development of a Minimum Viable Product (MVP). A key element of the methodology is, in fact, the so-called *build-measure-learn feedback loop.* Instead of creating a detailed business plan upfront, it is more recommendable for startups to start by building an MVP after they figure out the problems to be addressed and solved, in order to measure its performance, and learn from the feedback to make eventual changes and improve the products or service. By applying such a method, a company can figure out if it needs to pivot or implement a substantial course correction.
2) Validated Learning. The focus has to be on learning what works and what doesn't work through experimentation and customer feedback. This facilitates the adaptation and adjustment of strategies as required.
3) Continuous Deployment. It is essential to continuously release and test product/service updates, which helps in enabling improvements based on real-world feedback.
4) Pivot or Persevere. Being extremely adaptable and flexible is what makes a startup more likely to succeed among diverse challenges. The willingness and rapidity to implement significant changes to the product or business strategy,

hence the process of pivoting, based on the feedback received, or persevere if the initial hypotheses are valid.

The Lean Startup dramatically challenges the traditional paradigm of writing a long-term business plan, forecasting, raising money and then develop the product or service to be offered to the market. However, this process is extremely resource-intensive, both in terms of economic and human capital, as well as not time efficient (Blank, 2013).

Before deep diving into the role that OI can play for early startups, it is important to mention some peculiar features which are embedded into early startups. In particular, they face considerable challenges and barriers which are certainly summarised by the well-known concepts of *Liability of Smallness and Liability of Newness,* discussed by Perrow in his influential work *Complex Organizations: A Critical Essay* (1979). According to the author, both *liabilities* are representative of the big challenges and disadvantages faced by startups at the very early stages of their existence. Firstly introduced by Stinchcombe (1965), the concept of *Liability of Newness* shows that early organisations face complex challenges to compete against more established companies, and are precarious especially because they are new to the market. In fact, small, innovative startups often lack human and organisational resources, efficient operational routines as well as a solid structure. Moreover, they are not well-known in the market and need time to build partnerships, create stable supplier chains and gain customers. As a consequence, the failure rate of those early organisations is definitely high.

In addition to the *Liability of Newness*, innovative startups at the early stages usually deal with the so-called *Liability of Smallness*, which refers to some innate limitations mostly in terms of resources, human capital, and capabilities, given by the small size of such organisations. As a consequence, they are vulnerable to market or dynamics changes. The idea is that large businesses present improved chances of survival than small new companies (Hannan and Freeman, 1983). Therefore, due to their double liability of smallness and newness, startups ultimately have to deal with a structural lack

of resources, both tangible and intangible ones, in order to compete effectively with other, more established companies. Successful startups need to find ways to overcome such liabilities, often through innovation, agility, and strategic partnerships (Spender et al., 2017).

Essentially, startups face various, significant challenges as they navigate the complexity of establishing and growing a new business. Limited financial resources, market uncertainty, competition, scaling issues, talent acquisition, as well as product-related issues, plus marketing and branding, are just a few of the large number of challenges encountered at the early stages of their existence. It is exactly in this insidious environment that, in order to successfully navigate these challenges, they need to be resilient, adaptable, and then prove the ability to develop a strategic approach to problem solving. Many startups, therefore, encounter the opportunity of implementing OI mechanisms to overcome these obstacles.

2.2.1 Startups in the Open Innovation context

Over the last few decades, considerable research has been carried out on the phenomenon of startups, especially in the areas of entrepreneurship, financing, growth and scaling, technology and innovation, as well as policy and regulation.

Regarding long-term survival and success of startups, extensive research has shown that building relationships with different stakeholders can lead to the startup's success over time (Kask and Linton, 2013). Specifically, in the domain of OI, Bogers (2011) found that adopting OI practices becomes necessary for startups in order to overcome the initial challenges given by their double liability. Initial but scarcely analysed results of such a field of research have proven the growing importance of OI within startups, yet there are still unresolved questions on how startups adopt innovation practices, and why they choose some OI mechanisms over others, or basically what drives their OI initiatives.

Spender et al. (2017) presented a theoretical overview of the phenomenon of startups within the OI context. The key findings are summarized below:

1. **Startups' networks as a key factor for innovation processes**. Firstly, the role of networks to foster innovation has been widely recognized by literature. Networks are deemed crucial for acquiring new resources or introducing new products or services. Overall, a large network of beneficial relationships have a positive effect on startups' innovativeness, but this is true in particular with public networks like institutional partners, organisations, other companies. Neyens et al. (2010) examined how the duration of alliances influences the innovation performance of startups. They revealed that establishing enduring alliances with customers, suppliers, and competitors positively contributes to a startup's capacity for generating radical innovation. In contrast, forming brief alliances with customers, suppliers, and competitors positively contributes to a startup's ability to generate incremental innovation.

2. **Partners through Open Innovation mechanisms.** Opening up the innovation process involves the engagement of startups in relationships with various types of partners such as incubators, large corporations, public institutions and research institutes, and venture capitalist firms. The role of the business incubator, be it technology, industrial or university incubator, is to stimulate innovation and support the startups along its complete lifecycle. With this regard, universities play a marginal role as a source of new ideas for startups in the incubator, while they are more relevant in the later stages of new product development. On the other hand, partnering up with large companies can be beneficial when there is a bigger need of network which certainly the large company has.

3. **The role of the startups' ecosystem on OI processes.** A startups' ecosystem is a group encompassed by various organizations interacting in order to promote the success of startups. An active and efficient financing system, comprised by both private and public financing, is considered relevant to grant success of the startups'

ecosystem. According to Ferrary and Granovetter (2011), especially an effective system of venture capital is often regarded as a key success factor for the ecosystem, while public financing does not always meet the larger financial necessities and investment needs of startups.

Research in OI and Startups has produced several insights to identify the different ways and mechanisms to overcome both *Liability of Smallness* and *Liability of Newness*. In particular, it is widely recognized that adopting OI practices and mechanisms represents a necessity for innovative startups in order to overcome the initial lack of resources, and develop new innovative solutions. However, the literature on OI for startups is very diversified. For instance, extensive streams of research have focused on the role of partnerships and networks on the decision to start a new venture; many studies have also examined the effectiveness of OI practices on entrepreneurial decision-making. However, in the OI literature, the relevance of networks has always been paramount as well as instrumental for developing positive innovation processes.

2.3 Open Innovation between large established companies and startups: Why should David and Goliath synergize and cooperate?

Over the last decade, and especially during and after the outbreak of the COVID-19 pandemic, the phenomenon of OI has been expanding in established companies, particularly regarding collaborations with startups. On one hand, the advantages and success factors of OI have been researched exhaustively. On the other hand, how OI is managed and implemented between partners is yet to be fully understood. It is still quite acknowledged that startups can represent a winning partner for more established companies that are willing to cooperate and innovate together, by implementing solutions through innovative technologies, products, services or processes (Dahlander and Wallin, 2020),

Major established companies have traditionally explored ways to become more entrepreneurial oriented. They have experimented with various mechanisms such as corporate venture capital, internal incubators, strategic alliances, and joint ventures, adopting and sometimes discarding these strategies. However, the emergence and growing viability of startup firms, coupled with their inherent disruptive nature, create a new urgency for the development of more agile and rapid approaches for large companies to interact with the startup community. Rather than perceiving startups solely as agents of disruption, companies are now actively seeking collaboration with startups to transform them into catalysts for corporate innovation. This shift brings about three noteworthy consequences. Firstly, corporations must adeptly screen, identify, collaborate with, and monitor a larger number of startups than before, given the expanding and globally dispersed startup ecosystem. This necessitates swifter decision-making across a multitude of potential relationships. Secondly, corporations need to be aware of their value proposition, and how they can propose value to startups already connected to independent venture capitalists, incubators, and other support institutions. Lastly, corporations should have a clear understanding of their objectives in engaging with startups, with the strategic goals of the corporation dictating the most suitable model(s) for their collaboration with startups (Chesbrough and Weiblen, 2015).

According to Chesbrough et Weiblen (2015), *"When it comes to agility, startups have an edge over large corporations—whereas large corporations sit on resources which startups can only dream of. The combination of entrepreneurial activity with corporate ability seems like a perfect match".* Fundamentally, large corporations and startup are totally different organizations by nature, and each party possesses what the other one is lacking. Moreover, the inherent nature of startups of risk taking and experimentation puts them in a pole position for driving breakthrough innovations.

In addition to being recognized by academic environments, collaborative OI mechanisms with startups have gained momentum in the last few years, with several practitioners and business experts which have repeatedly celebrated the positive impact of fruitful

collaborations between more established companies and startups, as a win-win approach to solve grand challenges and foster a sustainable growth (Dahlander and Wallin, 2020).

The success factors of joint innovation projects can be manifold for both the established company and the start-up organisation. For instance, thanks to the strategic cooperation, the start-up can get access to financial, technological, and knowledge resources of the partner (Hite and Hesterly, 2001). Similarly, the traditional company can learn from the startup's lean and agile attitude, while potentially benefit from the startup's new technologies which can be strategically relevant for the company's long-term success despite the initial investments (Hogenhuis, 2016). Leveraging external knowledge to reinforce its innovative performance is also among the factors that influence the choice of collaborating with startups, from the perspective of the large company.

Moreover, Hogenhuis (2016) presented a collaboration decision-making model for large firms when considering a productive partnership with young ventures, which aims at providing managers with a useful framework to select fruitful startups as strategic partners. Such a model is built on some key factors, such as the exploratory or focused nature of the project, the need of manufacturing capabilities, and the role of the manager in charge of the project. All of those factors are relevant when choosing the right partner. For instance, the author argues that in less focused, exploratory projects, large companies are mainly looking for specific technological know-how or creativity. On the contrary, collaborative projects where manufacturing capabilities are relevant, young startups are less likely to be a good fit, as they usually lack the structural capabilities to manufacture on a large scale. Finally, the author underlines the relevant challenges of asymmetry collaborations between large firms and young ventures, especially in terms of organisational structure or the lack of good documentation skills in startups, thus stressing the importance of the right partner selection.

Chesbrough's investigation into General Electric's OI initiatives with startups, through the *2012 Ecoimagination Challenge* demonstrates that not every connection with startups yields positive results. The study highlights the necessity for substantial relationships between large established firms and startups to progress from basic connections to intricate associations for mutual benefit. Large corporations have adopted various strategies, including corporate venture capital, internal incubators, strategic alliances, and joint ventures, to collaborate with startups, foster new ventures, or establish spin-offs. The rapid growth and increasing viability of startup firms, coupled with their disruptive potential, underscore the need for large companies to develop more agile and efficient methods for engaging with the startup community.

Usman and Vanhaverbeke (2017) present two comprehensive case studies of effective collaborations between large companies and startups. In the first case, a large corporation implement and commercialize a startup's innovative solution, while the second case shows how a startup develops a disused technology which was developed in the past by a large company. The results of the first case show how a startup can capitalize on its groundbreaking technology through collaboration with a major corporation. This partnership results in a mutually beneficial outcome for both the large company and the startup. In fact, the startup benefits from engaging in outbound Open Innovation in multiple ways:

- it has the ability to bring its technology to the market without the need to invest in supporting assets.
- It also retains the flexibility to target selected markets, which are not directly interested by the large company
- The generated royalty income provides resources for investing in R&D activities for emerging technologies.

On the other hand, the large company benefits from the partnership by:

- Acquiring a new technology without the requirement of extensive and costly research projects
- The new technology accelerates its time to market, and can purchase the technology if the startup proves to be successful
- Enhancing the company's reputation as a reliable innovation partner for startups.

The second case study explores how a large company can benefit from licensing an underutilized technology to a promising startup. The licensing agreement seems advantageous for both parties, creating a mutually beneficial scenario. The startup gains numerous advantages from this partnership:

- It gains access to a ground-breaking technology crucial for its commercial success
- It receives continuous support from the large company in advancing the technology and products, thus accelerating the innovation process
- The partnership with the large company entails inherent value for the startup as it makes collaborations with other companies and organisations way easier thanks to the large network available.

On the other hand, the large company profits from this collaboration in several ways:

- It can gain financial and non-financial benefits, including insights and discoveries applicable to other related fields.
- It can observe the progression of developing a new technology and bringing it to the market within a startup
- This specific indirect involvement also suggests that the large company has the option to acquire the startup if it continues to expand and becomes strategically relevant.

