University of Deusto – Donostia
PhD in Business Competitiveness and Economic Development

Sustainability-oriented innovation: a mixed methods approach

Doctoral thesis

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ABSTRACT

Sustainability-oriented innovation (SOI) has been indicated as one of the most effective strategies through which businesses may contribute to sustainable development. However, the addition of social and environmental goals to economic objectives results in new trade-offs that increase the complexity of the innovation process. This must be tackled by businesses, which undergo an organisational transformation to gradually ingrain SOI practices. Therefore, the aim of this thesis is to elaborate on existing theory on SOI at the firm level, in order to understand how businesses engage in SOI.

The thesis utilises both qualitative and quantitative methods to examine SOI at the firm level from system-thinking and dynamic capabilities approaches. The results suggest that firms engage in SOI in a non-linear, path-dependent journey whereby dynamic capabilities in the strategic dimensions of sustainability-oriented market-sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership are developed in increasing levels of complexity (incremental, renewing and regenerative). The development of such dynamic capabilities for SOI is affected not only by the internal path-dependent processes and deliberate decisions taken at the organisational level, but also by change occurred in the economic, social and environmental systems in which the firm is embedded, and the knowledge it is able to obtain from it.

The study contributes to knowledge on SOI explaining the main ontological components of SOI; identifying three hierarchies of dynamic capabilities for SOI across three strategic dimensions of SOI; observing that market responsiveness and knowledge assimilation are relevant features of sustainability-oriented companies; demonstrating the relevance of alliance capabilities for SOI; examining the specific knowledge search strategies that yield best results for different SOI outcomes and illustrating the positive relationship between SOI outcomes and performance.

Keywords: sustainability-oriented innovation, sustainable innovation, sustainability, innovation, system-thinking, dynamic capabilities, resource-based view.

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Introduction

1.1. Research background, scope and motivation

In the quest for sustainable development, innovation has proven to be an effective strategy to minimize degradation of the environment, improve social welfare and sustain economic growth (European Commission, 2012; OECD, 2010). Therefore, *sustainability-oriented innovation (SOI), that is, innovation that aims to create not only economic but also environmental and social value* (Adams, Jeanrenaud, Bessant, Denyer and Overy, 2016; Hansen and Grosse-Dunker, 2013) has become a cornerstone of the sustainable development strategy of both public institutions (European Commission, 2012; OECD, 2010) and private and social organisations (Jay and Gerand, 2015; Carrillo-Hermosilla, del Río and Könnöla, 2010). With the aim of decoupling human social and economic development from environmental degradation (United Nations, 2011) technology, understood in a broad sense as the method whereby humans apply science (including social science) for development, has been raised as a way to ensure the prosperity of the economic, social and environmental systems (Perman, Ma, McGilvray and Common, 2011). In order to do so, different types of innovation outcomes (products and services, markets, processes and business models) must be directed towards sustainability: SOI is a helpful lever for sustainable development (Ahlstrom, 2010) if we are to maintain acceptable economic standards of living and eradicate poverty, improve social conditions and conserve the environment; in the line of Sustainable Development Goals (United Nations, 2014). For this reason, the sustainable growth strategies of the European Union or the OECD highlight its importance (European Commission, 2012; OECD, 2010). However, introducing environmental and social goals in the innovation processes brings in added complexity (Hansen, Grosse-Dunker and Reichwald, 2009; Harms, Hansen and Schaltegger, 2013) that must be overcome at both the technological and administrative levels, developing co-evolving socio-technical systems for successful sustainability transitions (Geels, 2010).

In this dissertation, the focus is placed on the organisational level, particularly aiming to understand how businesses engage in SOI. Therefore, the scope of the dissertation lies at the business organisation. The scientific disciplines on which the PhD dissertation is built and to which it makes a contribution are management and organisational sciences. Previous research on SOI has looked into it from different perspectives; the project level (Keskin, Diehl and Molenaar, 2013), the outcome level (Hansen et al., 2009) or the socio-technical system level (Boons, 2013; Coenen and Díaz-López, 2010; Geels, 2011). Part of this research has also looked at SOI and the organisational transformation it entails (for instance, Adams et al., 2016; or Huang and Li, 2015). However, more research is needed to explore SOI engagement at the firm-level, accounting for the multidimensional nature of SOI and the changes in organisational dynamics that occur as a result of the engagement in SOI. Therefore, the

research focus of this dissertation is placed on the organisation, taking into consideration its environment and socio-economic system and the engagement with other stakeholders of the economic, social and technical systems, understanding the firm as a system embedded in the economic, social, and environmental systems (Allen, 1998; Anderson, 1999; Gladwin, Kennelly and Krause, 1995).

The debate on how to achieve sustainable development using SOI as a tool has yielded a multifaceted corpus of literature (Adams et al., 2016; Boons & Lüdeke-Freund, 2013; Del Brío and Junquera, 2003; Hansen et al., 2009; Jay and Gerand, 2015) based on multiple sources of research and approaches such as green innovation, eco-innovation, social innovation, eco-efficiency, clean innovation and life-cycle analysis. However, research on SOI could benefit from further and advanced elaboration (Pratt, 2008) of current management and organisational theory looking at the distinct aspects of SOI that previous literature has examined (Carrillo-Hermosilla et al., 2010; Schiederig, Tietze and Herstatt, 2012). In addition to some comprehensive studies on SOI (Adams et al., 2016, or Hansen and Grosse-Dunker, 2013, as an example), research has also provided empirical studies focused on particular aspects of SOI implementation (for instance, stakeholder management, like Ayuso, Rodríguez, García-Castro and Ariño, 2011, or regulation-induced SOI, like Ashford and Hall, 2011).

1.2. Research gaps and objectives

Management and organisational scholars studying SOI have developed models mostly based on the literature, which try to explain the organisational transformation that SOI entails. Previous papers have completed literature reviews on SOI (Adams, Jeanrenaud, Bessant, Denyer and Overy, 2012; Klewitz and Hansen, 2014; Pereira and Vence, 2012) examining the intricacy of the concept, the drivers of SOI engagement or the management complexities associated to it. Therefore, a main topic of research has been the development of models of how SOI is implemented into business management and organisations. Advanced research in management of SOI has analysed SOI models (Adams et al., 2016; Carrillo-Hermosilla et al., 2010; Hansen et al., 2009; Jay and Gerand, 2015) aiming at synthetizing the processes by which companies adopt SOI practices. There are some studies trying to classify the literature on the concept, such as Adams et al.'s (2012; 2016) or Hansen et al.'s (2009), while others focus on business models and/or sustainable value creation, (Bocken, Short, Rana and Evans, 2014; Bocken, Rana and Short, 2015) or entrepreneurship (Schaltegger and Wagner, 2011). Beyond this, some studies have identified dynamic, path-dependent and staged adoption of SOI (Adams et al., 2016; Carrillo-Hermosilla et al., 2010; Hart, 1995; Hart and Dowell, 2011).

However, there is disagreement on some fundamental issues. Therefore, there is gap in the literature, that of assessing how firms engage in SOI and what organisational transformations come with it. Most of the research on SOI from the management perspective concentrates on particular issues (for instance, sustainable supply chain innovation (Harms et al., 2013; Zhu, Sarkis and Lai, 2012) or the effect of environmental management systems on SOI (Inoue, Arimura and Nakano, 2013; Ziegler and Nogareda, 2009)). For this reason, some scholars like Carrilo-Hermosilla et al. (2010) or Schidierig et al. (2012) have called for a common theoretical framework that sustains SOI knowledge and developments in SOI research. Having reviewed the literature, it is found that there is a knowledge gap on factors that enable the organisational transformation towards SOI. Previous models tackling this issue mostly adopt a deductive approach and are constructed on the literature (Adams et al., 2016; Jay and Gerand, 2015). Therefore, this dissertation builds on these studies but also incorporates empirical grounding, aiming to expand existing knowledge and elaborate on SOI theory (Pratt, 2008) from an inductive approach. In other words, the aim of this thesis is the following:

> T*he aim of this thesis is to elaborate on the existing theory and research on SOI in order to develop a model of organisational SOI, delimitating the main organisational dimensions that led the company to successfully engage in new sustainability-oriented innovation practices. In order to do so, previous research will be analysed from an integrative perspective, contributing to it with further empirical research.*

1.3. Approaches of the dissertation

At the organisational level, the SOI journey (Adams et al., 2016; Van de Ven, Poliey, Garud and Venkataraman, 2008) is the process by which businesses/firms engage in SOI in a non-linear path, in which recurrent but idiosyncratic patterns can be observed. In order to explain the organisational dynamics in such journey, two main perspectives are adopted; first, a systemic understanding of businesses, including the analysis of strategies and practices and different components of the system that the organisation is (Anderson, 1999; Eisenhardt and Piezunka, 2011). Second, a capability-based perspective is adopted: this approach understands that the assets a firm has to compete in its market are based on the distinct capabilities it develops building on the available resources in a path-dependent manner (Barney, 1991; Eisenhardt and Martin, 2000). The capability-based view perspective allows the study of SOI engagement of the firm, that is, the SOI journey, through the evolving complexity of its capabilities (Adams et al., 2016; Castiaux, 2012). However, in order to fully understand businesses in its context, and all the factors and agents intervening in SOI-based organisational transformation, the thesis is also approached from systems theory (Allen, 1998; Geels,

2010; Meadows, 2008), whereby the organisation or business is considered the focal system of study, embedded in the economic, social, technological and environmental systems, formed by networks of individual agents and groups, and in ongoing interrelationship with other systems or stakeholders (competitors, public institutions, industry associations…). Both perspectives seem opposed, since they focus on very different analyses and epistemologies; however the combined analysis of both and their contrast helps to understand SOI from two different approaches, and to frame an advanced approach for theory-building of SOI.

Consequently, SOI is studied in this dissertation from the field of management and organisational science, although it draws from several sources, as follows:

1. The several disciplines that have contributed to developing the concept: operations management (Geffen and Rothenberg, 2000; Harms et al., 2013), sustainability science (Boons and Lüdeke-Freund, 2013), strategic management (Chen, 2008; Hart, 1995; Hart and Dowell, 2011; Hart and Milstein, 2003; Nidumolu, Prahalad and Rangaswami, 2009; Prahalad, 2012), R&D and technology management (Carrillo-Hermosilla et al., 2010; Hansen et al., 2009; Seebode, Jeanrenaud and Bessant, 2012), design (Baumann, Boons and Bragd, 2002; Esslinger, 2011; Simon, Poole, Sweatman, Evans, Bhamra and Mcaloone, 2000) and CSR or business ethics (Blake, 2006; Elkington, 1998; 2012; Holmes and Smart, 2009; Hull and Rothenberg, 2008) have contributed to the SOI corpus of research.

2. Systems theory and dynamic capabilities (based on the resource-based view of the firm); the first one providing the necessary framework to acknowledge the complexity of different components interacting in SOI (Boons, 2013; Geels, Hekkert and Jacobsson, 2008), and the second contributing with a framework to explain the intra-firm dynamics for SOI; the firm being the focal point of this research.

This is illustrated in Figure 1:

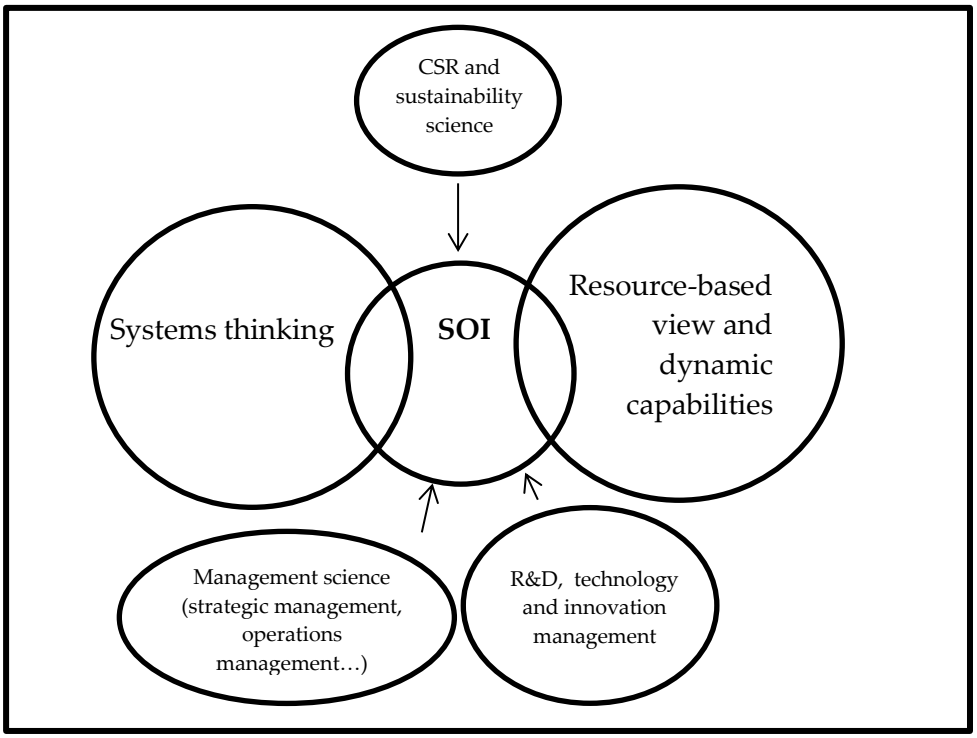

Figure 1. Theoretical framework and research streams of the dissertation

At this stage, research is needed to elaborate theory and, looking at the several literature streams that have fed SOI knowledge at the organisational level, help to respond the question of how firms engage in SOI successfully. Businesses, as the most numerous and relevant economic agents, are key in carrying out SOI (Porter and Kramer, 2006; 2011). In fact, many SMEs and multinational corporations are spearheading the SOI journey through their own research programmes and also as collaborators and promoters in their environment. The path to engage in SOI is different for each firm, since it is determined by is particular internal and environmental conditions (Schaltegger, Lüdeke-Freund and Hansen, 2012); the resource availability or capacity to adapt are not the same for larger or smaller companies, for instance. Nevertheless, the importance of this development lies on the vital role of SOI towards the transformation to a sustainable enterprise economy (Waddock and McIntosh, 2011). Consequently, the present research will look for an integrative model based on practice able to serve as a baseline for future research and help firms engage in SOI.

1.4. Research questions and main objectives

The intent of the thesis is to elaborate a theoretical model of SOI from the organisational perspective, taking into consideration previous advances in theory and building on them through empirical research (Pratt, 2008). Aiming to fill the research gaps outlined in the previous section, the main research question to be answered in the dissertation is the following:

How do firms engage in SOI?

In trying to respond to the main research question, and based on the multiple research gaps found in the literature (see previous Section 1.2. and Section 4.5.), seven sub-questions are formulated so as to facilitate the analysis of those aspects that may need to be taken into consideration to respond to the main research question. The first question is tackled in the literature review (Chapter 4), the next two questions are tackled in the qualitative study of the dissertation (Chapter 5), while the last four are addressed through quantitative methods (Chapter 6).

The first research question is concerned with finding a theoretical framework to bring existing research streams closer and find out how they connect to each other. In order to do this, an integrative literature review is performed to explain how different research fields contribute to SOI and which the main challenges that have been tackled by previous research are. Therefore, the first research sub-question is the following:

Q1. *Which are the ontological components of SOI; and how do they relate to each other?*

The second question is concerned with the organisational capabilities needed to engage in SOI, nurturing a gradual organisational transformation. This is examined under the light of dynamic capabilities theory, which is useful to examine how the organisation changes not only depending on its internal available resources, but also in relation to the external environment. Hence, the dynamic capabilities perspective allows observing the development of the firm as an evolutionary process and in relation to the environmental conditions of the firm. Although some previous studies have looked at organisational capabilities for SOI (Ayuso et al., 2011; Castiaux, 2012; Ketata, Sofka and Grimpe, 2015; Van Kleef and Roome, 2007), an integrative, inductive approach has not been yet applied to look at the whole capability building for SOI. Instead, previous research has either quantitatively examined the existence of pre-determined capabilities (Ayuso et al., 2011; Ketata et al., 2015), or try to respond to this question through the review of the literature (Adams et al., 2012; 2016; Castiaux, 2012; Van Kleef and Roome, 2007). This calls for qualitative research that can offer an insightful view of SOI to add and complement existing research. Therefore, the first research sub-question is the following:

Q2. *Which dynamic capabilities enable the engagement of firms in SOI?*

Another gap in the literature looking at organisational capabilities for SOI is the fact that its fragmentation in different research streams often prevents new research to build on previous findings. Consequently, the existing corpus of research is highly fragmented (Carrillo-Hermosilla et al., 2010; Schiederig et al., 2012), applies different

theoretical frameworks and is not consistent with the literature concerning the firm's evolution along the 'SOI journey' (Adams et al., 2012; 2016; Carrillo-Hermosilla et al., 2010). As aforementioned, a dynamic capabilities approach may explain the evolution of organisational capabilities across the gradual and increasing engagement in SOI. Therefore, an integrative approach to develop a theoretical framework that takes into consideration not only the existing dynamic capabilities at a certain point but also how they evolve as SOI engagement becomes deeper is needed. Under this logic, theories on the hierarchies of dynamic capabilities in different levels (Ambrosini, Bowman and Collier, 2009; Winter, 2003; Zahra, Sapienza and Davidsson, 2006) are useful to explain the gradual organisational transformation of SOI, with increasing complexity as firms engage in SOI. Thus, the second research question is formulated in this manner:

Q3. *How are dynamic capabilities for SOI structured in different levels?*

Indeed, the literature on organisational capabilities for SOI has not made distinctions between the possible need for different sorts of capabilities to carry out incremental or radical SOI, despite the fact that previous research on innovation has indicated that is the case for 'mainstream' innovation (Cembrero, 2013; Jansen, van den Bosch and Volberda, 2006; Tushman and O'Reilly, 1996). Based on the insight obtained from the qualitative study and aiming to find out how outward-oriented and inward-oriented capabilities affect SOI, the first research question to be answered quantitatively based on the results is the following:

Q4. *How are capabilities for SOI relevant for incremental and radical SOI outcomes?*

Networking and collaboration were found to be key for the development of SOIs in the literature review (Adams et al., 2016; Ayuso et al., 2011, de Medeiros, Ribeiro and Cortimiglia, 2014). Consequently, under the same logic of studying capabilities for SOI; the next research sub-question aims to explore the effect of alliance capabilities on SOI outcomes; as follows:

Q5. *How are alliance capabilities relevant for incremental and radical SOI?*

As signaled in the previous research question (see Section 4.3.2.) previous literature gives great relevance to collaboration for the development of SOIs (Guisetti, Marzucchi and Montresor, 2015; Hall, Bachor and Matos, 2014; Holmes and Smart, 2009). Part of this collaboration and relationship with the firm's environment lies in the integration of knowledge from actors external to the firm and complementary internal sources. However, although the impact of the different knowledge search strategies has been studied for innovation in general (Henttonen, Ritala and 2011; Laursen and

Salter, 2006), this has not been the case for SOI. Therefore, the next question is formulated:

Q6. *What knowledge search strategies favour engagement in SOI?*

Finally, a commonplace question in the business sustainability discussion is whether there is a trade-off between environmental and social sustainability and financial performance (Surroca, Tribó and Waddock, 2010; Wood, 2010). Although this has also been explored in the SOI literature (Przychodzen and Przychodzen, 2015), it is interesting to look at it for different SOI outcomes (process, product and service) and regarding distinct types of performance (financial, customer and sustainability), to find out the following:

Q7. *When does SOI pay off?*

1.5. Research methods

Therefore, the aim of this thesis is to understand and explain how firms are able to successfully engage in SOI. In order to do so, an inductive, convergent mixed methods design is adopted (Creswell and Plano Clark, 2011; Pratt, 2008). This has the objective of maximizing the available information so as to provide with a comprehensive framework grounded on the practices of firms that have embarked in a SOI-based organisational transformation.

A convergent research design will be deployed (Creswell and Plano Clark, 2011), which involves three stages: first, the analysis of the literature review and the development of the theoretical framework; second, a qualitative phase of research using data obtained from eight case studies that yields certain theoretical results, and finally the third, quantitative phase of the study. Although an inductive-deductive cycle is performed along the dissertation's research phases, the orientation of the thesis is inductive; that is, the objective is to build theory from empirical evidence using the theory-data-theory approach described by Pratt (2008). In addition, although the research design is convergent and the results obtained in the qualitative and quantitative studies are complementary, since the qualitative study was conducted before the quantitative study, the qualitative data has provided the foundations for the development of the survey instrument for the quantitative phase.

Mixed methods are an appropriate approach for the research objective, since they offer the chance of analysing the phenomenon from a systemic perspective in the qualitative study, observing the firm as a whole, while deepening on knowledge on certain issues in the quantitative phase. For a nascent field like SOI, mixed methods can

provide valuable answers and seed further empirical research, particularly because of its interdisciplinarity and the need for a systemic transformation of the firm, which requires a flexible and multidisciplinary approach in methods as well.

Hence, the rationale behind the choice for mixed methods lies on the aim of elaborating on existing SOI research (Bryman, 2006; Creswell and Plano Clark, 2011). Although some normative, theoretical approximations have been generated (Adams et al., 2016; Carrillo-Hermosilla et al., 2010; Hansen et al., 2009), an inductive, theory-elaborating approach is required for further advance of the discipline (Pratt, 2008). Moreover, the quantitative methods of the second phase will allow for more nuanced and elaborate theory building and the development of patterns and practices applicable to companies with features different to those participating in the qualitative study.

1.6. Outline of the dissertation

The thesis is divided in seven chapters, structured in three parts; the first one is introductory and presents the research problem, theoretical framework and methods (Chapters 1-3), the second covers the studies carried out to answer the research questions: literature review, qualitative study and quantitative studies (Chapters 4-6), and the third part is concerned with summarising the main results of the thesis, responding to the main research question (Chapter 7). The outline of the thesis is illustrated in Figure 2.

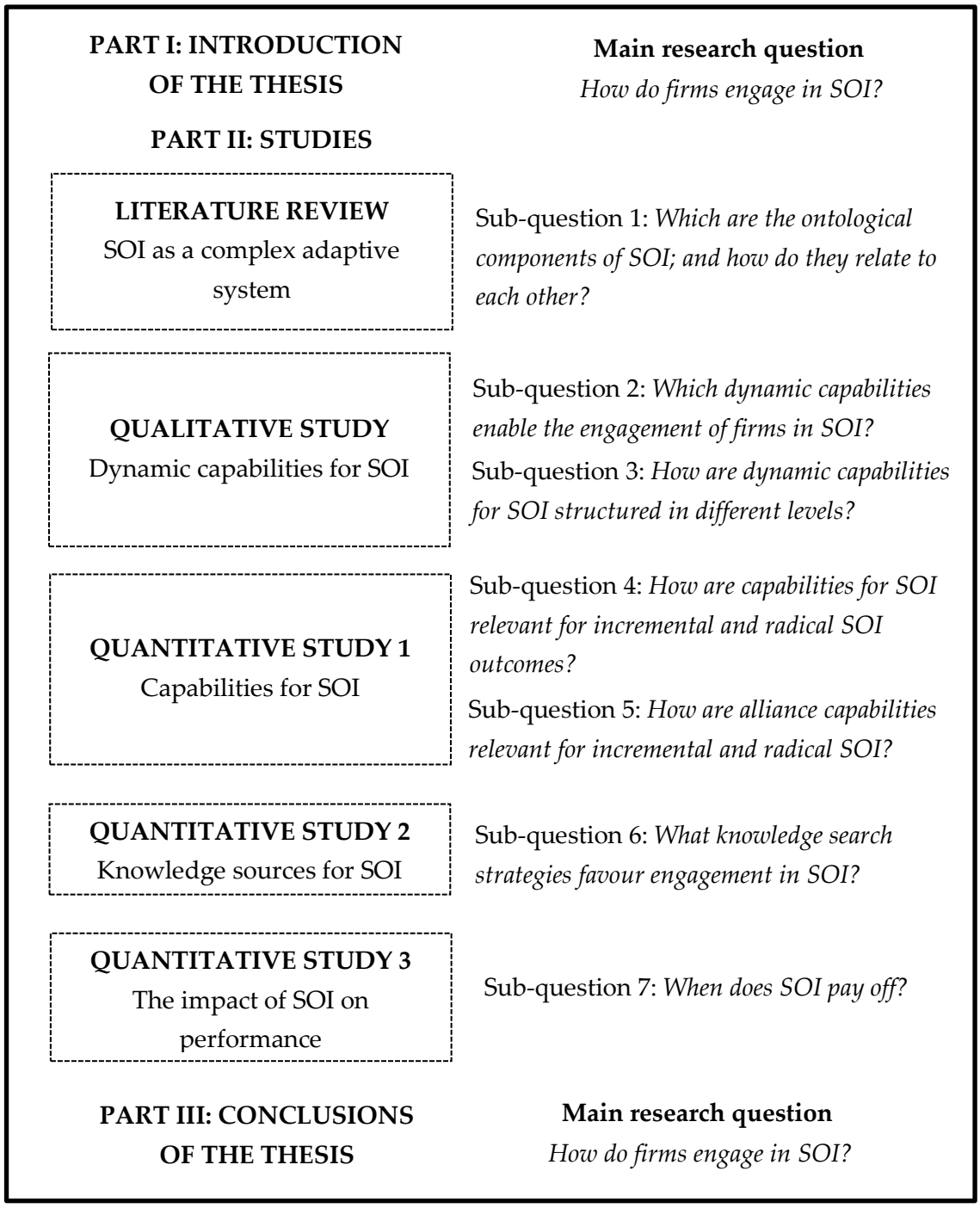

Figure 2. Outline of the thesis: research questions and empirical studies

Apart from the present introductory chapter, which has presented the motivation and need for further studies on how organisations develop in order to successfully engage in SOI; the rest of the thesis is organised as follows:

- Chapter 2. *Theoretical framework*. This chapter presents the theoretical framework on which the thesis is built: an overview on the two main literature streams on which the concept of SOI is grounded (innovation management and business sustainability) and the theoretical standpoints

from which this thesis approaches SOI, systems theory and the resource-based view of the firm and dynamic capabilities. An overview on how these have been applied to innovation management and business sustainability is provided in this Chapter.

- Chapter 3. *Research methods*. Chapter 3 outlines the mixed methods research design of the dissertation, highlighting the methods used in the literature review and the sampling, data collection and data analysis strategies deployed for the qualitative study first, and later for the quantitative study. To close the chapter, a section on how the gap between qualitative and quantitative methods has been bridged is included, as well as detailed account of the validity and reliability issues of the study.

- Chapter 4. *Understanding SOI as complex adaptive system*. The fourth chapter deals with previous research on SOI, in the form of an integrative literature review. Chapter 4 defines SOI based on previous findings, indicates the streams of knowledge from which SOI has been studied as well as previous literature reviews and models on the matter, and covers some of the studies that have approached SOI from the same theoretical standpoint as the thesis (systems theory and resource-based view and dynamic capabilities). This chapter provides with an ontological classification of the literature into five components, which helps to explain how rules of behaviour among components as a complex adaptive system in the last section, responding to research sub-question 1.

- Chapter 5. *Results of the qualitative study*. Chapter 5 presents the results of the qualitative study, responding to sub-questions 2 and 3. It explains how dynamic capabilities for SOI are structured in three dimensions; sustainability-driven market-sensing and seizing, sustainability embeddedness and sustainability-based talent, team-building, networking and leadership; and how these are structured in three levels of development (incremental, renewing and regenerative). It also discusses the properties of the evolution across these three hierarchical levels and the role of both path-dependence and contingent factors in the development of dynamic capabilities for SOI.

- Chapter 6. *Results of the quantitative study*. Chapter 6 presents and discusses the results of the quantitative studies of the thesis, responding to research sub-questions 4 to 7. It shows how different capabilities are required to carry out either incremental or radical SOI and that different knowledge search strategies yield different SOI outcomes in terms of process, product or

service. In addition, this chapter also shows that there is a positive relationship between SOI performance and financial, customer and sustainability performance. The chapter discusses some relevant issues raised by these results; mainly, the different configurations of dynamic capabilities that may lead to SOI outcomes, the relevance of choosing the right knowledge search strategy for the desired SOI outcome and the particularities of service SOI.

- Chapter 7. *Conclusions*. The final chapter of the thesis explains how the results of the whole thesis respond to the main research question by offering a model of development of the SOI journey. It also points out the main theoretical and practical contributions of the thesis, as well as its limitations and suggestions for further research.

Chapter 2

Theoretical foundations

2.1. Introduction

The aim of the present chapter is to set up the theoretical framework on which this thesis is sustained. On these grounds, it will revise the theoretical foundations of the thesis, according to the following structure:

a) First, how the concept of innovation in relation to management science and the forms and magnitudes of innovation and have been dealt with in the literature will be explored (Bessant and Tidd, 2007; Crossan and Apaydin, 2010). Due to great variety of perspectives from which innovation has been tackled, this section will serve to provide with a short background on what innovation is from the management perspective and some insight about how to approach its analysis from this field of study. That is, the concept of innovation will be framed for the purposes of this dissertation and in relevance to SOI.

b) The following section deals with the literature on business sustainability, a growing corpus of research that aims to understand how firms should or are able to (depending on the approach) expand their bottom line to include social and environmental goals along with economic ones; hence contributing to sustainable development and the responsibility of the firm towards society and the environment, or so-called corporate social responsibility. Nevertheless, the focus of this dissertation lies on business sustainability, integrating the strategic vision of the firm and its maintenance in its socio-economic and natural environment, embedding the responsibility towards society as an aspect of the wider model of sustainable firm (Bansal, 2005; Gladwin et al., 2005).

c) Next, systems theory and its usefulness to study SOI will be discussed. Analysis under the lens of this theory looks at the three core elements of a system: components, interconnections and purpose (Meadows, 2008). For these reason, the firm is considered as a system, which is, in turn, embedded in the wider economic, social and environmental systems. Approaching SOI from this perspective is appropriate due to its transversal nature and potential to induce change not only at the firm level, but also in its surrounding environment. Complexity theory is also applied to study the set of interconnections resulting in SOI, favouring the analysis of SOI as a complex adaptive system (Allen, 1998, Gell-Mann, 1994).

d) Finally, the literature on the resource-based view of the firm and dynamic capabilities and how it has been previously applied to the innovation

management and business sustainability fields will be examined (with a particular focus on the natural resource-based view of the firm (Hart, 1995)). The resource-based and dynamic capabilities view offer a useful framework to understand which specific features of a firm are able to provide a distinct vantage point in the point based on firm heterogeneity; therefore, examining SOI under this light allows understanding of what is different in firms successfully engaging in SOI as compared to those which have not been able to do so. Besides, as mentioned in the previous chapter, global business, economic, political, technological and environmental trends are changing at an unprecedented pace, and so it is indispensable for companies to adapt to these trends, which calls for the application of theory of dynamic capabilities of the firm (Ambrosini et al., 2009; Barreto, 2010; Teece, 2007; Teece, Pisano and Shuen, 1997).

Therefore, the first two theoretical foundations (innovation and business sustainability) contribute to the study by filling with meaning the concept of study; SOI: only fully understanding these concepts can fully explain the space of linkage between them. The two last foundations (resource-based view and dynamic capabilities and systems theory) contribute to the study by providing a framework to investigate the phenomenon of SOI at the firm level. This is illustrated in Figure 3. The chapter will close with a summary of the theoretical framework for SOI.

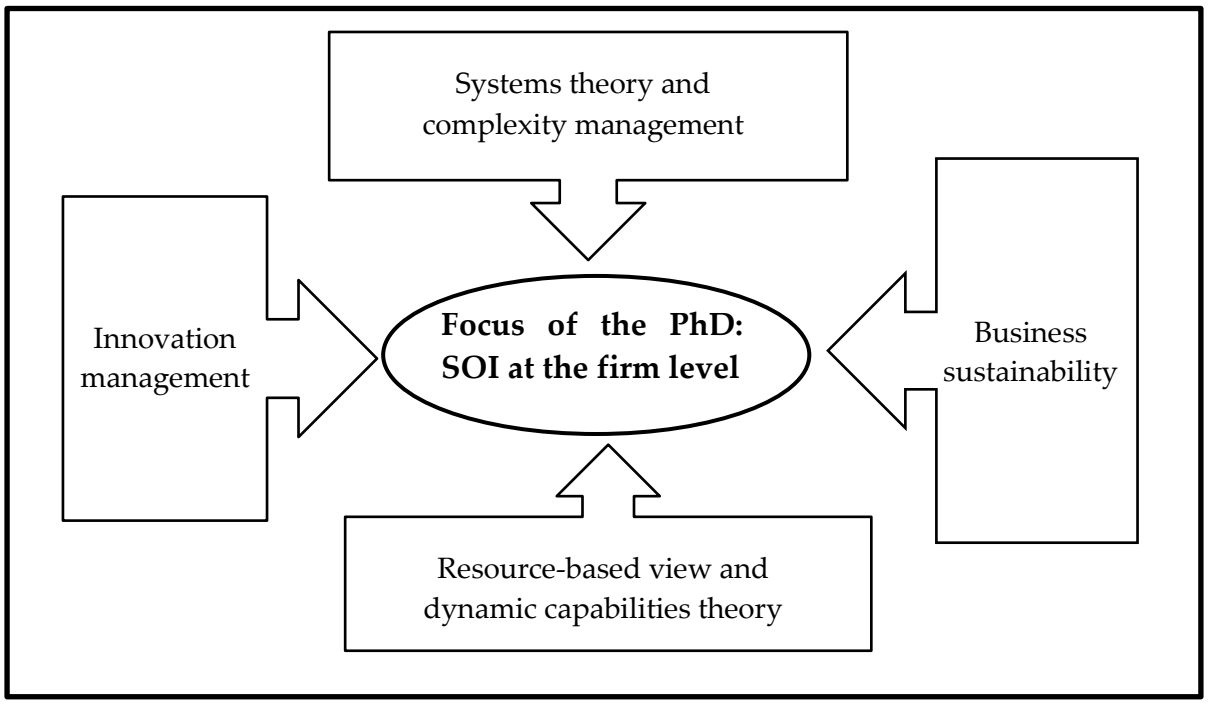

Figure 3. Departing theoretical framework of the study

Concentrating on these theoretical foundations implies excluding other frameworks that could have been of application. For instance, SOI has been previously examined from the perspective of stakeholder theory (Ayuso et al., 2011; Ayuso et al., 2006; Hall et al., 2014; Matos and Silvestre, 2013) or macro-economics and public policy (Ambec, Cohen, Elgie and Lanoie, 2013; Horbach, Rammer and Rennings, 2012; Nill and Kemp, 2009; Rennings, 2000). However, the focus of the thesis at the firm level calls for the application of management theories such as the resource-based view and dynamic capabilities. However, the importance of the relationship of the firm with its surrounding environment, including its stakeholders and the applicable regulations is acknowledged, and it is integrated into the conceptual framework of this thesis through systems theory. This is so because the main system object of study, the firm, is in ongoing interaction with other systems (i.e. its stakeholders and other agents in the environment) and is embedded in the wider economic, social and environmental systems, which have rules of interconnection (i.e., institutions and regulations). In fact, stakeholder management is cited in the literature as a part of the system required to engage in SOI, as a tool to break the decoupling between the sustainability and innovation systems (Decarolis, 2015; Steiner, 2008)- Smith, Voβ and Grin (2010) point out that the need to approach innovation for sustainable development as '*a process of linking broader analytical frameworks to successively larger problem framings*' calls for multi-level analysis of the system transitions. At the same time, systems theory allows for a more profound comprehension of complex issues in the management of SOIs (McElroy, 2003), and for the purposes of this dissertation, allows to study SOI from the focal point of the firm but without ignoring its wider system, including but not limited to, its stakeholders, looking at the different agents that take part in the system transition for sustainability (Fischer and Newig, 2016).

2.2. Innovation management

2.2.1. The concept of innovation

Despite the widespread literature on innovation, particularly during the last four decades, there is not a commonly accepted definition of what it entails (Crossan and Apaydin, 2010). Hence, the purpose of this section is to explore the concept of innovation as defined in previous studies, in order to find a working baseline for when mention to 'innovation' is made in this thesis.

The classic definition by Schumpeter (1912) defines it as '*the introduction of new products, new methods of production, the opening of new markets, the conquering of new sources of supply and the creation of a new organisation in any industry*'. This definition, whose fundamentals are still valid (Becheickh, Landry and Amara, 2006) stresses

novelty. However, as Hansen and Wakonen (1997) point out, as only very rarely are things conducted under identical premises, almost anything would qualify as innovation under this definition. For this reason, posterior scholarship has underscored the need to create economic value for a novelty to be called 'innovation': as Drucker (1984) explains, innovation is '*change which creates a new dimension of performance*'. Therefore, there are two elements that are central to the concept of innovation: the element of novelty, highlighted in the first novelty and value creation.

This notwithstanding, as Crossan and Apaydin (2010) collect, the corpus of research on innovation has identified a series of conditions to qualify as such: its necessity and sufficiency (Pittaway, Robertson, Munir, Denyer and Neely, 2004), its intentionality (Länsisalmi, Kivimäki, Aalto and Ruoranen, 2006), its beneficial nature (Camison-Zornoza , Lapiedra-Alcami, Segarra-Ciprés and Boronat-Navarro, 2004), its successful implementation (Hobday, 2005; Klein and Knight, 2005), and its diffusion (Holland, 1997), as illustrated in Figure 4.

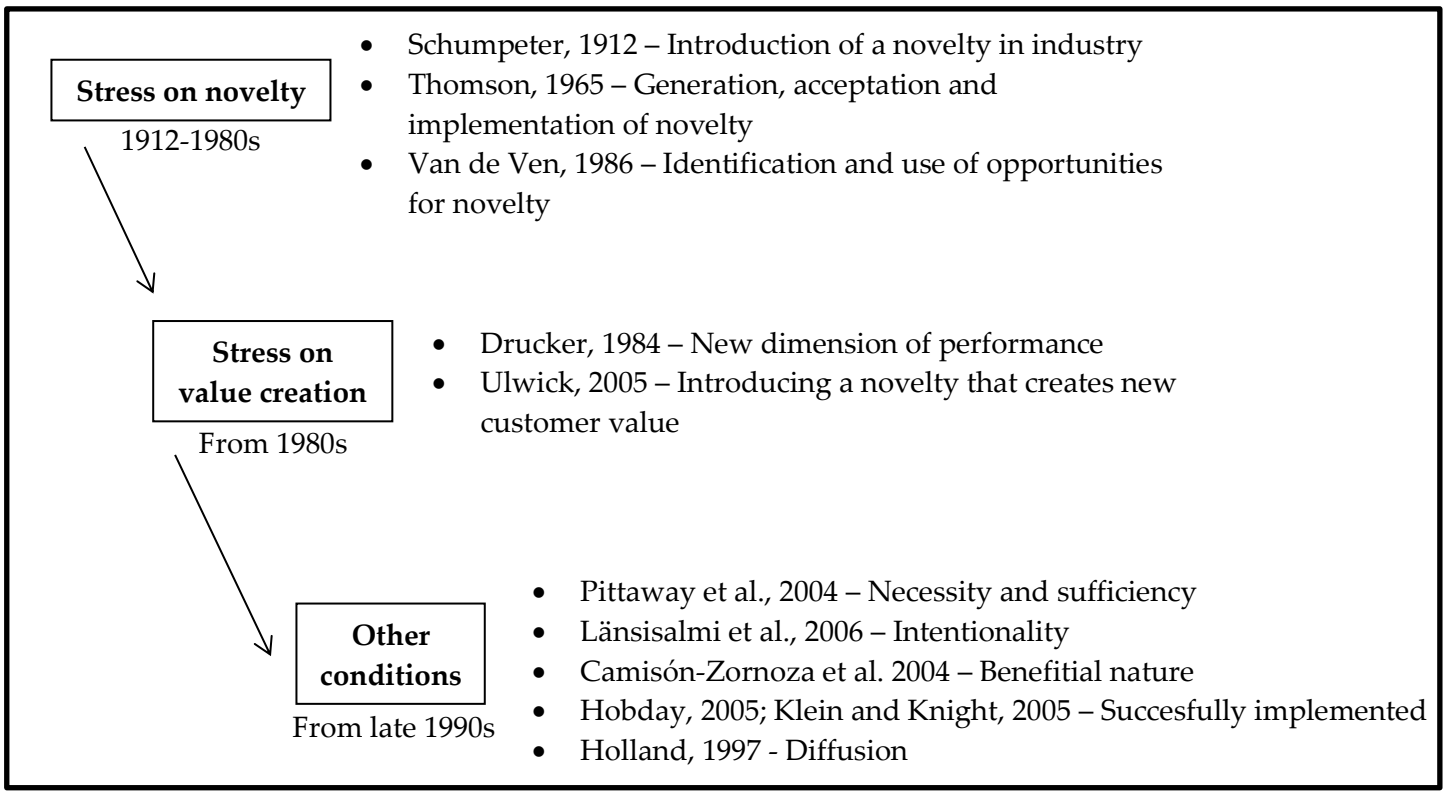

Figure 4. Development of the concept of innovation
Source: elaborated by the author

Based on this premises, Crossan and Apaydin (2010:1155) propose the following definition, which is of reference when the term 'innovation' is used in this thesis:

> *Innovation is: production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and*

enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome.

Due to its solid grounding on a systematic literature review and its comprehensiveness of the conditions to qualify as innovation previously reported in the literature, this is the preferred definition for the present purposes (Crossan and Apaydin, 2010). Nevertheless, despite its timeliness for current date, its limitations must be acknowledged: due to the very existence of innovation, scenarios that are not contemplated under this characterisation may occur in the future, and qualify as innovation. For this reason, holistic views on innovation opt for more open approaches, such as that of Bessant, Stamm, Moeslein and Neyer (2010), for whom innovating implies '*embracing change to create value*'. However, despite the comprehensiveness of such holistic definitions, they can be too broad to be operationsalised as a working concept that can be framed under the scope of a piece of research like this, since it may entail almost anything. This definition would entail further scenarios and aim to capture the complexity and multidimensionality of the concept (Wolfe, 1994); nevertheless, taking into consideration the cross-sectional nature of the present study and in an effort to provide an accurate definition, the abovementioned conceptualisation by Crossan and Apaydin (2010) is employed as reference. However, as illustrated in the next section, there are different manners of classifying innovation under this definition.

2.2.2. Types of innovation

There is a great variety of criteria by which taxonomies of innovation have been created, as illustrated in Figure 5. However, not all of them need to be thoroughly explained for the purpose of this thesis, although these criteria are useful to define the scope of the research.

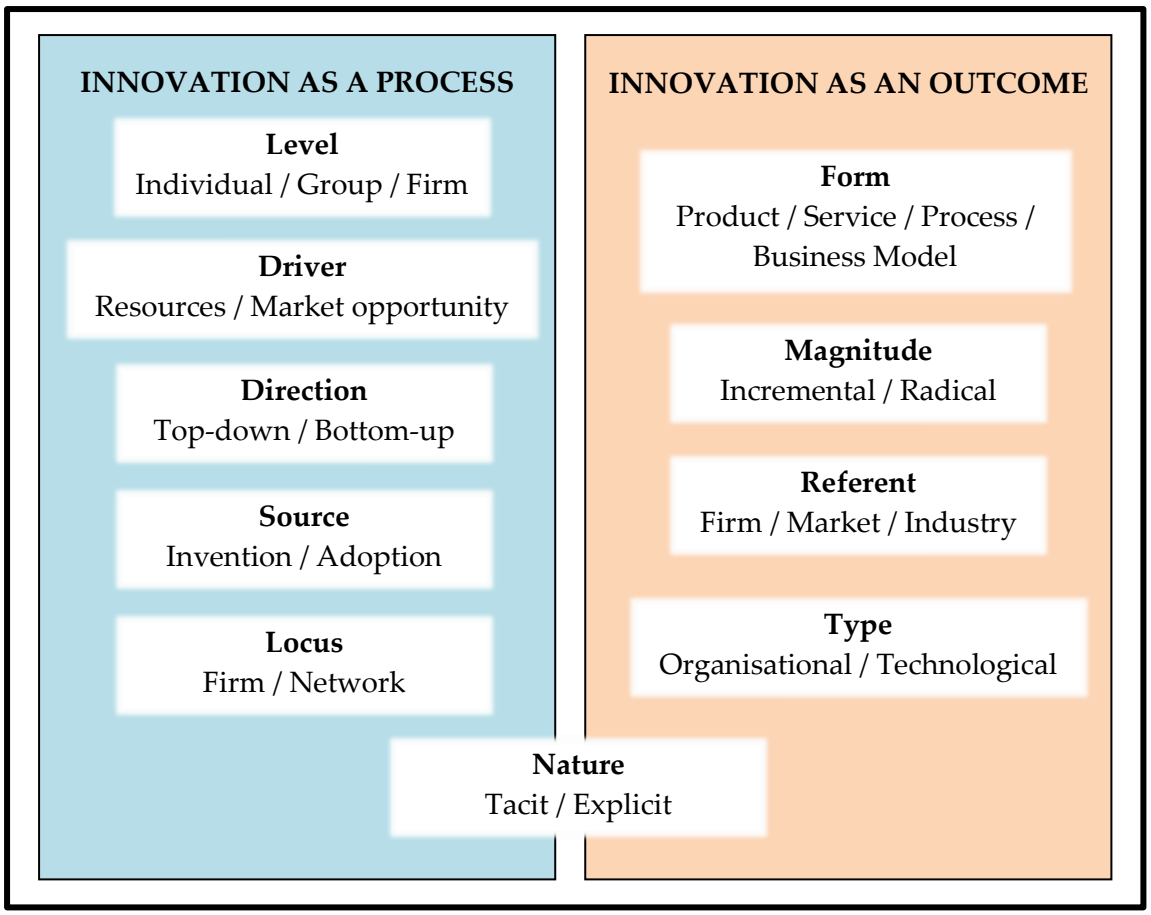

Figure 5. Criteria to create taxonomies of innovation
Source: adapted from Crossan and Apaydin (2010)

At this stage, only two main taxonomies need to be considered extensively; kinds of innovation by form and types of innovation by magnitude, because these will be the criteria deployed to differentiate outcomes of SOI in the second, empirical part of the thesis. These criteria, which are also the most recurrent form of classification of innovation (Bessant and Tidd, 2007; OECD and Eurostat, 2005), are further developed in the following subsections. Nevertheless, the rest of the criteria are useful in defining the scope of the research; consequently, Table 1 illustrates where the focus of the thesis lies regarding the criteria indicated in Figure 5.