Both case studies show effective and successful OI collaboration between a startup and a larger, more structured company. The study presented by Usman and Vanhaverbeke (2017), shows how both partners can tackle challenges by utilizing the skills and assets

of the counterpart. Figure 3 illustrates the key benefits, as well as challenges and barriers in the inbound and outbound OI process, related to startups.

Table I. Benefits and challenges for start-ups in inbound and outbound open innovation

Start-up as technology seeker inbound open innovation		Start-up as technology provider outbound open innovation	
Challenges	Benefits of open innovation	Challenges	Benefits of open innovation
Limited research capability	Saves on R&D cost	Lack of resources	Do not need funds for development or commercialization
Lack of financial resources	Quick entry into the market	Risk of misappropriation of technology	Royalty income
To earn market reputation/credibility	Technical/logistic support from large company	Little or nil market reputation/credibility	Reputation for future endeavors
Aligning venture capitalists interests	Capitalize on large company's reputation	Convincing potential buyers	Can tap niche markets not targeted by large company

Figure 3. Benefits and challenges for startups in inbound and outbound Open Innovation (Usman and Vanhaverbeke, 2017).

2.4 Sustainability: a broad concept

In today's world, sustainability has become increasingly critical as societies recognize the interconnectedness of the world's global challenges. as presented in the introductory chapter. With continuous integration among international people, companies, and institutions worldwide, as well as with an extensive flow of goods, services, technologies, and information across national borders, there is an increasing need of more sustainable, responsible actions to solve the pressing challenges of our society (UN, 2015).

This chapter introduces the concept of sustainable development and its the three pillars, as well as the main theories on the topic. Finally, a discussion on how OI can be integrated with sustainability will be presented.

2.4.1. The concept of Sustainable Development

Sustainable development, or sustainability, can be defined as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (UN Brundtland Commission, 1987). Initially, the focus was merely on environmental issues, while later in 1993, the World Bank economist Mohan Munansighe presented sustainable development as a triple approach concept, focusing on the economic, ecological, and socio-cultural issues to be considered when engaging with sustainability in a truly holistic approach. Despite initially sustainability was strongly linked with economic reasons, over time the integration of environmental and social considerations into the sustainability concept increased significally. Today, sustainability encompasses a wide range of topics, in the domain of CSR, Marketing for sustainability, sustainable supply chains, and other streams of research which tend to focus more on specific fields of studies. Regarding this research topic, several studies have explored the role of sustainable innovations, and more recently the role of OI for sustainable development. In the following sections an overview of the relevant studies on the integration of OI and sustainability will be presented.

Several representations of sustainability were introduced over the last decades, in order to provide a clearer understanding, both conceptual and visual, of the concept. For instance, a popular visual representation involves the three interconnected pillars, economic, social, and environmental, which sustains and foster sustainable development. An alternative representation, which gained more popularity over time, includes sustainability as the result of three intersecting spheres representing economic, social, and environmental aspects, as shown in figure 4.

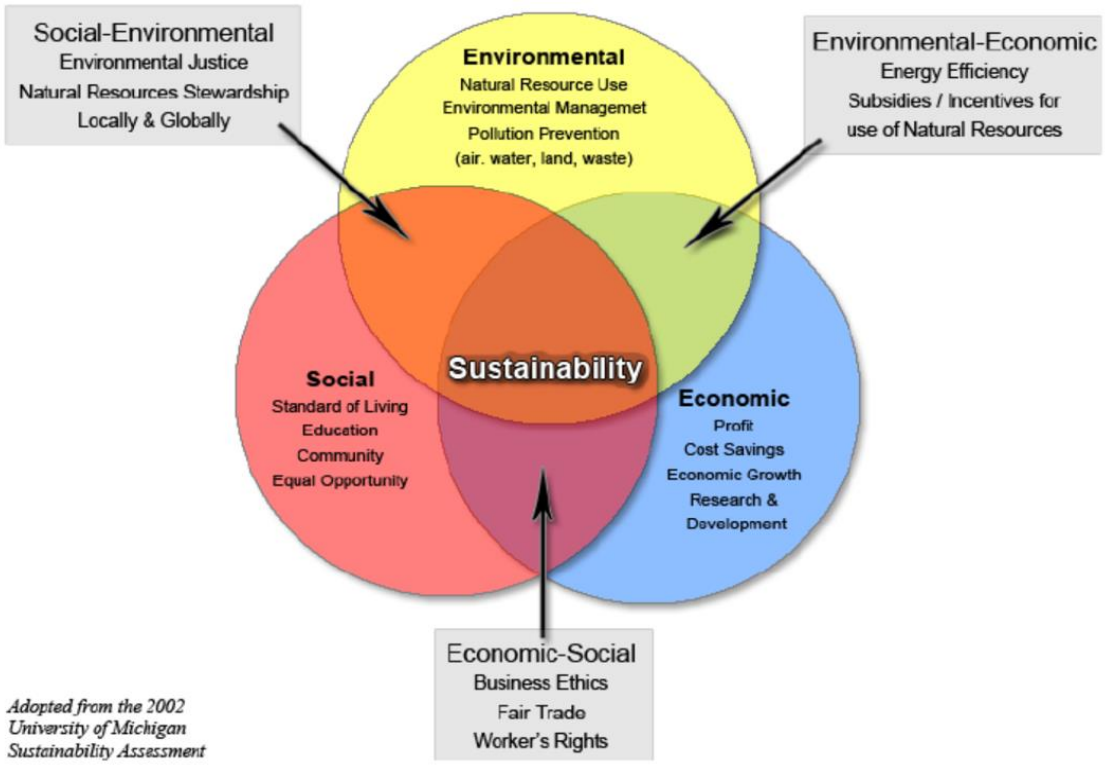

Figure 4. The three spheres of sustainability (University of Michigan Sustainability Assessment, 2002)

The concept of economic sustainability, from a micro perspective, can be explained as the ability of a company to sustain its economic and financial performance indefinitely, and therefore the "core idea is how organizations stay in business" (Jeronen, 2020). Furthermore, economic sustainability refers to the optimal use of existing resources in order to maintain positive economic results over time. This definition can also be referred as "weak sustainability", while under the "strong sustainability" view, economic sustainability emphasises an organisation's ability to foster economic development and growth by preserving the environmental and social impact of their operations.

As mentioned in the introductory chapter, the concept of sustainability is originally linked with environmental considerations, especially in the domain of resource management (Hediger, 1999). Under the environmental perspective, sustainability deals with an effective management of resources for future conservation, as all biosystems have finite resources. Under this perspective, there are critical business issues, from the

impact of industrialization on biodiversity, or the continuous use of non-renewable resources such as oil, steel, coal, as well as the production of CO2 and GHG emissions (Crane and Matten, 2019). When analysed on a more fundamental level, the concept of environmental sustainability is strictly related to economic growth, as the two aspects often were regarded as opposed. Despite concerns over the possibility of achieving growth without compromising the environment, several companies are now implementing innovative sustainability strategies into their business models, such as Patagonia, which on a popular advertising campaign was trying to persuade its customers to buy less, while raising awareness on sustainable consumption (Crane and Matten, 2019).

2.5 Sustainable Open Innovation

In today's rapidly evolving world, the intersection of sustainability and innovation has become increasingly vital. New approaches leverage on this intersection with the objective of fostering a ground for co-creation and exchange of sustainable ideas. As presented in the introductory chapter, in a popular article titled *"Tackling Grand Challenges Pragmatically"*, Ferraro et al. (2015) firstly coined the word Grand Challenges, by referring to great issues of today's societies, such as climate change and poverty, and called for a pragmatic multilateral approach to solve these challenges. Such great challenges demand that businesses, civil society, and institutions, start to significantly increase the level of collaboration in order to implement effective solutions. The call for multilateral effort through effective partnerships was launched already at the 2002 World Summit on Sustainable Development held in South Africa, as a way to foster sustainability and integrate sustainability concerns into projects decisions. Subsequently, the 2030 UN Agenda for Sustainable Development emphasised the need of effective partnerships between companies in order to facilitate the transition to a more sustainable world. According to such multilateral project, increasing the level of collaboration is paramount to reach the most relevant targets of the UN Agenda (United Nations, 2015).

Organisations are therefore increasingly required to explore innovative solutions to achieve long term sustainability goals, and may take different approaches to integrate innovation with sustainability. On one hand, many traditional organisations tend to view a trade off between profitability and sustainability goals, as if sustainability was perceived mostly as a "cost" rather than an investment, therefore with no profitable return. Another approach, which is becoming more popular nowadays, is to include sustainability in the overall business strategy with a collaborative approach which includes multiple stakeholders.

In the research domain, there has been an increasing call to strong efforts to work in collaborative innovation networks, which has been linked to positive outcomes in approaching sustainability issues. Lopes et al. (2017) highlighted the importance of OI, through which companies *"can promote sustainable innovation from a social, environmental and economic point of view".* Overall, OI can be a valuable tool for organizations looking to drive change and promote sustainability. By leveraging the expertise and ideas of a wider network of stakeholders, organizations can more effectively address the challenges and opportunities of the fast changing environment, and drive the development of innovative and impactful solutions.

There is a broad and deep discussion in the literature about the fundamental relevance of innovation in achieving sustainability goals, but the mechanisms and the implementation of OI for sustainability can often be challenging (Enkel and Gassmann, 2010).

2.5.1. The concept of Sustainable Open Innovation

Innovation alone does not imply a natural shift to sustainable development. Actually, innovation can also have negative effects on sustainability, and innovative technologies can worsen sustainability problems. For example, the widespread use of new and

innovative pesticides or synthetic materials mighty cause harmful effects on ecosystems or society. At the same time, innovations in marketing and product design might encourage excessive consumerism, hence a culture of overconsumption which leads to increased waste generation and environmental impact. However, by including sustainability into innovation, firms can come up with new products or services, as well as processes, that are both innovative and sustainable, and can serve well both the organization and society in the long term (Hill, 2023). In the rapidly evolving economic landscape, adopting OI mechanisms has become a part of business strategy for many companies, which are now integrating more and more external partners into new product or service development with the aim of developing innovative solutions which are also sustainable.

Bogers et al. (2020) introduced the concept of Sustainable Open Innovation (SOI), which is defined as *"a distributed innovation process which is based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model, thereby contributing to development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. Such a definition combines the key concept of OI with the definition of sustainability given by the Brundtland commission in 1987. In fact, the concept combines the key elements of OI with a commitment to long-term environmental and social goals. According to Arnold and Hockerts (2011), SOI refers to implemented ideas that enhance environmental and/or social outcomes when compared to the existing circumstances. SOI focuses on optimizing resource utilization, enhancing products and services, and developing innovative business models, all of which align with conventional business principles (Nidumolu et al., 2009). In light of these definitions, it becomes clear that SOI includes broader environmental and social sustainability, therefore OI projects which include strong environmental and social principles could be defined as projects driven by SOI.

As the need for multilateral collaborations for sustainability becomes more and more apparent, as presented in the literature so far, SOI can be seen as a business driver that

can enhance overall performance and provide a competitive advantage, despite traditionally sustainability was perceived as costly (Porter, 1995). According to Hall and Wagner (2011), organizations need to understand the factors that could boost their efforts in achieving groundbreaking innovations for new sustainable products. Key aspects that set apart Sustainable Organizational Innovations (SOI) include the level of innovation and the extent of planned enhancements in environmental and/or social performance. Studies indicate that initiatives aiming for radical improvements in sustainability face challenges such as high complexity, uncertainty, and inadequate financial returns.

In the popular article *Sustainable Open Innovation to Address a Grand Challenge: Lessons from Carlsberg and the Green Fiber Bottle*, Bogers et al. (2020) presented the case study of Carlsberg, the Danish beer manufacturer, which created the *Green Fiber Bottle* within its sustainability initiative using an open innovation strategy, in conjunction with complementary partners. This study demonstrates the characteristics of successfully tackling a significant sustainability challenge through collaborative innovation, and present challenges and opportunities that arise in the process. Regarding the Green Fiber Bottle, the initial driving force behind its creation was a commitment to enhancing sustainability performance. Many sustainability issues, in fact, start with the organization recognizing that it is negatively impacting the environment, but does not have the internal resources to mitigate such an impact, while keeping consistency with its overall business strategy. According to George et al., (2016), The inherent uncertainty and complexity of significant challenges, such as the one related to plastic waste in this instance, often necessitate coordinated and collaborative endeavours. And here is precisely where the two themes of sustainability and open innovation converge. This is also an example of “sustainability-driven open innovation” which aligns with the “purpose-driven, non-pecuniary” factors that drive individuals and organizations to pursue such projects.

According to Cappa et al (2016), SOI approaches can lead to significant improvements of sustainability performance like cost reductions, a more efficient use of resources and

lower pollutant emissions, thus making a positive impact on the environment. A recent report released by Capgemini (2023), finds that companies embrace open innovation to enhance current products, innovate new ones, establish novel business models, and optimize R&D expenditures. Additionally, the study notes that 83% of organizations view open innovation as a crucial determinant for achieving sustainability objectives. However, the research also shows that larger organizations are, on average, struggling more with open innovation for sustainability purposes. In fact, according to Pascal Brier, Chief Innovation Officer of Capgemini, while businesses recognize the significance of open innovation for sustainability and are increasing their investments in it, a considerable number remain dissatisfied with the present results. To overcome this, large companies must broaden their network to include a diverse range of partners, allowing for a more ambitious innovation approach and, ultimately, realizing greater long-term business value.

3 RESEARCH METHODOLOGY

In this chapter, the research design and the methodology chosen for this study are provided. Firstly, the philosophical considerations will be presented, considering the underlying principles and assumptions which guided the author's approach to the study and highlighting its significance in the context of the study. Subsequentially, the research design is presented in order to explain the reasons behind the use of a qualitative, exploratory method. The third section entails the methodology for data collection, elucidating the semi-structured interview process for primary data collection and outlining the approach employed for gathering secondary data. Additionally, it provides insights into the sample selection. The concluding paragraph focuses on evaluating the data's quality.

3.1 Research philosophy

According to Saunders et al. (2019), research philosophy *"refers to a system of beliefs and assumptions about the development of knowledge".* It is based on epistemological, ontological, and axiological assumptions, which eventually impact the way the author understands the research questions, as well as the methods to interpret findings. In particular, ontological assumptions are linked to the nature of reality, and surely Influence the way in which you perceive and examine your subjects of research. Epistemological assumptions entail the nature of knowledge, its validity and legitimacy, and the way knowledge can be communicated to the external environment. It is surely more concrete than ontology, as it includes different types of data which can have total legitimacy. Therefore, the choice of using different epistemological methods depends also on the objectives and delimitations of the research. Finally, axiology deals with the broad function of values and ethical considerations in the research process. The choice of the topic, among a different and vast number of topics, reflects how that specific topic is important for the author. Axiological considerations can be applied also to the choice of the data collection. For instance, choosing to conduct a qualitative study based on

interviews Indicates a greater appreciation for engaging personally with the participants in your study, rather than analysing views conveyed via anonymous questionnaires.

Examples of research philosophies include positivism, realism, interpretivism, and pragmatism, as mentioned by Saunders et al. (2019). This thesis adopts an interpretivist philosophy to comprehend the authentic significance of expressions, recognizing the potential variations in meaning for everyone, influenced by their surrounding environment. According to Saunders et al. (2019), the interpretivist approach assumes that reality is subjective and therefore can be perceived differently by diverse individuals. Furthermore, the data gathered and analysed would be less likely to be generalised through adoption of the interpretivist paradigm given the consideration that data were mainly dependent on a specific context, viewpoint, and values. This approach was selected primarily because of the nature of the study, which aims at analysing the context of OI within large companies and startups, and the relationship between OI and sustainability.

With regard to theory development, the research literature so far has widely discussed and adopted three main approaches: deductive, inductive, and abductive. These approaches influence how the stream of knowledge under examination is presented. The deductive approach involves testing existing theories and basing research on a theoretical framework derived from academic literature, with the aim of clarifying specific phenomena. Conversely, the inductive approach seeks to generate new findings and develop theory based on systematically collected data. Lastly, the abductive approach seeks to develop innovative understandings of phenomena by collecting data, testing theories, and proposing modifications or additional propositions (Saunders et al. 2019).

This study adopts a mixed approach, linking elements of both deductive and inductive reasoning. It adopts mainly an inductive approach, which is aimed at generating new insights through a bottom-up approach, deriving general principles from specific results,

allowing theories to emerge after the systematic analysis of the collected data. The objective is to integrate more precisely the current findings of the literature in a more exploratory manner. The reason behind the adoption of such an approach is given by the little literature present on the topic of SOI. However, the study also leverages the existing literature of OI in order to address the RQs and analyse the findings. Therefore, it is important to show the previous research on OI, specifically involving the dynamics of OI between large companies and startups, with the aim of generating new insights and perspectives through the examination of the collected qualitative data.

3.2 Research design

This study is designed to be exploratory, given that the main objective is to evaluate the key dynamics of SOI between large companies and startups, which is not broadly illustrated in the actual literature. Moreover, given that there is not precise theoretical framework which combines the theme of SOI, the purpose of the study will be to redefine more precisely the current findings, and provide a contribution to the existing yet little literature on the topic. The gaps presented in the introductory section would be addressed with this exploratory study established on real case studies. This exploratory nature of the study allows more flexibility and potential adjustments, with the objective of uncovering new insights and laying the groundwork for more focused investigations. Given the limited existing knowledge on the topic, the primary goal of such a method is to build hypotheses rather than testing specific hypotheses.

Regarding the research method, this study adopts a multi-approach method, through several case studies which are conducted in specific selected companies. This would allow to better understand the internal dynamics of the selected companies, thanks to a holistic approach. The advantages of the mixed approach include the opportunity of deep diving into the OI dynamics of the selected companies, with the goal of analysing with effectiveness the key factors behind the implementation of OI, in order to answer the research questions and fulfil the objectives of the study.

This study is designed to be qualitative. Qualitative data relies on the interpretation of meanings conveyed through words and images. Gathering such data leads to non-standardized information, which needs categorization, and its analysis is carried out through the process of conceptualization. Therefore, data will be gathered through diverse sources and methodologies to guarantee the research's validity, reliability, and credibility (Saunders et al. 2019).

In this study a combination of primary and secondary data will be chosen. Predominantly, primary data will be collected through semi-structured interviews within the selected companies which will serve as case studies, thanks to their active management and knowledge of OI. In particular, both the point of view of large companies and startups will be presented. Also secondary data will be used in order to develop a deeper knowledge of the companies interested to the case studies, and eventually enhancing the existing framework of the dynamics of SOI. By using secondary data, the goal is to develop a broader framework of the main reasons behind the adoption of SOI from both startups and large companies. The sources of secondary data will be text and non-text documents, data-set, annual reports, company websites and press release. Such multiple data sources can allow an inclusive and broad depiction of the case study, with the goal of comparing and broadening the theoretical framework on SOI presented in the previous chapters. The adoption of a qualitative research method, through semi-structured interviews, is chosen in order to lead to a better understanding of the dynamics to be analysed, as it can provide relevant insights thanks to high-quality, more intense interaction. Moreover, qualitative data are generally more varied, complex, and richer in content, and enables the researcher to explore complex subjects. Adopting semi-structured interviews offer a great flexible format in which, despite the presence of a predetermined set of questions and topics, the interviewer can freely explore and follow up responses in a conversational manner. The presence of open-ended questions encourages participants to provide detailed responses, and can

allow a deeper understanding of the interviewees' perspectives, experiences, and opinions (Saunders et al., 2019).

Regarding the sample, it will be chosen based on convenience, availability, and personal network for reaching companies that are involved in OI projects. Specifically, this study includes perspectives on OI from both sides of the picture. On one hand, the selected large, established companies which have implemented internally OI can provide relevant insights into how OI works for them, the reasons behind the choice of pursuing an OI approach, and eventually the key elements of the collaboration with startups for implementing sustainable solutions. On the other hand, startups can provide their reasons to collaborate with more established companies, as well as the benefits, risks, and barriers of such OI partnerships. The overall objective of the researcher, in fact, is to investigate both sides of the partnership, analysing their relationship and eventually be able to respond to the RQs. The choice and availability of the sample companies turned out to be extremely relevant for the purpose of this study, as two different cases of SOI will be presented, which entail collaborations between a large, established company, and the innovative startup.

The choice of the right companies for this study is important for reaching the objectives of the study. First of all, finding the right person who has knowledge about the topic of OI, is necessary in order to collect reliable data and insights. This is the first and most important prerogative for a reliable and trustworthy approach to the empirical part. The case studies are all selected in coherence with the literature, the RQs, and the objectives of the research. For this reason, this study presents a double partnership between a large company and a startup, therefore two large companies and two startups which mutually collaborate for different purposes.

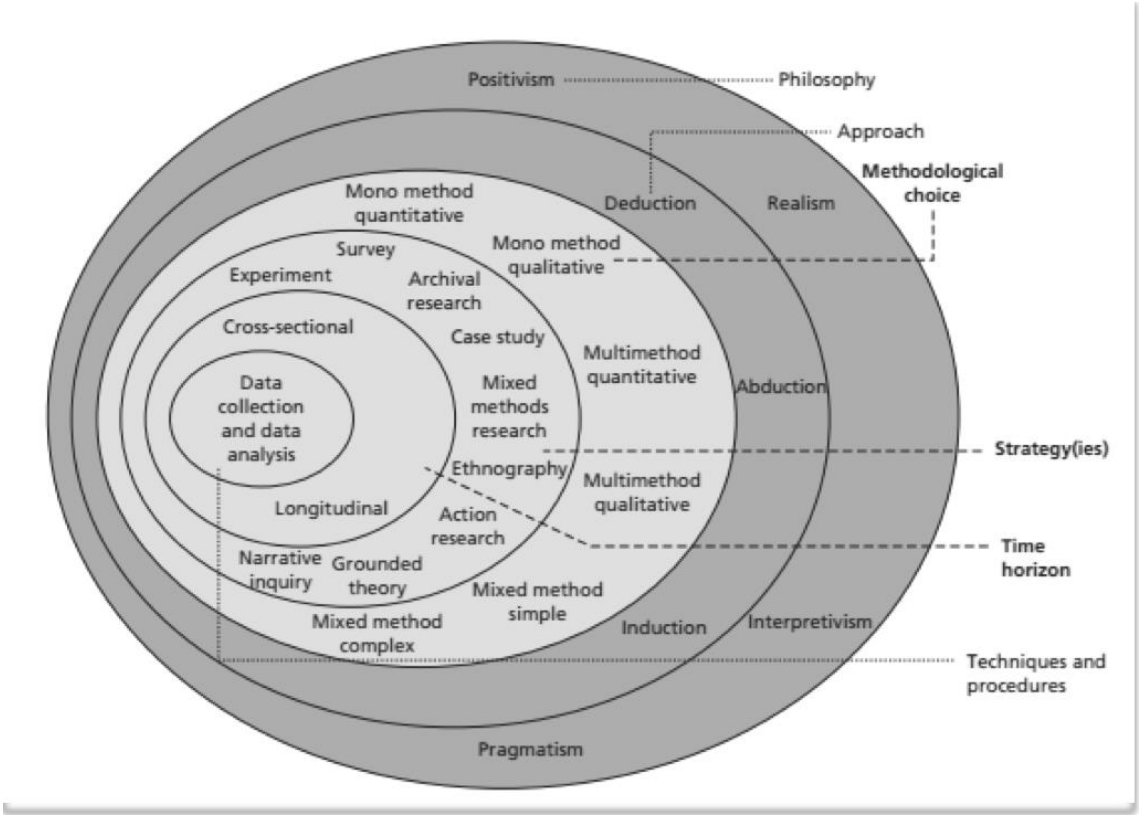

Figure 5. The research onion (Saunders, Lewis & Thornhill, 2019).

3.3 Data Collection

As previously mentioned, this study combines both primary and secondary data sources in order to have a comprehensive amount of evidence to better answer the RQs and align with the thesis' objectives.

Regarding primary data collection, there is a combination of in-person and virtual interviews with the selected participants. The procedure is the same for every interviews. Firstly, the researcher selected the interesting sample for the case studies, following the criteria presented before, and accordingly to the study's objectives. Then, a list of potential participants was contacted among the interested sample. Some of them showed positive interest in the case study and agreed on being interviewed, for a total of five respondents. Those participants were among the top choices and represented a significant feature which would validate the case study. In the end, two large companies

were contacted: the Italian energy giants Snam and Italgas, and two startups, Limenet and Oraigo, which collaborate respectively with Snam and Itlalgas on joint Open Innovation projects. Both the large corporates, Snam and Italgas, were contacted through the author's personal network, while the startups were identified while interviewing the referents of both large companies. In those contexts, given the specific relevance and pertinence of the collaborations with the two startups presented, they were eventually contacted by the author for the interviews. Therefore, in the end, four interesting case studies of SOI are presented, involving collaborations between large companies and startups in an OI context.