[1] The term distinction of innovation outcomes by 'type' originally comes from Gopalakrishnan and Damanpour (1997) and the original terms to refer to these categories were 'administrative' and 'technical', the first referring to those related to social structure and the latter to technological innovations (see Crossan and Apaydin, 2010:1168). The terms have been changed to better reflect the language in this dissertation. In addition, the term 'type' is not used to distinguish between these two categories, but also between different kinds of innovation outcomes.

Innovation as a process		Innovation as an outcome	
Level	Firm	All forms of outcome	**Form**
Driver	Both resources and market opportunity	Both incremental and radical	**Magnitude**
Direction	Both top-down and bottom-up	Firm	**Referent**
Source	Both invention and adoption	Both organisational and technological	**Type**
Locus	Firm	Both tacit and explicit	**Nature**

Table 1. Scope of research according to types of innovation

Source: elaborated by the author

2.2.2.1. Taxonomy by form of innovation outcome

In terms of form, the majority of the scholars distinguish between three types of outcome (Crossan and Apaydin, 2010): product or service innovation; process innovation and business model innovation. Under this classification, each of the categories is explained as follows:

a) *Product or service innovation* refers to novel and meaningful products or services that are introduced to the market at the appropriate time (Wang and Ahmed, 2004). However, some authors indicate how this novelty requirement may be relative to the customer (Wang and Ahmed, 2004), to the market (Lee and Tsai, 2005) or even to the company (Davila, Epstein and Shelton, 2012). Although traditionally the focus of the literature has been placed on product innovation, in recent years service innovation has gradually gained some prominence due to the importance of service-oriented industries in advanced economies (Mina, Bascavusoglu-Moreau and Hughes, 2014).

b) *Process innovation* -not to be confused with the innovation process (Crossan and Apaydin, 2010)- involves the introduction of novel production methods, new management approaches, and new technologies that improve the production and management processes (Wang and Ahmed, 2004). Consequently, as opposed to product or service innovation, process innovation has an essentially internal dimension, and the improvements will often be evaluated under different performative measures (e.g. material efficiency gains) rather than market performance.

c) *Business model innovation* is the result of simultaneous increments in customer value and new value creation that is at least partly captured by

the company through a certain revenue model (Matzler, Bailom, Friedrich and Kohler, 2013). As opposed to the previous categories, which often involve technical / technological innovation (as defined by Gopalakrishnan and Damapour, 1997) this category is mostly administrative / organisational. Again, in this case the novelty may be relative to the customer, the market or the company (Davila et al., 2012). Therefore, business model innovation "*represents a new dimension of innovation itself, which spans beyond the traditional modes of process, product and organisational innovation*" (Massa and Tucci, 2013:424) due to its capacity to bundle different product, process and organisational aspects in order to create and capture value in a novel way.

However, other classifications on the basis of form are also useful. Bessant and Tidd (2007) propose a four-category taxonomy, the four 'P's, which entails, on top of product or service and process innovation, two new categories: (1) position innovation (changing the perception of an established product and service by employing it in a different context), and (2) paradigm innovation (changes in the mental models that are dominant in a company or industry). The latter is closely related to the classification by magnitude that these and other authors develop drawing on Kuhn's (1962) theory of scientific revolutions (as further developed in Section 2.2.2.2.), and also to the concept of systems and systemic innovation (see Section 2.4.3).

The efforts of international bodies towards defining innovation and how to study it is collected in the Oslo Manual (OECD and Eurostat, 2005), which indicates the types of innovation that are considered as such, mainly, product or service, process, marketing and organisational innovation. Due to its generalised use and level of detail in the manual about which of them implies, this is the preferred classification for this thesis. In this manual, each of the categories is described as follows, (the level of detail clarifying each of the terms in this definitions can be found at the manual):

> *A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics* (OECD and Eurostat, 2005:48).

> *A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software* (OECD and Eurostat, 2005:49).

> *A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing* (OECD and Eurostat, 2005:49).
>
> *An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations* (OECD and Eurostat, 2005:51).

Although they introduce different nuances, these classifications often pivot around three categories: product (and service) innovation, process innovation and a third pillar containing non-technical innovations, more or less divided depending on the nature of the classification. While Crossan and Apaydin (2010) focus more on the strategic outcome (business model innovation), the Oslo Manual (OECD and Eurostat, 2005) is more concentrated on the object onto the innovation is performed; hence discerning between marketing and organisational innovations.

2.2.2.2. Taxonomy by magnitude of innovation outcome

Another way to classify innovations is by their magnitude, or degree of novelty. The classical classification is between incremental and radical innovation (Ettlie, Bridges and O'Keefe, 1984; Gopalakrishnan and Damanpour, 1997). The term 'incremental' is not very contested, although it is called 'steady-state innovation' under the paradigm view of Bessant, Lamming, Noke and Phillips (2005). Although the form 'radical innovation' is preferred for the purposes of this dissertation, other forms of innovation that ruptures with the previous socio-technical status quo are also identified in the literature with some conceptual nuances (García and Calantone, 2002), such as 'discontinous' (Bessant et al., 2005), 'disruptive' (Yovanof and Hazapis, 2008) or 'breakthrough' (Prahalad, 2012). In any case, radical innovation provokes substantial changes and is a fundamentally new practice in the organisation, whereas incremental innovation represents a variation of pre-existing practices (Crossan and Apaydin, 2010; Dewar and Dutton, 1986).

Incremental innovation is normally associated to established firms, because radical innovations tend to require unique organisational structures pivoting around such innovation (Ettlie et al., 1984) and organisational cultures and structures must endorse radical change for it to be successful (Büschgens, Bausch and Balkin, 2013). For this same reason, form and magnitude are often associated in the literature (Crossan and Apaydin, 2010), linking business model (or organisational or paradigm) innovation to radicalness (Bourreau, Gensollen and Moreau, 2012; Francis, Bessant and Hobday, 2003; O'Connor and DeMartino, 2006) while incremental improvements are connected mostly to product, service, process and marketing (or positioning) innovations (Björkdahl and Linder, 2015; Henderson and Clark, 1990).

As Abernathy and Clark (1985) point out, technological research follows the pattern of normal science and revolutions explained by Kuhn (1962); therefore, periods of incremental improvements are followed by radical innovations that change the paradigm (Bessant and Tidd, 2007) after a discontinuity produces a shift in the innovation frontier, creating new opportunities (Bessant et al., 2005; Utterback, 1994). Consequently, in the same way that periods of normal science are the norm and scientific revolutions the exception, incremental innovation is more common in practice than its radical counterpart. Despite this, scholarship has focused more on radical innovation (Jansen, Vera and Crossan, 2009), and managers often disqualify incremental innovation as such (Crossan and Apaydin, 2010) by referring to it as 'continuous improvement' or 'product development'. Nevertheless, the present research observes both phenomena as both of them are relevant not only for socio-technological advancement, but also forbusiness development through exploitation of incremental changes and exploration of new opportunities through radical change (Cembrero, 2013; Tushman and O'Reilly, 1996).

2.3. Business sustainability

2.3.1. The concept of sustainable development

Sustainable development was defined by the so-called Brundtland Commission (WCED, 1987) as '*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*'. From that moment on, this became the standard definition of sustainable development, and efforts at different institutional levels have been set in motion since then, establishing objectives to progress in that direction like the Sustainable Development Goals (United Nations, 2015) or the European Commission's (2009) Sustainable Development Strategy. However, this definition has been widely contested; in fact, it does not cover the threefold social, environmental and economic components that characterise the understanding that institutions and global actors have made of the concept. Instead, it focuses on the economic ('*meets the needs*') and the environmental ('*without compromising the ability of future generations*'). Consequently, the Brundtland Commission's definition of sustainable development comes to recognise the relationship between the economy and the environment, and the dependence of the first on the latter, as illustrated in Figure 6. This relationship, as acknowledged in this definition, requires an economic system that respects the renewal capacity of the environment or so-called 'planetary boundaries' (Whiteman, Walker and Perego, 2013).

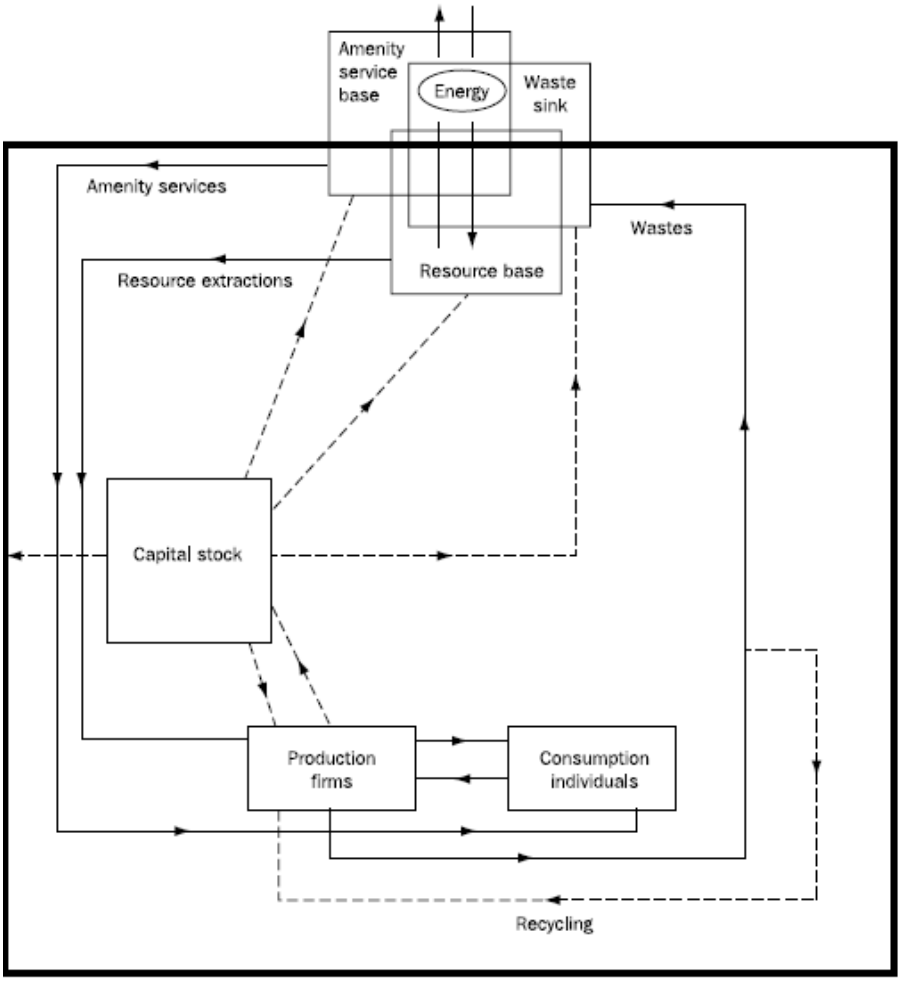

Figure 6. Economic activity in the environment
Source: Common (1995)

For this reason, this definition has been criticised by authors like McNeill (2004), who poses two main concerns. First, there is the potential conflict in the intergenerational trade-off: although the WCED (1987) suggests that current opportunities for development must be at least conserved or increased for future generations, the application of discount rates to the future minimises the conservation effort (Beder, 2000). The second criticism regards the absence of a social element, or intragenerational equity; in other words, the right of all individuals of the present generation to achieve similar levels of affluence. Consequently, the concept has been extended in order to include the element of intragenerational equity (Gladwin et al., 1995). To this respect, Sen (2000) and Nussbaum (2013) explain what this social aspect of sustainable development entails by adopting a capability approach to human development: empowering people so that they are able to do what they value. In the context of the WCED definition, 'sustainable' requires *securing* basic capabilities, and in order to build capabilities people need resources, security, participation in political process, social inclusion, gender equity, and other social factors.

Two other main debates are also unresolved in defining sustainable development; the first one, concerning whether there can be such if there is some form of environmental degradation, and the second, regarding whether it must involve economic growth. The first debate (Perman et al., 2011) is divided between the eco-centric view of 'strong' sustainability, in whose opinion sustainable development may only be called so if increments in the social and / or economic capital do not imply any decreases in the natural capital (Common and Perrings, 1992); and the anthropocentric defendants of 'weak' sustainability, who argue that development in which the overall capital stock (natural and man-made – social and economic -) increases despite losses of natural capital may be called sustainable (Hartwick, 1977; 1978).

Regarding the second debate, most definitions of sustainable development imply that there must be economic growth in sustainable development, following the capitalistic approach that growth is necessary for the good fare of the economy (Epstein, 2008; Weybrecht, 2010), and that greater affluence brings improvements in overall welfare, or that environmental degradation and economic growth may be decoupled (UNEP, 2011). However, other authors suggest that the environment's carrying capacity has been already been surpassed by Western living standards; therefore, they argue for de-growth as the only possible way of achieving sustainable development (Foster, 2011), due to the inevitability of environmental degradation associated with economic growth (Foster, 1992). The very concept of de-growth as an alternative to the paradigm of economic growth has been criticised, not only because it is deemed confusing and inefficient (Van den Bergh, 2011), but also because the strategy for sustainable development should be being indifferent about growth – the denominated a-growth – so as to pursue social welfare by whatever means necessary, which are not always necessarily economic growth.

For the purpose of this thesis, a pragmatist approach to sustainable development is adopted, taking into consideration social, environmental and economic matters at the intergenerational and intragenerational levels from a weak sustainability, capitalist perspective. This stance is taken in order to adopt a comprehensive approach. A weak sustainability perspective is adopted not only because it has been the dominating viewpoint in management science, but also because of the complexity of measurement of impacts. Since affirming that an innovation is fully sustainable is not possible in terms of measuring the complete impacts that it might have in the future, the most prudent approach is to not label them as such, but rather focus on their intentionality of producing an improvement in social or ecological terms. In addition, the capitalist approach allows for the introduction of the notion of compensation among different types of capital that characterises weak sustainability, and is able to capture in a simple manner the trade-offs between social, environmental and economic interests that have to be taken into consideration when engaging in SOI practices.

2.3.2. Business sustainability

As observed in the previous section, there is close relationship between the economy and the environment (Hoffman and Bansal, 2012), as observed in Figure 6. For this reason, companies, as one of the main actors in the economic system, are in a privileged position to contribute to environmental sustainability; moreover, it is recognised as part of their responsibilities both in informal (Buysse and Verbeke, 2003; Hart, 1997; Winn and Angell, 2000), formal (Berman and Bui, 2001; Khanna and Anton, 2002; Porter and Van der Linde, 1995) and self-regulation (Albareda, 2008; Nikoloyuk, Burns and De Man, 2009). Literature previous to the research stream of organisations and the natural environment, emerging mostly after the Brundtland Report (WCED, 1987) had not observed the non-human aspects of management (Gladwin et al., 1995; Orr, 1994). Instead, the emphasis in management literature was mostly anthropocentric in both in the business ethics stream and the emergence of corporate social responsibility, both concentrating on the duties of business towards society.

The initial literature on corporate social responsibility contemplated it as a way in which companies may, or may not, fulfil their moral obligation towards society, with actions ranging from legal compliance to fulfilling the ethical or economic expectations that society has of a firm (Carroll, 1979). Part of the literature did not see social responsibility management as strategic, but rather as a view of philanthropy, legitimation or 'corporate citizenship' (Matten, Crane and Chapple, 2003; Matten and Crane, 2005, Matten and Moon, 2008). However, Garriga and Melé (2004) summarised the corporate social responsibility approaches in four categories: (1) instrumental theories, in which corporate social responsibility is a mere instrument for economic benefit; (2) political theories, which are related to the consolidation of the power of the corporation in society; (3) integrative theories, in which the firm is concentrated on resolving social demands; and (4) ethical theories, which are concerned with the duties of the corporation towards society derived from ethical values. Hence, at least part of this literature stream already had a strategic concern in the management of the relationship between the firm and society (McWilliams and Siegel, 2011; McWilliams, Siegel and Wright, 2006; Surroca et al., 2010; Waddock and Graves, 1997; Windsor, 2001).

Another view that integrates CSR with strategic management is stakeholder theory (Freeman, 1984; Freeman, Harrison and Wicks, 2007), which affirms that the good relationship of businesses with those holding a stake in its activities will provide those forms with a competitive advantage. It is a common theory in CSR, since it takes into consideration interests external to the firm, and the environment is often included as a stakeholder. A fair treatment of these groups results in improved social and environmental performance.

However, the application of the concept of sustainable development as defined by the United Nations (WCED, 1987) and posterior understanding that included social matters as well, translated in a growing concern for resource use efficiency, with the aim of reducing the environmental footprint, and the reconcilement of business activities and social needs, gradually leading to the notion that sustainable development must be central to the core business, rather than something marginal (Aragón-Correa and Sharma, 2003; Bansal, 2005; Etzion, 2007; Hart, 1995; Hoffman and Bansal, 2012; King and Lenox, 2002; Porter and Van der Linde, 1995; Porter and Kramer, 2011; Prahalad and Hart, 2001).

In this sense, grey literature has operationalised business sustainability with so-called triple-bottom line, in other words, attending equally to the social, environmental and economic dimensions of the firm (Elkington, 1998), which may lead to developing a competitive advantage (Epstein, 2008). The International Institute for Sustainable Development brought sustainable development closer to companies as follows: '*For the business enterprise, sustainable development means adopting business strategies and activities that meet the need of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future*' (retrieved from Weybrecht, 2010:14).

2.3.2.1. The elements of business sustainability

The academic literature has tried to go one step beyond and distil the elements of business sustainability into more structured dimensions, with some authors focusing solely on one of the pillars (taking into consideration the interconnection among them, though). The collection of previous literature leads Bansal (2005) to a definition of corporate sustainable development, or business sustainability, based on the three (environmental, social and economic) principles, which are developed as follows:

a) *Environmental integrity through corporate environmental management*. This pillar is concerned with the minimisation of the potential environmental harm the company may cause through its operations. It is concerned with the development of reactive pollution control (Hart, 1995; Russo and Fouts, 1997) or proactive pollution prevention strategies (Aragón-Correa and Sharma, 2003; Hart, 1995). At a later stage, environmental management follows a product stewardship approach (Hart, 1995) that is concerned with the environmental impacts of the whole life-cycle of the product, process or practice (Bakker, Wever, Teoh and De Clercq, 2010; Matos and Hall, 2007).

b) *Social equity through corporate social responsibility*. According to Wood (1991), corporate social responsibility implies environmental assessment, stakeholder management and social issues management. The first one corresponds to the vigilance and identification of social, economic and environmental issues in the firm's surrounding environment in order to respond to the successfully; including regulation (Dlouhá, Barton, Janoušková and Dlouhý, 2013; Fahey and Narayanan, 1984; Khanna and Anton, 2002). The second is related to the responsiveness of the firm towards individuals and organisations external to the firm that have a legitimate interest in the firm (Bridoux and Stoelhorst, 2014; Freeman, 1984; García-Castro and Francoeur, 2016), aiming to create value for the whole network of stakeholders, in which some authors include the natural environment (Buysse and Verbeke, 2003; Starik, 1995). Social issues management consists of addressing social issues that imply that the firm would be acting immorally or irresponsibly if it failed to tackle them, such as using child labour, producing socially undesirable products or engaging with unethical suppliers, clients or business partners (Reinecke and Ansari, 2016; Selsky and Parker, 2005; Sharma and Ruud, 2003). This often involves making decisions that will not satisfy all stakeholders (Byl and Slawinski, 2015; Hillman and Keim, 2001).

c) *Economic prosperity through value creation*. As Bowman and Ambrosini (2000) point out, firms create value through the goods and service they produce and market, and the value captured by the firm are the rents from its sale, as the rest of the value is captured by the customer intermediaries, employees and other agents. Since value creation and value capture are related but independent processes, under certain circumstances, high value creation may not be related to high value capture by the firm (Makadok, 2001). However, in the last years scholarship has been focused on the creation of sustainable value (Hart and Milstein, 2003), that is, value that is created specifically aimed to be captured by the firm, society and the natural environment, or the firm and the environment (Paquin, Busch and Tilleman, 2015) or society (McWilliams and Siegel, 2011; Porter and Kramer, 2011; Sinkovics, Sinkovics and Yamin, 2014), even involving stakeholders in its creation (Gouillart, 2014)

However, there are holistic approaches to business sustainability that adopt a systemic view of the firm, focusing not only in the three elements of business sustainability but also in the interconnections between them. This literature looks at the firm as an actor of a wider sustainability transition, the core business being the

progress towards sustainable development through the tools and means provided by management techniques and the economic system (Gladwin et al., 1995; Hart, 2012; Waddock and McIntosh, 2011). The dramatic change in context due to man-made environmental change requires a new role for the corporation (Hoffman and Jennings, 2015; Scherer, Palazzo and Seidl, 2013; Whiteman et al., 2013). In that sense Hart (2012) summarises the characteristics of the sustainable corporation, as compared to the traditional or, as he puts it, 'industrial' corporation, which include development of disruptive innovations for sustainability, social and community embeddedness, inclusiveness and motivation by meaning and purpose, among others.

2.3.2.2. Performance issues and drivers of business sustainability

Unlike the case of innovation, the financial profitability of business sustainability has been extensively questioned in the literature. The concept of innovation, as defined in early literature, already implies that innovation must result in some kind of economic advantage as compared with the previous situation (Drucker, 1984; Schumpeter, 1912). On the contrary, the initial concern on the inclusion of social or environmental goals in business is not related to the creation of a competitive advantage or maximising shareholder value: early literature is preoccupied with either the ethical and legitimation aspects of business (resulting in the initial CSR corpus (Bowen, 1953; Carroll, 1979; Garriga and Melé, 2004)) or with the compatibility of business growth and environmental thresholds set by the Earth's carrying capacity (as in the early ecological economics literature (Arrow, Bolin, Costanza and Dasgupta, 1995; Meadows, Meadows, Randers and Behrens, 1972)). Because of this, from the very first discussions on business sustainability the economic performance concern has been present, as environmental or social concerns where seen by some as ancillary activities of the firm that minimised (economic) value creation (Friedman, 1970; Smith, 2003). Despite this, soon theories that make business sustainability central to the strategy of the firm were developed, sustaining that having an appropriate relationship with natural resources and society will provide the firm with a competitive advantage (Bansal, 2005; Hart, 1995, Hart and Dowell, 2011; Porter and van der Linde, 1995; Porter and Kramer, 2011), and allow for organisations to become profoundly ingrained in the social and environmental systems (Hoffman and Jennings, 2015; Shrivastava and Hart, 1995).

However, empirical research has yielded mixed results (Surroca et al., 2010; Wood, 1991; Wood, 2010). This may be explained by the fact that companies have often seen environmental management and corporate social responsibility as ancillary to the firm's core business, or in the worst of the cases, as an added economic burden (Porter and van der Linde, 1995), rather than an strategic activity aligned with the core business activities (Chen, 2008; Hansen and Schaltegger, 2014). A summary of the ways

in which the relationship between corporate social performance and financial performance is made by Wood (2010), confirming that previous empirical research did not answer the question whether business sustainability is financially profitable due to the variety of results (Orlitzky, Schmidt and Rynes, 2003). Surroca et al. (2010) find that the relationship is mediated by intangibles (innovation, human capital, reputation and culture) that create a virtuous circle between corporate social and financial performance. Kim, Kim and Qian (2015) introduce a contingency perspective that suggests that responsibility pays off in highly competitive environments, while irresponsible acts are more financially profitable in low-competition environments. In examining the relationship between environmental and financial performance, Ramanathan (2016) observes a curvilinear relationship consistent with the natural resource-based view of the firm (Hart, 1995), which argues that proactive environmental management provides the firm with a competitive advantage (Aragón-Correa and Sharma, 2003).

Beyond the measurement of the direct or mediated relationship between the inclusion of sustainability goals in business and profit maximisation, part of the literature aims to evaluate how environmental and social management builds long-term, strategic value, exploring how the multidimensionality of sustainability yields new sources of competitive advantage (Hart and Milstein, 2003). Funk (2003) observes how handling a set of sustainability indicators (that is, having a triple strategic bottom line) fosters the development of intangibles in the firm, sustaining the creation of long-term value for stakeholders. McWilliams and Siegel (2011) draw on resource-based theory to explain how strategic CSR (that is, CSR that is aligned with corporate goals) helps to build such unique resources.

Despite the extensive literature on the relationship between business sustainability and financial performance, this seems to argue that the economic pillar is disconnected from the social and environmental pillars of sustainable development, or that there is necessarily a trade-off between economic and social or environmental objectives. Consequently, a stream of research aiming to evaluate sustainability performance as a whole rather than confronting the results in each of the pillars is emerging (Santoyo-Castelazo and Azapagic, 2014; Schaltegger and Burrit, 2014; Schaltegger and Wagner, 2006; Searcy, 2011). This literature looks at value creation from a multidimensional perspective, taking into consideration how natural, social and economic value is created jointly, rather than in parallel or in opposition (Dyllick and Hockerts, 2002). In this sense, the purpose of the firm changes, since it is oriented to the maximisation of this threefold value, not only shareholder value: this is reflected in a systemic approach to management (Moore and Manring, 2009) and accounting (Gray, 2006).

In any case, due to the mixed results in the business sustainability and financial performance literature and the traditional conception of maximisation of shareholder value as unique bottom line of the corporation (Friedman, 1970), another major stream in the empirical business sustainability corpus of research has aimed to understand the drivers behind the adoption of sustainability practices. Beyond the contextual requirement because of a change of paradigm posed by normative literature (Gladwin et al., 1995; Hart, 2012; Hoffman and Jennings, 2015; Whiteman et al., 2013), empirical research has focused on three primary motives (Bansal and Roth, 2000): competitiveness (Hart, 1995; Porter and van der Linde, 1995; Russo and Fouts, 1997; Shrivastava, 1995) legitimation or legal compliance (Lampe, Ellis and Drummond, 1991, Lawrence and Morell, 1995) and social responsibility or moral obligation (Carroll, 1979, Wood, 1991). Later, other motives such as market responsiveness through the alignment of strategy (Crittenden, Crittenden, Ferrell, Ferrell and Pinney, 2010) have been observed. Lee (2009) extended the mainstream view on drivers of business sustainability by taking into consideration organisational structure, innovation capability, human resources, cost savings and competitive advantage as levers for business sustainability practices in small and medium enterprises.

Considering the existing literature on the relationship of business sustainability and performance, it seems that sustainability goals must be embedded in the firm's strategy to prove profitable; in other words, they must become ingrained in the core strategy of the firm rather than being limited to additional activities. This seems to build intangible value that yields long-term value, although the economic results in the short-term are affected by other environmental factors.

2.4. Systems theory

Systems theory is a holistic approach to understanding reality, avoiding the analysis of solely some of its parts and rather trying to comprehend the complexity of interrelations that characterises real (as opposed to archetypical) systems. Hence, it is useful in order to see the deeper structures and forces at play, not placing artificial boundaries to the unit of analysis (Senge, Smith, Kruschwitz, Laur and Schley, 2008). Consequently, applying systems theory to this thesis responds to the will of trying to understand the phenomenon of SOI as a whole. This means that the firm will be the main unit of analysis –or system-; however, by applying systems theory, not only the components, its interrelationships and the system purpose can be examined, but also how it interacts with other systems (agents and institutions) and how these interactions affect the internal system properties. Therefore, it is not the purpose of this thesis to examine the wider system, as it is not possible to look at each of the systems related to the firm in some manner within the time and resources devoted to the thesis. The

objective is to focus on the firm as a system and its properties, and how its relationships with surrounding or parallel systems affect them.

2.4.1. Systems and complexity

System-thinking has become a self-sustained body of knowledge aiming to understand the complexity in reality (Merali and Allen, 2011). A system is an '*interconnected set of elements or parts that is coherently organised and interconnected in a pattern or structure that produces a characteristic set of behaviours, often classified as its function or purpose*' (Meadows, 2008:188). Hence, there are three main elements to a system: its components or parts, their interrelationships and the function that sustains its existence. A system is much more than the sum of its parts; consequently, the separate analysis of each of these parts separately, as traditional problem analysis does, is not sufficient. Such analysis of each of the parts would miss the adaptive, dynamic, goal-seeking, self-preserving and sometimes evolutionary behaviours of systems; because the purpose of the whole often explains the behaviour pattern of the part in a non-evident manner (Meadows, 2008).

In the application of systems theory to social phenomena, complexity is observed; moreover, the presence of complex adaptive systems is apparent. Complex adaptive systems lie "*somewhere between a linear and a chaotic system, with partially connected components and agents whose decision making and interactions produce behavior and outcomes that are neither fully controlled nor arbitrary*" (McCarthy, Tsinopoulos, Allen and Rose-Anderssen, 2006: 442). They show complex patterns of evolution and a dense web of interrelationships and interdependencies among them, which allows them to, in a self-organised manner, learn together from experience and adapt (rather than simply reacting) to the surrounding environments (Gell-Mann, 1994; Merali and Allen, 2011).

Complex adaptive systems, as opposed to other multi-agent systems, feature adaptive behaviour by means of self-reinforcement and self-organisation, which explain the system capacity to change in response to prevailing conditions (Norberg and Cumming, 2008). Self-organisation refers to the adaptive processes that let the system capacity tolerate change and determine the way in which a system switches between different regimes (Berkes, Colding and Folke, 2003; Holling, 1973; Walker, Holling, Carpenter and Kinzig, 2004).

2.4.2. Characteristics of complex adaptive systems

Social systems (e.g., society, clans, businesses, or any other kind of human organisation) are often complex adaptive systems (Merali and Allen, 2011; Norberg

and Cumming, 2008); entities formed by several autonomous agents, with a dense web of interrelationships and interdependencies among them. They learn together from experience and adapt to the surrounding environments (Gell-Mann, 1994; Merali and Allen, 2011). In doing so, complex adaptive systems exhibit three main patterns of behaviour:

a) *Non-linearity and resilience*. Linear relationships, those in which the relationship between two elements can be explained by a straight line, have been the main object of study of science. However, the majority of the relationships in a system (and in real-life) are non-linear, that is, the effect of one element on another is not proportional but rather better described by a curve or a wiggled line (Meadows, 2008). Non-linearities produce changes in the feedback loops, shifting dominance from one to another and enhancing system complexity. Associated with the non-linearity are the concepts of threshold and resilience. Resilience is the ability of the system to survive, adapt and thrive under changing conditions; to come back to equilibrium after a shock (Common and Perrings, 1992; Holling, 1973; Meadows, 2008). Resilience implies dynamism, adaption through evolution. The concept of resilience serves to define the degree of disturbance that a system can withstand before a regime shift takes place. Hence, stability is not per se a property of systems; nevertheless, equilibrium is, but points of equilibrium may vary. However, there are limits to resilience: when the shock or external change surpasses a certain threshold, the system cannot absorb it any more, causing the radical change or destruction of the system. Non-linearity and the concept of threshold are illustrated in Figure 7:

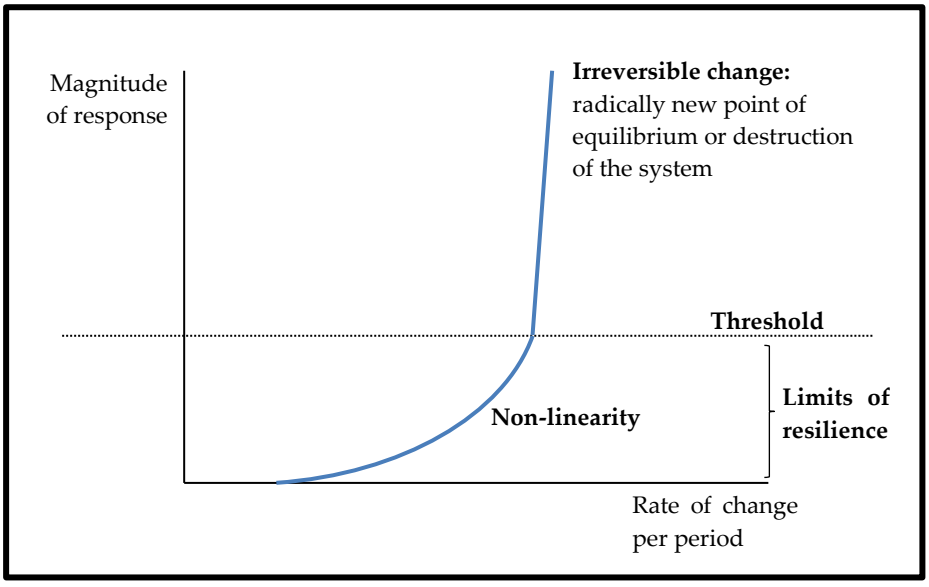

Figure 7. Non-linearity, resilience and system thresholds
Source: elaborated by the author based on Perman et al. (2003)

b) *Self-organisation, hierarchies and feedback loops*. Systems have the ability to generate new structures and behaviours in response to change (Meadows, 2008) without the intervention of any central control (Anderson, 1999). Self-organisation is the highest form of resilience, since it provides the systems with the means to survive under changing circumstances. It is path-dependent and non-deliberate, but there are some rules or patterns for self-organisation: balancing feedback loops. These are '*equilibrating or goal-seeking structures in systems*' (Meadows, 2008:189), the causal connections that explain the relationships among system components through flows of information. Feedback loops are self-reinforcing and lead to exponential growth or system collapse, since the feedback loops regime shifts under shocks or changes (Walker et al., 2004).

c) *Emergence*. Emergence is a phenomenon product of self-organisation, by which a completely new configuration emerges creating a new system (with or without destruction of the previous system), which might be embedded or independent from the system which gave rise to the emergent system (Goldstein, 2011). Emergence is based on unpredictability (Goldstein, 2011): through ongoing interaction, system components learn, adapt and create new emergent behaviour that involves new shifts of its own. Hence, through emergence, systems may not only adapt and evolve but also create completely new systems.

These patterns of behaviour observed in systems help to explain the complexity in reality and operationalise the relationships between different agents in reality. Understanding and embracing complexity and uncertainty in problem solving through system thinking leads to more profound and less diagrammatic representations of reality; for this reason, it has become a helpful framework of reference for business management, innovation and sustainability.

Many of the important problems to be dealt with in current day are complex, involve multiple units of analysis and are, at least partly, the result of past actions that initiated a path-dependent process that led to current status quo (Senge, 1999). Through systems theory, the complex set of systemic interconnections, relationships, causes and effects of business innovation practices and how they reshape organisations can be studied (Senge and Sterman, 1992). Several authors (Anderson, 1999; Eisenhardt and Piezunka, 2011; Levy, 1994; Mitleton-Kelly, 1997) indicate the value of complex adaptive systems to build organisations that evolve through effective solutions under changing circumstances, and the need of managers to embrace this complexity and let improvised, self-organised solutions evolve. Brown and Eisenhardt (1997) understand that under complexity, the boundaries and responsibilities in the organisation become

more blurred: structures become less strongly fixed and organisations engage in experimentation and bridge present and future through transition processes. Hence, enhancing diversity within the system and exploration-driven learning in the firm's network are relevant for organisational evolution (Allen, 2001; Galanakis, 2006). In fact, the chaos caused by the unpredictability of humans and organisations can be better managed applying a complexity and chaos perspective (Levy, 1994).

When trying to understand organisations as systems, we must take into consideration that, in social systems information is limited (Simon, 1981). Although traditional economics assume that agents are rational and have perfect information, Simon (1981) introduces the concept of bounded rationality as a framework for decision-making rather than mathematical modelling, due to the fact that knowledge is limited the cognition of agents, the tractability of the problem, and time. In this way, agents of decision find satisfactory rather than optimal solutions, affecting the way in which organisations evolve over time (Ethiraj and Levinthal, 2004; Gavetti, 2005).

2.4.3. Systems theory applied to innovation

Several authors in the innovation literature (Hobday, 2005; Mahdi, 2003) have signalled the ineffectiveness of innovation models in explaining the particularities of the innovation process across sectors. Hobday (2005) notes that these differences are explained by the path-dependent nature of the process; therefore, and evolutionary approach that takes equifinality into consideration must be taken. Equifinality is a property of system, which explains how different paths and configurations may be equally effective in achieving a certain goal (Gresov and Drazin, 1997). This is a consequence of self-organisation and the evolutionary nature of systems derived from resilience. Under this premise, authors like Van de Ven et al. (2008) propose the view of innovation as a dynamic system, with non-linearity features: a cycle of divergent and convergent activities may be repeated over time across the layers of the organisation. Assuming the self-organising and emergent properties of systems, managers must take an accepting approach in which they adapt to the flow of events and circumstances, since these cannot be controlled. The back-and-forth behaviour in the innovation process, characterised by feedback loops, is illustrated in Figure 8.

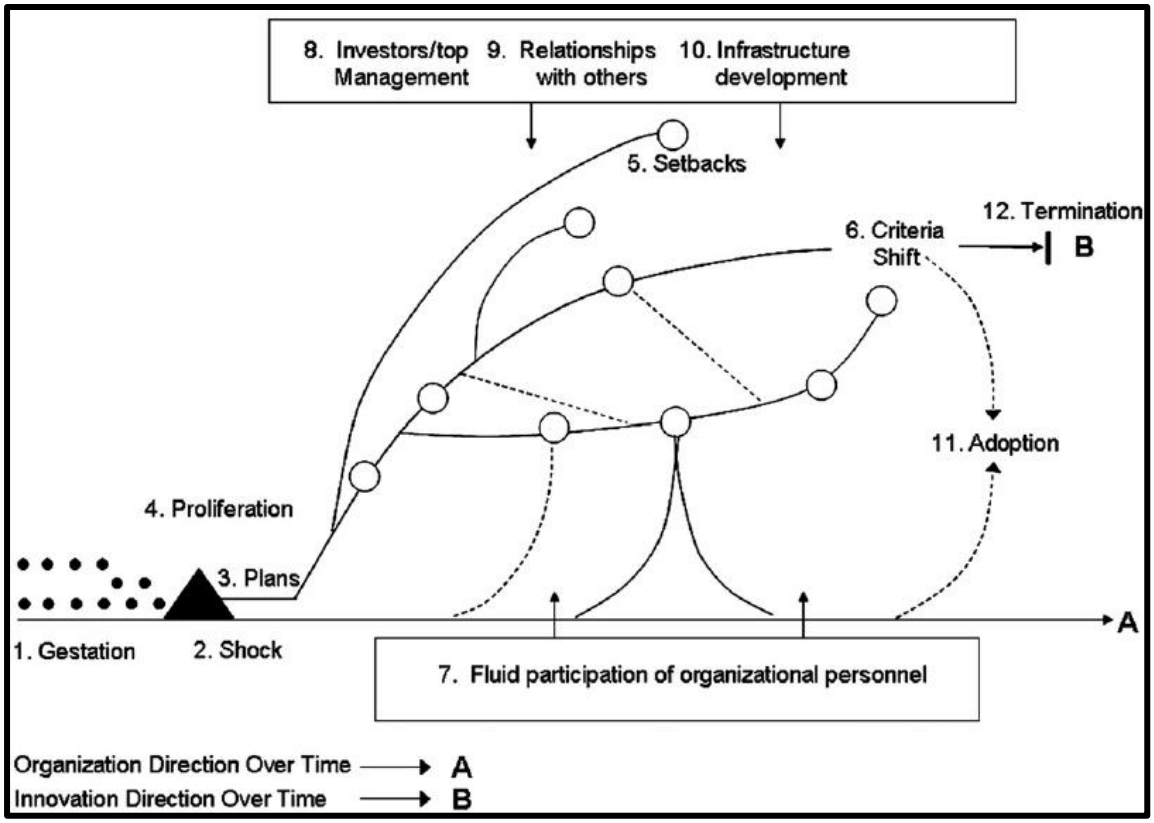

Figure 8. The innovation journey
Source: Van de Ven et al., 2008

Thinking in systems is useful not only in explaining the innovation journey, but also capabilities for innovation: as O'Connor (2008) explains, mere routines do not explain complex capabilities for innovation. Instead, their role in the innovation process is explain by system features: identifiable system with interdependent features; the whole being more than the sum of its parts, homeostasis achieved through interactions with its wider system, and a purpose in the larger system that is served through the innovation capability. This approach has also been applied to parts of the innovation process such as new product development (McCarthy et al., 2006).

Apart from being useful for explaining the innovation journey, from the macroeconomic perspective systems theory yielded the concept of innovation system (Lundvall, 1985). It departs from the assumption that firms operate in networks; therefore, the flows of information between people, firms and institutions shape the innovation process. This approach stresses the importance of the 'rules of operation' within the system; that is, how each of the agents within the system interacts with each other and how this results in various innovation outcomes depending on the participation of different agents (Cooke, 2001). In order to place boundaries to observe the innovation system as a unit of analysis, authors have placed the limits geographically (national innovation systems, regional innovation systems or local innovation systems), based on the development of a particular technology

(technological innovation systems) or on the grounds of industry (sectoral innovation systems).

2.4.4. Systems theory applied to sustainability

The rise of ecological economics as a discipline led to increasing preoccupation about sustainable development at the business level. The first 'green' economic models take into account environmental thresholds and material balance economic systems (as illustrated in Figure 9) and offer a systemic view of the economic system, which is embedded in the social system, and this is in the environmental system (Boulding, 1966, Van der Bergh, Truffer and Kallis, 2011).

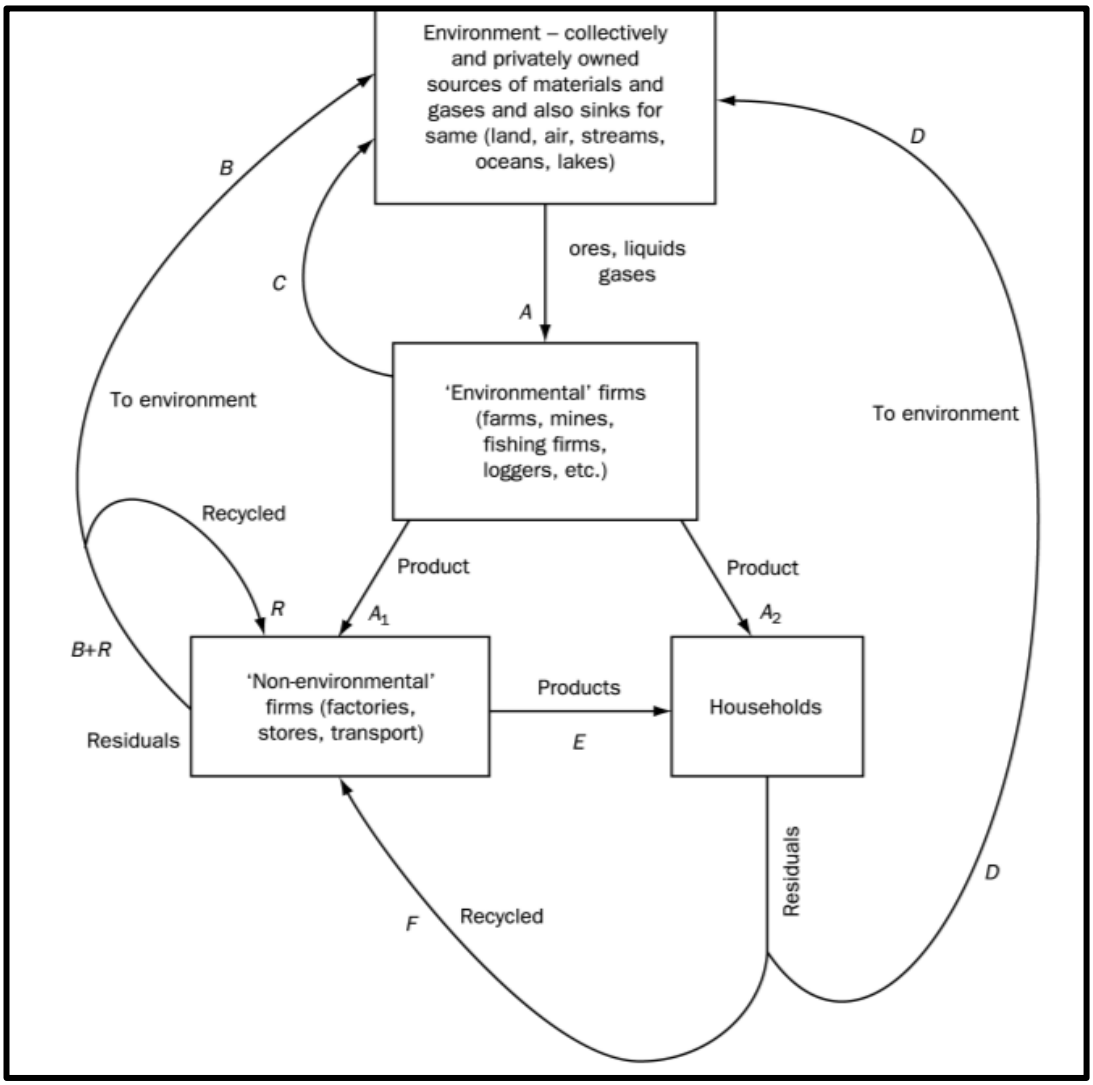

Figure 9. A system approach to the environmental and economic systems: a materials balance model of the economy
Source: Herfindahl and Kneese (1974)

Therefore, systems theory applied to business and the environment (including social aspects) sees the firm, which an economic agent, as an agent of the economic

system. This economic system is embedded and is dependent on the social system, which is, in turn, embedded in and dependent on the environmental system (Cato, 2009; Perman et al., 2011). Consequently, in order to pursue sustainability, certain rules of relationship between systems must be followed, respecting the laws of thermodynamics in the materials balance among systems – the so-called 'Daly rules', based on the works of Georgescu-Roegen (1971).