In the first phase of the data collection process, also the design and process of the interview were delineated. The questions were formulated considering the theoretical foundations and adjusted to align with the RQ and the study's objectives. The interview guide was prearranged in advance and shared with the companies simultaneously during the phase of participant recruitment. It must be noted that the interview text took into consideration the different nature of the companies involved. The themes discussed during the interviews were similar, in the case of the large companies as well as the startups, yet the focus was slightly different, without compromising the validity and reliability of the data collected. This choice was made by the author in order to meet the different nature of the selected companies, and to align with the interpretivist background.

Also secondary data were collected, mainly through internet sources. They come from publicly available sources, especially companies' websites, press releases, and articles. The secondary data presented in this study serves as a way to grasp a wider overview on the main drivers of the implementation of OI, and understand the different OI activities which are in place in the selected companies.

Overall, 5 interviews were concluded. They took place online, lasted from 30 to 75 minutes, and the language was Italian. Only the core concepts of the interviews were translated in English.

Table 1 shows a summary of the interview process, along with the specific roles of the companies' respondents which were interviewed.

Table 1. Summary of the interview process

Interview process	**Snam**	**Italgas**	**Limenet**	**Oraigo**
Date	B.A: 27/12/2023 M.L: 11/01/2024	12/01/2024	18/01/2024	18/01/2024
Location	Online	Online	Online	Online
Duration	B.A: 1 hr 7 min M.L: 35 min	49 min	46 min	42 min
Language	Italian	Italian	Italian	Italian
Job position of the interviewees	M.L. *PMO OI* B.A. *OI Specialist*	F.C. *Head of OI*	M.G. *Co-Founder*	B.C. *Junior Impact Assessment Specialist*

3.4 Data Analysis

According to Saunders et al. (2019), utilizing qualitative data may offer a broad perspective for the study, yet it can arise challenges in the articulation of the meanings conveyed by the interviewees. They are definitely well-suited for the exploratory nature of this study, as thet allow the author to generate hypotheses which can build on the existing literature. In this study, the findings are therefore classified and restructured for a clearer representation of the respondents' considerations and insights. Given the qualitative nature of the data, they inherently lack standardization, and therefore they need to be classified in order to align with the study's objectives.

As previously mentioned, primary data collected through interviews serve as the primary source of information for developing the empirical section. In addition, secondary data sourced from articles, company websites, and annual reports were utilized. The data obtained though the interviews are analysed to establish connections with the theoretical part. On one hand, they provide empirical evidence to support the previously discussed theory, while on the other hand they are used to build up the theoretical framework which will be presented at the end of the findings section. The data were analysed through mainly an inductive approach by the author, in accordance with the exploratory nature of the study. As a consequence, the goal is to generate new insights, theories, and generalisations based on empirical observations. However, it is important to underline that the theoretical part serves as a guide for developing the empirical section, therefore it is functional in building up the final theoretical framework.

The five interviews were analysed through a comprehensive examination of the data provided, with a specific focus on the data which were considered appropriate for the study. With this regard, it is important to analyse the interviews by taking into account the inherent meanings expressed by the respondents. In the following chapter, selected quotes from the interviews are included in order to enhance the comprehension and capture the essence of the information provided. Such an analytical approach addresses

the challenge of oversimplifying qualitative analysis, thereby ensuring that core aspects and considerations are not overlooked.

4 KEY FINDINGS AND EMPIRICAL INVESTIGATION

In this section, the empirical findings will be analysed in order to address the RQs and meet the empirical objectives outlined in the introductory chapter. The primary objective is to establish a connection between the theoretical part and the empirical results. However, given the exploratory nature of the study, the focus will be on the new insights coming from the data analysis. In the beginning, the author provides an overview of the selected companies, focusing on the role of OI within these companies, both in a general way and more specifically in relation to sustainable development. Subsequently, the findings coming from the primary data will be summarized and presented. Initially, the focus will be on the key drivers for the implementation of OI between large companies and startups, in order to be able to answer the first RQ. Secondly, the author will investigate the benefits and positive aspects, as well as the main issues, of the OI approach between large companies and startups, and this will be functional in order to answer the second RQ.

4.1 Presentation of the case studies

Below an overview of the case studies will be presented. Overall, a total of five interviews will be conducted, in the following four companies: Snam, Italgas, Limenet, and Oraigo. The first 2 companies are large and well-established companies with a strong heritage in the Italian energy industry. Over the recent years, they have pursued new innovation approaches in order to open up their innovation models, become more agile, stay competitive, and adapt to a very dynamic and fast-changing business environment. With this regard, in the past years they implemented Open Innovation as part of their present and future strategic plans. The third company, Limenet, is an Italian startup which patented an innovative technology that allows stocking of CO2 into water. It is establishing multiple collaborations with external stakeholders, especially with Snam, with the clear purpose of embracing a more collaborative approach to innovation,

strongly driven by sustainability. Finally, Oraigo is an Italian startup which developed an innovative brain-computer interface to tackle the issues of drowsiness and microsleeps while driving. It is collaborating with Italgas on several OI initiatives.

Both Snam and Italgas, the two large companies of this case study, have implemented OI for multiple purposes which will be presented in the following sections, with a clear focus on the fundamental role that OI is playing in accelerating their innovation path, and facilitating the transition to sustainable development. Both Limenet and Oraigo, the two startups presented in this study, are also benefitting by the collaboration in OI projects with respectively Snam and Italgas, and their motivations and key factors to pursue OI activities will be presented as well.

In January 2024, an interesting report from Mind the Bridge showed some forecasts on the investment plans of companies in relation to OI. Mind the Bridge is a leading organisation in the field of OI, and plays a vital role in promoting OI by facilitating collaboration between startups and established companies, providing support and resources to startups, building global entrepreneurship networks, advocating for favourable policies, conducting research, and contributing to ecosystem building efforts. Unfortunately, the report showed that a relevant number of companies in different industries, are planning to reduce their OI efforts, and therefore investments, in front of fears of economic downturns and for cost-efficiency reasons. (Onetti – Mind the Bridge, 2023). Nevertheless, both Snam and Italgas are planning to increase their OI investments over the years, as they recognize the importance of OI for their present and future innovation priorities, and are positively convinced, backed by concrete results, that OI can play a fundamental role in accelerating their business transformation, become more agile, and eventually speed up their transition to more sustainable businesses.

The empirical part and the discussion of findings will have the following structure: firstly, each company will be presented with a general overview of their business, history, and key characteristics. More importantly, the focus will be laid on the OI activities, as core

element in this study. Consequently, there will be a broader investigation into the triggers and drivers of OI for each of the companies interviewed. This part will allow to answer the first RQ, and provide relevant insights with relation to that. Afterwards, the study will explore further the OI dynamics and relationship between large companies and startups, which will allow to discover the key benefits and issues that emerged during the qualitative analysis. This second part will allow us to answer the second RQ.

4.1.1 Snam

Snam S.p.A. is an Italian energy infrastructure company, specialized in the transportation and storage of natural gas. It is one of the largest gas infrastructure companies in the world, with 3.515 billion revenues according to the latest 2022 financial report, and it operates in the midstream sector of the natural gas value chain, primarily involved in the transportation, regasification, and storage of natural gas. While its primary operations are in Italy, Snam has developed over the recent decades a strong international presence, in order to expand and foster collaboration in the energy sector. The company has a publicly traded ownership structure, and its shares are listed on the Milan Stock Exchange (Borsa Italiana).

Snam is actively involved in research and innovation projects related to energy transition, and has committed to many initiatives promoting the use of renewable gases in order to reduce its environmental footprint. The company is strongly communicating its commitment to tackle today's grand challenges, through a more collaborative approach to innovation: "*The global energy scenario presents us with crucial challenges for the future. Challenges primarily involve sustainable development and the energy transition of our country. In a context of continuous and rapid evolution, innovation and cross-fertilization have always been fundamental drivers in Snam's strategies*" (Snam website, 2023). Snam has launched a significant Open Innovation program, called *SnamInnova*, which is a multi-year Open Innovation program coordinated by a dedicated Open Innovation team. It is focused on three key areas:

1. Projects with Startups: Snam collaborates with startups to explore and implement innovative solutions, leveraging external expertise and creativity.
2. Development of Employee-Generated Innovative Ideas: The program encourages employees to contribute and develop innovative ideas, fostering a culture of creativity and problem-solving from within the organization.
3. Cultivating an Innovation Culture: Snaminnova is dedicated to spreading a culture of innovation throughout the company, emphasizing the importance of staying at the forefront of industry trends and embracing a mindset of continuous improvement.

In addition to the *SnamInnova* project, the company introduced another project called *Snamtec* which reflects the Snam's long-term strategy plan, which is more and more focused on innovation and sustainability oriented. In fact, the acronym TEC stands for "Tomorrow's Energy Company", aiming to accelerate the innovative capacity of the company and its assets to seize all the opportunities offered by the evolution of the energy system. Snamtec *"is built on four pillars: energy efficiency, technology, sustainable mobility, and renewable gas. It's a kind of Snam 4.0. Our network is increasingly becoming a network of sustainable energy. And with the work of the Snam Foundation, it also becomes a virtual network for a relationship with the territory based on dialogue and transparency. A network of ideas to connect all stakeholders and act by creating a system."* (Snam website, 2023). Sustainability represents therefore a key pillar of the company's present and future objectives.

OI was implemented internally almost three years ago, with progressive investments over the years in OI projects and activities. The general feeling oof the company is that the positive benefits can definitely overcome the investments efforts, according to Matteo and Benedetta, our interview's respondents.

Within its Open Innovation area, a fundamental role is played by scouting activities, through partnerships with external players in the innovation ecosystem, such as the Polytechnic University of Milan and its Startup Intelligence Observatory, of which the company is a partner, as well as through the internal Innovation & Technology team. Within the scope of its OI activities, Snam addresses both the national and international markets, and has undertaken partnerships with both Italian and international organisations.

4.1.2 Italgas

Italgas is a major Italian energy company, leader in the Italian natural gas distribution sector. With a long history, dating back to its establishment in 1837, it has always played a significant role in italy's energy landscape. The company is responsible for the management and maintenance of natural gas distribution networks in various regions of Italy, and it plays a crucial role in ensuring the efficient and safe delivery of natural gas to households, businesses, and industries. Italgas has 2.2 billion revenues as for the latest 2022 financial report, and it's publicly traded on the Milan Stock Exchange (Borsa Italiana).

Nowadays, like many other energy companies, Italgas is focusing more and more on innovation and sustainability to accelerate its business transition. This includes the adoption of advanced technologies for its network management, as well as efforts to align with environmental and energy efficiency goals. In fact, also due to the evolving landscape of the energy industry, the focus on innovation and sustainability is paramount, and entails the adoption of core technologies to improve operations efficiency, reduce environmental impact, and contribute to the broader goals of the energy transition. The company recognizes the great potential of cross-collaborations, especially with startups, in order to accelerate its transition to a more sustainable business, by allowing disruptive startups' technologies to be implemented internally, if already ready to use, or by closely collaborating in co-development projects.

In fact, nowadays OI plays a fundamental role for Italgas to achieve its long-term sustainability and strategic goals. Over the years, the company has intensified its search for technologies that fosters the evolution and sustainability of gas distribution networks. This is achieved through ongoing and consistent exploration of startups and innovative small and medium enterprises (SMEs) on both national and international fronts. Additionally, the company has established offices in Silicon Valley and Tel Aviv, strategically positioning itself to actively oversee two of the world's foremost innovative technology hubs. The energy company has also introduced the Ideas4Italgas platform as part of its OI initiatives. This platform serves as a tool to expedite corporate innovation and enhance strategic positioning within the global innovation network. It facilitates the collection of top-notch ideas from both external sources and internal company channels, fostering collaborative development processes.