When applied to business sustainability, diverse authors have argued that applying systems theory; that is, seeing the firm as a system helps to introduce a sustainability mind-set through materials balance logics (Herfindahl and Kneese, 1974; Shireman, 1999). The relationship between the environment, society, the economy and innovation has given rise to the stream of literature on so-called socio-technical transitions to sustainability (Geels, 2010). Socio-technical systems are an approach to complex systems that understands how technological developments are accompanied by societal transitions and changes in human behaviour. The study of these systems with the inclusion of the environmental dimension for a paradigm shift has concentrated attention on so-called system transition for sustainability (Coenen and Díaz-Lopez, 2010; Geels and Kemp, 2007; Kläy, Zimmerman and Schneider, 2015; Moore et al., 2014). Through the study of socio-technical transitions for sustainability, both the human and technological aspects can be examined, in order to develop policies that tackle those aspects that matter the most for the problem in question (Jacobsson and Bergek, 2011). In this manner, societal needs must be integrated in science and design issues as a single system (Gaziulusoy and Brezet, 2015); although multi-level approaches are preferred to examine systemic issues (Geels, 2010; Papachristos, Sofianos and Adamides, 2013). As further developed in Section 4.4., there are profound philosophical connections between technology and society that further justify the application of systems theory to socio-technical transitions to sustainability. This is particularly true in the so-called Anthropocene, when the human system and its activities have deeply impacted the climatic and geological behaviour of the environmental system (Hoffman and Jennings, 2015; Waddell, Waddock, Cornell, Dentoni, McLachlan and Meszoely, 2015).

2.5. The resource-based view of the firm and dynamic capabilities

The resource-based view of the firm (Barney, 1986a; 1986b; 1991; Barney, Wright and Ketchen, 2001; Mahoney, 2005; Wernerfelt, 1984) looks at the internal, inimitable resources of the firm to explain how to create a long-term competitive advantage. This contrasts with other theories of competitiveness that look outside the firm to explain competitiveness; for instance, Porter's (1985) competitive advantage theory, which looks at the positioning of the firm in the market relative to the competition, or strategic stakeholder management (Berman, Wicks, Kotha and Jones, 1999; Freeman,

1984), which places the focus of attention on the relationship with the external interest groups of the firm. The resource-based view, on the contrary, concentrates on the internal dimension of the firm (Barney, 1995; Mahoney, 2005).

Consequently, internal resources and how they are used to gain a competitive advantage (Sirmon, Hitt and Ireland, 2007) are the focus of this theory. Its ability to explain firm strategy has made it extensively used, and has given rise to sub-streams like the dynamic capabilities view of the firm (Eisenhardt and Martin, 2000; Teece et al., 1997). The stream of dynamic capabilities emerges from the idea that the resources of the firm must be renewed in order to respond to the changes in dynamic environments (Teece et al., 1997). Therefore, despite its focus on the internal resources and routines that form capabilities, the element of the external, changing environment is introduced to explain the mechanisms of renewal of the resource base (Eisenhardt and Martin, 2000).

The following sub-sections deal with both the resource-based view and the dynamic capabilities view and how they have been previously applied in the fields of innovation and business sustainability, so as to showcase the appropriateness of their deployment for the main subject of the thesis, SOI, which lies in the intertwinement of the two disciplines.

2.5.1. The resource-based view of the firm

The resource-based view of the firm is based on the idea that firms have a set of unique resources, the combination of which results in firm heterogeneity in the market and a sustained competitive advantage based on firm uniqueness (Barney, 1986a, 1986b, 1991; Nelson and Winter, 1982; Penrose, 1959; Wernerfelt, 1984). Building on the rather vague definition of resource provided by Wernerfelt (1984), which considers anything that an organisation may consider as a strength or weakness a resource; Barney (1991) defines resources as '*all assets, capabilities, organisational processes, firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness*'. Such resources are classified into three categories (Barney, 1991):

a) *Physical capital resources*: technology, equipment, location and access to raw materials (Williamson, 1975).
b) *Human capital resources*: training, experience, judgement, intelligence, relationships and the insight provided by individuals (Becker, 1964; Nahapiet and Goshal, 1998; Wright, Dunford and Snell, 2001).
c) *Organisational capital resources*: organisation's structure, planning, controlling and coordinating systems, and the informal relations among

groups within both the organisation and other bodies (Tomer, 1987; Zahra, Hayton and Salvato, 2004).

In addition, the later developed concept of intellectual capital is increasingly important for business because of the development of knowledge-based economies (Kianto, Ritala, Spender and Vanhala, 2014; Nahapiet and Ghoshal, 1998); therefore, it is also counted among the categories of resources. Intellectual capital includes knowledge, data, and the intangibles resources that are not included in the balance sheet but contribute to the uniqueness of the firm (Brennan and Connell, 2000; Petty and Guthrie, 2000).

These resources, in order to provide with a competitive advantage, must be valuable, rare, inimitable and non-substitutable, that is, these resources must have the so-called VRIN attributes (Barney, 1991; Conner and Prahalad, 1996; Peteraf, 1993), implying the following:

a) *Valuable*: the resource must add value to the organisation, enabling the implementation of strategies that improve efficiency or effectiveness, the exploitation of strengths or the neutralisation of threats.
b) *Rare*: particular to one firm or a small number of firms. If the majority of firms had the same resource or set of resources, conditions of competition parity would be created, under which firms would not be able to build a competitive advantage.
c) *Inimitable* or imperfectly imitable resources: a company that has a valuable and rare resource could be able to build a temporary competitive advantage, but for it to be sustained over time, this resource must be costly to acquire or imitate for other firms.
d) *Non-substitutable*, that is, they must perform a role than cannot be easily performed by another resource.

Therefore, the resource-based view of the firm makes two major assumptions: heterogeneity of firms, resources and strategies, and immobility of resources, at least for a determined period of time, from one firm to another and within the firm. In this conditions of competition disparity create a sustained competitive advantage, as shown in Figure 10.

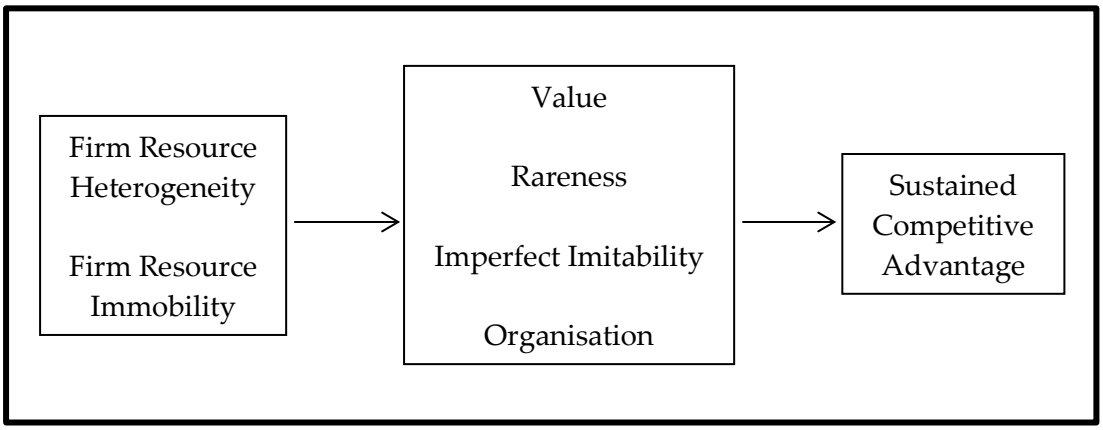

Figure 10. Summary of the resource-based view of the firm
Source: adapted from Barney (2011) and Rothaermel (2012)

However, posterior literature poses that resources with these attributes are necessary but not sufficient condition to build a sustainable competitive advantage (Dierickx and Cool, 1989; Priem and Butler, 2001). This means that only an organisation with the characteristics necessary for the exploitation of the VRIN resources will be capable of developing and sustaining a competitive advantage through the absorption and application of its resources (Barney and Zajac, 1994; Kraaijenbrink, Spender and Groen, 2010; Rothaermel, 2012). In order to do, it will need to develop organisational capabilities, as defined by Winter (2003:991):

> '*An organisational capability is a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organisation's management a set of decision options for producing significant outputs of a particular type*'.

The latter consideration of capabilities added a further organisational dimension to the resource-based view and left out of its scope those firms competing in highly dynamic environments, which led to the development of the dynamic capabilities view of the firm (Teece et al., 1997).

2.5.2. Dynamic capabilities

As mentioned above, dynamic capabilities theory was originally developed due to the contrast between the immobility of resources assumption and the fast-changing reality of firms involved in technological innovation (Teece et al., 1997; Teece, 2010)- However, this was later developed to include moderately dynamic environments as well (Eisenhardt and Martin, 2000), due to the rapidly changing trends of business: the rate of new innovative entrants in the market is high in a hypercompetitive environment (D'Aveni, 1994; 2010) and the technological and business models

generations are short in the majority of industries (Bourgeois and Eisenhardt, 1988; Wiggins and Ruefli, 2005).

But, what dynamic capabilities exactly are does not go without contestation. Since the seminal articles by Teece, Pisano and Shuen (Teece and Pisano, 1994; Teece et al., 1997), the literature has tried to define and refine the construct (Eisenhardt and Martin, 2000; Helfat and Peteraf, 2009; Winter, 2003). To Teece et al.'s (1997) definition as the ability to re-organise internal competences to address changes in the environment, posterior research has been adding features of dynamic capabilities. However, this first definition already extends the resource-based view of the firm (Barney, 1991), highlighting the embedment and path dependency of dynamic capabilities within the firm, a concept closer to evolutionary economics (Nelson and Winter, 1982). Hence, dynamic capabilities are a form of value creation particular to each firm, since they are built around the specific circumstances of their rapidly changing environments (Barreto, 2010). Dynamic capabilities are developed on the basis of path-dependent processes (Eisenhardt and Martin, 2000) but deliberate processes (Gavetti, 2005) also play a role: as Felin, Foss, Heimeriks and Madsen (2012) indicate, individuals, social processes and structure are the micro-level components underlying the routines and learning processes that sustain dynamic capabilities.

Posterior definitions have adopted positions closer to either the resource-based view or evolutionary economics. For instance, Eisenhardt and Martin (2000: 1107) refer to dynamic capabilities as the "*organisational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve and die*", whilst for Zollo and Winter (2002: 340) they are "*a learned and stable pattern of collective activity through which the organisation systematically generates and modifies the operating routines in pursuit of improved effectiveness*". Teece's (2007) revision of the concept disaggregates dynamic capabilities in three main capacities; (a) sensing threats and opportunities; (b) seizing opportunities; and (c) maintaining competitiveness through the protection and reconfiguration of the firm's assets. The review of previous research by Barreto (2010) yields a comprehensive definition of dynamic capabilities as "*the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market oriented decisions, and to change its resource base*".

Both highly dynamic (Teece et al., 1997) or moderately dynamic (Eisenhardt and Martin, 2000) environments foster the creation of dynamic capabilities. In fact, empirical research testing the relationship between dynamic capabilities and performance shows that environmental dynamism acts as a moderator, postulating that dynamic capabilities yield best performance in moderately dynamic environments, with decreasing levels of performance towards low or high dynamism environments (Schilke, 2014). Further research shows that dynamic capabilities

enhance organisational capabilities in any environment, but that this increased effectiveness yields better financial results in highly dynamic environments (Wilhelm, Schlömer and Maurer, 2015). However, these results are not supported in other studies when technological dynamism is measured as a mediator (Fainschmidt, Pezeshkan, Lance Frazier, Nair and Markowski, 2016). The meta-analysis on the effect of environmental dynamism on the dynamic capabilities – organisational performance relationship by Karna, Richter and Riesenkampff (2015) supports the notion that environmental dynamism enhances organisational performance derived from dynamic capabilities.

It is important to note that, although the research on dynamic capabilities closer to the resource-based view considers them unique to the firm following the VRIN scheme (Barney, 1991), other authors find dynamic capabilities as having commonalities and similarities across firms (Eisenhardt and Martin, 2000). Barreto (2010) argues that commonalities between dynamic capabilities do exist; however, these commonalities do not preclude variations in organisational performance derived from differences in the environments in which the firms operate or diverse organisational configurations.

2.5.3. Hierarchical views of dynamic capabilities

Dynamic capabilities have often been treated as a "higher-level ability", an ability to reconfigure those abilities closer to being resources in the resource-based view of the firm. In this sense, they change ordinary capabilities (Winter, 2003; Zahra et al., 2006) and are necessary for capacity building (Makadok, 2001). The three-dimensional conceptualisation of Teece (2007) also draws on this idea of dynamic capabilities having a different function than "ordinary" or "short-term" abilities (Barreto, 2010: 271). Therefore, beyond their definition a second major discussion in the literature is about the different levels of dynamic capabilities (Ambrosini et al., 2009; Collis, 1994; Danneels, 2008; Winter, 2003; Zahra et al., 2006). These hierarchies have been explained as different levels of dynamic capabilities, each with different roles and managerial perceptions and linked to different environmental dynamism (Ambrosini et al., 2009).

Collis (1994) was the first to mention the existence of "higher-order abilities". In this sense, significant research on dynamic capabilities has studied their levels and hierarchies more profoundly. Winter (2003) proposed a hierarchy between two main levels: zero-order capabilities or operating capabilities (e.g. production process), the first-order capabilities that allow to change the zero-order (e.g. a change in the production process), and finally higher order capabilities that result from organisational learning and create or modify a firm's dynamic capabilities. Zahra et al. (2006) also explore the role of these higher-order dynamic capabilities or "substantive

capabilities", those able to change and alter capabilities. Hence, higher-order capabilities change ordinary capabilities (Winter, 2003; Zahra et al., 2006) and are necessary for capacity building (Makadok, 2001).

Ambrosini et al. (2009) find three levels of dynamic capabilities: (a) incremental (fostering continuous improvement), (b) renewing (refreshing, adapting and augmenting the resource base) and (c) regenerative. The latter acts as a dynamic meta-capability, since it serves to regenerate existent dynamic capabilities; consequently, it offers a more systemic perspective. This model of hierarchical dynamic capabilities is illustrated in Figure 11.

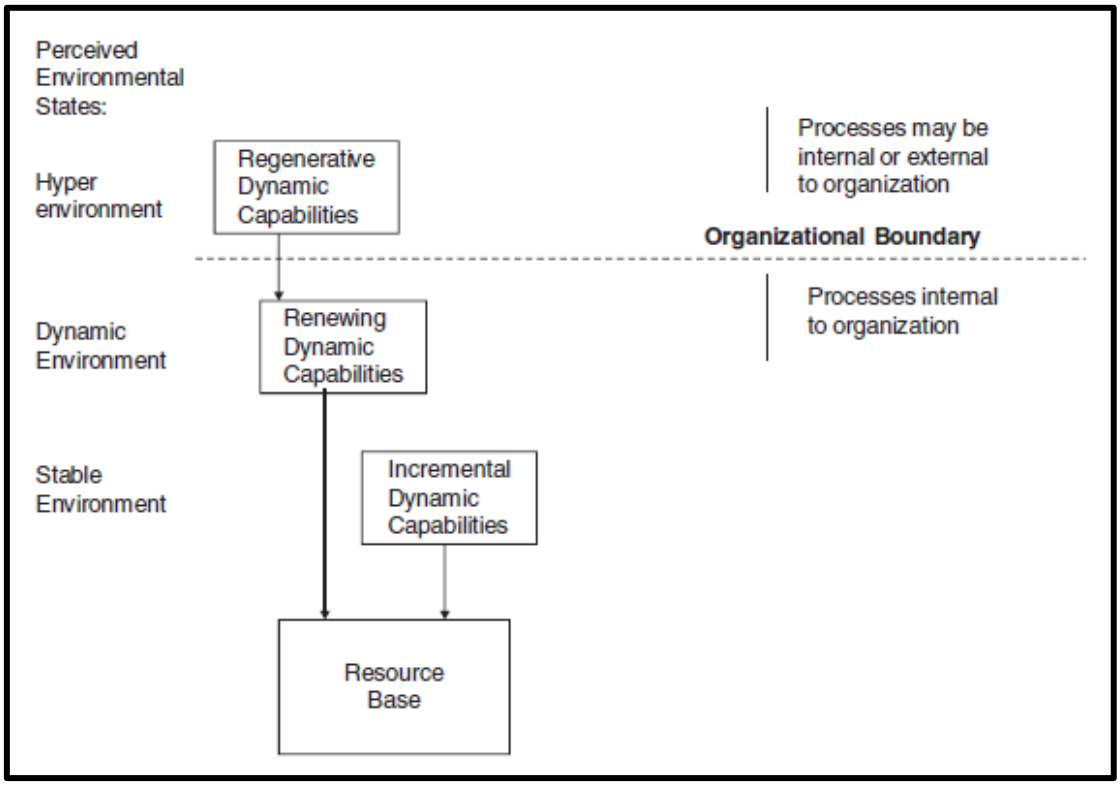

Figure 11. Three levels of dynamic capabilities
Source: Ambrosini et al., 2009

At the first level, incremental dynamic capabilities operate in a stable environment and involve the adaptation of the resource stock of a firm; such capabilities are concerned with continuous improvements and adjustments to a firm's resource base (e.g., small adjustments to product innovation). At the second level, renewing dynamic capabilities operate in a changing or dynamic environment, refreshing and renewing the nature of resources rather than incrementally adapting them (e.g., brand extension to other products or the introduction of new product lines or processes). At the third level, regenerative capabilities allow for the learning and unlearning of capabilities, strengthening a firm by building organisational resilience. Regenerative capabilities are nurtured in discontinuous and hyper-changing

environments (e.g., turbulent changes fostered by technological disruptions or social and environmental challenges (resource scarcity, climate change, demographic growth, urbanization and urban infrastructure)).

Regenerative capabilities reflect the need to change how a firm creates, extends and modifies its resource base, allowing a firm to move away from and transform previous practices toward new and more complex dynamic capabilities (Ambrosini et al. 2009; Helfat et al. 2007). Regenerative capabilities can originate from within a firm (perceptions of upper management regarding whether major firm-wide changes should be undertaken) or may be generated under the influence of external discontinuous trends. Ambrosini et al. (2009) note the importance of networking processes that involve external change agents and the need to alter a firm's leadership structure by hiring external managers when different competencies are required.

2.5.4. Dynamic capabilities for innovation

As in other disciplines, the resource-based view of the firm soon was soon applied to the field of innovation (Christensen, 1995; Christmann, 2000; Leonard-Barton, 1992). Organisational capabilities and driving innovation in alignment with the firm's strategy help the organisation to succeed in its innovation activities (Christensen, 2002). These initial interpretations of innovation through resources were characterised by a focus on the types and relationships between resources. Christensen (1995) identifies four types of assets necessary for innovation (scientific research, process innovation, product innovation application assets and aesthetic design) which may appear alone or in different configurations. Christmann (2000) observes the complementarity of process innovation and implementation assets, while Leonard-Barton (1992) highlights that apart from the three types of capital identified by Barney (1991) – physical, human and organisational – values are also necessary resources for innovation. She also recognises, how, in the same way that firms have 'core capabilities' (Prahalad and Hamel, 1990); they have 'core rigidities', resources that are hard to unlearn and deter the firm from innovating. It is precisely this assumption of immobility of the resource-based view that led to the development of the dynamic capabilities view for innovative environments (Teece and Pisano, 1994; Teece et al., 1997). For this reason, the latter has been widely deployed in innovation research; more than the original stream of the resource-based view as such (Lei, Hitt and Bettis, 1996; Teece, 1998).

Extensive research on the 'innovation capability' (Francis and Bessant, 2005; Lawson and Samson, 2001) refers to the ability to create, develop and exploit new ideas successfully (Börjesson, Elmquist and Hooge, 2014). Lawson and Samson (2001) point at the importance of "*linking organisational learning and knowledge to products, processes,*

technologies and mainstream capabilities". Therefore, the innovation capability is not limited to new product or service development; rather, it is systemic to the firm, as its components are related to each other and is the main determinant of the innovation output, as shown in Figure 12.

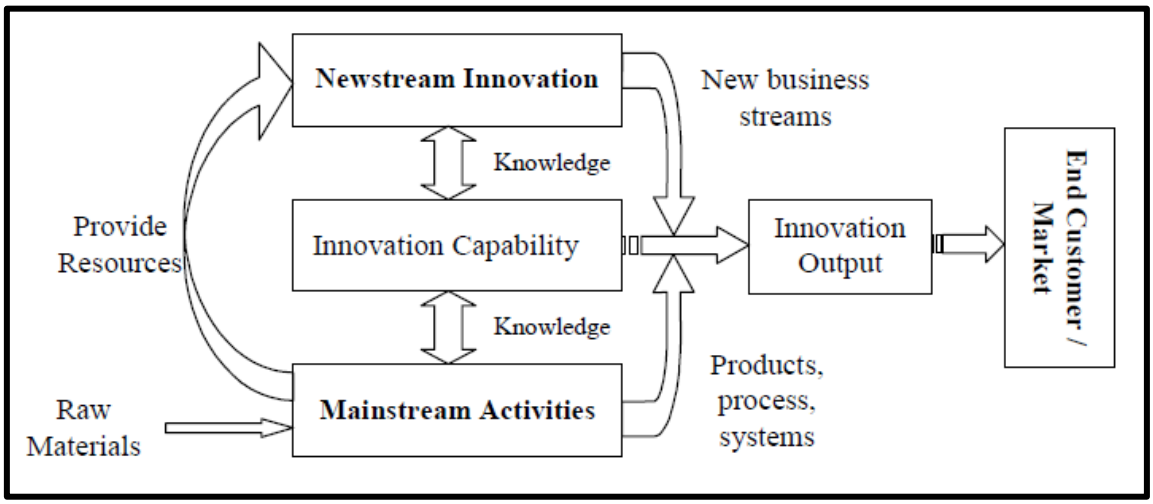

Figure 12. Integrated model of innovation based on the innovation capability
Source: Lawson and Samson (2001)

However, part of the literature (Figueiredo, 2002) focuses on the technological aspects of innovation capability, while other approaches adopt an organisational perspective (Lawson and Samson, 2001; Verona and Ravasi, 2003) or concentrate on the individuals taking part in the innovation process (Börjesson et al., 2014). Table 1 collects the main components of the innovation capability, according to the literature, which includes capabilities such as absorptive capacity, knowledge management and management of technology.

Table 1. Previous literature on capabilities for innovation

Research focus	Capabilities	Reference
Innovation capability from a multi-field perspective	Vision and strategy	Lawson and Samson, 2001
	Harnessing the competence base	
	Organisational intelligence	
	Creativity and idea management	
	Organisational structure and systems	
	Culture and climate	
	Management of technology	
Technological capabilities for innovation	User's decision making and control	Figuereido, 2002
	Project engineering	
	Process and production organisation	
	Product-centered	

	Equipment	
Examining the role of innovation capability in export performance	Learning capability	Guan and Ma, 2003
	R&D capability	
	Manufacturing capability	
	Marketing capability	
	Organisational capability	
	Resources exploiting capability	
	Strategic capability	
Capabilities for continuous product innovation	Knowledge creation and absorption	Verona and Ravasi, 2003
	Knowledge integration	
	Knowledge reconfiguration	
Steady-state innovation	Clear and accepted rules of the game	Bessant et al., 2005
	Strategies path dependency	
	Clear selection environment	
	Selection and resource allocation linked to clear trajectories and criteria for fit	
	Operating routines refined and stable	
	Strong ties and knowledge flows along clear channels	
Discontinous innovation	No clear rules – these emerge over time. High tolerance for ambiguity	Bessant et al., 2005
	Path independent, emergent, probe and learn	
	Fuzzy, emergent selection environment	
	Risk taking, multiple parallel bets, tolerance of (fast) failure	
	Operating patterns emergent and 'fuzzy'	
	Weak ties and peripheral vision	
Multi-level approach to innovation capability (individual, firm and network)	Intellectual human capital	Rothaermel and Hess, 2007
	Ability to discriminate among innovation mechanisms	
Systems approach to the innovation capability	Organisational structure	O'Connor, 2008
	Mechanisms for interfacing with the mainstream organisation	
	Exploratory processes	
	Development of skills and talent	
	Multi-level governance and decision-making mechanisms	
	Appropriate culture	
	Leadership	

Global dynamic capabilities	Applying enabling technologies creatively	Chen and Jaw, 2009
	Seizing market opportunities	
	Aligning routes to markets	
	Utilizing absorptive capacity	
	Enhancing organisational innovation	
	Staging cultural / aesthetic productions	
Relationship learning and absorptive capacity for innovation and competitive advantage	Relationship learning	Chen, Lin and Chang, 2009
	Absorptive capacity	
Open innovation knowledge capabilities	Inventive capacity (internal exploration)	Lichtenthaler and Lichtenthaler 2009
	Absorptive capacity (external exploration	
	Transformative capacity (internal retention)	
	Connective capacity (external retention)	
	Innovative capacity (internal exploitation)	
	Desorptive capacity (external exploitation)	
Absorptive capacity as a mechanism to transform knowledge into profits	Absorptive capacity	Kostopoulos, Papalexandris, Papachroni and Ioannou, 2011
Effects of capabilities on innovation performance	Technology development	Zawislak, Alves, Tello-Gamarra, Barbieux and Reichert, 2013
	Operations capability	
	Management capability	
	Transaction capability	
Role of individuals in innovation capability	Political astuteness of innovation champions	Börjesson et al, 2014
	Commitment from top management	
	Learning perspective	

2.5.5. Dynamic capabilities for business sustainability

As opposed to the field of innovation, where the resource-based view of the firm *stricto sensu* rapidly gave way to dynamic capabilities, one of the most commonly deployed theories in the field of business sustainability strategy is precisely the natural resource-based view of the firm (Hart, 1995; Hart and Dowell, 2011). Building on the resource approach, it affirms that a sustained competitive advantage can be grounded on the firm's relationship with the environment. Hart (1995) notes the existence of three path-dependent strategies on the road to sustainable development:

a) *Pollution prevention.* The key resource is continuous improvement with the aim of minimising environmental pollution and waste. Competitive advantage is gained through lowered costs of production.
b) *Product stewardship*. The key resource is stakeholder integration in order to minimise the life-cycle impact of products and services. Competitive advantage is gained through the pre-emption of the competition.
c) *Sustainable development*. The key resource is shared vision to minimise the environmental harm made by the firm through its growth, and competitive advantage is gained through securement of the future position. This stage is later disaggregated into clean technologies and base of the pyramid in later work (Hart and Dowell, 2011). In the case of clean technologies, the key resource is disruptive change to make radical societal advancements, and as in the previous conceptualisation of sustainable development, competitive advantage is gained through securement of the future position. As for base of the pyramid, the key resource is embedded innovation to meet the needs of the world's poorest, and competitive advantage is secured through long-term growth.

Interestingly, the latest characterisation of sustainable development by Hart and Dowell (2011) calls for innovation as a key resource both in its environmental and social branches. Hart (1995) understands that the strategies in the natural resource-based view are path-dependent and but embedded in a logic of cumulative resources, as illustrated by Figure 13.

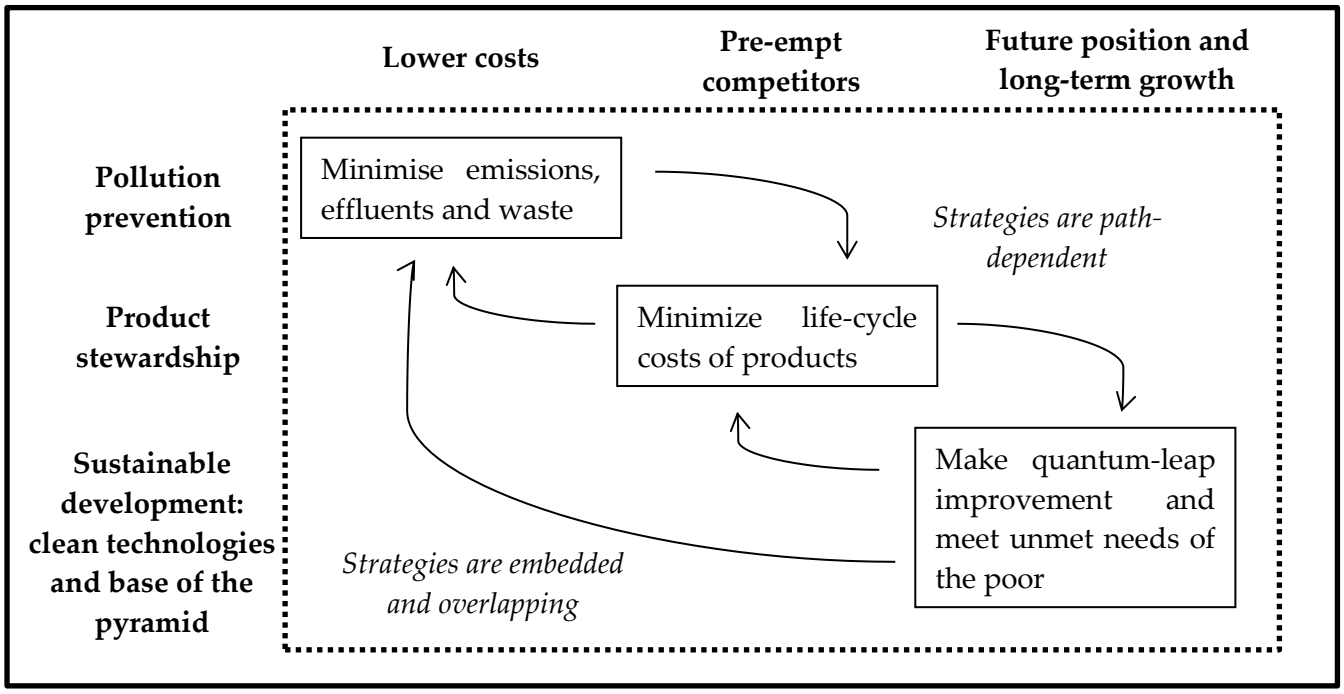

Figure 13. Interconnectedness in the natural resource-based view of the firm
Source: adapted from Hart (1995) and Hart and Dowell (2011)

After the enunciation of the natural resource-based view of the firm, research in the stream of organisations and the natural environment (Aragón-Correa, Hurtado-Torres, Sharma and García Morales, 2008; Russo and Fouts, 1997) adopted this approach. Litz (1996) also offered a resource-based view of the socially responsible firm, and corporate social responsibility also found explanations in this perspective (McWilliams and Siegel, 2011). Bansal (2005) adopted a resource-based view to explain the determinants of corporate sustainable development empirically, finding that international experience, capital management and organisational slack are relevant for successful business sustainability management.

Although the literature on innovation found an almost perfect fit on dynamic capabilities due to the requirement of a highly dynamic environment for their development (Teece et al., 1997), the re-conceptualization for moderately dynamic environments (Eisenhardt and Martin, 2000) and the generalization of hypercompetition in most markets (D'Aveni, 1994, 2010) opened the utilization of dynamic capabilities as an strategic framework in other areas linked to natural resources and sustainability challenges. The majority of the studies focuses either on the social (Ayuso et al., 2006) or the environmental (Aragón-Correa and Sharma, 2003; Sharma and Vredenburg, 1998) pillars of sustainable development, but the rationale behind it is that organisations ought to build capabilities for effective social and environmental management. Therefore, these dynamic capabilities will result in sustainable value creation and a competitive advantage based on sustainability performance (Hart, 1995; Hoffman, Theyel & Wood, 2012).

The main yields of such research are showcased in Table 2. The literature on capabilities for corporate sustainable development shows that the capabilities for innovation and sustainability are closely linked, due to the complexity, transversal and multi-level nature of them both. However, further research in this area uniting both of these corporate objectives is needed.

Table 2. Previous literature on capabilities for business sustainability

Research focus	Capabilities	Reference
The uncertainty of the relationship between business and the environment results in the development of unique capabilities	Stakeholder integration	Sharma and Vredenburg, 1998
	Higher-order learning	
	Continuous innovation	
Dynamic and sustainable view of the firm	Development of relationships with stakeholders	Rodríguez, Ricart and

	Building new resources based on the relationships with stakeholders	Sánchez, 2002
	Innovation	
Proactive environmental management as a dynamic capability and its moderators	Proactive environmental management	Aragón-Correa and Sharma, 2003
Capabilities of socially responsible companies	Stakeholder engagement	Black and Härtel, 2004
	Accountability	
	Ethics	
	Value-attuned public relations	
	Dialogue	
Capabilities as drivers of environmental management and sustainability practices	Adoption of advanced technology	Hoffman et al., 2012
	Experience with inter-firm relations	
	Capacity for product innovation	
Sensing, seizing and transforming capabilities for sustainable development	Monitoring capability to scan emerging sustainability requirements	Wu, He and Duan, 2013
	Seizing capability to identify and secure sustainable development opportunities	
	Reconfiguration capability to modify existing processes and practices	
Enablers of sustainable practices from a sustainability exploration and exploitation approach	Integration of sustainability into vision and strategy	Maletič, Maletič, Dahlgaard, Dahlgaard-Park and Gomišček, 2014
	Top management support	
	Sustainability-centered culture	
Social innovation capability	Integrating CSR in business strategy with top management commitment	Altuna, Contri, Dell'Era, Frattini and Maccarrone, 2015
	Structural ambidexterity	
	Systematic stakeholder engagement as a source of innovative ideas, even involving non-profit organisation in an open innovation process	
Competences for social innovation in non-profits	Internal market orientation	Sanzo-Pérez, Álvarez-González
	Information and communication technology competence	

		and Rey-García, 2015

2.6. Justification of the theoretical framework of the thesis

Taking all this into consideration, the focus of this thesis lies on the intertwinement between innovation and business sustainability, SOI, examined under the lens of the resource-based and dynamic capabilities based view of the firm and systems theory.

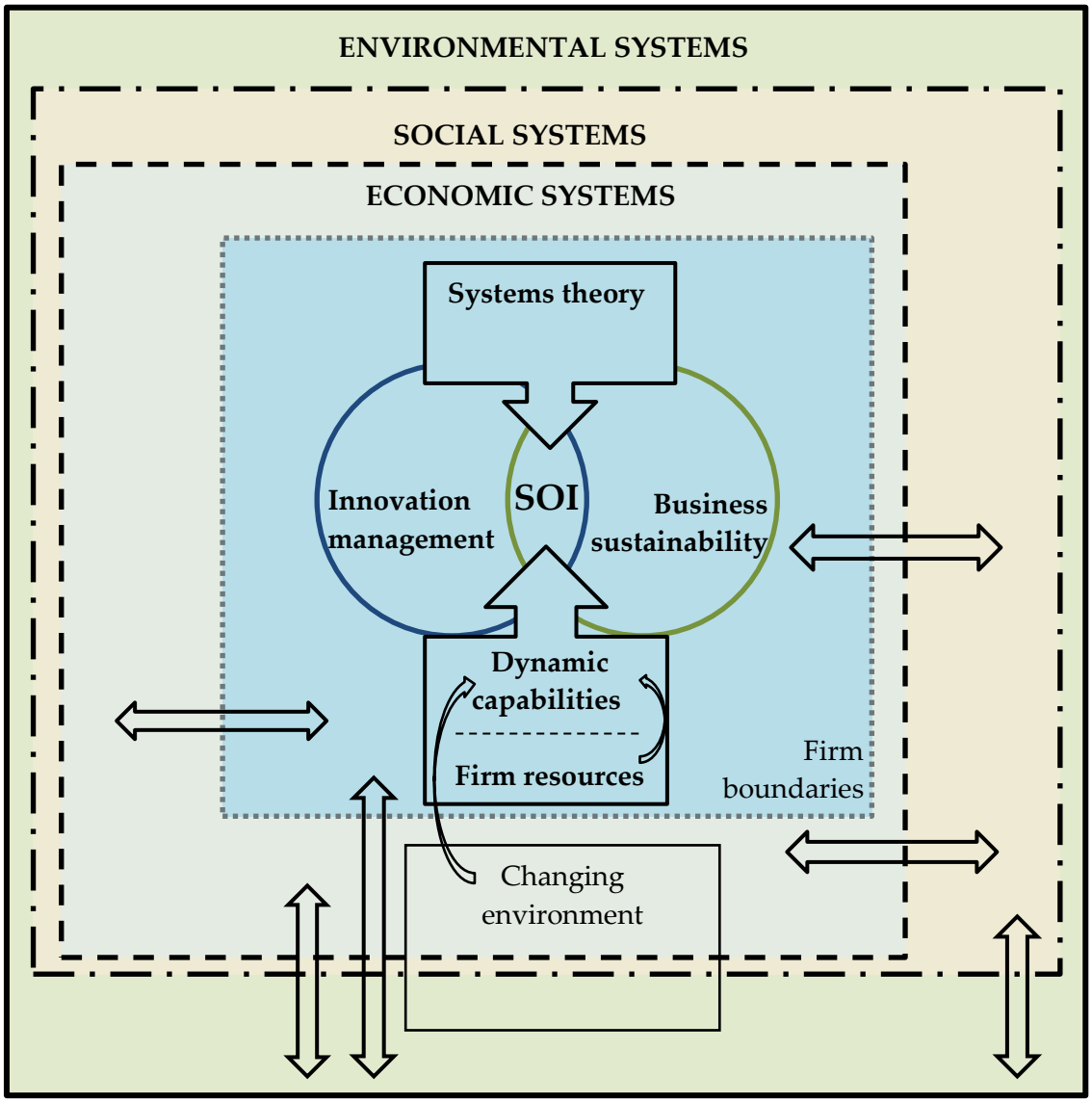

Figure 14. Theoretical framework of the thesis
Source: elaborated by the author

As illustrated in Figure 14, SOI is the linkage between innovation and sustainability; in other words, it is innovation that has a positive impact to simultaneously create new value - through products and services - and to solve economic, social and environmental challenges for society. In order to analyse this,

two main theories are used as framework: the resource and dynamic capabilities based view of the firm, and systems theory. The first concentrates on the internal dimension of the firm, emphasising the internal resources that are necessary for engagement in SOI. However, as shown in Figure, the development of dynamic capabilities (which are internal to the firm) is determined both by internal resources (path dependency) and the changing environment of the firm, which comprises economic, social and environmental matters. From systems theory, there are two-fold implications: first, the study of the firm dynamics as a system when engaging in SOI, and the relationship of the firm-system with the systems in which it is embedded (economic, social and environmental) and the subsystems in each of them (economic and social actors).

Each of the four theoretical foundations contributes to the thesis in a different way. The grounds of innovation management and business sustainability help to understand the underpinnings of the construct of SOI, which will be further explained in Chapter 4. This construct is based on the idea of setting sustainability goals for innovation; hence the interest of providing an overview of the corpus of literature. In addition, systems theory sets the underpinning framework of analysis, allowing for analysis of the subject of study, the firm, in its surrounding context. Resource-based view and dynamic capabilities theory, on the other hand, help to explain the intra-firm dynamics and enablers of SOI. Table 3 below summarises the main contributions of the theoretical foundations of the thesis.

Table 3. Main tenets of the theoretical framework
Source: elaborated by the author

	Systems theory	**Resource-based view and dynamic capabilities**
Key authors	Heidegger (1954) Simon (1981) Anderson (1999) Meadows (2008) Eisenhardt and Piezunka (2011)	Wernerfelt (1984) Barney (1986a; 1986b; 1991) Teece et al. (1997) Eisenhardt and Martin (2000) Ambrosini et al. (2009)
Key concepts	The firm is a complex adaptive system that exhibits non-linear, self-organising and emergent behaviour. It is embedded and relates to the wider economic, social and environmental systems	Heterogeneity among firms due to the uniquely developed resources and adaption to the environment through dynamic capabilities provide the firm with a competitive advantage
Implications for the study of SOI	SOI cannot be studied as a fixed organisational function or structure. The characteristics of system dynamics in the SOI process, uncertainty and complexity need to be accounted	The firm will develop a set of resources and capabilities in order to respond to the SOI challenge, building on its innovation and business sustainability knowledge and adapting to the new

	for, as well as the influence of other systems external to the firm	requirements derived from SOI

Hence, having reviewed the main tenets of the two building blocks of SOI (innovation and business sustainability) and the main implications of the theoretical approximations of this thesis for its study, Chapter 3 will deal with the research methods applied in the dissertation.

Chapter 3

Research methods

3.1. Introduction

The aim of this Chapter is to present and explain the research design and method of the thesis, which adopts a mixed methods research approach. This chapter is structured as follows. First, Section 3.2. will explain what a mixed methods research design is and how it is suitable for the study of SOI. Section 3.3. will look as how mixed methods have been applied to the present study as research design and methodology. Next, Sections 3.4., 3.5. and 3.6. will deal with the methods deployed in the literature review and the qualitative and quantitative studies of the study respectively. Section 3.7. will explain how the meta-inferences between both studies have been performed in order to maximise the value of approaching SOI both qualitatively and quantitatively. Finally, Section 3.8. will bring light on the validity and reliability challenges encountered throughout the study and how these have been tackled.

3.2. Definition of mixed methods and suitability for the study of SOI

Mixed methods is a research design that focuses on research questions that call for real-life contextual understandings, and employs rigorous quantitative and qualitative research in order to bring in the advantages of both. Greene, Caracelli and Graham (1989) emphasize not only the mixing of methods, but rather the integration of methods and the philosophy behind them. It must be also noted that it implies a new way of observing the world (Greene, 2007), accounting for the complexity of reality and the need for integration of several methods within the research design in order to obtain more complete results (Creswell and Plano Clark, 2011).

Mixed methods research normally adopts a pragmatist point of view when tackling issues; hence using whatever techniques useful to answering the question (Creswell and Plano Clark, 2011). Although some writers express unease about the 'whatever works' approach that underpins mixed methods research, it has become a distinct approach in its own right, along with quantitative and qualitative approaches. This has fed a conversation on the typologies of integration of methods, which may ease the researcher's work as it may clarify the intentions of their investigations (Bryman, 2006).

This point has been widely discussed, since some authors (see Yin, 2006) believe that the majority of self-identified mixed methods studies are not so, since they adopt a more restrictive definition of mixing methods. In this case, the studies that are designed with a qualitative phase followed by a quantitative phase or vice versa, would not be considered mixed methods; only studies with embedded designs would. However, the majority of the current mixed methods research deploys quantitative and

qualitative methods in different phases and then integrate them only for data interpretation (Bryman, 2006). For this study, the broader definition of mixed methods is adopted, as the results of separate qualitative and quantitative studies will be contrasted in order to provide with a full understanding of SOI, as provided by Creswell and Plano Clark (2011: 5):

> *Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis and the mixture of qualitative and quantitative approaches in many phases of the research process. As a method, it focuses on collecting, analysing and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone.*

Following the premises of this definition, the lack of extensive research on SOI at the firm / managerial level (Schiederig et al., 2012), the complex nature of the phenomenon (Fichter, 2005; Hansen et al., 2009; Harms et al., 2013) and the expected multifaceted answer to the research question – how business engage in SOI – call for the applicability of mixed methods for the study. The qualitative and quantitative studies offer different perspectives on SOI engagement, the first concentrating on the features of companies that are spearheading SOI engagement, and the second providing with an overview of the practices of the total population.

3.3. Research approach

3.3.1. Methodological approach

As indicated above, the choice of mixed methods at the methodologic approach is not discretionary. It is based on a reflection based on the goals of the study and the worldview as theoretical lens than inform the study, as illustrated in Figure 15.