Digitalisation also plays a relevant role in Italgas' OI strategy. Its "Digital Transformation journey" is driven by the company's ability to foster multiple collaborations with external partners, mainly startups. With this regard, large investments are planned in the coming years: €4.5 billion have been allocated for the development and modernization of the Italian gas distribution network, while a total of €1.5 billion have been planned for the ongoing digital transformation initiatives of the gas network. The goal is to achieve a fully digital network, which is essential for efficiently managing the distribution of renewable gases, including biomethane, synthetic methane, and hydrogen. Furthermore, 2.7 billion euros are dedicated to the ongoing repurposing, development, and enhancement of existing infrastructures. Such relevant investments will reflect the company's "*contribution to the creation of a net-zero energy mix by 2050, as envisaged by the European Union"* (Italgas website, 2023).

4.1.3 Limenet

Limenet is an Italian startup founded in 2020 by Stefano and Giovanni Cappello. The startup has developed a groundbreaking technology that allows stocking of carbon dioxide into seawater. The consequent positive effect entails the reduction of CO_2 in the atmosphere and the subsequent increase of water alkalinity, with positive benefits for marine life. The history of the startup dates back to 2018, when a community of scientists, researchers, investors, and entrepreneurs come together to share ideas, thoughts and new projects with the objective of tackling the issue of climate change. The name of such community is Desarc Maresanus, and the main intuition of the focus group was related to the absorption of CO_2 through calcium bicarbonates. Over the following years, thanks to a pool of experts and researchers which started to share knowledge on the technological process of stocking CO_2 into water, the community recognizes that its intuition was about to become feasible and actuable. Therefore, from theory to practice, and thanks to collaborations with other companies, the technical and scientifical evidence validated the newborn technology and confirmed the positive results in terms of stocking CO_2 into water. In 2023, the startup implemented the first productive plant with an operational storage capacity of hundreds of tons of CO_2 per year. Today Limenet is a tech benefit company with industrial collaborations and international partnerships, aiming to scale its technology for CO_2 storage in the form of bicarbonates to gigatons. The startup also holds the patents for its patented technology called, indeed, *Limenet* (Limenet Website, 2023).

For Limenet both innovation and sustainability are embedded into the company's nature. From the inception of the company, the original idea was also driven by the strong commitment to creating a positive change for the planet, in order to tackle the serious issue of climate change. Nowadays, with more scale-up plans and available resources, that mindset continues to shape the company's strategy and activities:

"Our commitment to sustainability extends beyond mere words; it is reflected in concrete actions and initiatives undertaken by Limenet since the very first day. In fact, the original

idea, that was further developed into the Limenet patented technology that we all know today, was born as a way to address a demanding and serious issue of our society: climate change" (Beatrice, Impact Assessment Specialist, Limenet)

In reaching Limenet's long-term goals, OI plays a vital role as it ensures a more rapid scale-up of the technology, while allowing the company to expand its commercial and partnership network. In particular, the partnership with Snam has been remarkable so far as it already resulted in concrete results which benefitted both partners. The relation between OI and sustainability is complementary for Limenet, and contribute to addressing complex global challenges, with potential positive results for the environment to be achieved, according to Beatrice. However, the focus of the startup is not only on environmental sustainability. In fact, Limenet employs a 360° degrees approach to sustainability, putting a serious focus on the broader social impact of its technology in place:

"One key point I want to emphasize is that, for Limenet, the economic value is inherently linked to the environmental value. To clarify, as we generate greater economic value, we concurrently produce a more positive environmental impact. Limenet's essence embodies complete integration of economic, social, and environmental sustainability on a comprehensive scale, at a 360° degree level"
(Beatrice, Impact Assessment Specialist, Limenet)

4.1.4 Oraigo

Oraigo is an Italian startup founded in 2019 and headquartered in Padova, Italy. The company developed a brain-computer interface (BCI) called AiGo, along with a mobile application and a web platform, dedicated to combating drowsiness and preventing accidents while driving. Their mission is to enhance road safety, particularly for B2B transport companies, with a SAAS business model. Oraigo seeks a solution against drowsiness while driving that intervenes, promotes responsibility, and fosters the

professional growth of drivers, and offers the opportunity to improve both driver and vehicle safety and productivity through their Aigo web platform driven by AI.

Figure 6 shows Oraigo's innovative brain-computer interface, which *"might look like a pair of earphones, but it's way different than that!"* (Michele, Co-Founder). The application is actually quite simple: when the user wears the interface, the item detects any fatigue or drowsiness with its advanced technology. If so, the intervention phase comes into place: *"Utilizing sound, visual, and haptic alerts, our system functions efficiently in both daylight and nighttime, operating seamlessly at any speed, even below 65 km/h—an area where many other systems may not function. This adaptability is crucial as we recognize that drowsiness or microsleep can manifest at any given moment, irrespective of speed or lighting conditions"* (Michele, Co-Founder). In addition to this, the fleet management web app allows to provide real time feedbacks on the physical status of the driver, with the objective of continuously improving safety by reporting valuable insights.

Oraigo's OI activities started as a mere necessity, as the startup was looking for partners that were willing to experiment the innovative technology, and contribute with feedbacks and insights in order to improve it. After receiving some relevant media exposure, with several newspapers and articles which started to praise the innovative and socially sustainable solution, the startup became more and more attractive as a partner for many organisations, among which Italgas. In fact, the Italian energy giant, immediately proposed a partnership in order to test the solution and provide insights and inputs, as well as resources. Such a partnership has proven to be beneficial for both players. An in-depth analysis of such benefits will be provided in the following sub-chapters.

The sustainability aspect is also embedded in Oraigo's core purpose, and is reflected by the great social impact of its solution. In fact, social sustainability, as an essential pillar

of sustainable development, is well pursued within the startup, which contributes with its innovative technology to health, safety, and well-being for all users:

"The social commitment of Oraigo is to promote road safety and well-being. We raise awareness about responsible driving practices and collaborate with organizations to promote safe driving. Our goal is to create a positive impact in society, safeguarding the lives of drivers and passengers." (Michele, Co-Founder, Oraigo)

Figure 6. Aigo, Oraigo's brain computer interface

Table 2. Sample companies

	Snam	Italgas	Limenet	Oraigo
HQ	Milan	Turin	Lecco	Padua
Business size	>250 employees	>250 employees	10-20 employees	5-10 employees
Industry	Oil & Gas	Oil & Gas	Climate Tech	IT
OI model	Mainly Outside-In	Mainly Outside-In	Inside-Out	Inside-Out
OI Inception	2019	2020	2022	2022

4.2 Factors and motivations to implement Open Innovation

In this paragraph are outlined the main factors and drivers behind the implementation of OI in the selected companies, therefore the motivations to pursue OI between large companies and startups. This paragraph presents the following structure: firstly, the focus will be on the analysis of the results in the selected large companies, hence Snam and Italgas. Subsequentially, the same analysis will concern the two startups, Limenet and Oraigo. Such a structure will also be presented in the following chapter on the benefits and challenges of OI.

4.2.1 Snam and Italgas

As mentioned in the sub-chapter regarding the presentation of the companies' case study, both Snam and Italgas have established strong OI initiatives which involve structural collaborations with external partners, especially startups. By embracing external sources of innovation, these large, well-established companies can enhance their competitiveness, agility, long-term growth, and stay at the forefront of technological advancements, according to both companies' referents.

By deeply investigating the triggers and drivers behind the choice of embracing OI as a new approach to innovation, several interesting insights came up during the interviews. According to Matteo Lusignani, Project Management Officer (PMO) Open Innovation at Snam, a diverse set of motivations were driving the initial decision to apply OI as part of the company's innovation strategy. With this regard, Snam's purpose is to undertake a holistic approach to innovation, with multiple stakeholders, both internally and externally, that can interact in order to enhance the innovation process. One of the main goals is to strengthen the presence of innovation hubs that can create environments in which internal teams collaborate with external, innovative, sustainable startups. This new approach conflicts with the traditional, vertical, closed innovation method which was applied in the past:

"Our key activity is the exploration of the Italian and international innovation ecosystem in order to detect the most promising, useful, sustainable startups. Such an external exploration of innovative technologies allows us to approach innovation in a more open and fruitful way. Closed innovation […] can result in a narrow range of solutions, potentially missing out on innovative ideas and solutions from external sources. We want to keep up with the pace of innovation, and we see this in a more open, collaborative approach to innovation" (Matteo, PMO Open Innovation, Snam)

Snam's leading objective is to implement sustainable solutions to shift their innovation model, and eventually their business model, because by nature startups have more innovative and sustainable solutions which can be applied to the company's core business, now and in the future. In fact, the respondent stressed in particular the implementation of external, sustainable innovations that can be directly applied to the company's business and operations:

*"We want to find and attract the best, innovative technologies that can be applied internally. Through our OI approach, we attract and detect startups which our fundamentally relevant for our core business needs, and that can help us accelerating our shift to a more sustainable business model. We also get a lot of external pressure, from society, governments, institutions, to do more in order to develop sustainable solutions, and in the long-term we see our traditional business model fast changing to meet such demands. Startups can help us achieving that" (*Matteo, PMO Open Innovation, Snam)

While the societal and institutional pressure to invest in sustainable activities arises, especially in the energy sector, and represents an important factor to pursue sustainable innovations, our respondent does not find such external pressures to be a core motivation to pursue OI sustainably. Snam surely recognizes the importance of meeting such environmental demands, and act accordingly. However, scouting and partnering up

with external startups is done in order to accelerate the application of solutions which can directly impact the present needs of the company. And such solutions must be sustainable, in order to meet Snam's long term goals. Given that the company is strongly committed in environmental sustainability, and is undertaking several initiatives to shift its business model, it automatically requires its OI teams to connect with, and onboard, only innovative and sustainable startups. Matteo pointed out quite clearly that there is no innovation without sustainability for Snam, and therefore if a startup proposes an innovative yet unsustainable solution, the company would not take it into consideration:

*"Our focus, in the startups' exploration phase, is above all on sustainable startups, in total coherence with Snam's strategic plan, in which sustainability and ESG criteria play a dominant role. Sustainable startups are often at the forefront of developing new technologies related to clean energy, and eco-friendly solutions. Collaborating with such startups provide us with access to those innovative technologies to enhance our own sustainability efforts. We strongly believe that there is no innovation without sustainability" (*Matteo, PMO Open Innovation, Snam)

A subsequent objective that Snam pursues in its OI activities, is scaling up external sources of innovation, internally:

"Through POC (Proof of Concepts) projects, pilot projects, and other collaborative projects with our partners, we aim to scale up the startups' innovative solutions internally. We can provide our startup partners with our resources, market access, knowledge and expertise to scale their solutions rapidly" (Benedetta, Open Innovation specialist, Snam)

Scaling up its startup partners' sustainable solutions through OI is fundamental in order to pursue the company's long term goal of shifting the business model, by making it more sustainable. In fact, as Snam is undertaking and planning a strong business transformation, it needs more and more external sources of innovation to accelerate the process. Startups are a powerful engine that can facilitate the process, and the mutual

collaboration is necessary and functional to Snam's purposes. The strong motivation to pursue OI as a trigger for implementing sustainable solutions more rapidly, is at the forefront of Snam's OI strategy.

Fundamentally, the main drivers behind the implementation of OI activites in Snam are the following:

- Accelerate the company's business transformation driven by sustainability, as OI collaborations can result in quicker development and application of solutions to be applied internally.
- Quicker and more effective implementation of innovative, sustainable solutions which would require significantly more time if pursued internally and independently. Hence OI with startups can be seen as a facilitator and more effective approach to a rapid implementation of innovative solutions.
- Accelerate the shift to sustainability, by collaborating with startups that provide innovative and most importantly sustainable solutions that can accelerate the transition to sustainable development, and a shift of business model eventually. OI can therefore represent a useful approach to business transformation driven by sustainability.
- Scaling up the partners' solutions internally, through a complete OI approach involving resources, know-how, and expertise from the large company.

Regarding Italgas' main triggers to implement OI, several remarkable insights were revealed in the interview process. A core motivation that was underlined was the strong need of a comprehensive business transformation strategy driven by innovation and sustainability. OI was initially perceived as a powerful approach to address a more rapid business transformation within the company:

"First and foremost, the company required a strong business transformation, according to Italgas long term strategy plan. Italgas' core business was mainly traditional, and by taking into account the current economic and geopolitical scenario, as well as the challenges faced by the energy industry, the company started to recognize the importance of opening up its innovation model in order to implementing innovative, leaner, sustainable solutions in a more effective way, and also more quickly, by partnering up with external players. How can we do that? Through Open Innovation" (Fabrizio, Head of Open Innovation, Italgas)

For Italgas, the external environment played a significant role in driving the new approach to innovation. As both general geopolitical and economic challenges, especially regarding the energy sector, strongly arised in the past years, the need to quickly adapt to that fast-changing environment was more and more visible and urgent. Accelerating the pace of innovation was considered necessary, as OI allows faster development and deployment of new solutions which can directly impact the company's business, and be functional in achieving the company's goals. In this specific case, the respondent believes that OI could lead to a quicker implementation of innovative solutions, and that can be functional in achieving the goal of shifting its traditional business model. Italgas' business transformation is already reflected into newest technologies that have been applied internally, over the recent years, also thanks to the company's more open approach to innovation. From a traditional to a *"network tech company",* Italgas is not only providing efficient gas to households, despite still representing the company's core business, but it also managed to create tech networks which innovated its main physical assets, the pipelines. By implementing innovative solutions, Italgas made those traditional assets smarter and digital.

Another fundamental factor in the choice of implementing OI was given by sustainability. According to Fabrizio, OI can facilitate the adoption of sustainable business practices as it encourages collaboration on environmental as well as social initiatives. By partnering with external stakeholders, especially innovative startups, businesses can co-develop

positive solutions to sustainability challenges, reduce their environmental footprint, and create shared value for society:

"Sustainability is at the forefront of Italgas' long term strategy, and represents a key driver of our OI method. Through a more open approach to innovation, it is more likely to partner up with sustainable startups that can provide sustainable solutions to our business needs. However, sustainability is not only limited to the environmental protection, yet we also embrace social sustainability, hence we want to create a positive impact for the whole society. That's why we don't like to select only startups solutions that directly affect our core business" (Fabrizio, Head of Open Innovation, Italgas)

Finally, a third factor to consider in the implementation of OI within Italgas is the mitigation of risk and uncertainty, which can occur through several mechanisms inherent in collaborative approaches. By diversifying inputs, sharing resources, and accessing valid knowledge and feedbacks, large traditional organisations like Italgas can navigate uncertainity with greater resilience, especially in increasingly complex and unpredictable business environment, like the energy sector. In fact, collaborating with startups provides access to specialized skills and expertise which might not be available internally. That can mitigate the risk of technical and knowledge gaps, which would have probably slowed down the innovation process which is needed in order to drive competitive advantage, according to Matteo.

To summarize, the key drivers for the implementation of OI activities in Italgas are the following:

- Accelerate the company's business transformation, driven by sustainability
- Implementing quicker and more effective sustainable solutions
- Accelerate the transition to sustainable development
- Mitigation of risk and uncertainty in an increasingly complex business environment
- Continue driving competitive advantage over time

4.2.2 Limenet and Oraigo

OI can play a crucial role in the success and growth of startups, as presented in the literature review. Despite the fact that Limenet and Oraigo have a different business and operate in different sectors, there are some common factors that characterized the choice of implementing OI as their main innovation model, specifically in relation to OI collaborations with larger companies. Such core factors are outlined as follows:

- Market access and distribution networks
- Scalability of operations
- Access to external resources

Market access and the enlargement of distribution networks are critical for startups in the initial phases. In particular, according to both respondents from Limenet and Oraigo, collaborating with established companies through OI initiatives provides startups with opportunities to access new markets and customer segments. Large companies often have their presence in different geographic regions, and a wide network of partnerships, which can help startups expand their market reach and penetrate new markets more effectively that they would do independently. In addition to this, by tapping into the knowledge and experience of their corporate partners, startups can gain a better understanding of market dynamics, customer preferences, and competitive landscapes, which in turn would enable them to refine their products or services to fit greater markets. According to Michele (Oraigo), if startups are able to exploit the advantages of a collaboration with large companies, they could be able to engage in a more effective business development:

"Collaborating with larger companies, which usually have a wide network of business relationships, certainly provides us with massive opportunities in terms of access to new markets and distribution networks, which is paramount for us at the very early stages, when we really need to start expanding our market reach"
(Michele, Co-Founder, Oraigo)

In addition to this, startups need to enlarge their operations and distribution networks, and this aspect represents another crucial factor to pursue OI with more established companies. Access to established distribution channels, such as the ones of larger companies, allow startups to rapidly scale their products or services, as well as their operations. In fact, large companies can assist in scaling production, distribution, and other operational aspects, helping startups meeting a potential increased demand for their products or services more efficiently. Such scalability needs often differ from startup to startup, mostly depending on the core business and sector they are operating in, according to both respondents. For instance, Limenet require scalable infrastructure as they grow its operations, which is functional in scaling up its innovative technology:

"It would be definitely harder to imagine scalability without our partnerships with more established companies, or at least it would require way more time to reach proper scalability of our operations. I couldn't emphasize enough the critical importance of scaling up our infrastructure to ensure a rapid implementation of our technology on a larger scale, and this is obviously functional, as a consequence, in enlarging our market and distribution network" (Beatrice, Impact Assessment Specialist, Limenet)

A third, core motivation in pursuing OI activities with more established companies is represented by the opportunity to leverage the partner's resources. As general as it might seem, from access to funding to infrastructure and facilities, as well as expertise and knowledge, leveraging the partner's resources can possibly result in an acceleration of the startup's growth and competitiveness. Depending on the proper needs, startups would benefit from different resources of the large companies. For Limenet, for instance, there is a high demand in infrastructural and technical resources, in order to scale up its technological production. With this regard, Snam possesses a well-established infrastructure, facilities and equipment that could serve well in reducing the operational costs and accelerating the development process. In addition to this, logistical support

and access to manufacturing facilities was mentioned during the interview as a core factor in overcoming the lack of initial resources:

"With Snam we have developed a fruitful collaboration which allowed us to scale our operations rapidly and more effectively. In particular, their infrastructural and logistical resources and assets made our life easier when it comes to firstly test, and then provide our Limenet technology on a broder scale. From my point of view, doing it independently would have been totally uneffective and would have required a significant amount of resources, which we certainly didn't possess" (Beatrice, Impact Assessment Specialist, Limenet)

On the other hand, Michele from Oraigo stressed the importance of accessing the partner's market and distribution network. As large companies typically have extensive market reach and distribution networks that startups can leverage to access new customers and distribution channels, while allowing continuous improvement of their new product. In fact, Oraigo's innovative brain-computer interface was initially being tested in partnership with Italgas, and the first users were Italgas shift workers which represented the good target for the startup's solution. Given Italgas' positive feedbacks on the product, there is a good chance for Oraigo to enlarge its distribution network by leveraging the wide network available within the partner, across multiple regions and market segments. With this regard, rapidity is another aspect to take into account as it would require more time to build market presence independently. A faster market penetration is therefore facilitated for the startup which can bypass some entry barriers and quickly develop its own market network and establish a stronger presence over time.

In general terms, the need of accessing external resources in a more rapid and effective way seems a core factor to take into consideration for pursuing OI partnerships with larger companies. It appears quite clear that different startups have diverse situations which require different OI solutions based on their priority needs. However, based on the interviews, as mentioned in this chapter's introduction, these are the main priorities

in pursuing OI with large companies: scalability of operations, faster market penetration and more effective distribution networks, and access to tech and infrastructural resources.

4.2.3 Summary of findings

This sub-chapter provides a summary of the findings obtained from the analysis of the main drivers behind the decision of implementing OI in each of the company considered in this study. This section shows a comprehensive overview of the results, offering valuable insights into the investigated topic.

Table 3 shows the summary of motivations behind the decision of implementing OI. The author chose to separate the factors in general OI factors and specific SOI factors, in order to highlight the ones with strong relation to sustainability, hence with the topic of SOI. With this regard, an interesting aspect has to be mentioned. From the interviews analysis, the strive for sustainability resulted as a fundamental aspect for each company analysed, yet in relation to OI only Snam and Italgas, the two large companies examined, have implemented SOI mechanisms. In fact, as mentioned in the previous paragraphs, both companies are pursuing a strong business transformation process driven by Open Innovation and Sustainability, meaning that they most likely collaborate on OI projects with sustainable startups only. At the same time, the solutions that they decide to apply internally, are strongly linked to environmental and/or social sustainability. On the other hand, the two startups analysed have already embedded sustainability in their nature, and have different needs in terms of OI activities with larger companies, namely scalability of operations, access to partner's resources, market and distribution enlargement. Therefore, sustainability represents a major driver for implementing OI for large established companies, especially when there is an overall business transformation strategy, which is in fact driven by sustainability factors.

To conclude, larger companies seem to pursue strong sustainability related purposes as a key driver for their OI initiatives, while startups are seeking to leverage the large partner's resources in order to quickly advance their business growth and operations. To clarify, they are in strong need of resources and scalability to achieve their goals.

Table 3. Summary of motivations behind the decision of implementing Open Innovation

	OI model	**General OI factors**	**Specific SOI factors**
Snam	Outside-In	Scaling up partner's solutions internally	Accelerate the company's business transformation More rapid and effective implementation of innovative solutions Accelerate the sustainable development process
Italgas	Outside-In	Keep driving competitive advantage over time Mitigation of risk and uncertainty in current business scenario	Accelerate the company's business transformation More rapid and effective implementation of innovative solutions Accelerate the sustainable development process
Limenet	Inside-Out	Market access and distribution networks Scalability of operations	

		Access to external resources	
Oraigo	Inside-Out	Market access and distribution networks Scalability of operations Access to external resources	

4.3 Benefits and Challenges of an Open Innovation approach between large companies and startups

In this paragraph are presented the key benefits and challenges, or issues, in OI activities between the selected large companies and startups. The structure of the paragraph will follow the prior structure of the section above. Therefore, initially will be presented the benefits and issues of an OI approach from the point of view of the large companies interviewed, while secondly from the point of view of the selected startups. It is important to mention that, In the interview process, each company laid a broader focus on the positive aspects of the mutual collaborations, rather than on the related issues. For this reason, also the analysis is more focused on the former aspect, which results in deeper findings in that regard.

4.3.1 Snam and Italgas

The insights coming from the interviews revealed several common benefits from both Snam and Italgas, when analysing their OI activites with startups. In particular, OI with startups often results in a more rapid innovation process, can have positive long term returns despite the continous investments in human and technical resources, as well as overall greater innovativeness.

Specifically, below is presented a summary of the positive aspects investigated in the interviews' data analysis:

- Increased innovation rapidity
- Increased credibility at institutional level
- Positive long-term returns
- Savings on operational costs
- Increases innovativeness and R&D acceleration

Rapidity represents a fundamental aspect that was underlined in both company's interviews. Startups are usually leaner organisations with more rapid response times compared to other partners, and this speeds up the overall onboarding process of the startup, which in the case of Snam is approximately 1 month, compared to the average of 6 months with other partners:

"On average, startups have a much quicker response time compared to larger companies, and this allows us to accelerate the innovation process. It happens often that they answer in 2 hours, while we had to wait 2 weeks before replying back. However, since we started to spread Open Innovation internally, also our response times have radically been faster" (Matteo, PMO Open Innovation, Snam)

Also Fabrizio recognized that Italgas' OI initiatives with startups tend to be more rapid due to their differences in organisational structure and, above all, decision-making

process. Startups often are more agile and flexible, allowing them to interact more rapidly in joint OI initiatives with large companies, which as a consequence benefit from the startups' natural agility and flexibility.

Another interesting aspect that arised in the interview with Snam was the increased credibility at institutional level, coming from OI initiatives. According to Benedetta, nowadays OI is perceived as a positive practice in the business innovation landscape, as it allows more traditional companies to be perceived as more open to embrace change, especially in traditional industries like the energy sector. There might be some positive outcomes when OI is communicated properly both outside and within the company, especially with a solid and clear long-term OI strategy, followed by concrete results supporting the case for OI.

Furthermore, implementing OI with startups often entails the application of innovative solutions related to the company's core business. Such partnerships are considered among the most beneficial for established companies, as they could easily replace one or more of their traditional products or services with more innovative startups' solutions, with relevant benefits in terms of cost-efficiency in the long term, according to both companies' respondents. In fact, on one hand, assuming that the option of developing the same solution internally, it would require significant in-house resources. Partnering up with innovative startups, for instance through POC or co-development projects, allows a shared use of resources and costs which are usually associated with innovation efforts, while increasing the chances of partnership success by leveraging complementary skills, expertise and resources.