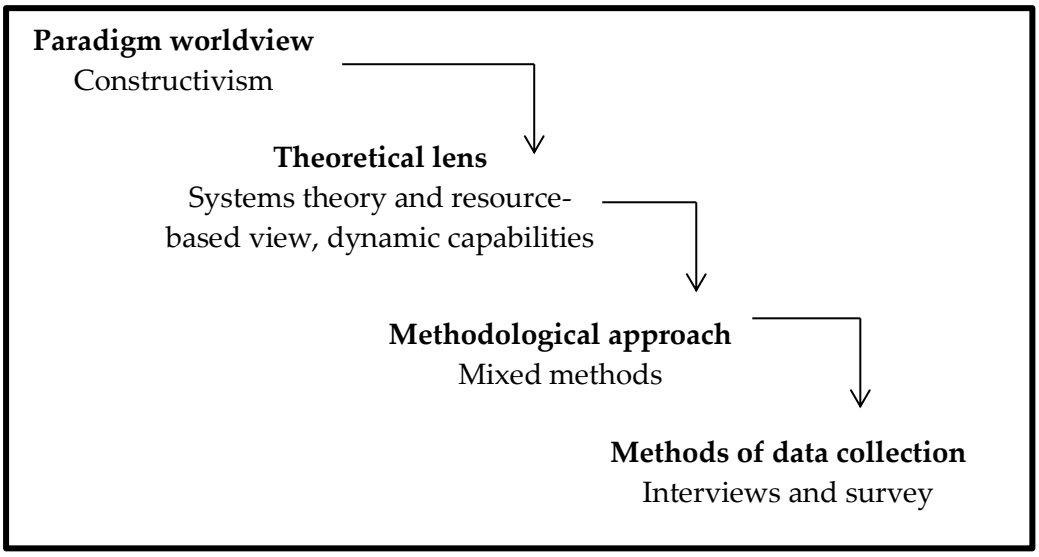

Figure 15. Levels for the development of the research study
Source: elaborated by the author, based on Crotty (1998)

The study departs from a constructivist worldview, which is theory generation oriented and builds of the meaning provided by the multiple participants of the study, trying to avoid reductionism. The main goal of constructivism is to understand, to comprehend how a phenomenon, in this case SOI engagement at the firm level, comes to being (Creswell and Plano Clark, 2011). Hence, this ontological position posits that social phenomena and what they mean to world are built by multiple social actors (Bryman, 2008). For this reason, it is often associated to qualitative approaches, but quantitative approaches can also contribute to the representation of the social world from this approach (Bryman, 2008).

Constructivism as a worldview is consistent with the theoretical lens of this study. The assumption that social phenomena are constructed by social actors, which influence its developments in its multiple, corresponds with notion of systems theory that the system is more than the mere sum of its parts (Meadows, 2008), and the feedback loops created and modified by these actors have a direct impact on the shape and behaviour of the wider system. In addition, the constructivist understanding that knowledge is indeterminate and dependent on the perspective of the researcher is coherent with the concept of bounded rationality (Simon, 1981) prevalent in systems theory.

In addition, the resource-based and the dynamic capabilities view of the firm are a useful theoretical lens for the study of SOI at the firm level from a constructivist worldview. The variety of resources considered in the resource-based view of the firm, including social and intellectual capital (Becker, 1964; Nahapiet and Goshal, 1998; Wright et al., 2001) allow for the introduction of different social actors as determinants of the phenomenon of SOI at the firm level, instead of focusing on a single enabler.

Moreover, the conceptualisation of dynamic capabilities builds on this perspective, adding the contingency factor and the relevance of the dynamism of the environment into the development of the firm.

3.3.2. Research design

The fact that the research design departs from a constructivist worldview does not imply that the thesis assumes a solely inductive approach to theory development. As illustrated above, mixed methods research design breaks the quantitative / qualitative divide not only when it comes to methods, but also when it comes to philosophical assumptions and the direction of theory generation. In this sense, the thesis follows an inductive-deductive approach. The main line of the study is inductive, building theory from findings and observations (Bryman, 2008) this being the approach taken in the qualitative study and some of the questions answered by the quantitative study, but deductive reasoning is also deployed in part of the qualitative study and the literature review. Consequently, the main objective is to elaborate theory from the findings, but in order to do so, theory is also explained by part of the quantitative observations (Bryman, 2008; Pratt, 2008).

The research design adopted for the study is a convergent mixed methods design. The aim of the convergent design is '*to obtain different but complementary data on the same topic*' (Morse, 1991: 122) taking advantage of the strengths of both the depth of qualitative studies and the breadth of quantitative studies (Patton, 1990) to achieve a more comprehensive understanding of SOI. The results of both studies of the convergent design are then contrasted between them and the results obtained from the literature review, and meta-inferences are made in order to obtain the triangulated results of the study (Creswell and Plano Clark, 2011).

Convergent designs are usually conducted in parallel (collecting and analysing data from both studies during the same period of time); however, for the purposes of this thesis the qualitative data collection and part of the analysis were carried out before the quantitative study. Consequently, the design of the survey instrument was informed both by the literature review and the results of the qualitative study (Creswell, Fetters and Ivankova, 2004). Hence, the purpose of conducting mixed methods research for both complementarity and triangulation (Hammersley, 1996) was achieved, enhancing validity and completeness of the overall study and the timeliness of the quantitative instrument (Bryman, 2006).

After the literature review, the exploratory qualitative study was carried out. Using the results of the literature review the interview protocols for this phase were designed. In the qualitative phase, transcriptions of interviews and focus groups from

eight case studies were used to produce a preliminary model of SOI. Along with the findings in the literature review, this preliminary model was deployed to design the survey instrument for the quantitative phase, which was performed at a later stage. With the survey questionnaire finalised, the quantitative data collection and analysis was completed, using descriptive statistics to examine the demographics of the sample, and T-tests and linear regression to explore new determinant features of SOI and confirm the findings of the qualitative phase. After this, a final stage of convergent interpretation of the results of both studies was carried out; yielding a complete model of SOI engagement resulted from the meta-inferences of the qualitative and quantitative studies. The research design is summarised in Figure 16.

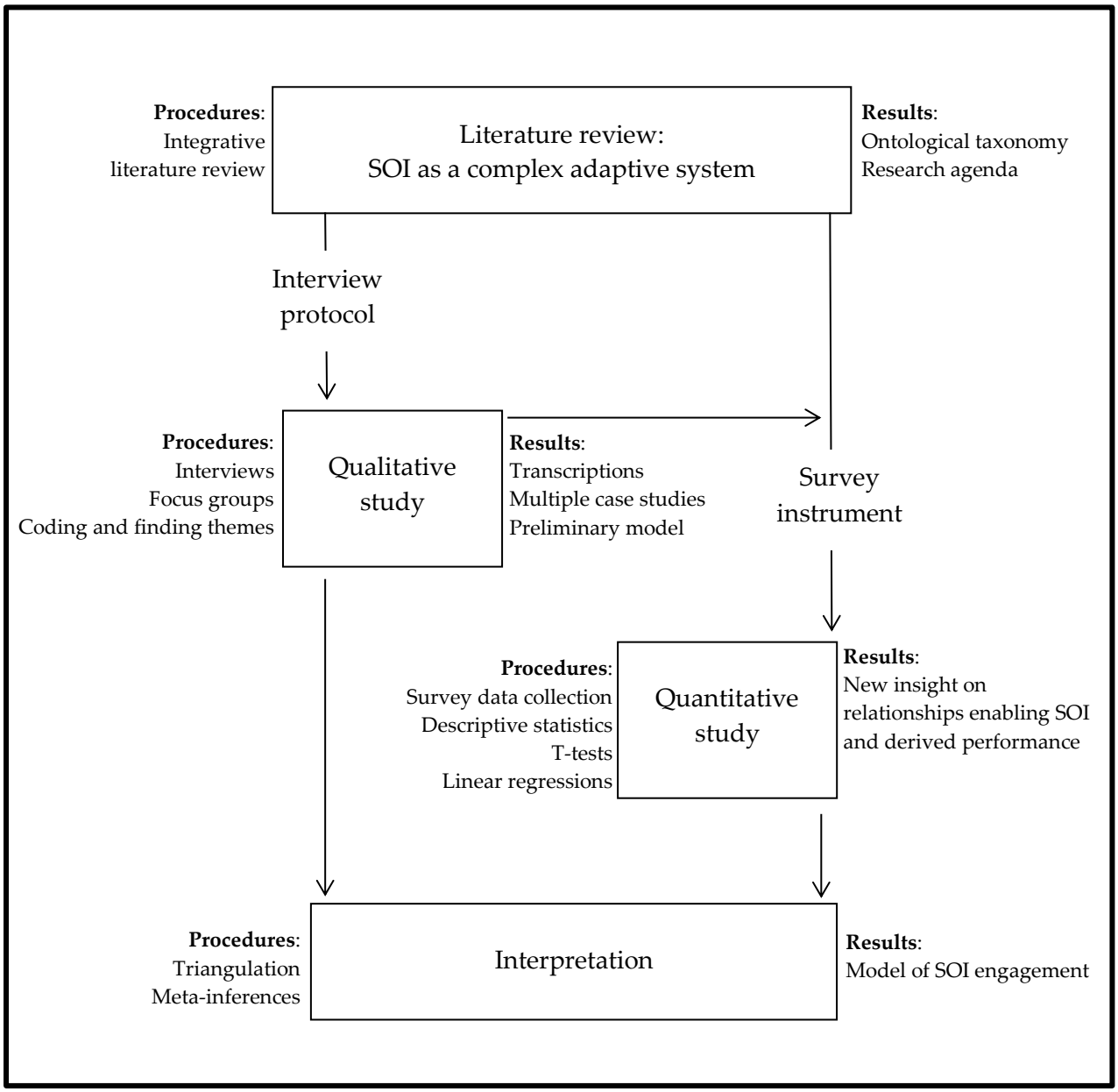

Figure16. Research design of the thesis
Source: elaborated by the author

3.4. Methodological issues in the literature review

The aim of the literature review is to analyse, classify and synthesise the existing knowledge on SOI in order to identify research gaps and clarify the concept of SOI and its components (Hart, 1998) and further elaborate SOI theory (Pratt, 2008). In order to do so, an integrative literature review was conducted, which is '*a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated*' (Torraco, 2005: 356). Two of the possible outcomes of integrative literature reviews are taxonomies or conceptual classifications of constructs and research agendas (Torraco, 2005). Therefore, it is the most appropriate review method for the purposes of this thesis, as it yields three main results:

a) Clarification of the origins, concept and development of SOI (Sections 4.2.).
b) Ontological taxonomy of SOI components (Section 4.3).
c) Elaboration of SOI theory (Pratt, 2008) on the basis of the literature review (Section 4.4.).

Consequently, considering the suitability of the method for the objective of the literature review, the three steps necessary to build integrative literature reviews – conceptual structuring, critical analysis and synthetic analysis - were taken (Torraco, 2005), as illustrated in Figure 17:

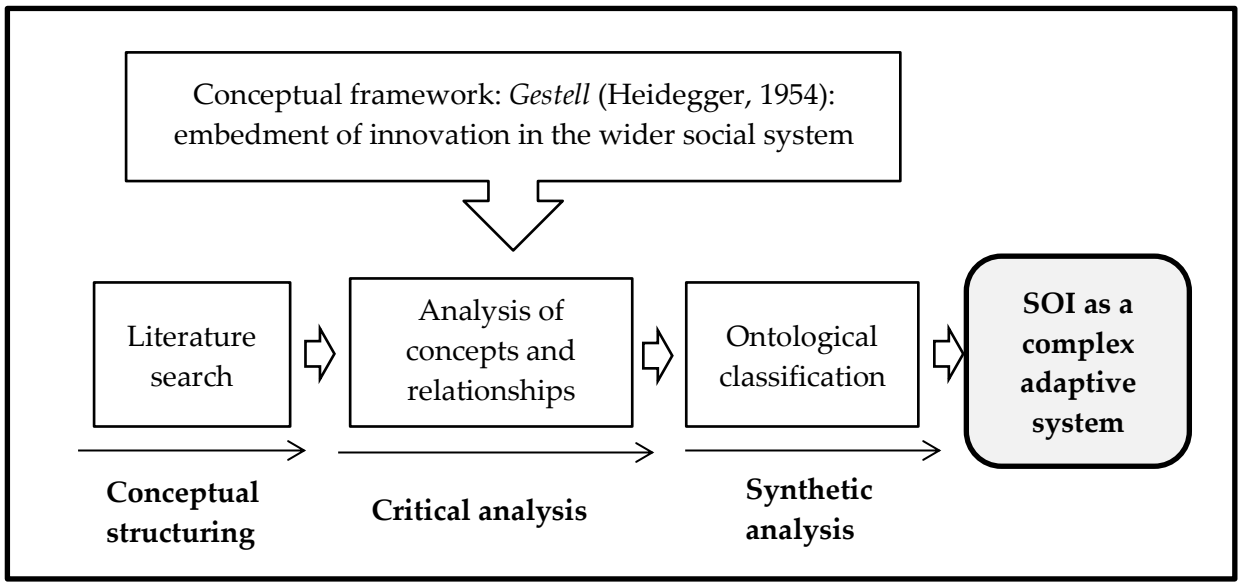

Figure 17. Literature review research method
Source: elaborated by the author

1. *Conceptual structuring* requires finding the relevant information on the topic and structure the concept through a guiding theory or set of competing theories

(Torraco, 2005). The building blocks for the present literature review have been set out in the theoretical foundations in Chapter 2. In order to ensure the inclusion of all relevant sources, two literature selection processes were carried out, the first from February to May 2013, and the second from April to May 2015. To initiate the literature selection, searches were conducted in the ISI Web of Science for texts between the years 1900 to 2015 using the following keywords: "sustainability" and "innovation" and "business" or "firm", "sustainable innovation", "sustainability innovation", "sustainability-oriented innovation", "eco-innovation", "green innovation", "eco-efficiency", "environmental innovation" and "social innovation." ISI Web of Science was chosen to conduct the searches to ensure the inclusion of rigorous, widespread literature with the guarantees of the peer-review process (Tranfield, Denyer and Smart, 2003). However, considering the methodological recommendations for integrative literature reviews and the limitation of using a single database, a snowballing-based literature selection process was conducted after the initial searches in ISI Web of Science. This process of snowballing among references was performed to identify other highly cited sources such as books and practitioner-oriented literature. The first list obtained after these searches comprised 887 items (n=887). In order to narrow down the sample, a manual literature selection was performed, based on the screening of titles and abstracts of the initial list. This selection was done manually to ensure that all references were related to SOI despite the variety of terms with which it is referred to. The resulting sample after this selection was 219 (n=219) full texts. It must be noted that, due to the heterogeneity of knowledge streams contributing to SOI literature, there was no topic-based narrowing down process.

2. *Critical analysis* involves the exploration of the main ideas and relationships within the topic of study (Torraco, 2005) from a critical point of view. In order to explore these relationships, a systemic approach is taken as standpoint; in particular, Heidegger's (1954) philosophy of technology. The four Aristotelian causes of change and then added a fifth component; *Gestell*, are used to explain the main components of modern technology, explaining the nature of holistic change in modern society.

3. *Synthetic analysis* results in the integration of the ideas in the examined literature to generate one or more of the possible outcomes of the literature review (Torraco, 2005), in these case, the ontological taxonomy of SOI, and the research agenda that guides the empirical part of this thesis. The ontology, based on Heidegger (1954), helps to identify the five SOI components in the literature: operational, collaborative, organisational, instrumental and holistic.

3.5. Methods in the qualitative study

3.5.1. Multiple case-study method

The qualitative study of the thesis research design adopts an exploratory approach, aiming to understand which the shared features of companies that have successfully engaged in SOI are. In order to do so, multiple case study method is found to be the most effective, because it offers the possibility of analysing firms with contrasting features in depth; offering a good start for theoretical replication (Yin, 2009). Besides this chance to observe the cross-case differences, case study method enables the researcher to obtain an overview of the firms in question, as well as their surrounding environments (Yin, 2009). Therefore, this is the fittest qualitative method for the research question of this study –which are the dynamic capabilities required for SOI engagement – because the unit of analysis, the firm, may be observed from multiple levels, looking also at its relationships with other agents and within organisational layers.

In order to fully comprehend dynamic capabilities, it is necessary to look at different parts of the firm where different resources and micro-foundations – individuals, processes and structures (Felin et al., 2012) lie. It is necessary to observe the relationships between them and their responsiveness to external stimuli. In order to understand how firms function for SOI through a dynamic capabilities framework, systems theory suggests looking at the components, the hierarchies of dynamic capabilities (Ambrosini et al., 2009), and their relationships. This multi-level understanding may be empirically collected through the depth that case studies offer.

In this regard, the multiple case study approach is theory-building oriented, involving an inductive-deductive cycle between empirical findings and the literature (Eisenhardt and Graebner, 2007), as shown in Figure 18.

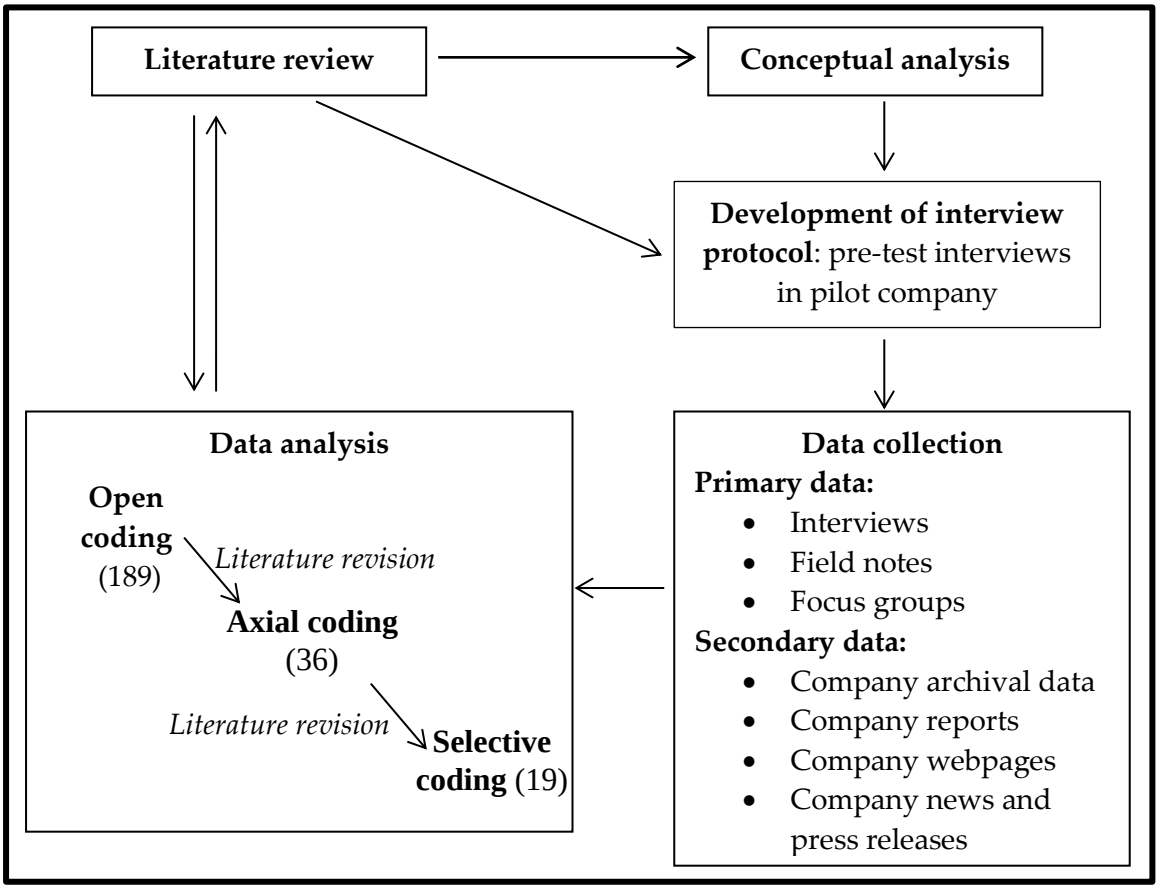

Figure 18. Methodological iteration of the qualitative study
Source: elaborated by the author

The case-study method was deemed appropriate due to the indetermination in the field of dynamic capabilities and the early state of development when applied to SOI, as this method allows for theory development (Eisenhardt and Graebner, 2007; Yin, 2009). It was applied to eight different companies in order to compare the results in each of the cases and, by finding repeated or contrasting patterns existent among firms, fully understand the phenomenon (Strauss, 1987). As observed in Figure 17, the study started with a review of the literature on dynamic capabilities, in order to analyse the concept and obtain a working framework to guide data collection based on previous research. Based on this conceptual analysis, the interview protocols were developed, and after collecting data from the eight case studies, the transcriptions were analysed in a three-level coding routine –open, axial and selective – (Saldaña, 2012; Strauss and Corbin, 1990). The inductive-deductive approach was used during this phase, coming back to the literature to build on it after each of the coding phases. After three rounds of literature review and data coding in a cyclical manner, a preliminary model of SOI was developed by saturation.

The first drafts of the interview protocols for semi-structured interviews were developed building on the conceptual analysis; however, the research approach being exploratory, the range of response was left intentionally open. These drafts were put to

test through exploratory interviews with the sustainability and brand managers of one of the firms, with the aim of assessing: (1) whether the protocol yielded responses answering the research question; (2) whether the questions were understandable and drafted in a language normally deployed by practitioners, and (3) whether the interviewee could respond to the questions without having to access additional data. After this pre-testing, the protocol was deemed valid regarding objectives (1) and (2), but some interview questions were adjusted to focus on information that managers could recall without needing to access additional data. In addition, some suggestions were added in the interview protocol to help the interviewee provide a more complete response in case she did not by answering to the main question only. Two interview protocols were designed in this manner: the main interview protocol on organisational features and SOI designed for company CEOs, sustainability and innovation managers, and a second interview protocol designed for project managers, regarding a successful and a failed SOI development process. The final versions of these protocols are available in Appendix 1.

3.5.2. Sampling

In order to select the sample companies for the case studies, theoretical sampling principles were applied (Eisenhardt, 1989) on a geographical convenience sampling approach (Bryman, 2008). In this manner, the cases were selected in the best way to approach the research problem, investigating companies that had already adopted SOI practices and were advanced in its development. Maximum variation sampling was looked for, in order to grant access to multiple organisational contexts as industry, age, and size are concerned, which allows for more comprehensive results (Patton, 2005). Therefore, sincethe common feature of the sample companies is the fact that they are engaged in SOI; the aim is to observe repeated patters in companies as different as possible, but which have achieved the same strategic goal of SOI-based transformation (Onwuegbuzie and Leech, 2007).

In order to select the sample, Internet searches were conducted in order to find out about Spanish innovative and sustainable companies, with a focus on companies of the Basque Country[2] following the geographical convenience logic. With the aim of determining what constituted engagement in SOI, we considered those companies

[2] Basque Country, in the context of this thesis, refers to the administrative delimitation of the Basque Autonomous Community in Spain (*Comunidad Autónoma Vasca* in Spanish, *Euskal Autonomia Erkidegoa* in Basque), which is commonly referred to by the name 'Basque Country' in English. This shall not to be confused with the cultural delimitation that also receives the name 'Basque Country' in English, which covers other territories as well (*Euskal Herria* both in Spanish and Basque).

which had adopted practices collected in the systematic literature review Adams et al. (2012, 2016), as noted in Table 4[3]:

Table 4. Practices of SOI
Source: adapted from Adams et al. (2016: 195)

	Operational optimisation	**Organisational transformation**	**System building**
Strategy	Comply with regulations or pursue efficiency gains	Embed sustainability as a cultural and strategic norm in a shaping logic that goes beyond greening	Logic of wide collaborations and investing in systems solutions to derive new, co-created value propositions
Process	Focus on internal and incremental innovation facilitated by use of tools	Adopt new values and platforms (e.g. reverse innovation) and new ideation practices (e.g. biomimicry)	Adopt new collaborative process platforms with diverse stakeholders
Learning	Exploit existing knowledge management capabilities to identify and access relevant knowledge	Engage with key stakeholders of the firm – internal and external	Develop ambidextrous skills enabling 'shadow tracking' and learning from experimentation with multiple new approaches
Linkages	Recruit external domain experts for new knowledge	Shift focus from intra-firm linkages to collaborations with immediate stakeholders	Get the whole system in the room to diagnose problems, understand system complexity, build trust and identify levers for change
Innovative organisation	Exploit existing innovation capabilities	Embed SOI culture through the organisation	Adopt new business paradigms (e.g. B-Corps)

After this review of practices, a shortlist of fifteen companies was generated, under the principles of geographical convenience sampling (Bryman, 2008). To assess if the companies had adopted at least some of these practices in an ongoing fashion, their websites and contributions to local sustainability association were screened, and this

[3] Table 4 is the latest, summarised version of the activities of SOI from the work of Adams et al. (2012; 2016). However, an earlier, more detailed list of practices –categorised under different headings- from the work of Adams et al. (2012) was used for sampling matters. This longer version may be found in Appendix 2.

fact was reconfirmed over the phone before conducting preliminary interviews. From the shortlist of fifteen companies, eleven responded positively to the request for a case study. The person with whom contact was established varied; in some companies, it was the innovation manager, in others, the sustainability manager and in some others, the CEO. After some initial interviews, three companies were discarded from the sample after realisation of the fact that, due to their young organisational age, they had different goals and structures as compared with the rest of the firms, which would skew the analysis. Consequently, the cross-case comparison is expected to show repeated patterns regarding organisation routines for SOI even in very dissimilar firms.

Under this sample design, the selected companies where firms spearheading engagement in SOI from different industries (chemistry and biotechnology; climate consultancy; wind energy; IT consultancy; technology; elevation systems; fashion; and electric networks and communication). A timeframe of six years since the adoption of the first SOI practices was chosen, from 2007 to 2013 (year of first data collection efforts) – which ruled out the start-ups that were initially part of the sample. There are three major reasons for choosing 2007 as the minimum starting date for having introduced SOI practices in the firm. First, SOI practices have emerged mostly over the last decade, under megatrends that have increased the involvement of firms in the challenge of sustainable development (OECD, 2010; WBCSD, 2010); therefore, finding companies with a strong SOI orientation since before that date greatly impaired the sampling options. Second, the minimum of a six year period for engagement in SOI ensured that SOI practices were ingrained in the company's innovation practices and culture and capabilities, with certain progression in terms of capability building. Third, this period enables to offer a sufficiently longitudinal view on each of the case studies, facilitating the study of different innovation cycles (Hobday, 2005).

The election of a maximum variation sampling ensured that they had experienced different regulatory pressures and market and sustainability challenges; in fact, their differences lie in key areas such as industry (e.g. manufacturing vs. service-oriented companies) or business model (e.g. business-to-business vs. retail). The year of foundation among the companies ranges from 1967 to 2004, and company size measured by number of employees varies from 25 to 39,000. Table 5 offers an overview of the main features of the sample companies.

Table 5. Summary of the features of sample companies

Case company and industry	Employees / year of foundation /turnover[4]	Strategy and SOI	Company selection based on the SOI stages proposed by Adams et al. (2012, 2016): operational optimization (OO), organisational transformation (OT), and system building (SB)
Chemical	25/ 2001/ 3,7	• Sustainable chemical products • SOI is embedded in all activities	OO: eco-efficiency (eco-design to redesign products) OT: adopt new process platforms (closed loop manufacturing and cradle-to-cradle innovation) SB: engage in institutional dialogue to adapt markets toward green chemistry, reframing the firm's purpose
Climate (Climate consultancy)	35/ 2004/ 2	• Advising on climate issues • Sustainability is at the core of their activities	OO: co-operate and network externally to compensate for a lack of resources and expertise. Enhance legitimacy and the social license to operate OT: explore new opportunities for collaboration with unrelated industries SB: engage in institutional dialogue to change climate change systems
Wind (Wind energy)	6.431/ 1976/ 2.846	• Metallurgical company focused on the development of wind turbines and wind farms. • Reducing energy costs; innovation criteria based on eco-design	OO: exploit existing innovation capabilities to facilitate the adoption of incremental innovation; design for sustainability OT: revisit and reframe the business model and modes of governance to acknowledge the firm's commitment to sustainability SB: X
IT consultancy	3.000/ 1973/ 247.7	• Private research institute • Innovation-driven • Has embarked on several sustainability-related projects that are designed to cater social demands	OO: collaborate internally to integrate SOI across the firm, and work with customers to identify their sustainability concerns OT: search for product innovation ideas in new areas, and develop long-term collaborative approaches with external partners SB: X
Technology (Technology development)	39.000/ 1993/ 2.940	• Developing technologies and catering to customer needs	OO: collaborate internally and across functions to integrate SOI across the firm, work with customers to identify their sustainability concerns, empower the upper management team to set the direction for

[4] Turnover is measured in million euros. All data are provided for year 2014.

		are at the core of the business model • Unit dedicated to sustainable products	SOI, and monitor performance against SOI criteria OT: develop long-term collaborative approaches in consultation with external partners and integrate sustainability metrics into financial reporting. SB: X
Elevation (Elevation systems)	4.333/ 1982/ 578	• SOI is at the core of its activities in a very competitive industry • Sustainability is a firm company commitment.	OO: co-operate and network externally to compensate for a lack of resources or expertise, empower the upper management team to set the direction of and climate for SOI, and design "green" from the outset OT: adopt a servitisation strategy, and revisit and reframe the business model and modes of governance to acknowledge the firm's commitment to sustainability SB: derive new value propositions from the entire socio-technical and ecosystem value network
Fashion	70/ 1997/ 20	• Sustainability has represented one of the cornerstones of the company since it was first founded • Sustainability has been considered with every new design as part of the company's identity.	OO: cooperate and network externally to compensate for a lack of resources or expertise, design "green" from the outset, and fill competence gaps through training OT: ensure that the upper management team is viewed as having a commitment to sustainability, and support long-term collaboration with external partners SB: initiate, mobilize, lead and inspire systems change
Electric (Electric networks)	1.500/ 1967/ 320	• Achieving further energy efficiency levels as part of their core business model • The efficiency and sustainability of raw materials and the development of new sustainable products: new product design criteria	OO: collaborate internally and across functions to integrate SOI, exploit existing innovation capabilities to facilitate the adoption of incremental innovations, design for sustainability, and reduce material effects and product energy consumption levels OT: exploit organisational slack; develop new networks into wider social, economic, legislative systems; and be attentive to disruptive and systems-changing innovations occurring elsewhere SB: X

Although the objective of the sampling design was to obtain maximum variation, the geographical convenience approach poses a methodological limitation, since all the companies are headquartered in Spain and seven out of eight in the Basque Country

Autonomous Community (although all of them manage international operations). For this reason, cultural and regulatory environments may skew the study; thus, extra caution has been taken when deriving analytical generalisations from the cross-case comparison.

3.5.3. Data collection

Primary data was collected through semi-structured interviews, focus groups and collected field notes (Bryman, 2008; Yin, 2009). Thirty participants were involved in interviews, and the focus groups were conducted only in three companies that agreed to it (Chemical, Climate and Fashion). The study was complemented with secondary data, gathered from internal documents, press releases, websites and other archival data provided by the informants. Semi-structured interviews and focus groups served as the main source of information. Access to the company was granted by the development of trustful relationships with key informants, who facilitated access to the company, sent secondary data files and pre-arranged meetings with the rest of the employees, acting as sponsors of the research project within the company.

The targeted interviewees were managers of innovation and sustainability and CEOs. However, in some companies, these responsibilities overlapped and were carried out by the same person, whereas in others, the responsibilities were shared or split between two people. In the latter case, both persons were interviewed. In some other cases, some of the targeted informants (mostly CEOs of the bigger companies) were unavailable for interview. During the process of data collection, informants other than the initially targeted were identified as relevant for SOI engagement, which led to interviewing corporate social responsibility, strategy, marketing or communication managers. When available, project managers for successful or failed SOI projects were also interviewed, utilising the second interview protocol (in those cases where innovation or sustainability managers were not directly responsible for such projects). Table 6 shows the list of interviewees and their form of participation.

Table 6. List of interviewees and form of participation

Company	Respondent position	Form of participation
Chemical	CEO	Individual interview, participation in focus group
	Sustainability and innovation manager	Key informant. Individual interview, participation in focus group, email correspondence. Interviewed about failed and successful projects
	Creativity management and	Individual interview, participation in

	innovation	focus group
Climate	CEO	Key informant. Individual interview, participation in focus groups, email correspondence, pre-interviews meeting
	Consultancy division manager	Individual interview, participation in focus groups
	Project manager	Individual interview, participation in focus groups. Interviewed about failed and successful projects
	Project manager	Individual interview, participation in focus groups
Wind	Innovation manager	Individual interview
	Environment & Safety manager	Individual interview. Interviewed about failed and successful projects
	CSR manager	Key informant. Individual interview, email correspondence
IT Consultancy	Innovation division director	Key informant. Individual interview, email correspondence
	Sustainability manager	Individual interview
	Project manager	Individual interview. Interviewed about failed and successful projects
Technology	Head of Innovation	Individual interview
	Head of CSR	Individual interview
	CSR senior associate	Key informant. Email correspondence, pre-interviews meetings
	Head of Strategy	Individual interview
	Head of Sustainability Solutions division	Individual interview
	Project manager	Interviewed about failed and successful projects
	Project manager	Interviewed about failed and successful projects
Elevation	Innovation manager	Key informant. Two individual interviews. Interviewed about failed and successful projects. Email correspondence
Fashion	CEO	Individual interview, participation in focus group
	Design Director	Individual interview, participation in focus group
	Sustainability and supply chain manager	Key informant. Individual interview, participation in focus group. Interviewed about failed and successful projects. Email correspondence
Electrical	General Manager	Individual interview

	Managing Director	Individual interview
	Head of New Businesses division	Individual interview
	Environmental sustainability manager	Key informant. Individual interview. Email correspondence
	Social sustainability manager	Individual interview
	Innovation manager	Individual interview
	Project manager	Interviewed about failed and successful projects

During the interviews, Kvale's (1996) criteria for interviewing were followed (knowledgeability, structure, clarity, gentleness, sensitivity, openness, steering, criticality, remembering and interpreting) to ensure that the interviewees felt at ease and provided truthful, valuable answers under the loose guidance provided by the semi-structured interview protocol (Bryman, 2008). To avoid serious reactivity effects that would compromise the validity of the study, long and extensive interviews wherein the participants were informed of the anonymity of their answers were conducted. During the interviews, trusting relationships were built to avoid receiving responses influenced by social desirability. Additional questions were asked, if necessary. Finally, focus groups were conducted with the interviewees of three of the eight sample companies to contrast their visions of SOI in their organisation. The aim was to collect their view after having had reflected on the topic after the interview (Merton, Fiske and Kendall, 1956) and also to have the participants challenged by new knowledge and the views on the topic of their colleagues from other corporate divisions (Bryman, 2008).

The information in the interviews and focus groups was recorded and transcribed verbatim. Interviews lasted from 50 minutes to over three hours. The interviews were conducted during several days of visits to the companies' premises, and were arranged over phone on email with some days or weeks in advance. During the interviews, field notes were taken. It must be noted that one of the companies, Elevation, did not consent to recording; therefore, the collection and posterior data analysis was conducted based on the field notes. Table 7 collects the amount of collected primary data.

Table 7. Primary data collected in the quantitative study

Case	Individuals interviewed	Individuals in focus group	Length (hh:mm)	Transcribed pages
Chemical	3	3	6:28	141
Climate	5	3	8:43	220
Wind	4	0	5:56	124
IT	4	0	6:42	169
Technology	6	0	4:58	98
Elevation[5]	1	0	5:10	80
Fashion	4	3	5:11	103
Electrical	5	0	4:45	89
Total	32	9	47:53	1024

Secondary data were also used as a complementary source of information to triangulate the results obtained from the primary data. Table 8 enumerates the sources of secondary data for each of the cases:

Table 8. Secondary data collected for the qualitative study

Case	Secondary data sources
Chemical	• Website • Annual report • News about awards and recognition in the media • Press releases from associations in which it participates
Climate	• Website • News about awards and recognition in the media
Wind	• Website • Annual report • Press releases
IT	• Website • Press releases from associations in which it participates
Technological	• Website • Annual report • Internal strategy plan • Press releases
Elevation	• Website • Press releases • News reporting advances in the media
Fashion	• Website

[5] Since the interviews conducted with the participant of Elevation were not recorded due to confidentiality issues, length reflects the duration of the interviews and the transcription of the field notes taken.

	• Press releases • News about the company in the media
Electrical	• Website • Press releases • News about the company in the media • Press releases from associations in which it participates

3.5.4. Data analysis

The transcripts from interviews and focus groups were coded in a three-level inductive-deductive cycle, in which the emergent codes from the literature – the interpretation made by the researcher over 'standardised codes' (Charmaz, 2000 – were contrasted with the literature after each round of codification (Saldaña, 2012). The emerging categories were revisited until a model was reached by saturation (Glaser and Strauss, 1967). NVivo software was used for the codification process, which involved three rounds of codification over two stages (Charmaz, 2006). The initial coding (Charmaz, 2006), which was very detailed, provided first impressions of the data, yielding concepts and categorising data (Bryman, 2008; Strauss and Corbin, 1990). The second stage of focused coding which calls for the analysis of the initial codes to categorise and order the data (Charmaz, 2006), involves two rounds of codification: axial and selective (Strauss and Corbin, 1990). During this phase, emphasis was put on the most common codes and those which are more revealing of the data. An example of the transition from one round to the other and the full lists of codes at each round may be found in Appendix 3.

Open coding is '*the process of breaking down, examining, comparing, conceptualising and categorising data*' (Strauss and Corbin, 1990: 61). The first level of codification was descriptive (Miles and Huberman, 1984) coding, focusing on the organisational routines and learning processes with an open, emergent approach. 189 codes were obtained at the first-level coding phase, which were used to identify categories in the data during the second phase of coding. These codes are mostly descriptive of the patterns observed in the data, for instance "co-creating with suppliers," "responsiveness to clients" or "alignment of strategy".

The second level of codification was **axial coding**; that is, '*a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories*' (Strauss and Corbin, 1990: 96), looking at the repeated patterns among companies and interviewees, and elevating the codes to categories that represented analytical concept. This codification round yielded 36 categories. This coding round was informed by the literature and the recurrence of codes in the open coding round, helping to classify codes into categories, as illustrated in Figure 19.

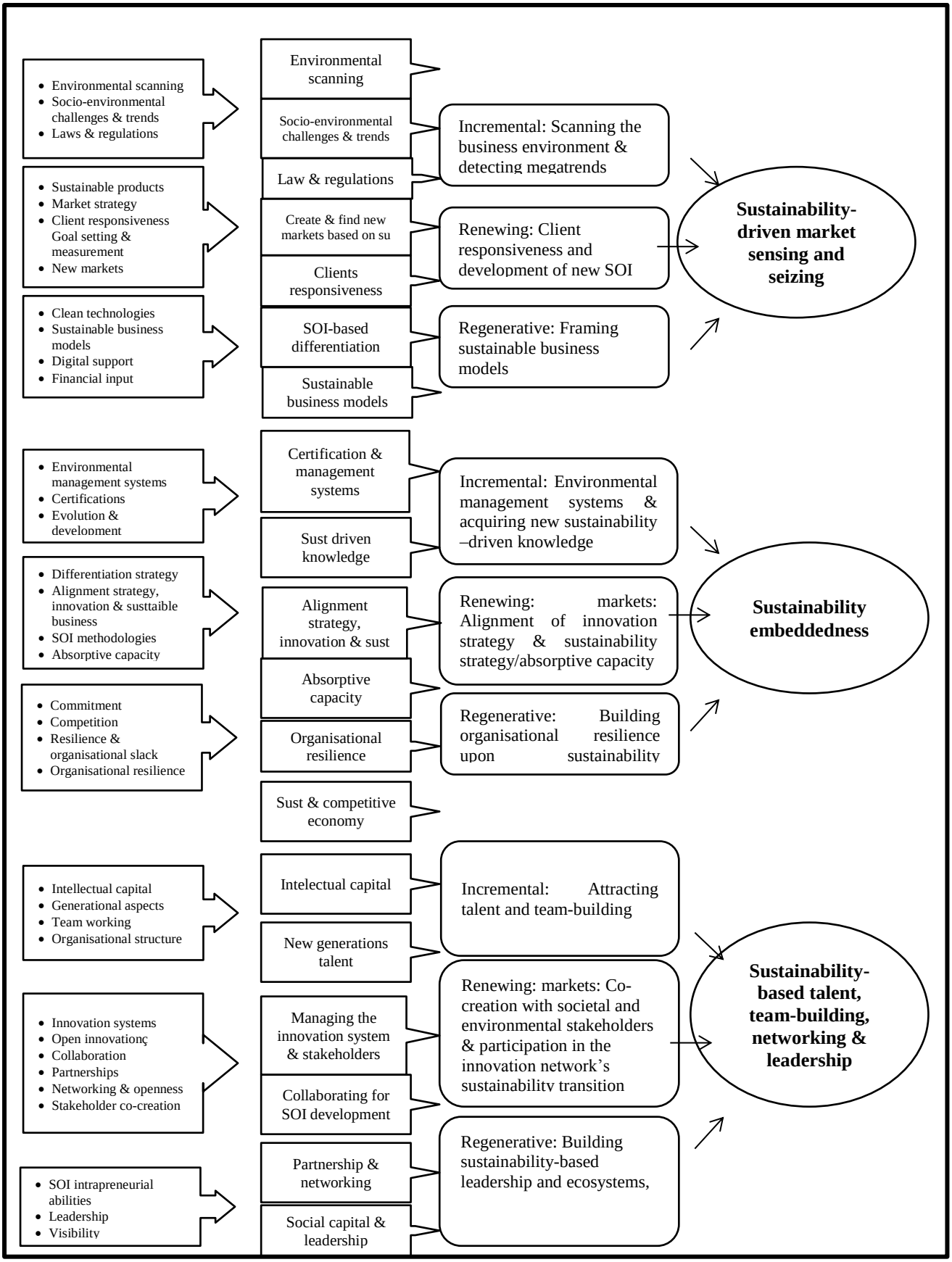

Figure 19. Data structure of axial and selective coding

The last level of codification was **selective coding**, or '*the procedure of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development*' (Strauss and Corbin, 1990: 116). The refinement of categories yielded 19 core categories, which, informed by the literature and their content, where ordered in the multi-level model presented in Chapter 5. At this level, categories included "sustainable business models", "organisational resilience" or "laws and regulations".

Secondary data was not coded, but used as a complementary and validation source to contrast the primary data obtained through the interviews and focus groups. The use of secondary data was twofold: (1) preparing the interviews to obtain specific knowledge on the companies' strategic approaches, products and services, technologies and challenges; and (2) validation of the information obtained from primary data, contrasting the interview transcriptions with the public statements of firms on their websites, press releases and internal documents, and other critical media information and third-party documents.

In order to ensure the quality of research, two forms or triangulation were deployed: data triangulation (Miles and Huberman, 1984; Yin, 2009) and informant triangulation (Denzin and Lincoln, 1997). The first one warranted coherence between primary (the informants' view) and secondary (the company's line of communication) data. The latter provided contrasting views from different agents, who perceived the SOI strategy of their companies from distinct angles due to their interests and responsibilities. Due to the nature of the qualitative study, it is not possible to generalise the results from this study to the whole population; nevertheless, there are possibilities for analytic generalisation (Firestone, 1993; Polit and Beck, 2010) due to the profoundness of the cross-case analysis (Yin, 2009). Consequently, the findings in this study may be applicable to other settings (Eisenhardt and Graebner, 2007); but, in any case, it serves as a conduit for further exploration in the quantitative study.

3.6. Methods of the quantitative study

The quantitative study of the study was designed as a cross-sectional survey (Bryman, 2008), comprising variables derived from the quantitative study as well as some other new variables to extend the understanding of SOI provided by the whole exploratory, convergent mixed methods study (Creswell and Plano Clark, 2011). This quantitative design entails collecting data from a big sample of cases at a single point of time to collect quantifiable data that allows for the analysis of relationships among variables, aiming to find patterns of association.

The cross-sectional design was administered on a random sample of companies from the Basque Country of more than 50 employees; this probability sampling was selected because it allows for generalisation to the population from which it was selected[6]. The main limitation of this design is its weaker internal validity due to its cross-sectional nature, as compared with longitudinal studies, due to the difficulty to establish unambiguous causality relationships from the data because of the fact of it being collected at the same point of time, although there are ways to identify such relationships during the data analysis phase (Bryman, 2008). However, replicability and external validity, thanks to the random sampling strategy, are strong.

Data was collected through a questionnaire conducted both over the telephone and a web-based platform, depending on the preference for an online or telephone based interview of each of the respondents. The development of such instrument is explained in the following section.