Finally, collaborating with startups on OI projects can help increase a firm's innovativeness in the long term. First of all, firms can gain access to specialized knowledge, insights, and perspectives that may not exist internally. They can also work together with their startup partners on already existing products or services which need to be co-developed in an OI mechanism, thus facilitating the good chances of positive

innovation outcomes. Furthermore, OI can enable larger companies to accelerate their research and development (R&D) activites by leveraging external resources and capabilities, and can help distribute the risks associated with innovation projects. This acceleration of R&D can take place in different ways, for instance through technology transfer or licesing, as well as through an accelerated learning and iteration which happens thanks to experimentation and external collaborations:

"Another aspect that we see as a consequent benefit of our Open Innovation activities is related to enhanced R&D outcomes. This happens especially when we closely collaborate with startups on non-finished products or services, which therefore require more co-development approaches. The continuous testing and feedbacks sharing allow us to accelerate our R&D efforts through continuous learning and improvements"
(Fabrizio, Head of Open Innovation, Italgas)

On the other hand, OI with startups can bring some issues which need to be considered in order to have a comprehensive view of the topic. As previously mentioned in the limitations section, an important limit to consider is given by the specific nature of the companies case study. With this regard, there are some inherent characteristics of both Snam and Italgas which might not apply to other companies. For instance, they are both partly under public participation, with the Italian state through its CDP - Cassa Depositi e Prestiti - holding a quota of the company shares – and they're also subject to typical regulatory limits which might affect the companies' decision.

Nevertheless, the data analysis revealed the following issues, that were detected mostly by both respondents:

- Strong bureaucracy due to public regulations
- Knowledge spillover
- Risk of *"Not Invented Here"* syndrome

To begin, strong bureaucracy is perceived as a structural issue of the Italian ecosystem. Both companies' respondents recognize bureaucracy as a negative factor that might disincentivise companies to collaborate with more external partners in OI activities. Despite, over time, more efforts were made by the Italian public institutions to slim down the embedded internal bureaucracy, there is still a lot of work to do in with this regard. The consequence of strong bureaucracy, which is for instance visible during the startup's onboarding process, affects the innovation rapidity. This also risks to negatively counterbalance the positive effects in terms of rapidity which were presented in the previous paragraphs, where indeed it was argued that partnering up with startups in OI projects can result in a relevant increase of innovation rapidity.

Furthermore, the phenomenon of knowledge spillover, intended as unintentional transfer of knowledge from one entity to other entities, with consequent benefits on the latter ones, can have negative implications. Despite the fact that knowledge spillover can also represent a positive factor, by disseminating valuable insights and perspectives on a specific topic, it can definitely lead to concerns about intellectual property rights or sharing of confidential information. Both companies evaluate knowledge spillover as an issue which has to be addressed, but they also recognize that in their specific OI activities, such an issue belongs more to the startup partners, given the nature of the partnership, in which the startups solutions are provided, then co-developed, to Snam or Italgas. However, knowledge spillover can also be represented by inherent internal knowledge and proprietary resources which should not be disclosed openly, as they might go back to historical time.

Ultimately, in OI activities there is a risk of internal opposition to an extensive collaborations with external stakeholders. The so-called *"not invented here"* (NIH) syndrome reflects indeed a sort of organizational culture where groups reject external ideas, solutions, innovations simply because they are not developed internally. This phenomenon can manifest in various ways within organisations. For instance, Fabrizio (Italgas) underlines the fact that it took him several years, and it is still a long work in

progress, to make various internal groups understand the positive impact of opening up the company's innovation model, through meaningful and effective partnerships:

"Especially at the beginning there was a sort of uncertainty and skepticism about the new OI activities that we were starting to carry on. Some groups of employees, mainly those with more years spent within the company, the veterans I mean, which were questioning the true benefits of our new innovation model, as they probably wanted to safeguard the company's traditional, vertical way of doing things and innovate"
(Fabrizio, Head of Open Innovation, Italgas)

The NIH mentality can lead to missed opportunities for collaboration and learning from external sources, and can limit a company's ability to innovate and adapt to our fast changing environment, according to both respondents. By overcoming the barriers of the NIH mindset, companies can leverage external resources and really achieve sustainable growth in a more rapid way. With this regard, according to Benedetta (Snam), it's necessary to cultivate a culture of innovation, as a key factor to promote valuable collaborations and cross-functional teamwork that facilitates the exchange of ideas and perspectives.

4.3.2 Limenet and Oraigo

The analysis of the benefits and issues related to OI activities with large companies resulted in greater emphasis on the positive aspects, rather than the negative ones. In particular, both Limenet and Oraigo recognize the importance of nurturing the partnership with both Snam and Italgas, respectively, as this can lead to better outcomes for both parties. Based on the data analysis, the following positive aspects were detected, as beneficial features of effective OI partnerships:

- Access to valuable resources
- Complementarity and synergies

- Co-development process

In general terms, partnering up with large, more-established companies provide startups access to a diverse set of resources, as it was also mentioned in the paragraphs above. This represents one of the most important benefits. Based on the specific startup's needs, there are several resources which can be leveraged, in order to meet different purposes as well. This also enables them to scale their business more quickly and effectively:

"We needed to develop our business more rapidly if we wanted to stay ahead of the market. For us, cooperating with Italgas represented a great opportunity to leverage our partner's business network and obtain new customers faster, thanks to their intermediation as well as positive feedbacks" (Michele, Oraigo).

Another positive factor to be considered when collaborating with larger companies is given by complementarity and effective synergies. Complementarity refers to the idea that partners in an OI collaboration possess different but complementary resources, expertise, or capabilities. These differences can be in terms of technology, market access, skills, or knowledge domains. By leveraging each other's strengths and filling in each other's gaps, partners can create a more comprehensive and impactful solution than what either could achieve independently. For example, in the case of Limenet, the startup with an innovative technology, has partnered up with Snam, the larger company with greater market reach and infrastructure capabilities, creating a symbiotic relationship where both parties benefit from each other's own strengths. In addition to this, having synergies with the partner results in new opportunities for value creation, as the combined effect of collaboration is greater than acting independently:

"it seems like both partners provide complementary assets, both tangibles and intangibles like knowledge or expertise, which indeed complement each other's gaps and increase the chances of positive outcomes derived by the partnership. This results in a win-win situation" (Michele, Co-Founder, Oraigo)

Moreover, a challenging yet potentially rewarding OI methodology to be implemented is related to the co-development approach. Such a collaborative process leverages the strengths and resources of each partner, hence the synergies, to accelerate innovation and create value. According to both respondents, an effective co-development process can result in a more rapid go-to-market process. For instance, when Italgas welcomed Oraigo's innovative solution to test it with their employees (hence providing proper resources), it also delivered feedbacks and insights to advance the product development. In addition to this, the experience of the larger and more established company can help understand future product developments, for an optimal market penetration. In fact, also product-market fit is essential for startups as it validates the market demand for their solutions. Having a partner with more experience in the market can represent a valuable asset when it comes to business development.

Regarding the main issues detected by startups, in relation to their OI activities, only two were mainly encountered when collaborating with larger companies: slower decision-making process and concerns over knowledge spillover. On one hand, larger companies might have more bureaucratic processes and longer decision-making processes. Incidentally, these aspects were also confirmed by the interview with Snam and italgas' respondents, which indeed recognized both themes as critical internal aspects which can slow down the innovation process. With this regard, it is important for startups to maintain and foster their lean approach and quicker processes, in order to counterbalance potential issues deriving from the partner. Additionally, the issue of knowledge spillover from the startup's point of view, can be limited by strong OI mechanisms in protection of diverse Intellectual Property rights. Despite concerns about the protection of IP when collaborating with external partners, with risks of infringement or misappropriation, both Limenet and Oraigo have implemented strong mechanisms to protect their IP. With this regard, knowledge spillover can be controlled:

"Even if knowledge spillover can represent a potential threat for us, given the high technological value of our solutions, we believe that such an issue can be limited with strong protection mechanisms, by carefully controlling access to our assets and technologies"
(Michele, Co-Founder, Oraigo)

4.3.3 Summary of findings

In this section is provided a summary of the findings obtained from the analysis of the key positive aspects as well as the main issues detected in relation to OI activities between large companies and startups. While the first part of the overall analysis aimed at detecting the key drivers behind the adoption of SOI in both large companies and startups, here the focus is on the key dynamics of the relationship between the two partners, by identifying the benefits and challenges of an OI approach in both sides.

Table 2 summarizes the results in each company examined. On one hand, larger companies like Snam and Italgas tend to focus on the positive aspects deriving from their OI activities with startups, which are mainly related to a quicker and more effective implementation of innovative, sustainable solutions (compared to internal vertical innovation, which usually requires more time and resources), as well as positive long-term returns despite the initial and continuous investments in OI activities. In fact, the general perception is that the investments can largely pay back in the future. On the other hand, the main issues detected are related to strong bureaucracy, mainly due to specific regulations. This aspect can negatively impact the innovation process with startups, which, as mentioned before, is seen as more rapid. Another issue, mainly detected in the interview with Italgas, is related to organizational cultural, with the syndrome of "Not Invented Here" that can impact the firm's innovativeness despite the strong collaborative OI efforts.

Regarding the startups situation, the key benefits of OI collaborations with larger companies are given by the opportunity to access a significant range of resources, which eventually foster their business growth and scalability. In addition to this, leveraging on complementary assets is perceived as a facilitator of OI. Finally, the co-development process allows to accelerate the development of the products or services, which leads to a quicker go-to-market process. On the other hand, the main issues identified by startups are related to the often slower decision-making progress, typical of large, traditional companies, and the risk of knowledge spillover, which can still be limited by placing strong IP protection mechanisms.

Table 4. Summary of benefits and issues of Open Innovation between large companies and startups

	Benefits of OI	**Challenges of OI**
Snam	Accelerates innovation Increased credibility at institutional level Positive long-term returns Increases innovativeness and accelerates R&D efforts	Strong bureaucracy due to public regulations Knowledge spillover
Italgas	Accelerates innovation Savings on operational costs	Strong bureaucracy due to public regulations

	Positive long-term returns	Risk of "Not Invented Here" syndrome
Limenet	Access to valuable resources Complementarity and synergies Co-Development process	Knowledge spillover Slow decision-making process
Oraigo	Access to valuable resources Complementarity and synergies Co-Development process	Knowledge spillover Slow decision-making process

5 FINAL THEORETICAL FRAMEWORK AND CONCLUSIONS

In this final chapter will be presented the conclusions of this study, along with the final theoretical framework developed after completing the empirical analysis. As previously stated, the objectives of this study were to better understand the key drivers of the implementation of SOI between large companies and startups, and at the same time to evaluate the positive aspects as well as the main issues of the OI relationship between the two partners. From a theoretical point of view, the goal of this research was to enhance the current understanding of the SOI paradigm between large companies and startups, which was little contemplated in the literature. For this reason, the final theoretical framework will be presented below. This final chapter also aims to provide conclusions of the study. Additionally, recommendations for future research as well as managerial contribution of this study, will be provided.

5.1.1 Results

For the purpose of answering the first research question presented at the beginning of this study: ‘‘*Why do large established companies and startups collaborate through a Sustainable Open Innovation approach?”* is essential to analyse the key drivers and motivations behind the choice of implementing OI within both large companies and startups. The main insights obtained through the analysis reveal that OI activities in large, established companies are mainly driven by the strong need of business transformation, led by sustainability. With this regard, it seems that larger, structured companies can implement innovative and sustainable solutions with more rapidity and effectiveness through their collaboration with startups, rather than acting independently. While startups’ OI activites aim to overcome their initial double liability of smallness and newness, by researching rapid access to the partners’ valuable resources in terms of operations, market access and distribution network. By leveraging such external resources they are able to scale up their business more rapidly and therefore foster their

business growth. In relation to SOI specifically, we can conclude that large companies are strongly committed to shift their traditional business model, which is sometimes unsustainable according to the current sustainability paradigm, into a more sustainable business model, as they wish to develop relationships with external partners only if they bring sustainable and innovative outcomes. Innovation without sustainability is not pursued, according to the results. With this regard, following the empirical analysis, we can conclude that sustainability is a strong driver of OI activities in large companies. On the other hand, innovative startups seem to have already embedded sustainability into their business model, and aim to traslate their sustainability objectives in their OI activities, therefore partnering up with larger companies which, on one hand, can secure them access to more resources and network, and on the other hand are willing to innovate with a strong sustainable mindset.