3.6.1. Development of the survey instrument

As part of the wider mixed methods design, the survey was designed based both on the results of the previous qualitative study, and the literature review. The questionnaire is based on multiple-choice questions, which facilitates data collection and replicability. These questions enhance the comparability of answers, ease the answering process for the respondent (which may be aware of approximate ranges but not exact data on matters like R&D investment, for instance), and reduce the risk of variability that other methods of quantitative data collection, such as structured interviewing, provide (Bryman, 2008). It must be noted that this kind of questions results in a loss of richness of data, as the respondent is not able to elaborate on the issue. However, for the purposes of the quantitative study of research, and the complementarity with the richness of data obtained in the qualitative phase, closed-ended questions in a questionnaire were considered the most appropriate for the survey.

The survey was designed in English but was administered in Spanish. The reason for this is that the reviewed literature and the original scales incorporated into the questionnaire were available in English, but Spanish was expected to be the mother

[6] The whole sample included in the Kompass database of companies of 50 or more employees established in the Basque Country (after removing duplicates) was contacted. The database included data for 1.178 establishments. However, Eustat (2015), the Basque Institute for Statistics, indicates that there were 1.805 establishments of 50 or more employees in 2015 in the Basque Country.

tongue or working language of the majority of the respondents[7]. In order to translate it to Spanish, a back-translation procedure was followed (Chapman and Carter, 1979): first, the author translated the original version in English to Spanish. Then, this preliminary version in Spanish was translated back to English by two other translators. After evaluating the differences in meaning that back-translated versions of the questionnaire had compared with the original (identified in two items), the drafting in Spanish was changed to better adjust to the original linguistic and cultural meaning.

With the aim of improving the questionnaire's face validity (Bryman, 2008), the Spanish version was submitted to pre-testing. First, the questionnaire was conducted over the phone with five practitioners belonging to different sectors (education, insurance, manufacturing of elevation systems, distribution of plumbing products and manufacturing of car parts). Some of them had trouble understanding the drafting of three of the items of the initial Spanish translation. After consulting them independently, the items were reformulated until a drafting loyal to the original meaning but understandable by all of them was reached. They also pointed out the fact that the questionnaire was to lengthy (the calls took from 25 to 30 minutes), and that this would reduce the chances of obtaining acceptable response rates. In order to respond to this concern, some overlapping questions were removed from the questionnaire; for instance, the measure on green innovation (Huang and Li, 2015) was removed as there was already a measure on SOI. Two of the practitioners also pointed out that they would have preferred to complete the questionnaire through a web-based survey instead of over the phone due to time availability. Therefore, a web-based survey was also developed, despite the original research plan contemplating telephone-based data collection only.

The web-based survey (with these changes incorporated) was designed using the Google Forms platform. It was also completed by another three practitioners from different sectors (education, manufacturing of food products, and logistics), as a pre-test. The practitioners, on this occasion, raised no issues regarding the survey instrument. Although web-based, self-administered questionnaires have some advantages over telephone data collection – mainly, the absence of interviewer effects and the convenience for respondents – the risks associated with it were also addressed. For instance, to avoid the lack of independence between responses derived from the respondents being able to read the whole questionnaire, the web format was designed

[7] The Basque Country region is a bilingual area – Basque and Spanish languages-; however, as of 2011, only 24% of the population was native in either Basque or both Basque and Spanish; as compared with 72% of native Spanish speakers (Eustat, 2013). Due to the preeminence of Spanish, Basque native speakers command Spanish language as well; for this reason, and due to the difficulties associated with performing another back-translation to Basque, the survey was administered in Spanish only.

in succeeding pages in which only the questions from that section were visible to the respondent, who had to respond to all questions in that section in order to proceed to the rest of the questionnaire. In order to avoid the risk of missing data due to the absence of prompting, the response mode was forced.

3.6.2. Sampling approach

The sample was designed as a simple random sample without replacement (Särndal, Swensson and Wretman, 2003), since every member has its representatives of the population and each was given equal opportunities of being selected. This probability sampling design offers a representative picture of the population, which allows for generalisation for the wider population (Bryman, 2008).

The population of interest was delimited geographically to companies established in the Basque Country. Moreover, the establishment in the region were set to have independent strategic decision-making power. Therefore, only companies that had either their headquarters or independent branches in the region were selected. In addition, a restriction was made to include firms that had 50 or more employees, because, as observed in the qualitative phase, the structures in start-ups are not comparable with more established firms. A temporal criterion could have been established looking at the year of foundation; however, due to changes in legal structures (mergers, incorporation of companies), well-established companies might have, on paper, recent dates on foundation. Since looking at each case individually was not possible when composing the database, the number of employees criterion was used to ensure that companies included in the sample had a minimum organisational apparatus. Companies from all sectors and firm age were included, aiming to observe cross-sectoral differences in the approach to SOI.

According to the Basque Institute of Statistics, there were 1805 companies with 50 or more employees in the Basque Country, as of 2015 (Eustat, 2015). Access to the whole population is not possible, since the official database is confidential; instead, access was granted by the Kompass database of firms. The Kompass search for companies established in the Basque Country of 50 or over employees yielded a database of 1178 companies. Duplicates (firms with more than one establishment in the region, branches with no capacity for independent strategic-decision-making, and corporations owned by the public administration (because this particular shareholding may skew their interest towards a positive social impact) were removed from the sample. Eventually, the actual sample consisted of 873 companies; that is, 48% of the whole population. Data collection yielded 170 responses from the target firms, businesses with strategic decision-making power established in the Basque Country, which consists of 9.4% of the whole population.

3.6.3. Data collection

The data collection procedure lasted from November 2015 to April 2016, and, as aforementioned, interviews were conducted both over the phone and on a web-based platform. The whole sample was contacted at least once. The key-informant technique was deployed, targeting innovation managers, sustainability managers or CEOs, if not available, project managers, and if there were not such positions in the firm, the person who was deemed more appropriate to respond within the firm. The data collection procedure is illustrated in the flow chart in Figure 20.

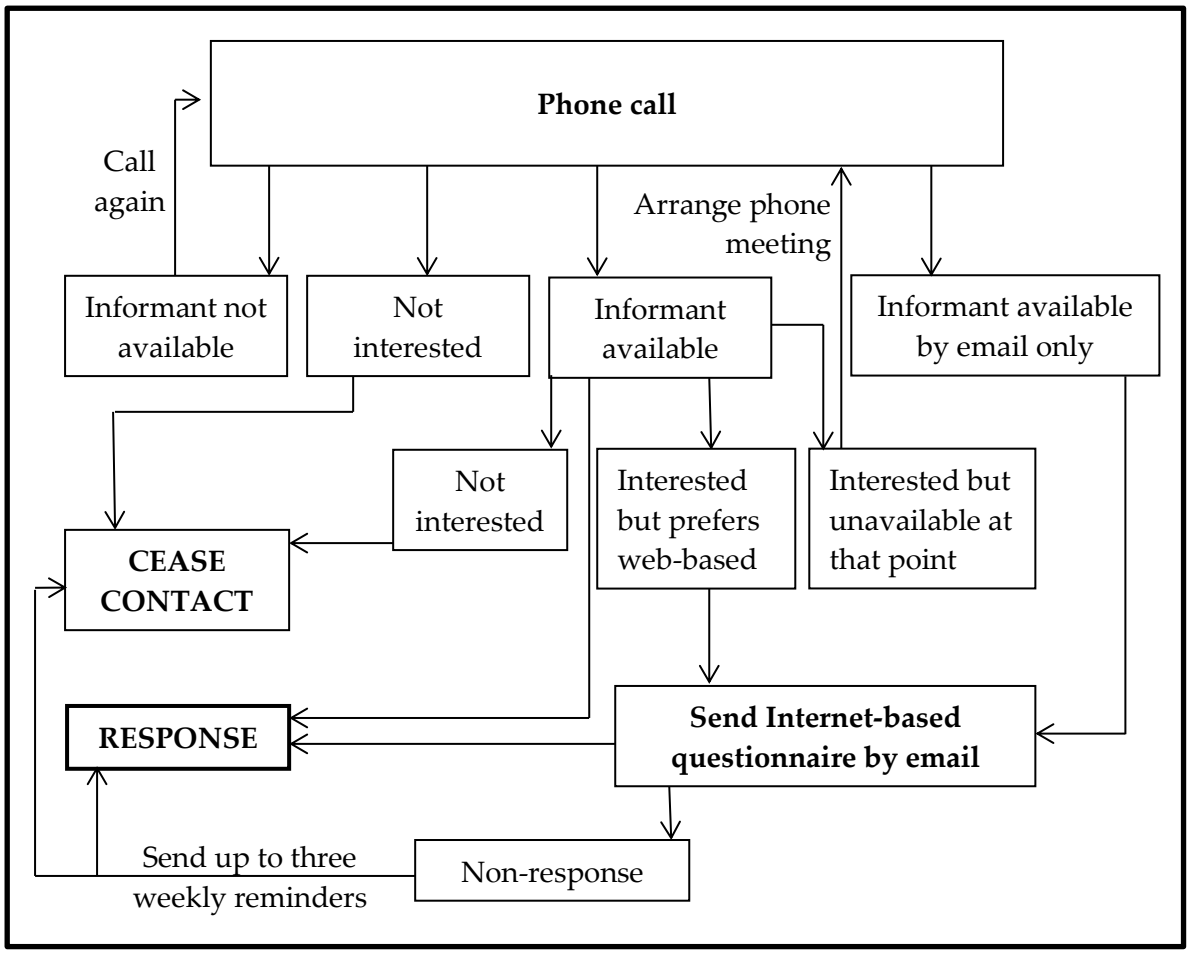

Figure 20. Data collection procedures
Source: elaborated by the author

Firms were contacted over the phone in order to identify the fittest person to respond to the questionnaire; this person responded either over the phone; or via the web based questionnaire which was sent to them by email, as illustrated in Figure 20. Combining these methods, a response rate of 19.5% (170 cases) was achieved in the time set for data collection. The motives for not-responding for the remaining 80.5% vary: 90 (10.3%) of the companies refused to answer the questionnaire, in 19 (2.2%) of the cases contact with the appropriate person was never reached, and in 594 (68%) of the occasions communications were ceased after three unanswered email reminders.

3.6.4. Variables and data analysis

The variables included in the survey were based on previous literature and the results from the qualitative study. The questionnaire is composed of eight blocks, as illustrated in Table 9.

Table 9. Variables in survey questionnaire

Blocks	Variable	Measurement	Source
Characterisation of the firm	Name of firm	Open-ended	Not applicable
	Postcode	Open-ended	Not applicable
	Industry	Multiple choice (10)	Eurostat (2008)
	Year of foundation	Open-ended	Not applicable
	Size: turnover	Open-ended	Not applicable
	Size: number of employees	Open-ended	Not applicable
	Position of the person filling in the questionnaire	Multiple choice (5)	Not applicable
	R&D intensity	Multiple choice (4)	European Commission (2014)
	Sustainability orientation	1-item 7-Likert scale	Self-developed
Business environment	Customer turbulence	Reflective measure, 3-item 7-Likert scale	Joshi and Sharma (2004)
	Competitor turbulence	Reflective measure, 3-item 7-Likert scale	Joshi and Sharma (2004)
	Technological turbulence	Reflective measure, 3-item 7-Likert scale	Joshi and Sharma (2004)
SOI activities	Process SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Collaboration for process SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Organisational SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Collaboration for organisational SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)

	Product SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Collaboration for product SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Service SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Collaboration for service SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Marketing SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
	Collaboration for marketing SOI	Formative scale, 3 items, 3 options	Self-developed, based on Oslo Manual (OECD and Eurostat, 2005)
Business strategy	Strategic types	Multiple-choice (4)	Barney and Griffin (1992); based on Miles, Snow, Meyer and Coleman (1978)
Capabilities	Alliance proactiveness	Reflective scale, 5-item 7-Likert scale	Sarkar, Aulakh and Madhok (2009)
	Alliance portfolio coordination	Reflective measure, 4-item 7-Likert scale	Based on Schilke and Goerzen (2010)
	Market responsiveness	Reflective measure, 3-item 7-Likert scale	Based on Garrett, Covin and Slevin (2009)
	Absorptive capacity	Reflective scale, 5-item 7-Likert scale	Based on Flatten, Engelen, Zahra and Brettel (2011)
Knowledge search strategy	Internal sources	Formative measure, 5-items, binary	Self-developed
	External sources	Formative measure, 17-items, binary	Laursen and Salter (2006), plus NGOs
Performance	Market performance	Reflective measure, 2-item 7-Likert scale	Hooley, Greenley, Cadogan and Fahy (2005)

	Financial performance	Reflective measure, 3-item 7-Likert scale	Hooley et al. (2005)
	Customer performance	Reflective measure, 4-item 7-Likert scale	Hooley et al. (2005)
	Sustainability behaviour	Formative scale, 9-items, 7-Likert scale	Based on Epstein and Buhovac (2014)

The first block, characterisation of the firm, provides control variables for data analysis and illustrates the demographics of the firms. The second, business environment, elaborates on the results of the qualitative analysis, which suggested that the environment of the firm has an effect on the development of capabilities for SOI. Hence, this block aims to evaluate the impact that dynamic environments have on the development of SOI (Eisenhardt and Martin, 2000)

The third block measures the SOI outcomes; taking into consideration five types of outcome and, for each of them, whether there has been no innovation, incremental innovation or radical innovation, and whether there has been collaboration in its development. These measures are self-developed based on the definition of each type of innovation outcome in the Oslo Manual (OECD and Eurostat, 2005). The type of measurement allows for the introduction of magnitude of innovation in the resulting variable; therefore, the multidimensionality of the measure provides a detailed explanation of the type of SOI firms in the sample have embarked on. It must be noted that during the qualitative study, it was found that not even the most advanced companies when it came to SOI kept a record of neither the number of SOIs introduced nor their economic output. Using traditional measures of innovation, such as R&D investment or number of patents was not advisable in this case; first, because these measures are contested because they neglect types of innovation that might cause great changes but do not a have a budgetary assignation or result in patents, such as organisational innovation; and second, because during the qualitative study it was observed that the studied companies did not keep separate records for SOI. Hence, the measure looks at the introduction of SOIs, either incremental or radical, during the year before. Therefore, it only measures whether the company has been engaged in SOI in each of the dimensions. This is recognised as a limitation of the study, which calls for caution when deriving conclusions from the data.

The fourth block measures business strategy, based on the description of strategic types by Miles et al. (1978) as extracted from Barney and Griffin (1992). This measure is introduced because, in the qualitative study, the alignment of the overall business strategy with innovation and sustainability appeared to be a major issue, as noticed also in previous literature (Hansen et al., 2009; Huang and Li, 2015; Loorbach van

Bakel, Whiteman and Rormans, 2010). In this measure, respondents self-categorise their firm in one of the four strategic types: prospector, defender, analyser and reactor, given an explanation of each of them.

In addition to the measures of collaboration in the SOI outcomes block and the knowledge search strategy block, these items respond to the claim in the literature that SOI requires external collaboration (Adams et al., 2016; Ayuso et al., 2011; Bonney, Clark, Collins and Fearne, 2007; Nidumolu, Ellison, Whalen and Billman, 2014). In order to measure how this is operationalised in the firm, the measures on alliance proactiveness by Sarkar et al. (2009) and on alliance portfolio coordination by Schilke and Goerzen (2010) are utilised.

The next block covers the main types of capabilities that were found in the qualitative study in terms of developing a relationship with the market (sustainability oriented market sensing and seizing) while accumulation and using internal knowledge for sustainability (sustainability embeddedness). The measure for market responsiveness by Garrett et al. (2009) was included. A measure for SOI culture was not found; however, due to the fact that sustainability orientation is already measured in the first block and the existence of SOI outcome measures in the survey, a measure for absorptive capacity, which was shown to be one of the main components of the culture-related capabilities in the qualitative study, was selected. A wide array of measures for absorptive capacity has been published (see Flatten et al., 2011; for a review); however, the assimilation component of the capability identified by Flatten et al. (2011) was found to be the fittest for this purpose.

The seventh block is related to knowledge search strategies; that is, where SOI ideas come from. This question was left relatively open in the qualitative study, and did not yield certain results. Due to the interest this has raised in the literature for innovation (Belderbos, Carree and Lokshin, 2004; Henttonen et al., 2011; Laursen and Salter, 2006), and considering the mixed results in the qualitative study, this measure was introduced. It consists of 22 binary variables, one for each possible source of knowledge, 5 internal (self-developed) and 17 external (extracted from Laursen and Salter, 2006, plus the introduction of NGOs).

A final to block was introduced to measure performance, in order to explore its relationship between SOI. In this block there are two sub-groups, the economic performance measures extracted from Hooley et al. (2005) – financial, market and customer performance – and the sustainability behaviour measure based on Epstein and Buhovac (2014). Regarding the economic performance measures, due to the cross-sectional nature of the study and the fact of them being self-reported, subjective measures, the results must be taken with caution: a study to establish full causality

between SOI and economic performance would require a longitudinal study evaluating time effects, and ideally with objective measures, such as turnover and number of SOIs introduced. However, the inclusion of these measures allows for a preliminary exploration of the relationship between SOI and performance, despite being acknowledged as a limitation of the study. Regarding the sustainability behaviour measure, it is based on the principles of sustainable business by Epstein and Buhovac (2014). It has not been used as a quantitative measure before, and, in any, the social desirability bias may be particularly present in this question, so again, the results of this being self-reported, the conclusions derived from the data must be taken with caution.

The full questionnaire is presented in Appendix 4, both the original in English and the translated version in Spanish that was administered.

In order to rule out the existence of non-response bias (Armstrong and Overton, 1997), an ANOVA test was performed. The sample was distributed in four groups depending on their form of responses, as follows: 1) telephone response (52 cases); 2) web-based response after first email (65 cases); 3) web-based response after second email reminder (36 cases); and 4) web-based response after third email reminder (17 cases). The groups were compared based on five central factors: R&D intensity, sustainability orientation, SOI outcomes (aggregated index variable), market responsiveness (from the scale based on Garrett et al., 2009) and customer performance (from the scale by Hooley et al., 2005). According to the results, as shown in Table 10, the differences between groups are not significant as these factors are concerned. Student-Newman-Keuls and Tukey's harmonic means B post-hoc tests were conducted, showing that the selected variables are homogenous between the four groups.

Table 10. Results of ANOVA test for non-response bias

		Sum of Squares	df	Mean Square	F	Sig.
R&D Intensity	Between Groups	5,045	3	1,682	1,476	,223
	Within Groups	189,167	166	1,140		
	Total	194,212	169			
Sustainability Orientation	Between Groups	8,618	3	2,873	,972	,407
	Within Groups	490,376	166	2,954		
	Total	498,994	169			
SOI Index	Between Groups	258,857	3	86,286	2,299	,079
	Within Groups	6231,049	166	37,536		
	Total	6489,906	169			

Knowledge Assimilation	Between Groups	6,291	3	2,097	,945	,420
	Within Groups	368,337	166	2,219		
	Total	374,628	169			
Customer Performance	Between Groups	7,457	3	2,486	2,054	,108
	Within Groups	200,931	166	1,210		
	Total	208,388	169			

Research questions 4 and 5 were answered through multivariable linear regression, explaining the relationship between capabilities for SOI and both incremental and radical SOI outcomes. This was also the method of choice to respond to research question 6, exploring how different knowledge search strategies result in different forms of SOI outcomes. In this case, in order to find out how different knowledge sources group into strategies, factor analysis was deployed. Finally, in order to examine the relationship between SOI and different forms of performance, T-tests were utilised in the absence of longitudinal, objective data. The particular data analysis procedures deployed to answer the research questions are explained in Chapter 6 in relation to the corresponding results.

3.7. Bridging the qualitative / quantitative divide

In the convergent mixed methods design, the final phase of interpretation is where the qualitative and quantitative studies come together (Creswell and Plano Clark, 2011), aiming to maximise the contribution of the results by complementing the findings in both studies. The exploratory component of the research design implies that the first bridge between the qualitative and quantitative studies has already been set up through the development of the survey instrument. However, the convergence at the final stage of interpretation is the key element where this mixed methods design is superior for the purposes of this thesis as compared with other possible designs.

In the interpretation of combined results, the constructivist worldview is imperative, meaning that results from both studies are read with the aim of theory elaboration (Pratt, 2008). However, although qualitative and quantitative methods are considered to be extremes in the same spectrum in mixed method research, the difference in their approaches involves some added difficulties during the contrasting of results phase of the research study (Bryman, 2008).

The first obstacle is the different approach to understanding of phenomena; the description of behaviours through scales of quantitative research, versus the quest for the comprehension of meanings of qualitative research (Bryman, 2008). In this case, the insight obtained in the qualitative study is used to explain the deeper meaning of the quantitative results.

Another matter is the reporting of results, the conclusions extracted and the generalisability of such results. This latter point is particularly relevant, since the analytic and statistical generalisations that belong to qualitative and quantitative research respectively have different implications. Therefore, the whole study cannot be extended to the whole population of the quantitative study, and this fact needs to be considered during results interpretation; explaining what might be the differences between both studies.

In any case, there are strategies for connected data interpretation (Creswell and Plano Clark, 2011; Teddlie and Tashakkori, 2009), not only making inferences from each of the studies independently, but also drawing meta-inferences between both study once both of them are completed. These meta-inferences are done in this study taking into consideration the particularities of this research design and the cautions that have been signalled along this chapter. This includes a strategy to ensure the validity and reliability of the study that is further developed in the next section.

3.8. Validity and reliability issues

Ensuring validity and reliability is essential to guarantee the quality and rigour of the study. Qualitative and quantitative methods present different threats to these vital characteristics of a research study, as does the mixing of both research traditions (see Creswell and Plano Clark (2011) for a review). Table 11 summarises the challenges to validity and reliability of this study and how they have been tackled.

Table 11. Validity and reliability threats and solutions in the study

Nature	Threat	Solution
Mixed methods	Sample integration: will the samples of the two studies yield quality meta-inferences?	The quantitative sample collects data from randomly selected companies of all sizes and sectors regardless of their current state of SOI engagement in order to address the sample bias of the qualitative study.
	Inside-Outside view: difficulty to separate the constructivist approach of the qualitative first study with the positivist approach typical of quantitative studies.	Contrast with the literature and pre-testing with a different set of practitioners have been used for instrument development, so as to level the insider view of the qualitative study.
	Paradigmatic mixing: will the worldviews typical of	The study is presided by a constructivist worldview and quantitative methods are

	both methods be successfully blended?	used with the same objective of theory building
	Political: will the audience understand the value of the meta-inferences?	Because of the multidisciplinarity of sustainability science and the systems theory lens of the study, it is particularly prone to mixed methods; hence, the reader will appreciate the extra effort.
Quantitative	Insufficient logic among research question, hypotheses, statistical tests and analysis	This may be an issue in exploratory mixed methods designs because the variables are not known from the onset. However, the objective of building a quantitative instrument has been accounted for during the qualitative phase, so that this issue does not go unaddressed.
	Matching bias during data collection	This can be a threat to the study because of the researcher's bias after realising the qualitative study. Particular attention has been paid so as to avoid this bias in the quantitative study.
Qualitative	Biased knowledge of previous studies and theories	The grounded theory approach would require having practically none knowledge on the topic to ensure that it is grounded on practice, but this is not the case of the researcher. However, acknowledging this possible bias has forced the researcher to identify (and eliminate) any possible biases in coding.
	Serious reactivity: changes in respondent's interviews because of being conscious of participating in a study	This has been partly addressed by conducting extensive interviews, informing the participants of the anonymity of their answers and trying to build trust with them.

Although validity and reliability in qualitative studies may not be measured by the same objectivity standards as quantitative studies, there are signs that indicate the validity of qualitative studies (Golafshani, 2003), mainly, it being a worthy topic, having rich rigour, sincerity and credibility, resonance, making a significant contribution, ethics and meaningful coherence (Tracy, 2010). In addition to attending to these requirements, as aforementioned in Section 4.3., some cautionary actions have been adopted to ensure the validity of the data, such as data triangulation (between primary and secondary data) and respondent triangulation. Moreover, the focus groups carried out in some of the companies allowed for member-checking of the interpretation of the results.

Quantitative studies allow for other measures of validity and reliability. In order to ensure the reliability of the reflective scales, the Cronbach α (Nunnally, 1978) was used as an indicator, providing acceptable results of at least more than 0,7 as illustrated in Table 12.

Table 12. Reliability indicators of the reflective measures

Variable	Cronbach α	Number of items
Customer turbulence	0,756	3
Competitor turbulence	0,822	3
Technological turbulence	0,853	3
Alliance proactiveness	0,928	5
Alliance portfolio coordination	0,969	4
Market responsiveness	0,925	3
Knowledge assimilation	0,950	5
Market performance	0,938	2
Financial performance	0,953	3
Customer performance	0,931	4
Sustainability performance	0,954	9

In terms of measuring validity, content and discriminant validity were measured, as well as the unidimensionality of the measured constructs (Hair, Black, Babin and Anderson, 2009). Content validity was achieved using pre-existing, tested scales and grounding the rest of the constructs on the literature and the previous qualitative study. In order to determine discriminant validity and the unidimensionality of the measures, exploratory analyses were run among the items in each of the survey block. Due to the results of these factor analyses, two measures were aggregated. Due to the results of the factor analysis with the SOI outcomes, three categories emerged; process, product and service SOI, as the items from organisational and marketing SOI clustered with the items in these categories in the survey if the factors were allowed to rotate freely. Therefore, the organisational SOI items and technology-related item – C9 - from product SOI cluster with process SOI items in a factor; marketing SOI and product SOI items (except technology-related – C9 -) aggregate in a distinct factor, and service SOI items remain as a factor. The measures of market and financial performance were also aggregated, as they clustered together in the same factor when factors allowed to rotate freely.

The following chapters of the thesis deals with the results these methods have yielded and how they are related, setting the ground for conclusions.

Chapter 4

Understanding SOI as a complex adaptive system

4.1. Introduction

In the last decade the study of the intersection of innovation and business sustainability, SOI, has yielded a multifaceted corpus of research (Adams et al., 2016). However, literature to date has not provided with a theoretical elaboration that understands SOI in an integrated manner and in which the concept of SOI converges (Schiederig et al., 2012), partly because of the different streams of knowledge that have informed SOI literature. For this reason, the aim of this chapter is to review and classify the existent scientific research on SOI, in order to design the empirical research, and further elaborate theory of SOI (Pratt, 2009). The second section is concerned with the theoretical development derived from the integrative literature review and the models of SOI that have been proposed in the past, including the different thematic approaches to SOI, in order to understand the nuances that various disciplines have incorporated into their SOI approach. This also includes a sub-section that provides with a closer look on prior approximations to SOI from the approaches proposed in this thesis, proposing a system theory approach to SOI and the resource and dynamic capabilities view of the firm. The third section develops an ontological taxonomy of SOI inspired by Heidegger's (1954) philosophy of modern technology, which is the main result of the integrative literature review, aiming to elaborate SOI theory as a complex adaptive system, as covered in the fourth section. Lastly, the chapter will close with the research gaps identified in the literature review.

4.2. The concept of sustainability-oriented innovation

4.2.1. Conceptual development: defining SOI

Recent literature has stressed the importance of innovation driven by sustainability to improve competitiveness (Esty and Charnovitz, 2012; Nidumolu et al., 2009; Pfitzer, Bockstette and Stamp, 2013). The linkage between innovation and sustainability is meant to yield results positive for society and the environment while creating economic value (Adams et al., 2016; Klewitz and Hansen, 2014). However, there are different approaches to SOI as an umbrella concept, as illustrated in Table 13. It has been defined as the introduction of a new product and service and the design or the revision of a process that has a positive effect on the net capital stock (Klewitz and Hansen, 2014). That is, the quantification of social, environmental and economic goods to be accounted for in the whole system (which corresponds with businesses' triple bottom line (Elkington, 1998) must be increased. Arnold and Hockerts (2011) also contemplate SOI as a realisation of ideas that improves the social or environmental situation as compared with the previous one. Moreover, Bos-Browers (2010) defines SOI as the renewal of products, services, technology and organisational processes that

aims to improve economic, social and environmental performance, taking into account the long and short terms. And finally, Adams et al. (2012) indicate that SOI has much in common with traditional innovation, but incorporates social and environmental dimensions to the equation, and to this point boil down the common points of the definitions of SOI: the inclusion of a triple bottom line – economic, social and environmental – to innovation activities. Table 13 collects how previous literature has defined SOI and related constructs.

Table 13. Most relevant definitions of SOI and related constructs
Source: elaborated by the author

Concept	Definition	Reference
Eco-innovation	"*New products and processes that provide customer and business value and significantly decrease environmental impacts*"	Fussler and James (1996)
Social innovation	"*Innovative activities and services that are motivated by the goal of meeting a social need and are predominantly developed and diffused through organisations whose primary purposes are social*"	Mulgan et al. (2007:8)
Sustainability-oriented innovation	"*A tool both to address sustainability issues and to tap into new customer segments and markets*"	Hansen et al. (2009:683)
Sustainable innovation	"*The renewal or improvement of products, services, technological or organisational processes to deliver not only an improved economic performance but also an enhanced environmental and social performance, both in the short and long terms*"	Bos-Browers (2010:419)
Eco-innovation	"*Overarching concept that provides direction and vision for pursuing the overall societal changes needed to achieve sustainable development. Sustainable innovation reflects an explicit emphasis on a reduction of environmental impact, whether such an effect is intended or not….It is not limited to innovation in products, processes, marketing methods and organisational methods, but also includes innovation in social and institutional structures*"	Machiba (2010:359)
Green innovation	"*The improvement of products or processes for energy-saving, pollution-prevention, waste recycling, green product designs and corporate environmental management in the field of environmental management*"	Chang (2011:363)
Sustainable innovation	"*Realized ideas that improve environmental and/or social performance compared with the current situation*"	Arnold and Hockerts (2011:394)

Sustainability-oriented innovation	"*An improvement (and/or introduction) of a product, technology, service, process, management technique or business model, which, in comparison to a prior version and based on a rigorous and traceable (comparative) analysis, has a positive net effect on the overall capital stock (economic, environmental and social)*"	Klewitz and Hansen (2011:3)
Eco-innovation	"*Sustainable innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resource use (including energy use) compared to relevant alternatives*"	Buttol, Buonamici, Naldesi, Rinaldi, Zamagni and Masoni (2012:212)
Sustainability-driven innovation	"*Innovation explicitly directed at a sustainability goal. While the innovating entity will aim to attach an economic opportunity to the innovation – economic sustainability is a dimension that we integrate in the sustainable development agenda – the innovation here occurs first and foremost to solve a societal and/or environmental problem*"	Jay and Gerand (2015)

However, there is disagreement among the aforementioned scholars regarding whether there is path dependency (Cecere, Corrocher, Gossart and Ozman, 2014; Könnölä and Unruh, 2007), the terms taken into account when engaging in SOI (Ceschin, 2013), its drivers (Bossle, Dutra de Barcellos, Vieira, Sauvée, 2016) or whether this innovation must be radical (Boons, Montalvo, Quist and Wagner, 2013; Charter, Gray, Clark, Woolman, 2008) (although, as indicated in Chapter 2 for innovation in general, it also holds true for SOI that the great majority of advancements in practice are incremental). Indeed, not everyone looks at SOI in an integrated manner; instead, part of the literature still refers to the social aspects only (Nicholls and Murdock, 2012; Pol and Ville, 2009), and another part to environmental, 'green' or eco-innovation (Arundel and Kemp, 2009; Schiederig et al., 2012). Mulgan, Tucker, Rushanara and Sanders (2007), for instance, define social innovation as the implementation of innovative activities and services with the aim of fulfilling a social goal by organisations driven by a social purpose. Nevertheless, this characterization falls short in explaining the concept, since it excludes innovation performed by non-socially oriented (at least primarily) organisations (Dawson and Daniel, 2010), such as businesses, which may have a triple-bottom line as a baseline, but do not have solely social issues as bottom line. In fact, social innovations have often been associated with non-for-profit organisations (Sanzo-Pérez et al., 2015), but other approaches to social

innovation do include businesses and investigate the trade-offs between social advancements and short-term profit-making (Halme, Lindemann and Linna, 2012) or the collaboration with societal partners to advance social innovation (Holmes and Smart, 2009).

Further has been researched on green, environmental or eco-innovation, which does not include the social challenges of sustainable development (Arundel and Kemp, 2009; Carrillo-Hermosilla et al., 2010; Fussler and James, 1996; Hellström, 2007; Pereira and Vence, 2012; Przychodzen and Przychodzen, 2015; Rennings, 2000; Schiederig et al., 2012; Wagner and Llerena, 2011). The literature on eco-innovation is relatively limited in scope when it comes to the types of innovation outcomes: although part of the scholarship adopts a rather open approach to what eco-innovation is (Arundel and Kemp, 2009; Oltra and Saint Jean, 2009), other authors take an exhaustive approach and reduce it to product and process innovation, with efficiency being its main point of attention (Björkdahl and Linder, 2015; Chen, Lai and Wen, 2006). For instance, Chang (2011) defines eco-innovation as '*the improvement of products or processes for energy-saving, pollution-prevention, waste recycling, green product design and corporate environmental management in the field of environmental management*'.

However, SOI goes beyond environmental and social innovation by integrating economic, social and ecological concerns (Schiederig et al., 2012). However, it has received multiple names which often leads to confusion in the corpus of research: due to this fact, terms referring to environmental and social innovation have also been included in the literature search. In fact, terminology issues go as far as the term to refer to SOI, which has been called 'sustainability-oriented innovation' (Adams et al. 2016; Altenburg and Pegels, 2012; Hansen and Grosse-Dunker, 2013; Jay and Gerand, 2015), 'innovation for sustainability' (Adams et al., 2012; Ashford and Hall, 2011; Mulder, 2007; Seebode et al., 2012), 'sustainability innovation' (Blowfield, Visser and Livesey, 2007; Schaltegger and Wagner, 2011) or 'sustainable innovation' (Arnold and Hockerts, 2011; Ayuso et al., 2006; Boons et al., 2013; Gauthier and Wooldridge, 2012; Nilsson, Hillman and Magnusson, 2012; Varadarajan, 2015).

Although the term 'sustainable innovation' has picked up in recent years, for the purposes of this thesis 'sustainability-oriented innovation' is preferred for two reasons. First, the weak sustainability understanding (Hartwick, 1977;1978) adopted for this thesis for pragmatic motives, and the presence of bounded rationality in the system (Simon, 1981) fit better with a term that does not imply that the innovation is sustainable per se, but rather improvement-seeking. Secondly, even from a weak sustainability standpoint, an innovation designed to pursue sustainability may not be sustainable because of rebound effects that increase actual consumption due to the reduced costs for consumers and producers (Allan, Hanley, McGregor, Swales and

Turner, 2007), the creation of lock-in effects that pre-empt the introduction of better innovations in the future (Cowan and Kline, 1996) or application of the innovation to uses different to the original (e.g. military). In addition, because of the increments in consumption and growth derived from innovation, 'sustainable innovation' is a paradox from de-growth or a-growth perspectives (Foster, 2011; Latouche, 2009). Having considered these arguments and the provided understanding of innovation and business sustainability (see Chapter 2), the definition of SOI preferred for these purposes is provided by Bos-Brouwers (2010:419):

> *The renewal or improvement of products, services, technological or organisational processes to deliver not only an improved economic performance but also an enhanced environmental and social performance, both in the short and long terms.*

4.2.2. Streams of knowledge and main themes in the SOI literature

Scholars from very different arenas have contributed with their threads to the weave of SOI knowledge, and this dispersion of sources in the research field results in important differences between this meaning give to SOI in the literature (Adams et al., 2012). The main approaches to SOI in different streams of knowledge and the major themes that have emerged in each of these disciplines are summarised in Table 14.

Table 14. Major themes in the different streams of knowledge feeding SOI

Knowledge stream	Major themes	Research focus	Selected references
CSR and business ethics	From this perspective, three main SOI related topics have been developed: (1) the evolution of CSR strategies from protective, risk-managing measures to proactive and strategic innovation-based measures; (2) the role of non-for-profits and the integration of stakeholders in the innovation process for SOI results; and (3) the interactions between CSR and innovation and its strategic implications.	Although part of the literature refers to both environmental and social concerns, the majority is focused on social and stakeholder aspects.	Blake, 2006; Hansen and Spitzeck; 2011; Holmes and Smart, 2009; Hull and Rothenberg, 2008; Spena and de Chiara, 2012

Economics	In the field of economics, there are two main concerns regarding SOI: (1) the effects of public economic instruments like environmental and social regulations and emissions trading on SOI, and (2) the role of clusterization and innovation systems in favouring SOI.	The focus of this stream is mostly environmental innovation.	Ambec et al., 2013; Bergek and Berggren, 2014; Borghesi, Cainelli and Mazzanti, 2015; Gerstlberger, 2004; Jacobsson and Bergek, 2011; Mazzanti and Zoboli, 2006; McCauley and Stephens, 2012
Entrepre-neurship	It deals mostly with the ability of start-ups and entrepreneurs to introduce radical innovations in the market, and the effect this causes on the rest of the system, mostly, incumbents. Part of the literature focuses on the particular characteristics of sustainable entrepreneurs, their drivers and the barriers to entry they face.	Divided between a bigger branch with a social focus and another with environmental concerns. Recent literature integrates both	Hockerts and Wüstenhagen, 2010; Mair, Battilana and Cárdenas, 2012; Schaltegger and Wagner, 2011; Witkamp, Raven and Royakkers, 2011
Design	This stream concentrates mostly on green or sustainable product development, from the introduction of environmental priorities in the process to full cradle-to-cradle design. It involves the literature on eco-design and design for sustainability (D4S) as product development methodologies	The focus is mostly environmental , but eco-design is extended to design for sustainability in most recent literature	Baumann et al., 2002; Bakker et al., 2010; Brezet and van Hemel, 1997; Clark, Kosoris, Hong and Crul, 2009; Gaziulusoy and Brezet, 2015; Petala, Wever, Dutilh and Brezet, 2010; Simon et al., 2000
Innovation management	This field of knowledge deals with the innovation process management and how it is affected by the inclusion of environmental and social goals: new typologies, outcomes, requirements and particularities that differ from traditional innovation	Fairly divided between environmental innovation and the inclusion of both social and environmental matters	Carrillo-Hermosilla et al., 2010; Hansen et al., 2009; Hillman, Nilsson, Rickne and Magnusson, 2011; Keskin et al., 2013; Wagner, 2007
Operations management	In this stream the main field of research is the greening of the innovation process through impact minimisation and ensuring the social fairness across operations. For this reason, three popular topics emerge in operations management related to	Most of the literature includes aspects of the social and environmental pillars of	Bönte and Dienes, 2013; Geffen and Rothenberg, 2000; Ghisetti and Rennings, 2014; Harms et al., 2013; Rehfeld, Rennings and Ziegler, 2007; Ziegler and

	SOI: (1) innovation for sustainable supply chain management and relationships with suppliers; (2) the development of technologies for the greening of the production process and; (3) the role of environmental management systems for the management of SOI in the production process.	sustainability, but the efficiency branch of operations management deals mostly with environmental issues.	Nogareda, 2009
Strategic management	This stream of knowledge is concentrated on how to sustain a competitive advantage through SOI and create value for the environment and society, while capturing at least part of that value	Fairly distributed between society, environment and sustainability-related	Chen, 2008; Chen et al., 2006; Hart, 1995; Hart and Dowell, 2011; Nidumolu et al., 2009; Seebode et al., 2012; Prahalad, 2012
Sustainability science	Adopting a holistic approach, this knowledge stream sees SOI as a lever for wider sustainability transitions	Sustainability (three pillars)	Boons, 2013; Hansen and Coenen, 2015; Kläy et al., 2015; Loorbach et al., 2010

4.2.3. Previous literature reviews on SOI

Beyond the scholarly impact, SOI includes a broader scope of innovation practices, technologies, processes and strategies adopted by organisations and businesses. How businesses engage in these SOI activities and create value for society and the natural environment has been the object of study of several studies in the few years. Previous papers have set up different literature reviews on SOI, offering interesting conclusions about the nature of SOI, as illustrated in Table 15.

Table 15. Main findings of previous literature reviews on SOI and related fields of research
Source: elaborated by the author based on Adams et al. (2012)

Research focus	Findings	Reference
The effect of environmental concerns on R&D practice	Both R&D and environmental management are at an early stage of development, and are considered mostly tools and techniques rather than strategic	Winn and Roome, 1993
	Some literature begins to consider organisational and technological change	
Green product development	Most of the literature is normative and the need to develop new theories to incorporate environmental	Baumann et al., 2002

literature (1970-1999)	matters is questioned	
	Over time, environmental concerns are incorporated in product design, moving on from viewing them as a burden on businesses	
Strategy-oriented review of environmental innovation in SMEs	SMEs, unlike MNEs, require public support to implement SOI	del Brío and Junquera, 2003
	The main determinants of SOI in SMEs are financial resources, organisational structure, management style, human resources, environmental management status, manufacturing activity, technological approach, innovative capacity and external co-operation	
Response of businesses to sustainability challenges through innovation	Innovation for sustainability calls for collaboration with a wider network, to include actors with local knowledge of the sustainability implications of the innovation	van Kleef and Roome, 2007
	Businesses need to develop a different set of capabilities for SOI than for traditional innovation	
Review of sustainable manufacturing and eco-innovation practices	End-of-pipe solutions have given rise to more integrated, life-cycle approaches	OECD, 2009
	Sustainable manufacturing requires multi-level innovations, which must be coordinated and integrated but yield better results	
	Some advanced players have adopted new business models but the majority is focused on technologies	
Clarification of the concept of 'green innovation' and review of the literature 1990-2010	Several terms are used interchangeably, including 'sustainable innovation', but the focus is on environmental concerns	Schiederig et al., 2012
	The literature has concentrated on economic topics at the medium and large scales of innovation science while the managerial, intra-firm matters are not very developed	
Determinants of eco-innovation at the firm level (2006-2011)	The main drivers of eco-innovation at the firm level are: (1) being in a very polluting sector; (2) financial gains (through increased competitiveness and efficiency gains); (3) customer expectations; (4) technological capabilities; and (5) use of environmental management tools.	Pereira and Vence, 2012
Business models for sustainable innovation	Sustainable innovation literature has neglected the importance of business models (value proposition, organisation of the upstream and downstream value chain, and financial model)	Boons and Lüdeke-Freund, 2013

	Regarding value proposition, business-society dialogues must identify trade-offs between optimal product and service performance and improved social and environmental effects. Barriers to business models for sustainable innovations are often in supply chain dependencies and locked-in infrastructures. Customer interface must be addressed differently, considering processes of co-creation of value. Financial models must change from price-per-product to servitised models	
Impact of environmental regulation on environmental innovation in highly polluting sectors	Policy is a main driver of environmental innovation in highly polluting sectors	Bergek and Berggren, 2014
	General economic instruments induce mainly incremental innovation, general regulatory instruments drive mostly modular innovation (recombination), and technology-specific instruments are needed for the development of radical environmental innovation	
	Policies for environmental innovation must be designed taking into consideration their selection impact, increasing stringency levels, appropriateness of scale and policy stability	
Literature and practice review of business model innovations for sustainability	Sustainable business models are important in driving and implementing corporate SOI and help to sustain a competitive advantage.	Bocken et al., 2014
	Sustainable business model archetypes develop a common language of business model innovation for sustainability: (1) maximise material and energy efficiency; (2) create value from 'waste'; (3) substitute with renewables and natural processes; (4) deliver functionality rather than ownership; (5) adopt a stewardship role; (6) encourage sufficiency; (7) re-purpose the business for society/ environment; and (8) develop scale-up solutions	
Systematic literature review of success factors for environmental product innovation	There are five main critical success factors for environmentally sustainable product innovation: market, law and regulation knowledge; interfunctional collaboration; innovation-oriented learning; and R&D investments	de Medeiros et al., 2014
Systematic literature review of sustainability-oriented	Development of a conceptual framework of SOI in SMEs consisting of six factors: (1) strategic orientation; (2) degree of innovativeness; (3) predominant practices; (4) mechanisms of	Klewitz and Hansen, 2014

innovation in SMEs (1987-2010)	influence; (5) involvement of external actors; and (6) predominant driver	
Systematic literature review of sustainability-oriented innovation (1992-2012)	SOI involves 'making intentional changes to an organisation's philosophy and values, as well as to its products, processes or practices to serve the specific purpose of creating and realising social and environmental value in addition to economic returns'	Adams et al., 2012; 2016
	Little attention has been paid to SOI in previous literature, and the received attention has been only partial	
	A staged model for SOI is developed, with the following phases: operational optimisation, organisational transformation, and systems building	

4.2.4. Previous models of SOI

These reviews have been successful at incorporating the intricacy of the concept and are very useful in explicating several issues; such as the drivers of SOI or its management complexities. They also show how, over time, the intertwinement of social and environmental concerns with innovation has evolved from ancillary to strategic. In this sense, a main topic of research has been the development of models of how SOI is implemented into organisations, focusing on the analyses of SOI models that aim to synthetize the processes by which companies adopt SOI activities (for a review, see Kolk and Mauser, 2002; and Adams et al., 2012). The major goal of this thesis is to build on the existing literature and the empirical study to construct an integrative model of SOI, which will be developed along the dissertation.

The first described model aims to categorise types of SOI, in order to ease its management. Hansen et al. (2009) develop a meta-method for the assessment of SOI in order to reduce their associated risk and realise their potential, aiming to integrate the previous fragmented literature, which treated separately issues that are in fact interconnected (supply chain and technology management, for instance). However, they note that the majority of the empirical literature is still concentrated on the integration of social and environmental standards in technological advances, since only some advanced players are working on new business models. Through the review of the literature, they develop the 'sustainability innovation cube', a framework to structure innovation and where they are able to create sustainable value (Hart and Milstein, 2003). In this model, the focus is on reducing the directional risk of SOI

through categorisation of its activities, due to the fact that the inclusion of social and environmental goals in innovation process increases its complexity (Fichter, 2005; Harms et al., 2013). As illustrated in Figure 21, the model groups different types of SOI according to three dimensions: target (ecological, social or economic effects), life-cycle (manufacture, use and end-of-life) and innovation type (business model, product-service system and technology).

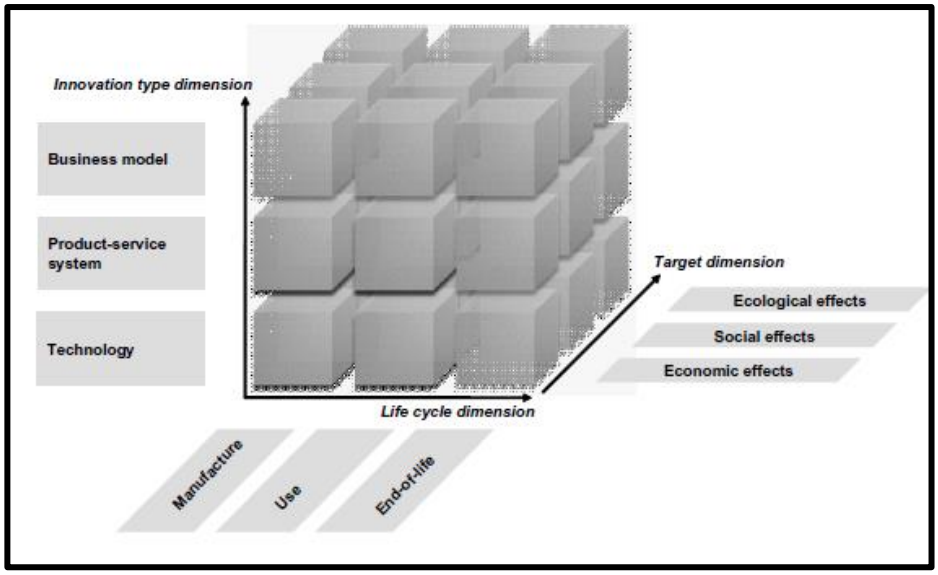

Figure 21. Sustainability innovation cube
Source: Hansen et al. (2009)

The second model of SOI is representative of those that aim to provide an overview of the whole SOI process, looking, in this case, at both its drivers and outcomes (Varadarajan, 2015). There are three main types of drivers of SOI: institutional, firm-related and industry-related. According to Varadarajan (2015), the position of the firm regarding the sustainability of its innovations will depend on determinant factors across these dimensions. If a sustainability innovation orientation is acquired, process and product innovations will be produced as an outcome, as well as improved employee performance due to increased job satisfaction and organisational commitment. Process innovation impacts positively on environmental performance, which betters financial performance through efficiency gains, while product innovation has a positive effect on both environmental and marketing performance, which has a direct beneficial impact on financial performance, as shown in Figure 22.

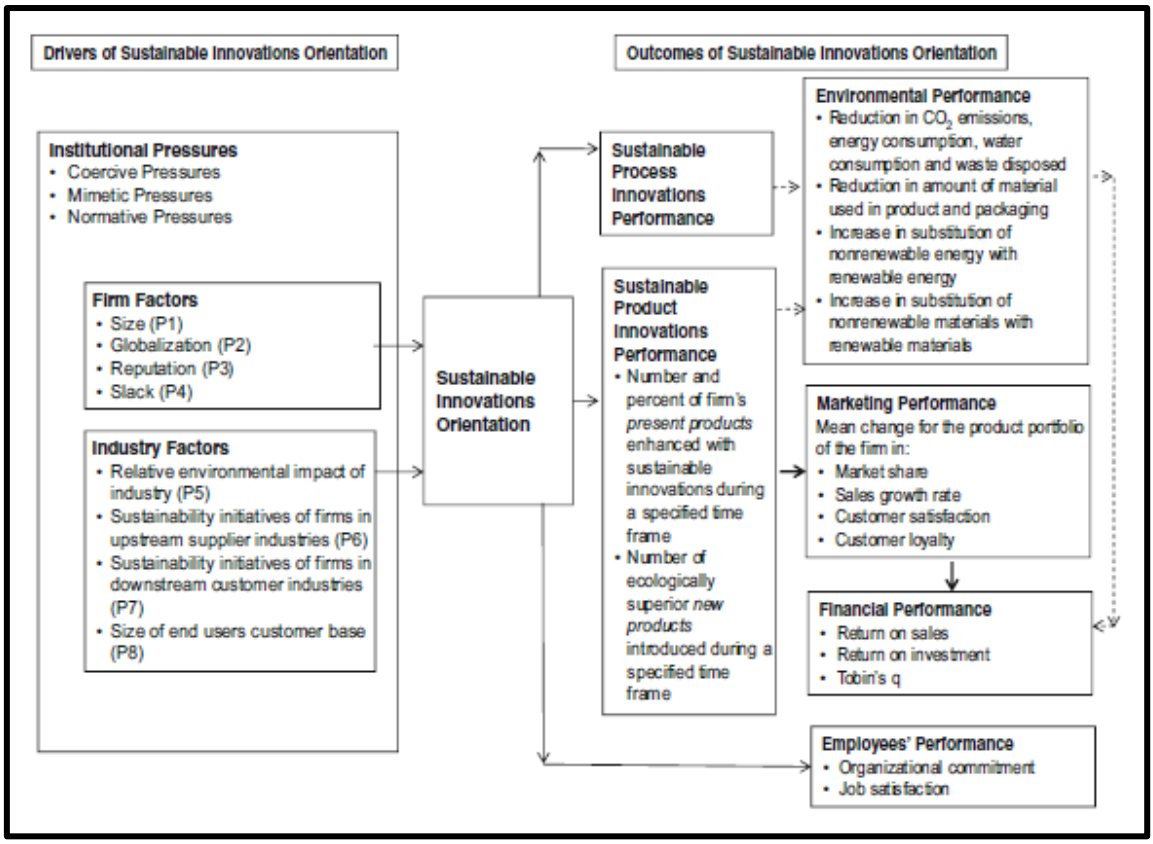

Figure 22. A conceptual model of sustainable innovations orientation
Source: Varadarajan (2015)

SOI goes further than mere eco-efficiency (Hart, 1995, Hart and Dowell, 2011; Shrivastava and Hart, 1995), integrating the firm in a wider system, and viewing business as a value creator for the whole system (Porter and Kramer, 2011). Despite this, some SOI models still refer to eco-innovation, or the improvement of the environmental performance of a product or service (Low, Lamvik, Walsh and Myklebust, 2001; Roome, 1992). However, most recent models go a step further and involve the systems theory element (Adams et al., 2012; 2016; Carrillo-Hermosilla et al., 2010; Tukker and Tischner, 2006), as in the last two reviewed models of SOI.

Beyond technologies and tools, scholars have developed models for dynamic, path-dependent and staged adoption of SOI. Adams et al. (2012; 2016) propose a model of SOI based on three evolutionary stages: operational optimization, organisational transformation and system building explaining the deeper systemic transformation that SOI affects to companies. The path dependency remains in this case, with organisations evolving by adopting either small steps or radical innovations along the way. In the first stage, organisations are concerned with efficiency gains and the minimisation of environmental and social impacts and the savings in risk management, materials and disposal associated to it. In the second phase, there is a cultural shift within the organisation, towards a more ambitious goal: having a 'net positive impact' in the environmental and societal systems in which the organisation is

rooted. At a later stage, the organisation may enter the aspirational context of systems building that is, becoming a leader in the transformation towards sustainable systems. The model of Adams et al. (2012; 2016) is summarised in Figure 23.

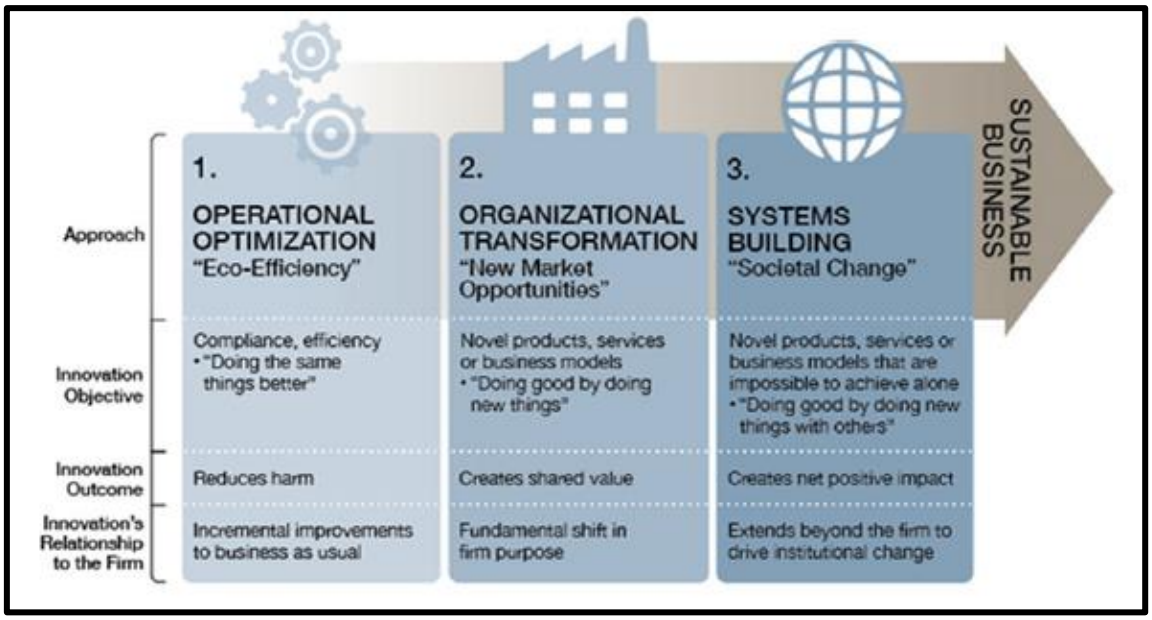

Figure 23. Model of SOI
Source: Adams et al. (2016)

Therefore, the concept of system to evaluate and frame SOI proves useful; in fact, Carrillo-Hermosilla et al. (2010) classify types of SOI depending on the impact they cause in the system. Although they refer to eco-innovations, the social dimension is included in their work. Under this classification, the stages are component addition (end-of-pipe), sub-system change (eco-efficiency) and system change (eco-effectiveness), as illustrated in Figure 24.

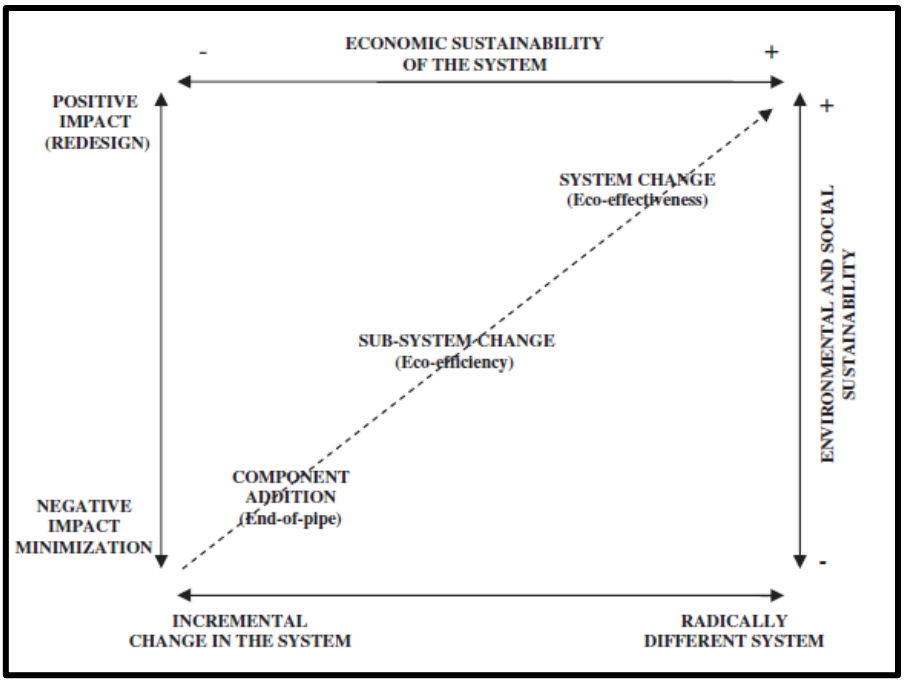

Figure 24. Typology of eco-innovations according to the radical or incremental nature of produced technological change and the level of impacts to the system
Source: Carrillo-Hermosilla et al. (2010)

At the lowest level of change by magnitude, incremental change in the system, the focus lies on the development of additional components to improve environmental quality, aiming to repair or minimize negative impacts. At the medium level, eco-efficient solutions and the optimisation of existent resources is the objective. Lastly, in order to make radical changes in the system that create positive net impacts on the ecosystem and society at large, companies must go beyond existent practices and redefine their production and behaviour patterns, through the creation of systems that are able to upcycle the 'waste' created by the economic activity. These systems may be open or closed-loop (Braungart, McDonough and Bollinger, 2007; McDonough and Braungart, 2002): the first refers to the use of components that are biodegradable and initiate new cycles in the ecosystem, the second, to the uptaking of the outcomes from industrial processes to produce new products. The latter has been the approach taken by many industrial parks, in which the production externalities of certain firms become raw materials for others situated nearby through so-called industrial symbiosis (Chertow, 2000; Jiao and Boons, 2014; Mirata and Emtairah 2005; Walls and Paquin, 2015).

4.2.5. Approximations to SOI from the theoretical perspectives of the thesis

4.2.5.1. From the systems theory perspective

The concept of SOI might be understood as holistic by definition, if it offers a view of the firm within a system (Anderson, 1999; Boulding, 1966; Georgescu-Roegen, 1979) in which the firm is an agent of change in the wider sustainability transition that uses innovation as a lever (Loorbach et al., 2010; Loorbach and Wijsman, 2013). It is systemic, because it is concerned with the evolution of the open system that is the firm within the broader socio-economic and physical system. Thus, the firm is not an agent acting regardless of its environment; as a consequence, it must work in order to become a 'systems builder' (Adams et al., 2012; 2016). This means that corporate innovation efforts should be aimed at achieving good results in the triple bottom line (Elkington, 1998) and sustaining its competitive advantage in the long term. Furthermore, there must be a total integration of the firm within its system, to the extent of participating in the change of paradigm.

As illustrated in Section 4.2.4., several models of SOI (Adams et al., 2012; 2016; Carrillo-Hermosilla et al., 2010; Tukker and Tischner, 2006) adopt this system building approach, but in these cases, the relationship with the wider system and the impact the firm makes for the wider system transition is taken into consideration only at a final stage of SOI engagement. Hence, systems theory has not been applied in a holistic manner to SOI from a firm and managerial perspective, concentrating on the process of SOI and the firm as systems even from early stages of SOI engagement. This calls for further research from this perspective, taking into consideration the appropriateness of systems theory for sustainability related topic due its transversal nature, as research on socio-ecological and technical transitions illustrates.

Nevertheless, particularly from the beginning of the 2010s decade, there is an emerging literature that focuses on socio-technical systems transitions for sustainability that approaches SOI from a systemic perspective, as a lever for wider change. The focus of analysis in this corpus of research is the wider socio-ecological system (Boons, 2013; Moore et al., 2014), although the role of businesses in these transitions has also been explored (Loorbach et al., 2010; Loorbach and Wijsman, 2013). This interest is reflected in the nascent emergence of dedicated journals, such as *Environmental Innovation and Societal Transitions* (van den Bergh et al., 2011) or dedicated issues in *Research Policy* (Smith et al., 2010), *Technological Forecasting and Social Change* (Farla, Markard, Raven and Coenen, 2012) and *Technology Analysis & Strategic Management* (Geels et al. , 2008). This literature has approached system transitions for sustainability from the design (Gaziulusoy and Brezet, 2015), governance (Bolton and Foxon, 2015) and public policy (Gee and Uyarra, 2013), space and territories (Coenen, Benneworth and Truffer, 2012; Gee and Uyarra, 2013; Hansen and Coenen, 2015), entrepreneurship (Gibbs and O'Neill, 2014), innovation systems (Jacobsson and Bergek, 2011) or scientific (Kläy et al., 2015) perspectives.

The unit of analysis may be the wider system (Boons, 2013) from a multi-level perspective (Geels, 2010; Papachristos et al., 2013; Westley et al., 2011) or a smaller system on which SOI is applied; for instance, a city or region (the Greater Manchester area in the case of Gee and Uyarra (2013)), a building (a zero-energy residential building in the case of Brown and Vergragt (2008)) or innovation systems or clusters (as in the case of Jacobsson and Bergek (2011)).

4.2.5.2. From the dynamic capabilities view

Probably due to its innovation component and its complexity (Fichter, 2005; Harms et al., 2013), the dynamic capabilities view has been preferred over the original resource-based view as a theoretical approach to SOI. The research from this perspective is scarce because, as identified by Schiederig et al. (2012) research on SOI from the firm perspective has not been widespread. As aforementioned in Section 2.5.5, previous literature on capabilities for business sustainability already defines innovation-related or technological capabilities as necessary to develop corporate sustainability dynamic capabilities (Hoffman et al., 2012; Rodríguez et al., 2002; Sanzo-Pérez et al., 2015; Sharma and Vredenburg, 1998). Consequently, there is an apparent relationship between innovation and sustainability, because cleaner technologies, products, services processes combined with new business models reduce the negative impact of the firm on society and the environment and enhance its transformative capacity (Bocken et al., 2014). Under these premises, several capabilities for SOI that capture its complexity and multidimensionality have been found in the literature.

Table 16 below illustrates the main (ordinary and dynamic) capabilities that, according to previous literature, are required for successful engagement in SOI: (a) more openness to agents that are external to the firm (Ketata et al., 2015); (b) involving stakeholders in the innovation process (Ayuso et al., 2006; Castiaux, 2012); (c) in general, fomenting networking activities with other agents (Van Kleef and Roome, 2007); (d) a systemic approach to society (Adams et al., 2016); (e) trust (Van Kleef and Roome, 2007); and (f) commitment (Castiaux, 2012). SOI implies more systemic and disruptive innovation (Boons et al., 2013); therefore, trust and commitment become key capabilities for the development of SOI, since trustful relationships must be created with all the agents, and long-term projection is required. In addition, environmental and social laws and regulations are key drivers of SOI (Horbach et al., 2012; Jaffe and Palmer, 1997; Porter and van der Linde, 1995). Consequently, reactivity to changes in the regulatory environment is also essential (Castiaux, 2012; Ketata et al., 2015).

Table 16. Capabilities for SOI identified in the literature

Research focus	Capabilities	Reference
Stakeholder management as a dynamic capability for SOI	Stakeholder dialogue	Ayuso et al., 2006
	Stakeholder knowledge integration	
Sustainable business management as innovation	Think independently	Van Kleef and Roome, 2007
	Think inventively	
	Create and maintain trust	
	Solve problems collectively in research teams	
	Networking capabilities	
	Form and maintain strong relationships	
Sensing, seizing and transforming capabilities for SOI	Sense new technological capabilities with a green lens	Castiaux, 2012
	Anticipate environmental rules and practices	
	Integrate key stakeholders to select new products and business models	
	Manage the industrial ecosystem contributing to the SOI	
	Manage collective decision-making	
	Build loyalty and commitment	
	Decentralizing, co-specializing, adequate governance and knowledge management to transform the firm coherently	
Dynamic capabilities for innovation in resource constrained environments	Sourcing	Salazar and Peláez, 2012
	Leveraging	
	Learning	
	Aligning	
	Mobilizing	
Dimensions of SOI	Focus innovation on people	Adams et al., 2016
	Systematic relationship with society	
	Integrated approach to innovation	
Organisational capabilities for green innovation	Dynamic capability	Huang and Li, 2015
	Coordination capability	
	Social reciprocity	
Firms' internal capabilities for SOI	Improving internal absorptive capacity	Ketata et al., 2015
	Open culture that allows exposure to a diversity of external knowledge sources	
	Respond to regulatory pressures	

4.3. Ontological taxonomy

Complexity and systems theory brings new ontological implications for management and organisation science, including new systemic views of organisations (Anderson, 1999; Eisenhardt and Piezunka, 2011; Mitleton-Kelly, 1997). Therefore, systems theory and Heidegger's (1954) philosophy of modern technology are useful in providing conceptual structuring to the existent literature on SOI. The analysis is inspired by Heidegger's (1954) ontology, which has its starting point in Aristotle's classical theory of the four causes of change or motion: the matter, the form, the agent and the end or purpose. Beyond these causes, Heidegger (1954) thought that none of the four were responsible for creation of modern technology on their own; they were all related and interconnected in the creation in a component called *Gestell*.

Heidegger (1954) studied the meaning of modern technology in the 20th century, comparing it to the meaning that classical Greeks gave to technology. According to Heidegger (1954), the ancient Greeks understood technology as an instrument, which means that they adopted an object-oriented framework by which they could explain the sense of the causality of four main causes of Being. In particular, Heidegger (1954) studied the sense of the four causes based on the classical theory of Aristotle's Physics.

Aristotle observed four causes of change or motion, which he defined as: the matter, the form, the agent and the end or purpose. This instrumental way of thinking stems from the Greek assumptions about causality as ways of being responsible for the arrival of things into existence. Thus, Aristotle was looking to the roots and sources as the basic understanding of causality that underlies in the origin of the four causes. The material cause is related to the matter, the raw materials of which the object is composed. The formal cause is the form or pattern that is followed for the creation of the object, the shape that makes us recognize what and which type the object is. The efficient or 'moving' cause is the agent, the cause that makes movement start or stop (for instance, the artisan melting metals and pouring them into the mold to create a chalice). The fourth cause is the final cause; the purpose, the end to which the object is created.

None of the four causes is responsible of creation on its own account; they are all related and interconnected in the creation, which is not understood as a mechanical act but as a way of being responsible. Drawing on this idea, Heidegger (1954) developed the concept of *Gestell* in relation to modern technology, since we live now in a technological world, as compared with the ancient Greeks. The conscious relationship with technology and the acknowledgement of the human role in its forthcoming will allow for a free relationship, a new era in which technology will be used, but not an era of technological order.

However, Heidegger's main argument was that the essence of modern technology has to do with the way we are oriented to the coming-into-existence, or the "revealing" of the world, as he named it, the 'enframing' or *Gestell* (Heidegger, 1954). In his own words, '*enframing means the gathering together of that setting-upon which sets upon man, i.e., challenges him forth, to reveal the real, in the mode of ordering, as standing-reserve. Enframing means that way of revealing which holds sway in the essence of modern technology and which is itself nothing technological*' (Heidegger, 1954:10).

Thus, the main objective of Heidegger (1954) was the discussion of how the four traditional causes have been overtaken by a new dimension that lies on the framework of the systemic complexity of modern technology, beyond simple causes. Thus, he introduced the concept of *Gestell*. *Gestell* is used by Heidegger (1954) as a description of the essence of modern technology and the way in which truth is revealed: how it appears to society and responds to us as a challenge. Heidegger verifies an authentic notion of modern technology, beyond an instrument or an object by which technology was a means to getting things done. In order to understand which cause meant for Aristotle, Heidegger used the Germanic concept of *Verschulden* referring to the moral obligation linked to "responsibility", or being responsible for, rejecting the use of cause as the sense of being guilty for some lapse or failure (Rojcewicz, 2006). Therefore, Heidegger included a new dimension on coming-into-existence, which he also referred to p*oiesis*. He introduced a new dimension by asking about the unity of the four causes as the unity of the four modes of active letting. He believed that the four causes were ruled by an integrative force or dominant character that holds the four causes, and integrates them into a single systemic causal nexus (Rojcewicz, 2006:36).

In order words, *Gestell* explains how modern technology has become enframed in modern societies, becoming part of them; hence, its essence is not technological at all, but rather a form of human living. The concept helps to provide a systemic understanding of innovation, because it comprehends the holistic nature of being responsible of this forthcoming. The embeddedness of modern technology in society as co-evolving systems is also useful in explaining the inclusion of concerns of the environmental and social systems into the innovation system, leading to a deeper understanding of the object of study of this thesis, SOI.

With the aim of understanding the impact of SOI on modern organisations, the main result of the review of the literature on SOI from different research streams is the classification into identified challenges and the solutions the literature has provided. Inspired by Heidegger's (1954) analysis of the five causes of creation, these challenges are classified under five categories; or components of SOI.

1. The first is the operational component. It is concerned with the material inputs of SOI (*causa materialis*).
2. The second is the collaborative component. It is related to the form or pattern to generate SOI, how SOI takes form (*causa formalis*).
3. The third component is the organisational, which focuses on the organisational transformation occurring as a result of SOI practices (*causa efficiens*).
4. The fourth component is the instrumental; it understands SOI as a means to the goal of economic growth Thus, it is related to the cause of the innovation's desired effect (*causa finalis*).
5. The fifth component is the holistic, as it explores SOI within a higher system transformation and as a lever for the widening of a new innovation paradigm (*Gestell*). This component encompasses the previous four, constituting, per se, the holistic cause.

The taxonomy is summarised in Table 17 in Section 4.3.6. This classification does not mean that each of the SOI components does not touch upon any of the other parts, since they are all closely interrelated and interconnected. However, the key behind this sorting lies within each of the component's main concern.

4.3.1. Operational component

The operational component of SOI focuses on the logistics of delivering new products, services, and processes that generate sustainable, economic, social and/or environmental value. Thus, this research refers to the necessary resources, tools, technologies and techniques to engage in SOI across the whole life-cycle, in order to reduce or transform negative impacts to positive impacts (Baumann et al., 2002; Carrillo-Hermosilla et al., 2010). Dealing with SI requires new capabilities, resources, skills and clean technologies in procurement, life-cycle analysis, project management, product design, recycling-reusing or product-service design for sustainability (Baines et al. 2007; Beske, Koplin and Seuring, 2008; Clark et al., 2009, Crul, Diehl and Ryan, 2009). Engagement in SOI requires the development of new tools, methodologies, skills and technologies in all of the activities related to the innovation and operations processes, such as procurement of supplies (Harms et al., 2013; Schaltegger and Burritt, 2014). As this often implies interactions and relationships with suppliers, customers and other agents, the operational component is closely linked to the collaborative. There are three main challenges within the operational component: life-cycle concerns, sustainability issues in product and service development and sustainability performance in the innovation process.

4.3.1.1. Life-cycle concerns

The first challenge within the operational component is related to ensuring that sustainability criteria are guaranteed across the whole lifecycle, in open and closed loop cycles (Braungart et al., 2007; McDonough and Braungart, 2002). The literature has responded to this challenge through two main solutions:

a) Supporting a sustainable supply chain management (SSCM) in order to embed sustainability in operations. Supporting a sustainable supply chain requires dealing with a higher degree of innovation complexity. Consequently, the focus is on the relationship with providers, users, consumers, and other stakeholders and the creation of sustainable value along the supply chain.

b) Adopting techniques to manage the whole life-cycle, like cradle-to-cradle or circular economy, thereby utilising the components of their own disposed products for new developments. In relation to the collaborative component, when the loop is closed through material exchange with other industries, it is referred to by the term industrial symbiosis.

4.3.1.2. Sustainability issues in product and service development

The second challenge in the operational component is the introduction of sustainability goals in product and service design and development. In this category, scholars focus on the results of their innovation, be it products or services (Schiederig et al., 2012). This will affect their logistics and procurement decisions and impose the introduction of sustainability criteria in product design. The current corpus of research provides with two solutions:

a) Development of methodologies such as design for sustainability, eco-design, lifecycle analysis, checklists and analytical tools. They are useful in providing a framework for sustainable product and service development, particularly in the first steps of engagement in SOI, when sustainability knowledge is not widespread in the firm.

b) Introduction of product-service systems, which have changed how products are designed to reduce their environmental and social impact when used. Product-service systems incorporate innovative strategies that shift businesses away from designing and selling physical products to developing integrated systems of products and services, moving from an ownership to a 'right-to-use' paradigm.

4.3.1.3. Sustainability performance in the innovation process

The third challenge is a link to improved sustainability performance in the innovation process, which has been integrated in the literature with a focus on its attractiveness for every market since it results in lower priced, better quality products, with enhanced functionality, longer and more resource-saving lifecycles, and material production that accounts for the community (Petala et al., 2010). The literature offers two main solutions to this challenge:

a) Environmental management systems to gather data to be able to monitor and reduce their environmental impact and manage resources. This kind of standards has been shown to be a lever for SOI.

b) Impact minimisation technologies and tools, that is, cleaner technologies that often bring about efficiency gains for the firm, as well as social and economic benefits such as the creation of new jobs or increased safety for the worker.

4.3.2. Collaborative component

The knowledge on collaborative SOI is grounded on the direct or indirect involvement of different actors, networks and institutions on SOI processes. The reason for these interactions is that firms do not exist in a vacuum; and innovation is becoming increasingly collaborative, user-focused and open to co-creation with other agents in the system (Ghisetti et al., 2015; Hansen and Spitzeck, 2011). Collaboration is commonplace in SOI since, because of its increased complexity, knowledge is often found outside the firm (Adams et al., 2012; 2016). This implies a closer relationship with the firm's stakeholders, involving them in strategic decision-making and obtaining knowledge about the orientation of the SOI, the issues to be tackled and how to address them. This is obtained not only from stakeholders traditionally involved in innovation (for instance; suppliers, clients or competitors) but also from NGOs, industry associations or knowledge institutions. In addition, companies are swayed by a regulatory framework, the economy and competition, as well as their surrounding innovation ecosystems and clusters (Demirel and Kesidou, 2011; Gerstlberger, 2004). Consequently, they will develop differently and direct their innovation efforts in a myriad of ways depending on their business environments, clusters, partnerships and networks. Taking this into consideration, there are three main challenges in the collaborative component of SOI: the relationship with public institutions, local networks and clusters and innovation in partnerships and co-creation.

4.3.2.1. Relationship with public institutions

The first challenge is created by the firm's relationship with the public system, comprising public administrations and their policies and soft (Bergek and Berggren, 2014) and hard (Horbach et al., 2012) regulations. Solutions emerge either indirectly, by response, or indirectly, by collaboration:

a) Responding to regulations that tighten sustainability requirements through innovation. When adaption to the regulatory framework is required, SOI enables businesses to be profitable over the long term; particularly if a proactive strategy to SOI, anticipating rather than responding to regulation, is adopted.

b) Collaborating in public policy programs and public-private partnerships to foster SOI. Besides regulations, public authorities may influence SOI developments by jointly strategizing with businesses to fulfill the administration's sustainability goals and entering public-private partnerships. Public administration can also direct corporate activity to areas that companies or groups of companies cannot tackle on their own; channeling action in commons pool resources or addressing long-term issues such as climate change.

4.3.2.2. Local networks and clusters

The second challenge is based on how businesses participate in local networks and clusters to promote SOI (Gerstlberger, 2004; Jiao and Boons, 2014; Oltra and Saint Jean, 2009). Companies adopt two main strategies, as observed in the literature:

a) Clustering for SOI, which refers to the participation in strong, locally-rooted networks of industries and suppliers. The complexity of addressing sustainability problems requires taking part in networks and forums where such issues might be discussed, and the pertinence of a firm within a business or innovation ecosystem will determine its innovations' sustainability orientation.

b) Experimenting with new collective solutions such as, industrial symbiosis systems. This involves includes physical exchanges of raw materials, energy, water, and waste (the latter possibly reused or recycled by other companies and industries).

4.3.2.3. Innovation in partnerships and co-creation

The third challenge refers to how companies innovate in partnerships and co-create SOI solutions, and how this brings firms closer to market demands and the various agents which may have an input in the innovation process (Hall et al., 2014; Holmes and Smart, 2009). By acknowledging several actors who may have interests other than economic profit, firms are more exposed to sustainability criteria and thus more inclined or more likely to introduce them during the innovation process. There are two main solutions to this challenge:

a) To adopt open innovation strategies that improve firm performance and may help to create a sustainable competitive advantage. These strategies blur the boundaries of the firm and make it more permeable to SOI-related knowledge.

b) To partner with broad groups of social stakeholders (end users, suppliers, R&D suppliers, universities, and NGOs) to co-create new sustainable solutions. This open the way to the development of wider range of SOIs in which the input and interests of societal stakeholders is incorporated.

4.3.3. Organisational component

The organisational component of SOI provides explanations regarding the implementation of SOI and its impact on organisational features, as well as the effect of organisational capabilities on the development of SOI. In order to do this, the analysis focuses on building capabilities that enable the firm to engage in SOI (Hellström, 2007) and the integration of complexity in the management of SOI (Arnold and Hockerts, 2011; Loorbach et al., 2010). This nurtures the generation of sustainability-oriented capabilities (Adams et al., 2012; Van Kleef and Roome, 2007). Therefore, the three main challenges in the organisational component of SOI are capacity building, business model transformation for SOI and resource-constrained SOI.

4.3.3.1. Capability building

The first challenge is concern with the generation, maintenance and renewal of capabilities that enable firms to engage in SOI (Ayuso et al., 2006; Castiaux, 2012; Hellström, 2007). Thus, the study of the ability of organisations to improve their capabilities to compete and enter new SOI-based markets, develop new clean technologies and set up design for sustainable products and services is an important element of the organisational component. The literature offers two main solutions:

a) Development of internal capabilities like ambidextrous behaviour or absorptive capacity. SOI involves a shift on the level of analysis of organisations, since it is based on an interconnected network of projects and organisational changes on the basis of complex organisations. In order to be able to create and capture value in this new environment, the firm must be ambidextrous and be able to absorb new knowledge: the ability to explore and exploit will allow it to manage its current business lines and also innovate with the incorporation of the long-term sustainability vision.

b) Development of external or relational capabilities, so as to cover the need to create valuable relationships with a wide range of stakeholders and involve them in the innovation process. As aforementioned in Section 3.5.2., collaboration is an important component of SOI; hence, alliance portfolio management, external knowledge management, alliance proactivity and other relational capabilities must be nurtured.

4.3.3.2. Business model transformation

Business model transformation for SOI has also been a recurrent topic of interest in recent years (Bocken et al., 2014). This category focuses on the evolution of business models not only to integrate SOI, but to place it at the core of the corporate strategy in order to create sustainable value for the value chain (both upstream and downstream) and capturing value during the marketing phase (Boons and Lüdeke-Freund, 2013). There are two main solutions to respond to the challenge of business model transformation for SOI:

a) Incremental business model innovation, which builds on the existent business models by fostering gradual changes. These transformations are driven by need to refine existent business models for changing environments, to introduce sustainability goals or to enter new SOI-based markets.
b) Radical business model innovation, which has a major effect on how the firm organises itself and how markets, industries and systems transformation. Radical approaches are taken when a completely new SOI overturns the way in which the firm creates and captures value. It allows the firm to break from lock-in effects in its industry and approach a sustainability-related issue in a completely novel way.

4.3.3.3. Resource-constrained SOI

The third challenge is related to how companies address the issue of scant resources and creating value from these situations (Govindarajan and Trimble, 2013). This branch of SOI studies the innovation process starting from a resource-constrained situation regarding natural resources, capital, and raw materials as a key element for business sustainability (Salazar and Peláez, 2012). It has been addressed from the organisational bricolage perspective; that is, responding to resource scarcity by bundling all types of available resources into a new solution (Baker and Nelson, 2005; Halme et al., 2012). The literature offers two solutions to this challenge:

a) Frugal SOI: the principle is that companies undertake efficient SI when resources for innovation are scarce. Adopting this mind-set for innovation requires organisational adaption to the use of less resources and results in more sustainable innovations because the efficiency in the use of materials.

b) Reverse innovation: the term refers to the application of resource-constrained conditions from developing countries in developed countries. These innovations must be efficient in the use phase and inexpensive to cater the needs of the bottom of the pyramid, which results in more efficient products and services that take into consideration social aspects of innovation from the design phase.

4.3.4. Instrumental component

The instrumental component primarily addresses cost-analysis, value creation and economic performance. For businesses guided by an instrumental SOI component, profit-seeking and economic performance are the main drivers behind such innovation practices (Nidumolu et al., 2009). However, economic performance driven SOI often leads to the creation of mind-sets in which the triple-bottom line, with the inclusion of social and environmental goals, gains relevance. Along with regulation, it is often the main driver of SOI in companies that do not have a strong commitment to sustainability (Esty and Charnovitz, 2012). There are three main challenges related to the instrumental component: market orientation, strategic SOI and efficiency gains.

4.3.4.1. Market orientation

The first challenge is related to market oriented SOI; that is, SOIs that are developed in response to identified demands in the market or in order to tap into unexplored sustainability-related markets. Market orientation may lead companies to

develop products and services that tackle global social or environmental challenges, creating sustainable value (Hart and Milstein, 2003). This requires having including social or environmental goals while keeping with the company's economic objectives, which may occur because of the company's mission or as a reactive strategy to market demands of sustainability. The literature offers two solutions to the challenge of market-oriented SOI:

a) Evaluation of SOI under competitiveness lens, which involves analysing the relationship between economic and ecological performance through the Porter hypothesis (Porter and van der Linde, 1995).

b) Sustainable value creation or shared value creation. The objective is to maximise value by balancing the trade-offs among stakeholder interests to create sustainable value (Hart and Milstein, 2003), adopting SOI as part of the core business.

4.3.4.2. Strategic SOI

The second challenge is based on how SOI is incorporated to corporate strategy; that is, how it might become strategic to the firm. In that sense, sustainability goals become a way of sustaining a competitive advantage but become inbuilt into corporate purpose (Hart, 1995; Prahalad and Hart, 2001). The literature offers two possible avenues for this:

a) Path-dependent environmental capacity building; gradually introducing the concern for natural resources and ecosystems in strategy making, for instance, the natural resource-based view of the firm. In this manner, greening the firm becomes strategic to the firm because it provides with a long-term competitive advantage.

b) Bottom-of-the-pyramid approaches, through which the firm engages in less-developed markets to search for new business opportunities with the goal of making advances towards sustainable development by marketing products and services that improve the welfare of the world's poorest. Therefore, it is an strategic orientation that aims to serve a new market segmentation through a new business model or technology (Prahalad and Hart, 2001).

4.3.4.3. Efficiency gains

The third challenge is based on how SOI involves efficiency gains, including economic performance improvement through cost reduction derived from clean and renewable technologies (Cagno and Trianni, 2013; Ghisetti and Rennings, 2014). Here the argument is not to obtain direct benefits from the commercialisation of the innovation results but to reduce costs by its introduction, improving environmental performance, consumption of raw materials or costs of emission rights. This challenge is perceived as fundamental for the decoupling of environmental harm and economic growth. The literature observes two solutions:

a) Energy efficiency: reducing companies' CO2 footprints and promoting low-carbon economies. In order to do so, new practices or technologies have to be introduced, which, in addition to reducing economic costs, will reduce the harmful environmental emissions.

b) Resource efficiency: reducing the amount of raw materials and inputs in the production process. This category is especially visible in process innovations and often results in the application of life-cycle analyses for resource use efficiency.

4.3.5. Holistic component

The holistic component encompasses studies that aim to embed SOI in the wider social and environmental systems, aiming for systems transitions for sustainability, encompassing a new level of human and organisational activity (Boons, 2013; Keijzers, 2002). The holistic component considers the firm as a system within the wider natural ecosystem and the social institutions (social system), and the relationships with them. The drivers for businesses embracing the holistic component observe current trends and challenges of sustainable development and tackle them through innovation (Seebode et al., 2012). Hence, corporate transformation is developed along the transformation of its surrounding systems (Hart, 2012; Waddock and McIntosh, 2011). Radical innovation is set at the core of organisational and societal transformation (Boons et al., 2013).

In the same way that *Gestell* encompasses all causes of creation; the holistic component of SOI comprehends all the previous components and the relationships between them, involving the socio-ecological and technical aspects of SOI. The intertwinement of these components makes up a whole, a whole that, as a system, is more than the sum of its parts (Meadows, 2008). In this sense, the combination of

different parts at different points of time is equifinal (Gresov and Drazin, 1997), allowing for different configurations of SOI components to lead to holistic viewpoints.

In order to pursue holistic SOI, there are three main challenges posed in the literature: system-level transitions, linking the social and technological aspects of SOI, and social innovation and entrepreneurship.

4.3.5.1. System-level transitions

The inclusion of social challenges for sustainable development in the Brundtland Report (WCED, 1987) has made these aspects gain prominence along with environmental goals (Ahlstrom, 2010) because their focus is anthropocentric rather than eco-centric (Gladwin et al. 1995). These organisations shape their strategy taking sustainability transitions into account and have a clear goal: improving their systems, adopting a systemic approach and avoiding separation among people, planet and profit (Gladwin et al. 1995). Businesses connect their technological and organisational innovation with the wider environment, looking for a contribution to the transformation of paradigm towards a long-term sustainability vision (Boons, 2013). Two main approaches are found in the literature.

a) The first approach consists of the acknowledgment of the company as a system, which is embedded in the wider systems and realising how this can affect SOI. The majority of the literature in this approach is prescriptive and / or normative.

b) The second approach is more ambitious, and considers how SOI may become a lever for change for firms actively pursuing system transformation. Apart from realising the position of the firm from a system approach, SOI practices for deliberate system transformation are proposed.

4.3.5.2. Linking social and technological aspects of SOI

The second challenge relates to how SOI is a driver for sustainable production and consumption; that is, how improvements in sustainable production are matched with advances on the consumption side. Systemic innovation involves technological substitutions, but also changes other societal elements such as user practices, regulation, industrial networks, infrastructure and culture. Hence, the social and technological aspects of SOI must be linked to approach a systemic transformation. Two main solutions emerge from the literature:

a) Socio-technical transitions, through the use of new, clean technologies, technology diffusion and replacement of old technology along with changes in other societal elements (Geels, 2010; 2011).

b) Linking sustainable production to sustainable consumption; for instance, changing the consumption process from mere sales to user-based processes (Stahel, 2010) in which the consumer is made participant of sustainability.

4.3.5.3. Social innovation and entrepreneurship

Developments in the field of social innovation (Hockerts and Wüstenhagen, 2010; Yunus, Moingeon and Lehmann-Ortega, 2010) have integrated the long-term vision of sustainable development in the business model: this creates new market and system opportunities for the development of SOI. This requires re-inventing cost structures and re-defining the bottom line of the firm, in order to align it with broader sustainable development concerns. Social innovation and entrepreneurship have been linked to the role of products, services and process with social purpose, the role of social entrepreneurs (Schaltegger and Wagner, 2011) and the emergence of new business models and social business (Yunus, Moingeon and Lehmann-Ortega, 2010). New organisational structures leave behind the traditional for-profit model, proposing social benefit as the new bottom line but maintaining business practices (Mair and Marti, 2006; Yunus et al., 2010). Two main solutions are proposed in the literature:

a) Emergence of new socio-institutional forms for business in the larger-scale system transformation. Examples of these configurations are hybrid organisations, not-for-profit business models and sustainable businesses such as B corporations, or companies that adopt bottom of the pyramid approaches

b) Sustainable entrepreneurship, highlighting the role of SOI based start-ups that incorporate system transitions to sustainability as goals of the core business from the outset.

4.3.6. Summary of the classification

As observed in the previous sections, there are five components to SOI, each of them facing three challenges to which the literature has proposed 30 solutions. The main references for each of them are collected in Table 17 below.