For the objective of answering the second research question: *"Which are the critical elements and success factors, as well as the barriers and challenges of an effective implementation of Open Innovation between large companies and startups?"* is essential to provide a broader overview of the key benefits as well as the main issues detected by both large companies and startups in their mutual OI collaborations. The insights from the empirical analysis revealed that large companies recognize multiple encouraging factors in their OI relationship with startups, such as a more rapid development of internal innovation and positive returns over time, while they identify challenges like strong bureaucracy, which slows down their OI process, as well as organizational cultural risks like the so-called *"Not-Invented-Here"* syndrome. Instead, startups benefit from the opportunity to accessing the partners' multiple resources, operating in OI activities with synergies by providing complementary resources, and engaging in valuable co-development processes with their more structured and established partners. On the other hand, the risk of knowledge spillover and the often slow decision making process of large companies represent the main issues detected in their OI relationship with their more structured partners.

In the literature review, were presented the dynamics of the OI relationship between large companies and startups, showing in particular how these two partners can cooperate and synergize for achieving different goals, by putting together complementary resources. The analysis of literature suggested some insights on the fundamental drivers of OI activities between both large companies and startups. For instance, Chesbrough (2015) recognized that, especially in the outside-in OI model, large companies can benefit from the agility and leanness of startups, while startups require the partner's large resources to increase their chances of success, therefore highlighting the need of complementary resources and synergies which are embedded in their motivations of driving OI efforts. In addition to this, Hite & Hesterly (2001) detected the startup's need of accessing diverse resources as a key driver of their OI activities. Furthermore, Hogenhuis (2016) found that traditional companies can obtain robust long-term returns by partnering up with leaner organisations like startups. Moreover, OI represents a fundamental tool for startups in order to overcome their double liabilities of smallness and newness, as presented by Boger's research (2015). Such key elements were outlined in the initial theoretical part, and subsequently validated through the empirical evidence. Regarding the barriers and hinder detected in the literature, Dogson et al. (2006) focused on the NIH syndrome as a potential barrier in OI activities, especially in larger companies which may show some hesitancy towards expanding their innovation commitment beyond their established boundaries. With this regard, strong cultural shifts are required to adopt innovation from external sources and facilitate collaboration with partners. Such considerations were also proven by the findings. Finally, regarding the quite recent topic of SOI, Bogers et al. (2020) in their article on the *Green Fiber Bottle,* the SOI initiative developed by the large Danish conglomerate *Carlsberg* and its startup partner revealed that sustainability can definitely represent a key driver of innovation. In fact, numerous sustainability challenges often begin with organizations acknowledging their adverse environmental impact, but at the same time they lack the internal resources to address it while aligning with their broader business strategy. As a result, they decide to implement OI mechanisms and partner up with innovative startups which can help them overcoming their issues.

Finally, the empirical findings revealed new insights on the topic which will integrate the existing theoretical framework, which is shown in Figure 7.

Chesbrough et al. 2014:
"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model"

- **Chesbrough (2015)** : complementary resources and synergies as a key driver of

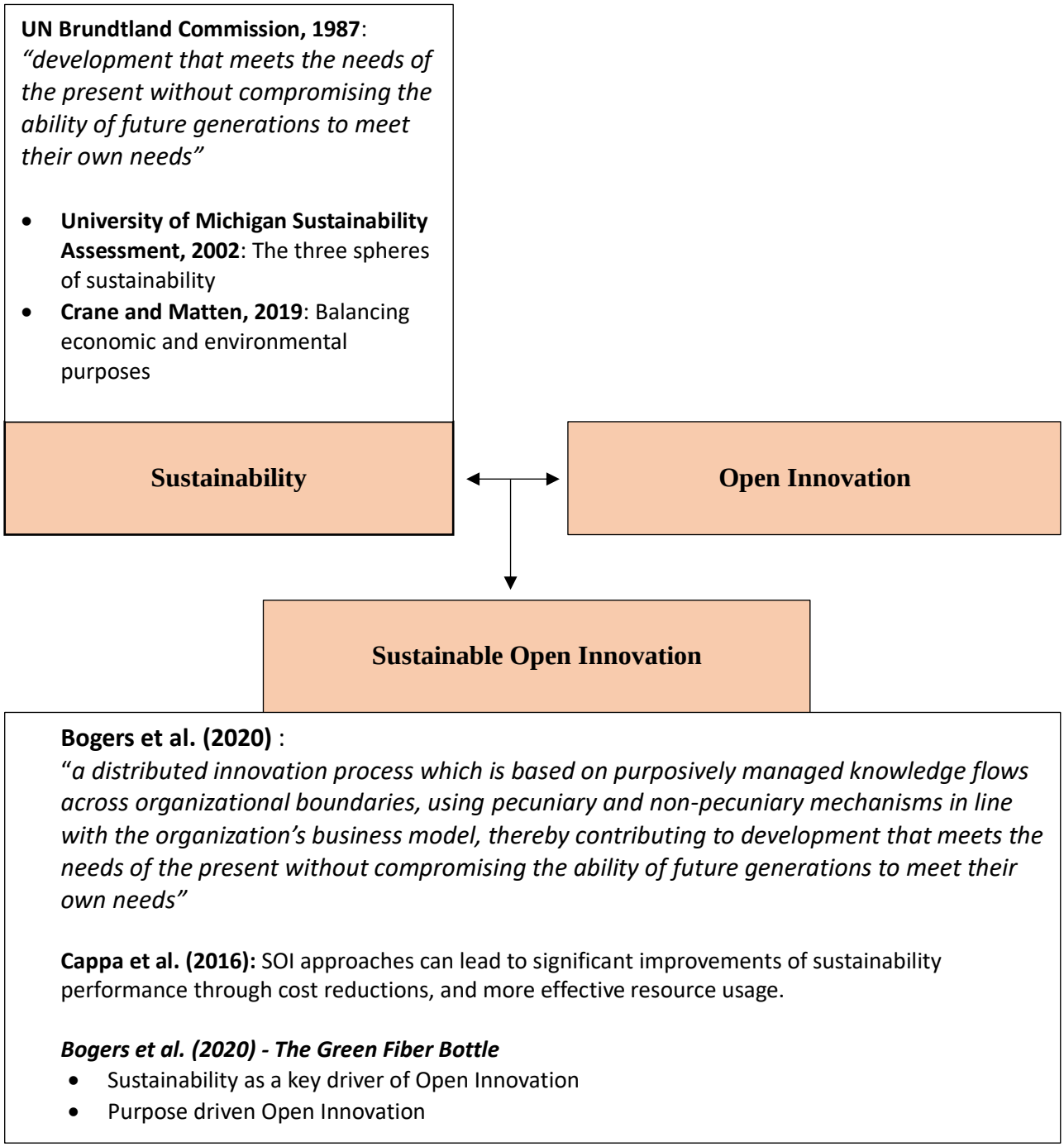

Figure 7. Theoretical framework

5.1.2 Future Research Opportunities

In the continuously evolving landscape of academic literature, it is relevant to explore future research opportunities following this master's thesis. Through this research and analysis of findings, the author aimed at contributing to the existing literature on the topic of SOI within the major area of OI, by examining the relationship between large companies and startups when they mutually collaborate in OI activities. However, while this study has provided valuable insights and addressed certain gaps in the literature, it is crucial to understand that the field of OI is extremely dynamic and continuously evolving. For this reason, this sub-chapter is dedicated to exploring potential research avenues beyond the scope of this study. Reflecting on the implications of the findings, the objective is to inspire future researchers to advance the current understanding of the SOI topic, not only in relation to large companies and startups, but also comprising various and different stakeholders.

By analysing the topic of SOI within both large companies and startups, in particular concerning the motivations to pursue OI mechanisms between large companies and startups, future researchers must be conscious about the theoretical delimitations and practical limitations of this study. As already presented in the *delimitations* section, this study, only a few Italian companies were analysed for the study's purposes, specifically two large companies and two startups, and the total number of interview was limited. In fact, this study provides a grasp on the topic of SOI between large companies and startups, but cannot be considered a comprehensive and extensive overview of the topic analysed. Certainly, collection of more data, especially of primary nature, could represent a substantial improvement in terms of reliability and width of the study, and potentially lead to a more detailed framework of the topic.

Within the area of OI, more studies could be conducted in relation to the startups environment. On one hand, OI in large companies have been examined quite thoroughly, with several insights on the main mechanisms and success factors, as well as challenges, of implementing OI internally. At the contrary, there is little research concerning the OI

topic within startups, despite the increase of interest about the topic, over the recent years. With this regard, several approaches could be pursued. For instance, a quantitative approach aiming to investigate the relationship between the commitment to OI initiatives (in terms of quality and quantity) and success rate of startups, could be beneficial in order to show the positive impact of effective OI collaborations with more structured partners. Moreover, it could be useful to provide a deeper investigation into the motivations behind the choice to adopt SOI mechanisms within startups, with more case studies, in order to have a better understanding of the topic. In addition to this, considering a wider sample would provide a broader overview of the specific situations in which startups operate. The same applies to the analysis of the SOI mechanisms within larger companies: the enlargement of the sample will be very likely to provide deeper insights into the topic analysed. More specifically, considering that each industry has some exclusive dynamics which might affect the results of the analysis, and given that both Snam and Italgas, the two large companies analysed in this study, belong to the energy industry, it could be valuable to examine the results of a similar study in firms belonging to various industries. In that case, a comparison of results might be interesting to pursue. Nevertheless, also conducting industry-specific studies to understand the unique challenges and opportunities for OI between large companies and startups, could represent a positive, yet sectorial, knowledge advancement in that specific field. By enlarging the sample size, within the same industry, the analysis of results could provide valuable insights into the dynamics of the specific industry, therefore representing strategic recommendations to help organisations make informed decisions about their business strategies, operations, or resource allocation.

Within the sub-area of SOI, which is little contemplated in the current literature, plenty of topics could be investigated in order to enhance the current understanding of the topic. For instance, examining different collaborative models and platforms for SOI, with different partners involved. This could include, for example, investigating the collaborations involving universities, research institutes, startups accelerators, VCs etc. In fact, exploring the potential for cross-sector collaboration in SOI, including

partnerships between several stakeholders, could identify specific barriers and enablers of effective collaboration across sectors, with the potential of developing strategies for overcoming such challenges. Another potential research avenue within SOI could aim to explore how OI can contribute to the transition towards a circular economy, therefore studying initiatives related to waste reduction, sustainable supply chain management, remanufacturing, only to name a few. With this regard, there could be explored new business models and approaches to include circularity.

5.1.3 Managerial Contributions

Managerial implications involve insights and recommendations that are relevant and valuable for practitioners and decision-makers in the field of study, and they go beyond the academic theory developed. The objective is to provide practical guidance for managerial practice, by identifying best practices that can be implemented by managers to improve the company's performance, efficiency, and effectiveness.

The practical objective of this study was to build up a case study for SOI, by analysing the key benefits, as well as the main challenges, of an OI approach between large companies and startups, driven by sustainability. The main argument implied that this collaborative approach to innovation has the potential to foster the adoption of innovative, sustainable solutions, resulting in a more efficient and impactful results for both partners involved, and eventually to the society and environment.

The results of this study suggest multiple recommendations for managers and practitioners in both large and small organisations. Firstly, focusing on large companies, engaging in OI initiatives with leaner and innovative organisations like startups can provide effective outcomes to drive their internal business transformation, driven by sustainability. Identifying the key startup partners, which can provide effective solutions and exchange of resources for co-development projects, can result in quicker implementation of initiatives and activities leading to substantial change within the

organisations. In the current fast-changing and rapidly evolving environment, this potentially beneficial outcome is paramount. On the other hand, also startups managers and entrepreneurs can capitalize on the partnership with more structured companies, by evaluating those which can provide the most useful resources and assets which can help accelerating the company's market penetration and scalability.

Basically, external collaboration through SOI approaches, be it inside-out, outside-in, or mixed OI approaches, can provide companies with valuable outcomes and returns over time, which can overcome the initial challenges and investments. Managers can enhance the company's innovativeness by strategically and effectively partnering up with external partners. Moreover, effective OI initiatives between large companies and startups can help foster a culture of innovation within the organisation. As the literature and findings suggest, one of the issue of OI implementation is related to the need of cultural changes within the organisation in order to embrace external sources of innovation, therefore overcoming the initial *"Not Invented Here"* syndrome.

A call for action, to managers of diverse companies, is therefore needed in order to lead the firm's cultural and organisational change, embrace OI driven by sustainability, and successfully implement OI initiatives with multiple partners.

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