Table 17. Ontological classification of SOI components and main references

Ontology	SOI components	Challenges	Solutions
Material	**Operational**: encompasses the necessary resources, methods and techniques to perform SOI	Ensure the sustainability of the innovation across its lifecycle	Sustainable supply chain management (Beske et al., 2008; Gualandris and Kalchschmidt, 2014; Harms et al., 2013; Isaksson, Johansson and Fischer, 2010; Schaltegger and Burrit, 2014; Seuring and Müller, 2008; Spena and de Chiara, 2012; Tsoulfas and Pappis; 2006; Zhu et al., 2012)
			Cradle-to-cradle or circular economy (Bakker et al., 2010; Geng, Fu, Sarkis and Xue, 2012; Kumar and Putnam, 2008; McDonough and Braungart, 2002; Rizzi, Bartolozzi, Borghini and Frey, 2013)
		Incorporate sustainability criteria in new product and service development and design	Product development methodologies (Baumann et al., 2002; Carrillo-Hermosilla et al., 2010; Simon et al., 2000), including eco-design (Brezet and van Hemel, 1997; ISO, 2011; Johansson, 2002), design for sustainability (Clark et al., 2009; Crul et al., 2009; Frondel, Horbach and Rennings, 2006) and lifecycle analysis (Matos and Hall, 2007)
			Product-service systems (Aurich, Fuchs and Wagenknecht, 2006; Baines et al., 2007; Ceschin, 2013; Kastalli and Van Looy, 2013; Manzini, Vezzoli and Clark, 2001; Maxwell, Sheate and van der Borst, 2006; Tietze, Schiederig and Herstatt, 2013; Vandermewe and Rada, 1988; Vezzoli et al., 2014)
		Improve sustainability performance in the innovation process	Environmental management systems (Inoue et al., 2013; Rennings, Ziegler, Ankele and Hoffman, 2006; Wagner, 2007; Wagner, 2008; Ziegler and Nogareda, 2009)
			Impact minimization technologies and tools (Arnold and Hockerts, 2011; Bönte and Dienes, 2013; Dangelico and Pujari, 2010; King and Lenox, 2002; Petala et al., 2010; Rothenberg, Pil and Maxwell, 2001; Tsiliyannis, 2014)
Formal	**Collaborative**: how actors other than the focus firm, networks and institutions are involved in SOI processes	Respond to public policies and regulations	Regulations that tighten sustainability requirements and spur innovation in that direction (Ambec et al., 2013; Ashford and Hall, 2011; Borguesi et al., 2015; Esty and Charnovitz, 2012; Foxon, Gross, Chase, Howes, Arnall and Anderson, 2005; Horbach et al., 2012; Jaffe and Palmer, 1997; Lanoie, Patry and Lajeunesse, 2008; Popp, 2003; Porter and van der Linde, 1995)

			Public programs, policies and partnerships to foster SOI (Bergek and Berggren, 2014; Bossink, 2002; Brunnermeier and Cohen, 2003; del Río, Carrillo-Hermosilla and Könnölä, 2010; Demirel and Kesidou, 2011; Gee and Uyarra, 2013; Johnstone, Haščič and Popp, 2009; Lehr, Nitsch, Kratzat, Lutz, Edler, 2008; Mazzanti and Zoboli, 2006; Nesta, Vona and Nicolli, 2014; Panapanaan; Uotila and Jalkala, 2014; Rehfeld et al., 2007)
		Participate in local networks	Clustering for SI (Cainelli, Mazzanti and Montresor, 2012; Gerstlberger, 2004; McCauley and Stephens, 2012; Oltra and Saint Jean, 2009; Pavlovich and Akoorie, 2010)
			Industrial symbiosis (Dong, Gu, Fujita, Hayashi and Gao, 2014; Jiao and Boons, 2014; Mirata and Emtairah; 2005; Paquin and Howard-Grenville, 2012; Park, Rene, Choi and Chiu, 2008; Puente, Arozamena and Evans, 2015)
		Innovate in partnerships	Open innovation (Bonney et al., 2007; Chesbrough and Crowther, 2006; Ghisetti et al., 2015; Holmes and Smart, 2009; Laursen and Salter, 2006; Nidumolu et al., 2014; Ornetzeder and Rohracher, 2006; Partidario and Vergragt, 2002; Van Geenhuizen and Ye, 2014; Zelenika and Pearce, 2013)
			Co-creation with stakeholders (Ayuso et al., 2011, Chen and Hung, 2014; Hall et al., 2014; Wassmer, Paquin and Sharma, 2014), such as NGOs (Hansen and Spitzeck, 2011), universities or research centers (De Marchi, 2012; Lavie and Drori, 2012), and suppliers (Geffen and Rothenberg, 2000)
Efficient	**Organisational**: concerned with the transformation and evolution of the business due to SOI implementation	Organising for SOI: capacity building	Internal capabilities (Buttol et al., 2012; Castiaux, 2012; Hellström, 2007; Horbach, 2008; Petruzzeli, Dangelico, Rotolo and Albino, 2011; Keskin et al., 2013; Raisch and Birkinshaw, 2008; Van Kleef and Roome, 2007; Zollo, Cennamo and Neumann, 2013)
			External or relational capabilities (Ayuso et al., 2006; de Medeiros et al., 2014; Dentoni, Veldhuizen, Vis, Torn and Mauser, 2012; Gouilliart, 2014; Matos and Silvestre, 2013; Sharma, 2005; Wheeler and Ng, 2004)
		Business model transformation for SOI	Development of existing business models (incremental business model innovation) (Bocken et al., 2014; Bohnsack, Pinkse and Kolk, 2014; Boons and Lüdeke-Freund, 2013; Esslinger, 2011; Richter, 2013; Hall and Wagner, 2012; Short, Bocken,

			Barlow and Chertow, 2014)
			Radical business model innovation (Birkin, Polesie and Lewis, 2009; Boons et al., 2013; Carayannis, Sindakis and Walker, 2015; Girotra and Netessine, 2013; Philipson, 2014; Shireman, 1999; Yovanof and Hazapis, 2008)
		Resource-constrained SOI	Frugal innovation: efficient SOI when resources for innovation are scarce (Halme et al., 2012; Radjou, Prabhu and Ahuja, 2012; Ray and Ray, 2011; Salazar and Peláez, 2012; Sharma and Iyer, 2012; Tiwari and Herstatt, 2012; Zeschky, Widenmayer and Gassmann, 2011)
			Reverse innovation: applying resource-constrained conditions from developing countries for efficient SOI (Govindarajan, 2012; Govindarajan and Ramamurti, 2011; Govindarajan and Trimble, 2013; Sarkar, 2011; Zeschky, Widenmayer and Gassmann, 2014)
Final	**Instrumental**: SOI practices whose main concern is economic performance	Market orientation: guide SOI by market demand and value creation	Evaluate SOI under the competitiveness lens (Boons and Wagner, 2009; Chen et al., 2006; Driessen and Hillebrand, 2013; Hansen et al., 2009; Hull and Rothenberg, 2008; Ketata et al., 2015; Marin, 2014; Pujari, 2006; Shrivastava, 1995)
			Sustainable value creation, triple bottom-line, creating shared value (Björkdahl and Linder, 2015; Blake, 2006; Hart and Milstein, 2003; Nidumolu et al., 2009; Pfitzer et al., 2013; Porter and Kramer, 2011; Varadarajan, 2015)
		Strategic SOI	Natural resource-based view of the firm (Gallego-Álvarez, Prado-Lorenzo and García-Sánchez. 2011; Hart, 1995; Hart and Dowell, 2011; Halme and Korpela, 2014) and capacity building for SI (Adams et al., 2012; 2016; Aragón-Correa and Sharma, 2003, Blum-Kusterer and Hussain, 2001; Bowen, 2002; Chen, 2008; Huang and Li, 2015; Keijzers, 2002)
			Bottom-of-the-pyramid SOI strategies (Hall, 2014; Hart and Christensen; 2002; Hart and Dowell, 2011; Prahalad, 2012; Prahalad and Hart, 2001; Tukker, 2005)
		Efficiency gains: improve economic performance	Energy efficiency (Albino, Ardito, Dangelico and Petruzzeli, 2014; Cagno and Trianni, 2013; Gauthier and Genet, 2014; Gerstlberger, Knudsen and Stampe, 2014; van Soest and Bulte, 2001)

		through cost reduction	Resource efficiency (Anttonen, 2010; Bos-Browers, 2010; Gazi, Skevis and Founti, 2012; Ghisetti and Rennings, 2014; Machiba, 2011; Schmidheiny and Stigson, 2000; Xiao and Huang, 2012)
Gestell	**Holistic**: embed SOI in human sustainable development and social and environmental ecosystems, including a new level of human and organisational activity	System-level transition	Realization of the company's embedment in wider social and environmental systems (Adams et al., 2012; 2016; Ahlstrom, 2010; Common, 1995; Fiksel, 2003; Hansen and Coenen, 2015; Miller et al., 2014; Potocan and Mulej, 2003; Tukker, Charter, Vezzoli, Stø and Andersen, 2008)
			Large-scale transformation through SOI (Boons, 2013; Gaziulusoy and Brezet, 2015; Hart, 2012; Kläy et al., 2014; Moore et al., 2014; Rennings, 2000; Seebode et al., 2012; Smith et al., 2010; Waddock and McIntosh, 2011)
		Link social and technological aspects of SOI	Socio-technical transitions: new technologies, new technology diffusion, and replacement of old technology along with changes in other societal elements such as user practices, regulations, industrial networks, infrastructures and culture (Carrillo-Hermosilla et al., 2010; Cecere et al., 2014; Coenen and Díaz-López, 2010; Geels, 2010; Geels, 2011; Geels and Kemp, 2007; Hillman et al., 2011; Jacobsson and Bergek, 2011; Loorbach et al., 2010; Loorbach and Wijsman, 2013; Nilsson et al., 2012; Raven, Verbong, Schilpzand and Witkamp, 2011; Stephens and Jiusto, 2010)
			Linking sustainable production with sustainable consumption (Barber, 2007; Montalvo, 2003; Niinimäki and Hassi, 2011; O'Rourke, 2005; Stahel, 2010; Tukker et al., 2008; Welford, Young and Ytterhus; 1998)
		Social innovation and social entrepreneurship	Sustainable business, new organisations and hybrid business models (Arora and Kazmi, 2012; Mair et al., 2012; Mair and Marti, 2006; Markman, Russo, Lumpkin, Jennings and Mair, 2016; Mulgan et al., 2007; Oetzel, Westermann-Behaylo, Koerber, Fort and Rivera, 2010; Yunus et al., 2010)
			Sustainable entrepreneurship (Gibbs and O'Neill, 2014; Hockerts and Wüstenhagen, 2010; Larson, 2000; Lichtenstein, 2011; Pacheco, Dean and Payne, 2010; Schaltegger and Wagner, 2011; Witkamp et al., 2011; Woolthuis and Rosalinde, 2010)

4.4. SOI as a complex adaptive system

As illustrated in Chapter 2, systems-thinking and complexity science have also studied organisations as complex systems. (Anderson, 1999; Levy, 1994; Merali and Allen, 2011). The application of theory on complex adaptive systems (Gell-Mann, 1994) to strategic management leads to the understanding of system components that can evolve towards effective adaptive and self-organising solutions, reconfiguring the organisational architecture of a firm (Eisenhardt and Piezunka, 2011; McCarthy et al., 2006). As observed in the taxonomy derived from the review of the literature, SOI at the firm level is composed of five components (operational, collaborative, organisational, instrumental and holistic). The aim of this section is to discuss the rules of behaviour of these components under the light offered by the notion of complex adaptive system (Gell-Mann, 1994).

According to McCarthy et al. (2006: 442), a complex adaptive system is "*somewhere between a linear and a chaotic system, with partially connected components and agents whose decision making and interactions produce behavior and outcomes that are neither fully controlled nor arbitrary*". Therefore, we may observe that developments in each of the components will also produce results on the others, thus creating an equifinal but unique path towards the integration of components in systemic SOI. The tendency in the firm, once engaged in the SOI journey, is to fare towards an integrative, system building approach to SOI (Adams et al., 2016; Boons, 2013; Carrillo-Hermosilla et al.,2010); that is, the holistic component of SOI. However, in terms of the processes carried out to achieve this, the process is guided by the rules of complex adaptive systems: non-linearity, self-reinforcement and emergence (see Section 2.4.2.). Thus, there will be cross-fertilization among SOI components based on multi-dimensional innovation throughout the firm, in the way to nurture the holistic component of SOI towards a new understanding of innovation. This means that, in the evolution towards holistic SOI, each from of the components is translated in a different set of challenges and solutions (see previous section) that will reinforce each other towards the integrative, holistic component of SOI, as illustrated by Figure XX.

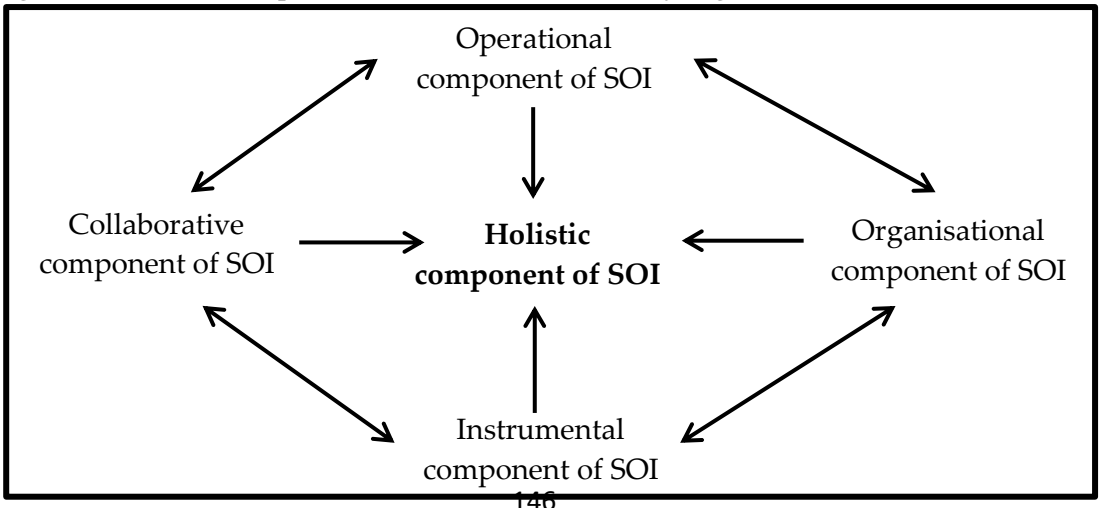

Figure 25. Relationship among components of SOI

This model of progression towards holistic SOI has some similarities with previous models but also remarkable differences. It draws from previous system-based models (Adams et al., 2016; Carrillo-Hermosilla et al., 2010 – see Section 4.2.4.-) in that it considers a gradual progression into system building through engagement of SOI. However, the ontological taxonomy does not support the progression of SOI as a staged, linear process but rather as a non-linear, path-dependent and sometimes emergent process. The main arguments that support this claim are based on the study of SOI at the firm level from as a complex adaptive system, focusing on the interconnections of SOI components at the firm level to develop new system configurations.

The process of adaption of SOI components towards systemic transformation depends on (McCarthy et al., 2006): a) previous experience and capabilities of the firm (path dependency); b) the interaction and connections between internal multiple business units, departments, research teams and projects; c) the nature of the transformations experimented by different SI components in relationship with external stakeholders and partners; d) the ordering and disordering effects and consequences of the SI process, organisational rules and organisational culture; and e) the ability of the agents leading each SI component to succeed and transform SI projects into positive feedback loops within the firm. These will be guided by the main rules of behavior of complex adaptive systems, as illustrated in Section 2.4.2; non-linearity and resilience, self-organisation and feedback loops, and emergence.

Thus, the systemic interaction within SI as a complex adaptive system shows a complex structure based on three continua of relationships between the five SI components (operational, organisational, collaborative, instrumental, and holistic). This structure implies three different types of organisational transformation:

a) Non-linearity: SOI as a complex adaptive system involves the transformation of chaotic interrelationships between different SOI components toward hierarchical and organised interrelationships. This involves the development of self-reinforcing processes between different SOI components within an organisation. Complex systems are not homogeneous relationships and linear interconnections; instead, they include self-reinforcing processes and increasingly hierarchical relationships.

b) Self-organisation: SOI as a complex adaptive system involves the transformation of SOI components from volatile and ephemeral practices to more stable and long-term practices and relationships. This promotes self-organisation of SOI components, creating complex systems through positive feedback loops.

c) Emergence: SOI as a complex adaptive system might involve the emergence of new technologies, relationships and management techniques that transform SOI components from individual practices and relationships into networked interrelationships that overcome the SOI complex system's boundaries and transform the purpose of the firm toward a more radical and systemic SOI organisation.

These three rules of behavior are mutually interdependent and interconnected within a firm. The three explain SOI reconfiguration, adaptation and new experimentation, although each of them has a specific dynamic. Therefore, for each of the phenomena, three different interaction mechanisms between the SOI components are illustrated in Table 2.

Table 18. Interaction mechanisms among SOI components

	Interaction mechanisms		
Non-linearity	Simple rules of relationships that result in complex systems	Positive and negative feedback loops that reinforce system dynamics: changes in a part that affect the whole	System transformation or failure, depending on the capacity of business units, projects and teams to coordinate, communicate and collaborate
Self-organisation	Organisation into new structures, new configurations	Complexity fosters adaptability through decentralization and learning from other components	Increased system resilience; different agents and components acting autonomously under the rules of the system but without central control
Emergence	New clean and disruptive technologies, new relationships, new management techniques that completely disrupt the firm	Networked interrelationships that overcome the system's, firm's and industry's boundaries toward sustainable development	Disruptive transformation of the firm's purpose or the creation of new ventures; pathway towards a sustainable business and markets, and sustainable economy and society

Therefore, a main outcome of this research is an integrative literature review that describes the conceptualization of SOI around five components: operational, collaborative, organisational, instrumental and holistic. Secondly, the application of complex adaptive system theory helps to understand how these SOI components interact. At the firm level, these components interrelate with one another, building non-linear dynamic pathways. However, each pathway is unique and specific to each firm, as the dynamics between components, ruled by these phenomena, are singular. Firms cannot control and copy others' SOI into their own companies. The study of SOI taking into consideration the rules of behavior of complex adaptive systems supports an analytical and conceptual approach to study how companies engage in, experiment and configure SOI, transforming the dynamics between agents, business units and external partners. Therefore, SOI configuration evolves and is characterized by the complex nature of SOI component interactions, creating non-linear and chaotic dynamics among SOI components, with emergent properties, discontinuities and self-organising patterns that might become a platform for further disruptions toward sustainable development. Each firm engages in SOI on the basis of the interactions among its components guided by these three phenomena. However, this makes firms continuously evolve thanks to the adaptability dynamics.

4.5. Research gaps

The review of the literature reveals that the phenomenon of SOI has been researched from various perspectives, and looking at its different components: operational, collaborative, organisational, instrumental and holistic, and that SOI may be studied as a complex adaptive system. However, some of these areas are prone for further research.

As noted by Schiederig et al. (2012), analysis of SOI from the firm and managerial aspects has not been extensive. Other units of analysis have been the focus of previous research; mainly, the wider system transition and public policies. When analysed from the managerial perspective, the thematic focus has lied on how SOI may improve economic performance, without providing, in most of the cases, of a framework of implementation and engagement in SOI. Those who do provide with staged-gated, literature-based models of SOI (Adams et al., 2012, 2016; Carrillo-Hermosilla et al., 2010; Kolk and Mauser, 2002; Tukker and Tischner, 2006) may be complemented with further empirical research. Hence, the analysis of previous research shows the need to study SOI from the firm perspective using empirical methods, in order to incorporate the actual corporate practice into SOI models.

When looking at the analysis by components, some of them have attracted more scholarly attention than others. The operational component has been widely researched

on, as well as the instrumental, because the early literature focused mostly on efficiency gains and the incorporation of environmental concerns in product and process innovation. In addition, the effort to engage firms in SOI by showing its instrumentality to achieve better financial performance has attracted researchers to strategic SOI and its ability to create sustainable value. The collaborative component of SOI has also been widely investigated, particularly from the macroeconomics perspective, looking at the effect of public policies on SOI. Partnerships for SOI co-creation and participation in local networks have not been so extensively researched on but they are a popular topic in recent literature, as previous studies have highlighted the importance of collaboration of SOI. Therefore, at the firm level, the organisational and holistic components have been the less popular in academic literature. Nevertheless, the study of business model innovations for sustainability has picked up in the last years, with several special issues in relevant journals published hitherto, as it has been the case for the holistic component when it comes to system transitions to sustainability and the view from entrepreneurship.

Therefore, the results of the literature review on SOI suggest that further research is needed on the organisational and holistic components of SOI. The latter implies approaching all of the components, but analysing their interrelationships and how they interact for engagement in SOI. Having considered this, the theoretical foundations of this thesis; that is, systems theory and the resource-based view of the firm and dynamic capabilities, enable the approximation to SOI from these perspectives, concentrating on the firm level. First, system thinking is able to provide explanations about the complex phenomena that enable a firm to engage in SOI. Although the focus of the study is the firm, previous literature suggests that engagement in SOI is affected not only by the organisation's internal processes but also by a myriad of external factors and collaboration with different agents. In order to untangle this complexity of relationships and intervening factors, systems theory provides with a powerful tool to explain how several agents at different levels participate of the SOI activities of the firm (Schneider, Wickert and Marti, 2016). However, the firm being the main object of study, it is worth to look at the evolutionary process of transformation derived from the engagement in the SOI journey at the internal level, concentrating on the internal dynamics of the firm-system. In this case, resource-based view and particularly dynamic capabilities approaches are useful to explain what internal enablers allow for the participation of the firm in successful SOI activities.

The next chapter deals with the qualitative study of the thesis. Although previous literature and the conclusions drawn in this chapter have been taken into account for theory elaboration (Pratt, 2008), the inductive approach adopted in this thesis calls for the evaluation of the qualitative data from a novel approach with a posterior contrast with the corpus of research.

Chapter 5

Results of the qualitative study

5.1. Background and objective

The objective of this chapter is to explore which the dynamic capabilities that enable firms for engagement in SOI are. As previously discussed in Chapter 4, there is a gap in the investigation on such capabilities hitherto; since preceding studies are mostly based on the literature or adopt a normative or prescriptive approach rather than empirical. The objective of the qualitative study of the thesis is to find out, through case-study research of companies that have successfully incorporated SOI practices, which dynamic capabilities have enabled engagement in SOI. By studying firms from different sectors, size and age with the commonality of having engaged in SOI, the aim is to find similar patterns among them that explain their engagement in SOI.

The maximum variation among companies looked for in the theoretical sampling (as explained in Chapter 3) is based on the idea that not only entrepreneurial firms have engaged in SOI through new ventures (Hockerts and Wüstenhagen, 2010; Schaltegger and Wagner, 2011): as observed in the literature, incumbents have also embedded SOI as part of their strategy in order to find new ways of sustaining a long-term competitive advantage (Nidumolu et al., 2009; Seebode et al., 2012). Established firms with mature markets have found a way to adapt to the evolving regulatory frameworks and demands of their systems, which call for the development of innovations that take into consideration social and environmental concerns. Under these new requirements, newer companies have also emerged with a clear commitment to contributing to system transition for sustainability. Therefore, the business environment (at the social, environmental and economic levels) is as changing as ever due to the challenges associated with sustainability, with rapid socio-technical, ecological and market fluctuations (Scherer, Palazzo and Seidl, 2013). This imposes a new pace of transformation of organisational routines and learning processes (Felin et al., 2012; Zahra et al., 2006) in the form of dynamic capabilities. Theory on dynamic capabilities (Eisenhardt and Martin, 2000; Teece, 2007; Teece et al., 1997) suggests that these allow companies to adjust and thrive under these rapidly changing conditions. However, there are limitations to this, posed by internal obstacles to organisational change the intervention of other factors in the firm's capacity to adapt to change. Despite this, dynamic capabilities may indeed help to respond to the new expectations that markets and societies have of businesses. In any case, it must be noted that the organisational embeddedness of dynamic capabilities creates lock-in paths of development within firms (Ritala, Heiman and Hurmelinna-Laukkanen, 2016).

For the purposes of this thesis, a broad understanding of dynamic capabilities is adopted (Ritala et al., 2016). There are discrepancies between the findings of theoretical and practical papers on dynamic capabilities; the first ones referring to higher-order

capabilities or generic capabilities, and the second to domain-specific dynamic capabilities, which are framed for a specific purpose (Andreeva and Ritala, 2016). Therefore, in terms of formulating the research questions both generic and domain-specific dynamic capabilities are considered in the investigation; although, as discussed in Section 5.3., these are ordered at different hierarchical levels.

Consequently, the dynamic capabilities theory is seen as appropriate to analyse the phenomenon of SOI at the firm level, in order to explore the profound organisational transformation for SOI looking at dynamic capabilities. Although the literature on SOI is growing (Adams et al., 2016; Boons et al., 2013; Carrillo-Hermosilla et al., 2010; Hansen et al., 2009; Varadarajan, 2015), the capabilities required for successful engagement in SOI have yet to be thoroughly investigated (Castiaux, 2012; Huang and Li, 2015; Ketata et al., 2015; Van Kleef and Roome, 2007). Therefore, the aim of this qualitative study is to go beyond previous literature-based studies (Adams et al., 2016; Castiaux, 2012; Van Kleef and Roome, 2007) and explore the different levels of dynamic capabilities that firms develop for SOI, since explanation about how these capabilities are connected and how they evolve along the organisational transformation triggered by the SOI journey (Adams et al., 2016; Carrillo-Hermosilla et al., 2010) are still lacking. Therefore, the field would particularly favor from a multilevel and hierarchical perspective of dynamic capabilities, since SOI involves a staged organisational transformation toward system building (Adams et al., 2016; Van Kleef and Roome, 2007). Consequently, more theoretical and empirical research based on this perspective is needed to elaborate the existing theory (Pratt, 2009).

Following this rationale, there are two main research questions:

(1) which dynamic capabilities enable the engagement of firms in SOI; and
(2) how dynamic capabilities for SOI are structured in different levels.

Despite the use of dynamic capabilities theory to explain the enablers of engagement in SOI at the firm level – both in the case of larger and smaller companies across various dimensions, it must be noted that systems theory is present as a theoretical framework throughout the study. Consequently, as aforementioned in Chapter 2, this is kept present in order to explain how the firm behaves as a system embedded in the wider economic, social and environmental systems. This is in accordance with the findings, which show that different companies follow path-dependent processes to engage in SOI, based on three strategic dimensions of capabilities: (1) sustainability driven market sensing and seizing; (2) sustainability embeddedness; and (3) sustainability-based talent, team-building, networking and leadership. As suggested by Ambrosini et al. (2009), dynamic capabilities may be

disaggregated into three main levels: (1) incremental capabilities; (2) renewing capabilities; and (3) regenerative capabilities.

The following section introduces the results of the three-levelled coding as described in Chapter 3. After that, Section 5.3. discusses these results. Finally, Section 5.4. summarises the contributions of the qualitative study and what they have implied for the design of the quantitative study of the study.

5.2. Results

This section focuses on the results obtained from the cross-case data analysis and on their interplay with the existent literature. These are presented with supporting quotes of each of the elements (Pratt, 2009). Repeated patterns among the eight case studies were found despite their differences (Eisenhardt and Graebner, 2007); however, different degrees of development and interaction between levels of capabilities yielded different organisational configurations, although these diverse roads led to successful engagement in SOI. The development of each of the dimensions of dynamic capabilities depends on each company's rate of adaptation, in a path-dependent process (Nelson and Winter, 1982; Sydow Schreyögg and Koch, 2009). Three levels of dynamic capabilities for SOI (incremental, renewing and regenerative) emerged from the data, grouped around three SOI strategic dimensions: (1) sustainability-driven market sensing and seizing; (2) sustainability embeddedness; and (3) sustainability-based talent, team-building, networking & leadership. The routines for capabilities found in the literature are summarised in Table 19.

Table 19. Incremental, renewing and regenerative SOI capabilities in the studied companies
Source: elaborated by the author

Capability level	**Incremental SOI capabilities** Ability of the firm to acquire new knowledge and skills in order to continuously improve its resource base			**Renewing SOI capabilities** Capacity to engage with the external environment, integrate knowledge and create sustainable value, refreshing, adapting and augmenting the resource base			**Regenerative SOI capabilities** Capacity to respond to discontinous challenges and impact on the firm's resource base, redefining its current set of dynamic capabilities		
Degree of complexity	Low	Low	Medium	High	High	Medium	High	High	High
Path dependency: previous organisational routines and requirements	Low	Low	Low	Medium	Medium	Medium	High	High	High
Dimension	**Sustainability driven market-sensing and seizing**	**Sustainability embeddedness**	**Sustainability based talent, team-building, networking and leadership**	**Sustainability driven market-sensing and seizing**	**Sustainability embeddedness**	**Sustainability-based talent, team-building, networking and leadership**	**Sustainability driven market-sensing and seizing**	**Sustainability embeddedness**	**Sustainability-based talent, team-building, networking and leadership**
Chemical	Sustainability and technological vigilance through global media data analysis	Leveraging of certifications (ISO 14001 or 14006, UNE166 002, EU Eco-Label) as a tool for eco-efficient adaptation Ongoing training in	Hiring also biologists and non-chemists as part of management and innovation teams	Creating new markets by attending to clients' demands and by educating them on sustainable product demand	Cohesive, trustful teams guided by a collective, shared leadership spirit	Proactive collaboration with technological centres, and business sustainability organisations The central element of its business and	Adopting a sustainable green chemistry business model	Organisational slack and trust to adapt to environmental and market changes	

		sustainability and innovation (e.g., creativity, impacts of the chemical industry)				innovation ecosystem is sustainability			
Climate	Vigilance of regulations and global trends in carbon management	Adoption of certifications (BSI PAS 2060, ISO 9001, ISO 14001, EMAS) as routine reminders of the company's mission Learning from industry reports	Diverse (scientific and social) consultant backgrounds In-company development of commitment to sustainability	Capacity to adopt projects based on client needs Finding and exploiting niche markets for sustainability purposes	Medium absorptive capacities of opportunities in its ecosystem Embedded sustainability is a core business value and mission	Co-creation (mostly with clients and public institutions) of sustainable services	Adopting four different business models based on sustainability (by creating separate businesses) while transforming existing ones	Trust-based organisation with the capacity to adapt to megatrends and shocks	Shared responsibilities and cohesive teams, excellent internal relationships
Wind	Vigilance of global regulations relevant to the industry Technological vigilance of competitors and patents	Certifications as a means to integrate safety and sustainability across all levels of value creation (OHSAS18001, ISO 14001, ISO 14006, ISO 14064, ISO 9001) Environmental product certification of several products	Hiring highly trained professionals for innovation teams	Market focused on the need for sustainable energy. New eco-designed windmills to differentiate from competitors	Sustainability is the core business; thus, the strategy is focused on this direction	Participating in industry and sustainability associations and promoting sustainability in its ecosystem	Business model adaption to the wind energy niche (renewable energy)	X	X

IT	Vigilance of trends in financed projects to enter consortiums Systematised technological vigilance	Certifications to guarantee quality and sustainability (ISO 9001, ISO 20000-1, ISO 27001, ISO 14001, Lean IT, others) and improving eco-efficiency	Scientific and social backgrounds to create a diverse, complementary team	Strong focus on client needs when developing services	High absorptive capacity of opportunities identified in the environment	Co-creation with multiple stakeholders to incorporate different interests Active member of innovation partnerships	X	X	Complementary profiles that work remotely based on trustworthy, visionary and inspiring leadership
Technological	Vigilance of regulations to rapidly respond to changes Systematised technological vigilance	Certifications to guarantee quality and eco-efficiency of the lifecycle (ISO 9001, ISO 14001, EMAS, ISO 20000 and others)	Scientific and social backgrounds to create complementary teams Complementarity among departments	Adapting projects based on client needs Business unit dedicated to sustainability	High absorptive capacity of opportunities in the market	Co-creation with multiple stakeholders	X	Ample organisational slack to absorb shocks and to face risks associated with entering new markets	Excellent relationships between departments, listening to new ideas from other perspectives
Elevation	Technological vigilance concerning global patents Involvement with stakeholders in consideration of their needs and interests	Leveraging certifications for sustainable management (ISO 14006, ISO 14001, ISO 9001) Ongoing training to upgrade skills Consultants as a means to	Involvement of all employees (from manufacturing to upper management) in management and innovation	Rapid adaptation to client demands Products offering differentiation through sustainability	Medium absorptive capacity from stakeholders Sustainability is aligned with business objectives Own technology development is a strong	Active partner for technology development Pivotal role in its business ecosystem	X	Engaged with its community to ensure resilience in case of shocks in its ecosystem	Collective and inclusive leadership in which responsibilities are shared but well-defined

		incorporate new knowledge			strategic focus				
Fashion	Vigilance concerning sustainability advances in its industry Involvement with stakeholders to advance designs	Leveraging of industry-related certifications(GOTS) Acquiring knowledge through industry associations	Hiring complementary profiles	Product differentiation through sustainability	Sustainability is aligned with business objectives	Excellent management of its business and innovation ecosystem, integration of all stakeholders	Adopting the slow fashion business model to ensure its triple bottom line performance	Ability to absorb environmental shocks thanks to the support system created in collaboration with its stakeholders	X
Electric	Technological vigilance concerning global patenting Vigilance in terms of regulations as a driver of SOI	Certifications that guarantee safety and sustainability (ISO 9001, ISO 14001, OHSAS 18001, others)	Development of specialised task forces for technological development	Entering new markets through differentiated sustainable products Transforming its products to cater efficiency client demands	High absorptive capacity Sustainability is aligned with the business objectives	Active member of industry and sustainability associations	X	Increased resilience through decentralization and diversification	X

Each of the dynamic capabilities dimensions has a different purpose in relation to SOI engagement. As observed in Table 19, not all the studied companies have developed the same set of dynamic capabilities; however, all of them have been able to successfully engage in SOI, which suggests that, within this framework, different configurations are possible. This is so because, despite observing general trends in the direction these dynamic capabilities have been developed for (sustainability-driven market-sensing and seizing, sustainability embeddedness and sustainability-based talent, team-building, networking and leadership), dynamic capabilities are path dependent and organisationally embedded (Eisenhardt and Martin, 2000; Ritala et al., 2016) and their microfoundations are linked to the specificities of each firm (Felin et al., 2012). It is notable that many companies have fewer regenerative capabilities (Ambrosini et al., 2009). This is so because dynamic capabilities evolve and become more complex over time and practice, and are also dependent on previous organisational routines and learning practices (Zahra et al., 2006). Consequently, not all of the companies had managed to develop regenerative capabilities for SOI at every dimension at the moment of study.

Sustainability driven market sensing and seizing is instrumental in achieving economic sustainability of the SOIs, either by creating new markets from a sustainability challenge or by responding to a pre-existent market demand. Sustainability embeddedness is a very important lever for SOI, driving the people in the firm to introduce sustainability-thinking in the organisational processes, integrating related knowledge, technology and mindsets that serve as the ground for new SOIs. Finally, the human and relational aspects also play an important part in developing SOIs. On the one hand, attracting the right sort of talent and developing an inclusive leadership are important enablers of SOI; on the other, the networking element is also very relevant for SOI. Due to its systemic nature, interests from other agents in the system and complementary knowledge are introduced in the innovation process; for this reason, the ability to interact with others is vital for SOI development. Dynamic capabilities are created as a result of path-dependent (Eisenhardt and Martin, 2000) and deliberate (Felin et al., 2012) processes within the firm, as a response to dynamic environments (Ambrosini et al., 2009; Teece et al., 1997). It has been observed in the sample companies that the environment has an important effect in the development of dynamic capabilities, indeed: the competitive environment and socio-environmental challenges seem to drive the development of dynamic capabilities in the studied companies.

In the next sub-sections the findings will be further explained relating each of the dynamic capabilities to SOI dimensions and the external environment. Each of them is framed under the multi-level dynamic capabilities hierarchy by Ambrosini et al. (2009); which explains the growing complexity of organisational routines and learning

processes adopted in the three SOI strategic dimensions. Incremental capabilities have emerged in most of the examined companies as continuous improvements to their resource base. Renewing capabilities can be found in some of the studied companies as more adaptive organisational and strategic processes. Regenerative dynamic capabilities have only emerged in the companies that have employed them to reconfigure firm capabilities, thus recombining renewing and incremental dynamic capabilities. Figure 26 summarises the findings in the qualitative study.

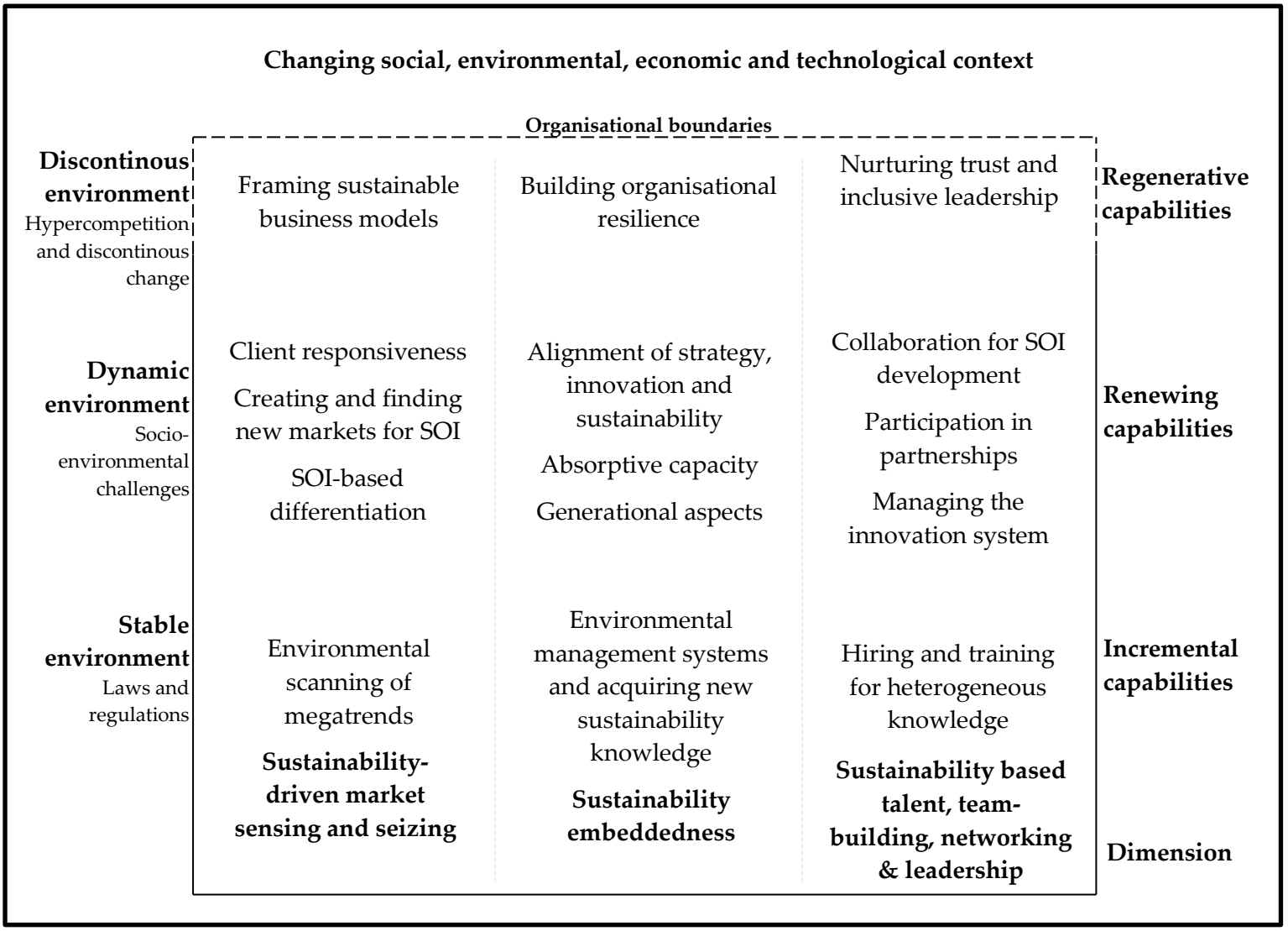

Figure 26. Summary of findings: hierarchy of dynamic capabilities for SOI
Source: elaborated by the author

5.2.1. Sustainability-driven market sensing and seizing

These capabilities for SOI are related with ensuring the economic viability of on the introduced innovations (Crittenden et al., 2010; de Medeiros et al., 2014). This appeared as a major concern for all the studied companies, not only in terms of securing profitability, but also because often markets had to be created for some products for which there was not a pre-existing demand. Sustainability driven market

sensing and seizing is based on the ability to understand the market, to identify new opportunities and to contribute sustainable products and services to the market. Such ability is particularly critical to the economic success of SOI, although they may also guide their development, providing new ideas about markets and customer demands.

These set of capabilities is related to the concept of sensing, seizing and reconfiguring capabilities identified by Teece (2007:1326) include those "*analytical systems (and individual capacities) to learn and to sense, filter, shape and calibrate opportunities*". Therefore, the function of these dynamic capabilities in Teece's framework is very similar to the one identified as the 'market-sensing' dimension in the sample companies. However, the rest of the framework does not correspond with the kind of ordering found in the research, which is more coherent with Ambrosini et al.'s (2009). First, regenerative dynamic capabilities where found for the three dimensions, which does not match with Teece's (2007) perception of 'reconfiguring' capabilities' as a type of dynamic capabilities. Second, what Teece (2007) classifies as seizing capabilities may also fit under this 'market-sensing' dimension, particularly with the most advanced dynamic capabilities within this dimension (renewing and regenerative). Therefore, although the similarity in this section is acknowledges, Teece's framework was not found applicable to the findings because here 'market sensing' refers to a dimension, an orientation of dynamic capabilities at different hierarchical level; whereas Teece's deploys the term 'sensing' to refer to the function of a particular set of capabilities that does not correspond to the rest of the framework presented here.

Some of the studied companies, particularly the smaller ones, struggled in the marketing phase and underwent trial-and-error processes to learn new market sensing capabilities. More established firms leveraged their marketing capabilities to successfully commercialise their SOIs; however, they also found immature markets that were not ready for their SOIs or needed to explore new markets, with characteristics different from their traditional markets. This required them to develop new dynamic capabilities, particularly regenerative, in order to frame new business models that enabled the company to tap into sustainability related markets. The following sub-sections describe the findings related to market-sensing incremental, renewing and regenerative dynamic capabilities.

5.2.1.1. Environmental scanning of megatrends

At the most basic level of capability development, the incremental, firms need to develop scanning skills, in order to sense the regulatory and environmental changes and the market megatrends, since these will be a lever for the creation of a demand for the development of SOIs. Environmental scanning is the process by which the firm

systematically analyzes and interprets external data to identify opportunities and threats from competitors, markets or consumers. Hence, environmental scanning has served to identify new sustainability megatrends and emerging demands in consumers and society linked to sustainable development values, as illustrated below:

> "*We collect policies in the sector we find interesting and make them ours; […] we are incorporating needs in product innovation in environmental matters (environmental footprint measurement, for instance) because it gets to us somehow, from the trends in the sector. Some of the clients have since started to demand it as well*" (CSR Manager, Wind)

Some firms such as Technological and Elevation have formalised technological vigilance systems, and others, such as Chemical, include sustainability trends in the formalised system of technological vigilance. However, other forms of market-sensing are also in place, like in the case of Elevation, which involves its stakeholders in order to identify future market directions during the idea generation process.

5.2.1.2. Market responsiveness, creating and finding new markets and SOI-based differentiation

At the level of renewing capabilities, the studied companies exhibit three dynamic capabilities: client responsiveness, creating and finding new markets for their SOIs and SOI-based differentiation.

First, client responsiveness is found to be essential for SOI, and especially for business-to-business companies. By listening to clients, companies learn of future trends and the social, environmental or regulatory challenges that they face. This brings in new SOI ideas and helps to develop products and services that are better tailored to client needs.

> "*One ought to have ears for listening, but [the development of new business ventures and ideas] has occurred through conversations with clients. […]. Almost every new product has somehow been created after some kind of intuition derived from what we have spoken about with clients*" (CEO, Climate).

Apart from serving as a source of ideas, responsiveness to client needs has been a major driver of SOI in certain companies, and particularly in older ones that have acquired commitments to sustainability over time. For instance, clients of Electrical have increasingly demanded more eco-efficient services. Being responsive to client needs ensures that the SOIs developed will receive a positive response from the market, rapidly responding to demands for sustainability.

Second, SOI occasionally runs ahead of market demand. In such cases, successful companies can find and create new markets based on sustainability-related challenges, as in the case of renewable energy. This capability is based on an exploration and exploitation process (Van Kleef and Roome, 2007) and implies a technology push from firms, thus creating demand that did not previously exist for a product or service. This capability is particularly well developed in companies that are very advanced in their commitments to sustainability, as their products or services find no demand in less advanced markets, as it is the case of eco-designed products of the chemical company studied:

> "*When we started, it was like preaching in the desert. None of our clients knew what eco-design was or what lifecycle was, and our salesman was desperate because he had to give too many explanations. We had to change our sales strategy completely by highlighting the efficiency of our products rather than their environmental sustainability.*" (Innovation Manager, Chemical).

Other companies have developed capabilities to create new markets for SOIs, which often requires educating the customer base on the sustainability-related advanced features of their products, as is the case not only with Chemical, but also with Elevation, which sells in different national markets. In some of them, sustainability requirements are not so advanced, and in order to advocate the use of their sustainable products, the company must also educate clients to create a new market.

Third, for SOI to be successful, another renewing market-related dynamic capability was achieved by the sample companies: the use of SOI as a differentiation strategy. This approach facilitates the success of a product or service in the market and serves as a branding product, especially in retail settings. The Fashion firm studied has started to communicate its sustainability strategy to its clients as part of its branding message:

> "*We are the only brand in our sector that offers such a diverse product at the level we develop our products at - at this level of sustainability with a holistic approach to sustainability. Other brands touch upon sustainability but don't have it as embedded in their designs. We have started to communicate this and to use this as a marketing strategy*" (Design Manager, Fashion).

Other firms, such as Technological, have incorporated sustainability messages into their internal and external communication strategies to highlight their commitment to social and environmental issues. For others, such as Chemical,

sustainability implies added value for the client that is worth transmitting as part of a sales message when clients are concerned about issues of sustainable development.

5.2.1.3. Framing sustainable business models

Only a few of the studied firms, mostly SMEs with a clear commitment to sustainability, have been able to develop the complex regenerative dynamic capabilities in the market dimension of SOI, framing sustainable business models. Sustainable business models are the manner in which companies are organised in order to create and capture sustainable value for themselves, society and the environment (Bocken et al., 2014; Boons et al., 2013). Although this value creation aspect is highly tied to the market aspect of this dimension, changes in the business model affects almost every aspect of the organisation (value creation, operations, partnerships…). This is because regenerative capabilities have amplified effects because of their intersecting nature (see Section 5.3.2.); consequently, although they are created on the basis of the evolution of a certain dimensions, they have effects on all of them. They are vital for the development and engagement in SOI in discontinuous environments, and ensure the survival of the company:

> "*We believe our business model is our main responsibility as a company. […] We employ a differential business model; should we have done what everyone else was doing, we would not have been sustainable, we would have collapsed*" (CSR Manager, Technological).

Discontinous changes will require not only minor changes in terms of how firms operate but also a major reframing of market dynamics and of firm operational components. Highly unstable environments will require SOI in business models that support and introduce firm SOI developments to the market. For instance, the slow fashion business model adopted by Fashion required a major reboot of its operations, logistics and design cycles and requirements, different from its major competitors. This reconfiguring requires a complex learning process, as imitating previously successful business models is not possible.

5.2.2. Sustainability embeddedness

Although the studied companies present very distinct cultures that rely heavily on the founders, the age of each company, their sizes and industries as well as some strategic and cultural traits concerning the process of embedding sustainability in strategy. Beyond the idea of triple-bottom line (Elkington, 1998), previous literature has shown how organisational culture; that is, the actual integration of the idea of sustainability in the way in which companies develop their activities, is a pre-condition

for becoming a sustainable organisation (Baumgartner, 2009). Indeed, in order to permeate down to all the activities and employees, the sustainability mind-set must be integrated throughout all organisational functions (Bansal, 2002). This implies a change of paradigm that puts business at the service of sustainable development, both at the human and environmental levels (Boons, 2013; Gladwin et al., 1995; Pfeffer, 2010).

At the internal level, this capability acts as a major SOI strategic driver and enabler; at the external level, it reinforces the development of a corporate identity built around sustainability. These cultural traits pivoting around sustainability influence the kind of knowledge the company looks for and acquires, and equip the firm for long-term strategizing beyond merely economic terms; social and environmental issues are also planned for. Consequently, SOI gradually becomes, despite its complexities, the manner in which the company innovates. This goes on building organisational resilience, improving the chances of survival in case of shocks created by discontinuous environments.

5.2.2.1. Environmental management systems and acquiring sustainability knowledge

At the less complex level of dynamic capabilities, i.e., incremental capabilities, firms gradually implement environmental management systems (ISO, EMAS and others). Although the evidence on the effect of management standards for innovation and environmental innovation is mixed (Allen and Sriram, 2000; Rennings et al., 2006; Wagner, 2007), the studied companies use environmental management systems and management standards to create value, adopting them as a resource to learn new methodologies, monitor progress, align strategies and integrate different aspects of the innovation process:

> "*Management systems [ISO, EMAS, AENOR and others] give us the basis for the whole model, because it makes systemization an obligation. Consequently, you get the whole process accelerated, and people acquire certain habits because we ought to comply with a reference norm.*" (Innovation Manager, Chemical)

However, they also acquire knowledge on sustainability from other sources, such as industry associations, sustainability-oriented organisations (e.g., a local eco-design center, environmental agency or inter-industry associations for sustainability) or methodology courses (on eco-design, lifecycle, bio-mimicry and others). Most of the companies explain how they need to develop a sustainability-oriented knowledge strategy; including research and development in clean technologies that allow for cleaner production or the development of sustainable practices. Clean technologies are also used by service-focused firms in order to account for their footprint, organise their

processes for sustainability or to account for different stakeholders in their service provision. This knowledge favours sustainability awareness and its subsequent inclusion of social and environmental criteria during the innovation process, and is also necessary in order to fulfill these requirements appropriately. However, when there is awareness, knowledge may be acquired from external sources: as a design manager stated:

> "*We were using [material "x"] because we thought it was the most sustainable in the market, as the raw materials needed for its fabrication are minimal. But then, we learnt at an industry meeting that it's actually very polluting because of the chemicals used to stabilize it. Since then, we're using sustainably sourced natural materials that are also recyclable*". (Design Director, Fashion)

It is also of utmost importance to have access to technological resources for sustainability, as newly developed applications and machinery allow for more sustainable outcomes. Although these technologies may be externally acquired, some of the firms strive for the development of their own systems, such as Technological, for which developing its own technology is considered a pillar of the firm strategy.

5.2.2.2. Alignment of strategy, innovation and sustainability, absorptive capacity and generational aspects

At the renewing level, the capability to align business strategy, communication, innovation and sustainability is essential to include sustainability objectives in companies' innovation goals. Companies have developed organisational routines and learning processes that foster the development of capabilities differently depending on their size and entrepreneurial drive. For instance, Technological includes SOI goals in its Action Plan for the following years. The latter is part of the company's longer-termed strategy. For Climate, however, sustainability is part of its core business. Thus, innovation activities have a built-in sustainability component. This is backed by a culture of intraorganisational communication and joint planning, and although it is relatively easier to achieve in smaller companies, it is major capability in larger companies: avoiding turfs and collaboration and bargaining among the different departments within the firm is required; since different skills are needed for SOI.

> "*The innovation plan in developed in an integrated manner; therefore, if I have rapport with [the department of] Sustainability, I have rapport with the three of them [Sustainability, Innovation and Strategy departments]. For this reason, our objectives are always aligned*" (Head of Sustainability Business Unit, Technological)

In any case, this requires absorptive capacity (Cohen and Levinthal, 1990) in order to upgrade the company's incremental capabilities and to impregnate SOI culture throughout the organisation and transform previous routines into more sustainable value-creating learning processes. As defined from the dynamic capabilities perspective, absorptive capacity is a "*set of organisational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organisational capability*" (Zahra and George, 2002:186).Therefore, it is necessary to develop dynamic capabilities, and in relation to SOI, it is essential to acquire, assimilate and exploit sustainability-related knowledge and integrate it in the firm's activities and processes, so as to create a sustainability culture that impregnates the organisation (Gluch, Gustafsson and Thuvander, 2009; Williander, 2007).

It is related to the openness of firms to sustainability and innovation trends and new scientific knowledge, and how this is assimilated and deployed in the SOI processes. Prior literature has found absorptive capacity as key dynamic capability for competitiveness and innovation (Kostopoulus et al., 2011), and also a capability for SOI (Ketata et al., 2015). Notably, medium and small companies had a higher degree of permeability that larger ones, although these were in the way to blur the frontiers of the firm. This knowledge is assimilated in the firm and becomes part of the corporate culture and the way in which it innovates and commercializes its offering.

> "*[Whenever we start an innovation project] we include all the requirements we deem necessary from the environmental and technical aspects. In a first phase, we resort to all the existing knowledge of the company in relation to these issues. From there, we define the requirements of components and the machine is designed, taking into consideration what we had learned before*" (Environmental Manager, Wind).

Finally, generational aspects are important in the culture of firms engaged in SOI. Younger generations trained in innovation or sustainability management or sustainability-related scientific degrees, have shown to be more sustainability-oriented in some of the studied companies. Hence, younger companies or companies hiring younger people (mostly because of their sector) drive their innovation towards sustainability more often, since these people tend to embed sustainability in anything they do due to the fact that their generation is more concerned about major sustainability issues than generations before (Mannheim, 1952). In addition, younger generations are more open to new ideas learning and development processes.

> "*The average age of the organisations helps, because there's this nuance in our education that wasn't there before. And that even more notable in those coming after us. Here, for instance, when we talk about the environment, we can't see*

ourselves doing things differently; this is our business, what we do." (CEO, Climate)

5.2.2.3. Organisational resilience

Finally, at the regenerative dynamic capabilities level, some of the studied firms developed their organisational resilience while transitioning towards a sustainable business core strategy. For example, Chemical created a whole sustainable business approach including a sustainable business model, green chemical technologies, eco-design processes and operation, client alliances and training courses, and leads the transformation of the chemical industry. Resilient companies are able to absorb shocks at many levels of the firm from high discontinuous environments, build from them and use them as a learning experience in which their set of capabilities is regenerated. Because of this, they are better fit to survive changes in their environment, face new challenges and assume risks derived from innovation. Thanks to organisational resilience, the firm can anticipate and react to discontinuous change, and thrive in turbulent environments and survive times of crisis:

"*We have undergone a very delicate financial situation, which we have survived thanks to the relationships of trust that we have with our suppliers. They have agreed to delayed payments and supported us all along.*" (Sustainability Manager, Fashion)

Moreover, resilience is observed in the creation of robust but not always permanent governance structures that allow for continuous adaptation and strategic adaptability:

"*We are not very much in favour of permanent structures. I mean, I picture that everything will have an expiration date: for instance, if we are finally able to set up the [name of project], it will have a couple of years of peak, because people will be motivated, contribute… But most surely a moment will come when the effectiveness and capacity to integrate ideas will be reduced and we will need to find another way to do it. We will have to change it. And I think that this is very important to keep in mind"* (CEO, Climate)

As observed in the cases of Fashion, Climate or Chemical, organisational resilience is a very complex regenerative dynamic capability that builds on the relationship of the company with its surrounding environment and the actors in its system. For this reason, the sustainability embeddedness culture that builds on the idea of system transition for sustainability strengthens the relationships of the firm with its environment, making it more able to adjust and absorb shocks.

5.2.3. Sustainability based talent, team-building, networking and leadership

The final set of renewing capabilities is related to people and relationships (Van Kleef and Roome, 2007; Wang and Rajagopalan, 2015). The networking dimensions, supported by intellectual capital have shown to be an important aspect in developing SOI capabilities. From choosing the right combination of talented professionals to networking with relevant stakeholders and having a committed leadership, people and networking-based capabilities were very important for all the studied companies. Most of the studied companies have engaged in forms of collaborative innovation and have actively participated in business fora and partnerships. Such participation serves not only as a source of ideas but also constitutes a technical requirement in many cases; the specificities of SOI and the required added expertise lead to inter-firm collaboration at various stages. Hence, nurturing the individual abilities of persons and their relationships and how this makes the firm relate to the various actors in its environment are important elements of dynamic capabilities for SOI; as illustrated in the following subsections.

5.2.3.1. Hiring and training professionals to acquire required knowledge

Having access to trained and committed professionals is crucial for SOI, since they are a source of ideas and the ones that will be developing the innovation process, in which they serve as a source of sustainability knowledge, ideas, clean technologies and creativity for the development of SOI. This applies both in bigger and smaller companies, but it is vital to have these professionals aligned with the objectives of the company. Hence, formal training is not the only aspect sought for in these professionals, but also commitment to the company objectives. As one of the managers affirmed:

> "*Here, the [thousands of employees] are responsible, that is crystal clear to me. The responsibility is of every employee in the company, innovating, and doing it this way*". (CSR Manager, Technological)

This responsibility is even more apparent in medium and smaller companies, which have to take this into consideration even in the moment of hiring, since even one misaligned employee may create imbalances, as the CEO of a medium-sized company acknowledged:

> "*That culture of listening, and being with the clients, is reproduced. That has happened to us, and is something that has worried me for some time. Sometimes,*

when we hired a senior professional, with years of experience, our model has not worked". (CEO, Climate)

Furthermore, in demonstrating the need to build a base of differing knowledge and scientific backgrounds, new professionals have been hired in some cases in order to acquire new knowledge and to collaborate in generating diverse and efficient teams teams (e.g., Fashion, Elevation and Climate). This means training or promoting professionals who have completed formal sustainability-related technological and certification training programs (e.g., green chemistry, whole lifecycle assessment and circular economy) but also demonstrate a commitment to company objectives.

5.2.3.2. Collaboration for SOI development, participation in partnerships and managing the innovation system

At the renewing level, collaboration with other actors oriented towards sustainability often leads to product or end-user co-creation, which is a source of added value. This implies that a company must maintain an open attitude towards local and global stakeholders in order to learn about them and attract them to its SOI innovation projects (e.g., developing new products or services). In order to do this, companies need to participate in and support the transition to sustainability in the innovation networks in which the firms participate, and manage the innovation system in which it operates, finding complementary partners and learning to adopt an open approach to collaboration.

First, the capacity to find and attract co-creators and to develop innovation processes with them requires flexibility and openness on the part of the firm and the development of particular skills to develop joint projects. This requirement implies that a company must maintain an open attitude toward local and global stakeholders in order to learn about them and attract them to SOI projects:

"*In the communities where we operate, it is important to work with centers of knowledge, universities and colleges because they are sources of knowledge that we can integrate, and that is where our innovation model is rooted*" (Sustainability Manager, Technological).

Second, this expertise is also often acquired through participation in technological SOI partnerships and associations, wherein knowledge is openly shared. As an example, Fashion joined a major industry association to learn ways to integrate sustainable materials into production mechanisms. Capacities to participate in these fora imply that firms maintain a high degree of openness while protecting their own expertise and knowledge.

"*I would say that, regarding training, we have done things with [name of association], and it was the CEO who encouraged this. It is important to learn; we used a raw material and marketed it as sustainable and then learned that when mixed with other materials, it can be very polluting*" (Design Manager, Fashion).

Third, managing this ecosystem and approach to stakeholder integration will be of utmost importance to such firms, and capabilities to manage these relationships will help firms obtain financial and institutional resources, more-appropriate partners and access to research centers. Companies operate in certain ecosystems in which competitors, public administrations, clients and other stakeholders can prove useful at different stages of the SOI process:

"*As a small company, one cannot get far alone. Hence, it is good to collaborate and cooperate with other companies, and we have always been very active in the [regional administration] programs […]. This is also very important - we have forged alliances with other companies that have followed our same approach to sustainability*" (Innovation Manager, Chemical).

5.2.3.3. Nurturing trust and inclusive leadership

Collaboration, networks and team building are of critical importance to the development of SOI (Van Kleef and Roome, 2007). The forging of ties between team members adds value to SOI through the development of social ties that add intangible value to the firm, through the creation of trust among members of teams. Cohesive teams that are an asset for SOI are integrated, flexible, efficient, interdisciplinary, complementary, and committed to both the company and sustainability. Hence, the creation of these teams concerns not only the acquisition of the right skills, but also the creation of matching social ties and trust, that must be matched through a shared leadership style that promotes SOI and creates the right conditions for its implementation (Bessant, 2003):

"*It's not only about knowledge of the process […]. Evidently, the organisation keeps working and certain profiles alternate, appear or disappear, but the core competences have not disappeared. For me, that is really important, and there is a lot of training and knowledge available in these areas*" (Innovation Manager, Elevation).

In addition to this, for this framework to thrive within the company resulting in successful SOI practices, an inclusive leadership who is committed to idea of

sustainability is required so as to push the drive forward. This inclusive leadership increments the commitment of employees in return (Bacha and Walker, 2012), which creates a virtuous circle that amplifies the results of dynamic capabilities on performance. This responsibility is even more apparent in medium and smaller companies, which have to take this into consideration even in the moment of hiring, since even one misaligned employee may create imbalances. The effect of nurturing an inclusive leadership is visible not only in terms of driving the organisation forward towards system transition, but also in terms of creating a certain culture based on the advancement of the company through SOI. The effects of exercising an inclusive leadership includes the creation a culture of shared responsibility that empowers employees at all layers of the organisation to push forward SOI projects.

5.2.4. Effects of the environment in the development of capabilities for SOI

As Felin et al. (2012) point out, there are three types of microfoundations of dynamic capabilities; individuals, processes and structures. These belong to the inside dimension of the firm, and draw heavily on the resource-based view of the firm (Barney, 1991). In this approach whether dynamic capabilities will provide a competitive advantage may be determined looking mostly at the internal dimension of the firm (Helfat et al., 2007). However, the findings in the sample companies suggest that the external environment has a profound effect on both how dynamic capabilities are developed, as part of the literature advocates (Eisenhardt and Martin, 2000; Danneels, 2008; Dunning and Lundan, 2010; Schilke, 2014). These views in which environmental factors are taken into consideration from a resource-based view perspective have been previously introduced in the literature (Maurer, Bansal and Crossan, 2011). Following the ordering by Ambrosini et al. (2009) in stable, dynamic and discontinuous environments affecting the development of dynamic capabilities – incremental, renewing and regenerative, respectively-, the studied companies seem to be affected by different environmental factors at each of the levels. In the case of development of dynamic capabilities for SOI; three factors seem to be influential in shaping capabilities at each of the levels of the hierarchy: laws and regulations, socio-environmental challenges and discontinous economic and technological change. These are discussed in the following sub-sections.

5.2.4.1. Stable environments: incrementally changing regulatory framework

The legal and regulatory framework is a driver for the focal company to develop sustainable products. Despite occasional sudden or major changes, it evolves incrementally (aiming to provide a relatively stable environment). It is also an

instrument to create markets for already-developed SOIs that had no clientele. Consequently, firms engaged in SOI will closely monitor the regulatory advances and develop their products and services accordingly:

> "*Our second "antenna" is regulation. In our world, regulation is what generates business in many of the areas.*" (Head of Sustainable Business Unit, Technological)

The existence of a regulatory framework that makes social and environmental requirements from firms stricter creates a stable but evolving environment to which companies gradually adapt through adjustments to their resource base, through incremental dynamic capabilities. These changes occur in due time; therefore, the environmental change is not radical and companies have more time to fine-tune their routines and processes in response to new regulations. In addition, these are stable

5.2.4.2. Dynamic environments: socio-environmental challenges

In a more advanced state of development, the matter is not about adjusting to the gradual adjustments of regulation, but rather responding to socio-environmental challenges posed by their business context through innovation. Companies with a strong commitment to sustainability will seek a holistic viewpoint from which to integrate the greatest number of issues possible.

> "*Through the improvements in technology, we make society advance. Consequently, it is inside necessity where market niches are created, and the strategies to develop [a product line] come because we have seen that it can help out.*" (Innovation manager, IT).

At this stage, renewing capabilities are needed in order to evolve at the rate of socio-environmental problems; as these become more complex, the capabilities needed to respond to their rate of change are also increasingly complex. As compared to laws and regulations, which affect all companies in a sector in a given territorial limit, tackling socio-environmental challenges might be a choice of the company (because of commitment to sustainability, market opportunities or both) or a requirement of the community within it operates. Hence, the benchmarking possibilities are reduced; path-dependencies and deliberate processes come into place in capability development.

5.2.4.3. Discontinuous environments: major changes of business contexts

Hypercompetition (D'Aveni, 1994) requires not only the development of new products and services, but also new organisational forms and business models to generate new dynamic capabilities, at a continuous rate of change (D'Aveni, Dagnino and Smith, 2010). Discontinuous technological change pushes firms to develop SOI not to be left behind, and to adapt to it through new markets and business models. The innovation manager of a large company described it this way:

> "*Well, we are a technologically intensive company, a company that competes in a global market, whose adversaries are big multinationals, intensive in technology as well, and whose clients are also very capable and professional. We have to keep up.*" (Innovation manager, Technological)

Technological discontinuity is accompanied by a social change (Geels, 2010) to which companies must also adapt, and be part of. Besides, in the case of SOI, apart from technological discontinuity companies must face system transitions to sustainability, which requires the development of regenerative capabilities that inform the roads to be followed by the firm in relation to systemic change.

5.3. Discussion and contributions

The findings in the sample companies reveal that there are three dimensions of dynamic capabilities for SOI; sustainability driven market sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership. Each of them is organised in a hierarchy of three levels: incremental, renewing and regenerative dynamic capabilities (Ambrosini et al., 2009). These capabilities evolve and increase in complexity, and enable the company to adapt to more discontinous environmental change. This study investigates the nature and interactions among dynamic capabilities for SOI, which serve as a tangible measure that transforms a company's strategic vision and goals into a sustainable business transformation approach (Adams et al. 2016; Van Kleef and Roome, 2007).

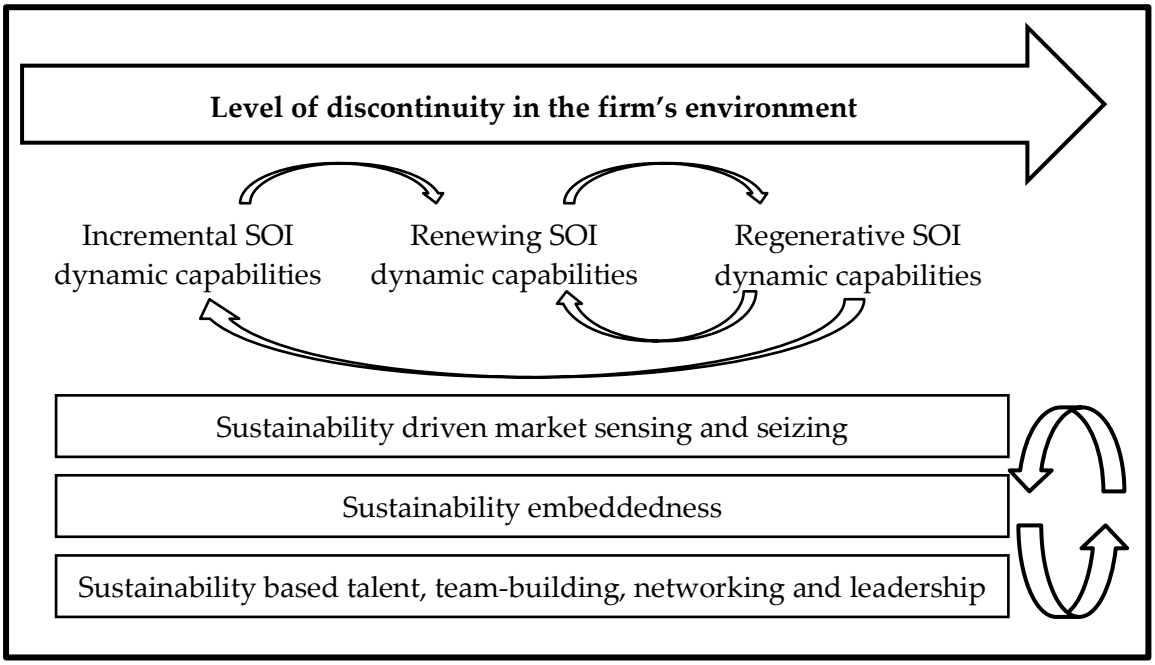

Figure 27. Relationship between levels of dynamic capabilities and self-reinforcing processes among dimensions
Source: elaborated by the author

As illustrated in Figure 27, the observations made in the qualitative study allow for the discussion of how firms evolve through the development of dynamic capabilities for SOI. Three aspects are worth further discussion, as indicated in the next subsections: (1) the hierarchy and levels of dynamic capabilities for SOI, and how they evolve through path-dependent and deliberate processes; (2) the self-reinforcing patterns among the dimensions of dynamic capabilities for SOI; and (3) the impact of dynamic capabilities for SOI on sustainable value creation.

5.3.1. Hierarchy and levels of dynamic capabilities for SOI: path-dependent and deliberate processes

First, this research sheds light over the nature and purposes of the different levels of dynamic capabilities for SOI. By doing SOI, it elaborates on the scarce literature on the matter (Adams et al., 2016; Castiaux, 2012; Huang and Li, 2015; Ketata et al., 2015), offering a multi-level view based on the cases of eight companies. The results are consistent with the view of dynamic capabilities in a hierarchy offered by Ambrosini et al. (2009): at a lower level, there are incremental dynamic capabilities, which are concerned with the continuous improvement of the resource base. They are developed in stable environments, in the case of SOI, in response to the gradual changes in the regulatory framework. On a second level, there are renewing dynamic capabilities, which deal with the refreshment, adaptation and augmentation of the resource base, and are developed to confront dynamic environments. In the case of the companies

engaged in SOI, it requires developing such capabilities in order to tackle the socio-environmental challenges posed by the communities in which they operate; hence creating unique value from SOI rather than merely adjusting to legal and regulatory requirements and recommendations. At the highest level, regenerative dynamic capabilities impact not only on the resource base, but also on the development and unlearning of dynamic capabilities in the face of severely discontinuous environments. Therefore, as illustrated in Figure 27, renewing dynamic capabilities evolve from the incremental, and the regenerative from the renewing (Ambrosini et al., 2009), This is also illustrated by previous theorizing on dynamic capabilities in a hierarchy and in evolution, such as Winter's (2003) or Zahra et al.'s (2006) –see Section 2.5.3 -. However, regenerative dynamic capabilities have an effect on the both levels beneath them, as they are concerned with the renewal of the dynamic capabilities base.

As the findings suggest, all the three levels of dynamic capabilities have a role in the engagement in SOI, performing different roles and sustaining different process that allow for a different degree of engagement. Nevertheless, a path-dependent upward trajectory is found in the studied firms. Having developed incremental and renewing capabilities gradually leads to the generation of regenerative capabilities, in order to deal with new SOI related challenges and manage the existent dynamic capabilities for SOI. Engagement in SOI, as shown in the findings, requires individual routines and heterogeneity among dynamic capabilities for SOI within each firm (Barreto, 2010; Makadok, 2001; Teece at al. 1997).

In addition, each of the firms presents a unique dynamic capabilities development process and obtains different degrees of performance; however, the three main dimensions of dynamic capabilities for SOI are shared across firms. This is so because engaging in SOI leads to driving the orientation of the development of dynamic capabilities in a certain direction, suggesting common patterns of development (Barreto, 2010; Eisenhardt and Martin, 2000). However, within the common trend, each firm's architecture of dynamic capabilities is unique, due to their path-dependent and organisationally embedded nature (Ritala et al., 2016). As observed in the studied companies, some of these levels of dynamic capabilities have emerged in certain companies but not in others; they are not shared by all of the firms. The incremental dynamic capabilities have been developed by most of the companies, as they entail a lower level of complexity and do not require much previous action; renewing capabilities are present in some of the companies, as they require a higher degree of adaption of the organisational and strategic process, since they must be built on previous action. Nevertheless, regenerative dynamic capabilities, due to their higher complexity, have only emerged in the companies that have assumed a broad commitment to reconfigure the firms' dynamic capabilities in order to continuously evolve along with its external environment, using SOI as tool for the wider system

transition to sustainability. Regenerative dynamic capabilities are infrequently observed and require a high level of previous action; therefore, the firm's pre-existing resources and capabilities are key determinants of the posterior capability-development path.

Therefore, if we observe the behaviour of the firm as an evolving system, as dynamic capabilities develop towards higher degrees of complexity, the boundaries of the firm become more blurred and the company gradually becomes a relevant agent in the system transition for sustainability (Dunning and Lundan, 2010). The firm experiences the systemic phenomenon of self-organisation (Eisenhardt and Piezunka, 2011; Meadows, 2008), through which dynamic capabilities, as components of the system, are hierarchized in the three-levels in each of the dimensions without a central control (Anderson, 1999). Hence, path-dependence (Sydow et al., 2009) plays a major role in the development of dynamic capabilities for SOI. However, in the case in the sample it was also observed that often firms in the need to adapt to their environment voluntarily adopted new sustainability knowledge and practices; hence guided by an upgrade of the existing capabilities under the leadership of managers or intrapreneurs (Garud, Kumaraswamy and Karnøe, 2010). Consequently, deliberate processes leaded by the individuals in the system also cause leapfrogging in the development of dynamic capabilities, triggering emergent properties in the organisation (Goldstein, 2011; Mintzberg, 1978).

This is consistent with the views on dynamic capabilities development in the literature, part of which stresses the path-dependent learning process of dynamic capabilities (Eisenhardt and Martin, 2000; Hine, Parker, Pregelj and Verreyne, 2014; Ritala et al., 2016; Vergne and Durand, 2011). Others highlight the importance of cognition and the role of particular actions of individuals in the learning and the development of dynamic capabilities (Felin and Foss, 2011; Felin et al., 2012; Gavetti, 2005). Routines evolve into capabilities through local search, limited by the bounded rationality of individuals (Simon, 1981), and the mindful altering of them by individuals; consequently, dynamic capabilities may have either emergent or effortful properties (Gavetti, 2005).

5.3.2. Self-reinforcing patterns among dimensions of dynamic capabilities for SOI

It was observed in the sample companies that the development of dynamic capabilities in each of the dimensions had self-reinforcing effects with the rest, creating positive feedback loops (Abdelkafi and Täuscher, 2015; Meadows, 2008) that enhanced the development of dynamic capabilities in the other dimensions. This was particularly

salient in the case of regenerative dynamic capabilities, because of their intersecting nature. Despite having found three different dimensions of dynamic capabilities, these are interrelated and developing some of them enhances the development of others in the other dimensions, creating a cascading effect that affects the other dimensions. This implies the creation of equifinal but distinct paths of development of dynamic capabilities for the engagement in SOI (Gresov and Drazin, 1997; Peteraf and Bergen, 2003), which are also influenced by the decisions taken deliberately by the relevant actors of the firm (Garud et al., 2010).

In the case of regenerative dynamic capabilities, the linkages among them are even closer, and the reinforcing feedback loops are more apparent because of their interrelations. The development of regenerative dynamic capabilities in one of the dimensions will eventually require the development of dynamic capabilities in the others; for instance, sustaining the constant change derived from framing sustainable business models requires organisational resilience to support these changes and also an inclusive and shared leadership to bring the people into collaboration with the organisation to support and bring about the changes. This has been the case; for instance, of Climate, which has framed a new sustainable business models through new ventures more or less every two years since its foundation. Self-organisation through reinforcing feedback loops led to the development of dynamic capabilities in the other dimensions, creating a trust-based resilient organisation in which employees and collaborators are profoundly ingrained in the business model.

At the lower levels of the hierarchy of dynamic capabilities these linkages and positive feedback loops are also apparent but less so, since it is often the case that lower levels of dynamic capabilities are less dependent on other dimensions. For example, Fashion focused on hiring and training individuals with heterogeneous skills coming from other sectors in order to acquire sustainability knowledge and implement environmental management systems; showing that dynamic capabilities might also be related at the incremental level. However, Chemical managed to integrate its management systems with the existing team of chemists, despite hiring people with other backgrounds to develop its variety of innovation. This shows that at the lower levels the links among dimensions are weaker and may or may not be dependent on each other. Consequently, there are equifinal but diverse paths for the hierarchization of dynamic capabilities for SOI.

5.3.3. Impacts of dynamic capabilities for SOI on sustainable value creation

The fact that all firms try to reach the same goal (dynamic capabilities development for SOI) but follow equifinal but distinct paths and are set in different environments, implies that there is a clear difference in the process through which individual firms have tried to engage in and make adjustments to their innovation approach to position themselves strategically vis-à-vis their competitors in the new SOI based markets. Path-dependency implies that previous decisions and resources affect to a great extent the development of dynamic capabilities for SOI at all levels. Consequently, major differences in such development are appreciated between small and large companies, which deal with very different organisational apparatuses, and incumbent and entrepreneurial firms, which are positioned in unlike market situations.

Therefore, SMEs and some entrepreneurial firms find a relative advantage as compared with bigger firms in developing renewing and regenerative SOI capabilities because they are not cognitively constrained by previous innovation capabilities. Their value creation focus is placed on novelty and improving social and environmental conditions. As compared with larger companies, they have a higher degree of adaptability and flexibility thanks to the faster channels of intra-firm communications and personal closeness favours the creation of trust (McAllister, 1995; Ruiz-Moreno, García-Morales and Llorens-Montes, 2008). However, large firms have other advantages at the starting point for the development of incremental dynamic capabilities, since their resource base is broader. Nevertheless, the preexistence of dynamic capabilities and resources often hampers the development of new dynamic capabilities, because of the lock-in effects created by the existing resources and capabilities. Hence, new SOI practices and technologies must be fitted into existing strategies. In these companies, at least initially, the focus is placed on efficiency rather than experimentation. Due to these particularities, the actions to be implemented to engage in SOI will be different, and each firm will need to concentrate on distinct matters. The research confirms the propositions by Zahra et al. (2006) for the sample companies, showing that SMEs assume more continuous, novel and rapid changes and adaptations in dynamic capabilities for SOI, which are more difficult for more established, incumbent firms, helping them to rapidly change and explore compared to the more deliberate transitions of established firms. Hence, the size and the age of the company are key variables when adopting SOI capabilities.

Due to the diversity among them, companies draw different strategic paths (adopting different capabilities depending on their strategic focus and context) and operate in different ecosystems and markets. Therefore, the value creation performance

results derived from the engagement in and adaptation of dynamic capabilities for SOI will vary. Previous research has implicitly or explicitly explained how dynamic capabilities are unique for each firm (Barreto, 2010; Teece at al., 1997) despite showing commonalities across firms (Eisenhardt and Martin, 2000). Due to these differences, their performance and forms of value creation vary, particularly taking into consideration their different environmental contexts (Makadok, 2001). For instance, Fashion, which has a strong sustainability focus and has developed alliance capabilities to a considerable extent, also has limited market capabilities. For this reason, its environmental performance is very good, as it is its organisational performance: SOI and the relationship of trust with its suppliers have helped the company survive the recent financial crisis. However, its market performance was not as good until very recently; the company has started to work on SOI as a brand differentiation strategy in order to tackle this issue. Other companies like Technological have a very strong market strategy but have only recently started to embed sustainability into their operations; hence, although it is improving, the company's overall environmental performance (sustainable product business line) is not as strong as it could be; however, the company's market performance has thrived over the years.

5.4. Implications for the quantitative study

As explained in Chapter 3, in spite the convergent nature of the mixed methods study (Creswell and Plano Clark, 2011) the qualitative investigation was conducted before the second, quantitative study; therefore, the preliminary results affected the development and design of the quantitative section in number of ways, as illustrated in Table 20, below.

Table 20. Contributions of the qualitative study for the quantitative studies

Main contributions in the qualitative study	Reflection in the quantitative study
There are three dimensions of dynamic capabilities for SOI – sustainability driven market sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership – hierarchized in three levels – incremental, renewing and regenerative -.	Simplified measures of capabilities for SOI have been introduced in the survey instrument (market responsiveness, knowledge assimilation and sustainability orientation, alliance proactiveness and alliance portfolio coordination). Their influence on SOI outcomes is tested.
The need for external collaboration (networking dynamic capabilities) calls for external knowledge integration.	Measures for knowledge search strategies have been introduced in order to find out how each of them affects SOI outcomes.

Despite having similar dynamic capabilities for SOI, performance results are different for each firm.	SOI outcomes will be tested against measures of financial and customer performance and sustainability behaviour.

Chapter 6

Results of the quantitative study

6.1. Background and objective

As illustrated in Chapter 3, the quantitative study of the study builds on the results of the qualitative study (see Chapter 5). The outcomes from the qualitative study indicated that there are three main groups of dynamic capabilities that enable firms to engage in SOI: sustainability-driven market sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership. These dynamic capabilities present self-reinforcing properties and their development is influenced by the dynamism of the environment in which the firm operates.

Therefore, this chapter has various objectives:

1) To describe the status quo regarding engagement in SOI among firms of more than 50 employees that have establishments with strategic decision-making power in the Basque Country.
2) To explore the relationships between capabilities and SOI outcomes (see Section 5.4.) in a larger sample, examining all kinds of firms and not only those which have engaged in advanced SOI practices, as those in the qualitative sample.
3) To look at the knowledge search strategies that firms deploy as part of the networking dimension of dynamic capabilities and how each of them results in different SOI outcomes.
4) To examine the relationship between SOI and firm performance, in order to contrast it with the results of previous studies of this relationship.

Therefore, the quantitative study of this dissertation fits the purposes of both the explorative and convergent aspects of the mixed methods research design: evaluating the validity of the results of the qualitative study in a larger sample, and exploring new relationships that help to understand the phenomenon of SOI. Consequently, the following section proceeds with a characterisation of the sample, so as to provide with a general view of the respondents and the *status quo* regarding SOI in the Basque Country. Next, Section 6.3. evaluates the results of the previous chapter, examining the outcomes of capabilities for SOI and how environmental dynamism affects the development of dynamic capabilities for SOI. After that, Section 6.4. deals with the knowledge search strategies that companies deploy when starting new SOI developments, while Section 6.5., next, is concerned with the relationship between SOI outcomes and firm performance. The final section of this chapter discusses the findings in the quantitative results under the light of the theoretical framework and the literature covered in Chapters 2 and 4 as well as the qualitative results in Chapter 5, paving the way towards the conclusions of the dissertation in the next chapter.

6.2. Characterisation of the studied companies

Drawing a simple characterization of the sample provides with some extra information about the respondents and the *status quo* of firms of more than 50 employees established in the Basque Country in relation to SOI practices. The following sub-sections offer a more detailed view of the respondent firms as it comes to the control and descriptive variables as well as SOI outcomes.

6.2.1. By general features

The questionnaire was initially addressed to innovation and / or sustainability managers, in their absence, to the CEOs or SOI project managers, and, lastly, if the company lacked such established positions, to respondents who were involved in the firm's innovation and / or sustainability activities. As illustrated in Table 21, the majority of respondents (40,6%) were responsible for innovation related tasks; however, a large percentage of the respondents (35,6%) did not hold an innovation or sustainability related position (at least nominally), but was involved in such practices as part of their job. This is understandable due to the large number of medium-sized companies in the sample (see Section 6.2.2.), where such responsibilities are often shared due to the limited resources and organisational structure and the lack of specialisation of managers (del Brío and Junquera, 2003).

Table 21. Respondents in the sample companies

	Frequency	Percentage
Innovation / technology/ R&D / product development manager	69	40,6
Sustainability / CSR / environmental manager	10	5,9
CEO	28	16,5
Project manager	3	1,8
Other	60	35,3
Total	170	100,0

Due to the fact that the three territories in the Basque Country region have slightly different public policies and tax regimes, it is desirable that companies from the three territories are represented in the sample in a balanced manner. Therefore, the classification by territories in the sample is compared in Table 22.

Table 22. Sample and respondent companies by territory

	Frequency in the sample	Frequency among respondents	Percentage in the sample	Percentage among respondents
Araba	180	30	15,3	17,6
Bizkaia	598	74	50,8	43,5
Gipuzkoa	400	66	33,9	38,9
Total	1178	170	100,0	100,0

Even if companies from Gipuzkoa are slightly overrepresented in detriment of the Biscayans, this difference is not sufficient as to consider the respondent companies not representative of the sample. As for geographical concentration of respondent firms, there are three areas that concentrate the most firms: the postcodes corresponding to the Technological Park of Zamudio, in Bizkaia (48170, 9 respondents), and to the industrial areas of Jundiz (01015, 9 respondents) and Gamarra (01013, 8 respondents) in Vitoria-Gasteiz. None of the other postcodes accumulated more than 5 respondents. These results are representative of the importance of the Technological Park of Zamudio, the concentration of population and economic activity in the capital of the territory of Araba and the geographical dispersion of firms among the municipalities of Gipuzkoa.

6.2.2. By control variables

As observed in Table 23, manufacturing industries are prevalent among the respondents, followed by trade and logistics and services. Despite services being a small group, it is a sufficiently big group for analysis.

Table 23. Classification of respondent companies by industry

	Frequency	Percentage
Manufacturing[8]	95	55,9
Trade and logistics[9]	45	26,5
Services[10]	30	17,6

[8] The manufacturing group includes the following high level aggregation sectors from the NACE Rev. 2 Classification (Eurostat, 2008): agriculture, forestry and fishing; manufacturing, mining and quarrying and other industry; and construction.

[9] The trade and logistics group includes the following high level aggregation sectors from the NACE Rev. 2 Classification (Eurostat, 2008): wholesale and retail trade, transportation and storage, accommodation and food service activities

[10] The services group includes the following high level aggregation sectors from the NACE Rev. 2 Classification (Eurostat, 2008):

- Information and communication

Total	170	100,0

By firm age, the respondents are very heterogeneous, with a minimum of 5 years (which excludes start-ups, which was one of the sample design requirements) and a maximum of 136 years. The mean is 32,43 years; however, the high standard deviation (20,038) makes it unrepresentative of the sample. Therefore, in order to provide with a more nuanced view of the age ranges of the respondent firms, they have been divided in 4 groups, as illustrated in Table 24:

Table 24. Sorting of respondents by firm age

	Frequency	Percentage
5 to 34 years	117	68,8
35 to 69 years	45	26,5
70 to 99 years	5	2,9
100 or more years	3	1,8
Total	170	100,0

As with firm age, the variation among firms by turnover is too broad for the mean (158.219.836,06 €) to be representative of the sample, as the standard deviation is 867.285.555,649 €. For this reason, and as above, the respondent sample has been classified in four categories, as illustrated in Table 25:

Table 25. Sorting of respondents by turnover

	Frequency	Percentage
0 to 4.999.999,99 €	21	12,4
5 mil. to 19.999.999,99 €	67	39,4
20 to 99.999.999,99 €	58	34,1
100 million € or more	24	14,1
Total	170	100,0

Regarding the number of employees, although all the respondent companies have at least 50 employees as determined in the sample design, there is great diversity among firms, ranging from 50 to 53551, with a mean of 951,82 employees. In order to provide a more useful picture of the sample of respondents by number of employees, they have been classified in two groups following the European Commission's

- Financial and insurance activities
- Real estate activities
- Professional, scientific, technical, administration and support service activities
- Public administration, defence, education, human health and social work activities
- Other services

recommendations (European Commission, 2003). The frequencies are illustrated in Table 26.

Table 26. Sorting of respondent firms by number of employees

	Frequency	Percentage
Medium sized enterprises (50 – 249 employees)	122	71,8
Large enterprises (more than 250 employees)	48	28,2
Total	170	100,0

The majority of the firms in the sample are medium sized enterprises, as it is expected from the SME-based economy of the region (OECD, 2011).

R&D intensity, measured by the percentage of turnover invested in R&D, is measured in four groups classified under the 2014 EU Industrial R&D Investment Scoreboard (European Commission, 2014), as illustrated in Table 27:

Table 27. Sorting of firms by R&D intensity

	Frequency	Percentage
Low R&D intensity (0% - 0.9%)	40	23,5
Medium-low R&D intensity (1% - 1.9%)	48	28,2
Medium-high R&D intensity (2% - 4.9%)	46	27,1
High R&D intensity (≥ 5%)	36	21,2
Total	170	100,0

The R&D intensity of the firms is fairly evenly distributed among groups in the sample; therefore, the sample captures firms that devote different degrees of invested resources in innovation. This heterogeneity among firms regarding innovation was looked for in the sample design, as explained in Chapter 4.

Regarding sustainability orientation, measured by a 1 to 7 Likert scale, the responses seem to lean towards the centre, with an average of 5,01 and a standard deviation of 1,72. Table 28 shows the frequency of responses grouped around categories of low, medium and high sustainability orientation.

Table 28. Sorting of firms by sustainability orientation

	Frequency	Percentage
Low (1-2)	17	10
Medium (3-5)	77	45,3
High (6-7)	76	44,7
Total	170	100,0

The majority of the respondent firms have either a medium or high sustainability orientation, but if it translates into their innovation practices will be observed in Sub-Section 6.2.3.

6.2.3. By SOI outcomes

When it comes to SOI outcomes, the respondent firms were presented with five categories by form of outcome of SOI: process, organisational, product, service and marketing. Each of them distinguishes between no innovation, incremental SOI and radical SOI. This sub-section presents the frequency of response for each of the items concerning SOI outcomes in the survey.

Regarding process SOI, the majority of the firms have introduced incremental improvements to their methods of manufacturing or supporting activities for sustainability, but the great majority has not introduced any logistics related SOI in the last year. Only a few have introduced radical process SOIs in the last year, as illustrated in Table 29.

Table 29. Sorting of firms by process SOI outcomes

	No SOI		Incremental SOI		Radical SOI	
Process SOI	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Methods of manufacturing or producing goods or services that improve the environmental or social impact of the company	55	32,4	91	53,5	24	14,1
Logistics, delivery or distribution methods for your inputs, goods or services that improve the environmental or social impact of the company	103	60,3	58	34,1	9	5,3
Supporting activities for your processes that improve the environmental or social impact of the company, such as maintenance	57	33,5	96	56,5	17	10

systems or operations for purchasing, accounting, or computing						

As shown in Table 30, the majority of firms has not introduced any organisational SOIs in the last year, and only a few have introduced radical organisational SOIs. However, a considerable number of them has introduced incremental innovations in this regard.

Table 30. Sorting of firms by organisational SOI outcomes

	No SOI		Incremental SOI		Radical SOI	
Organisational SOI	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Business practices for organising procedures in a sustainable way (i.e. sustainable supply chain management, business reengineering, lean production, environmental management systems, etc.)	74	43,5	78	45,9	18	10,6
Methods of organising work responsibilities and decision making to improve the environmental and social impact (i.e. sustainability education/training systems, creation of sustainability task forces, etc.)	78	45,9	76	44,7	16	9,4
Methods of organising external relations with other firms or public institutions to foster sustainability (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc)	92	54,1	69	40,6	9	5,3

Table 31 illustrates how the studied firms have not developed, in the great majority, product SOIs. However, the greatest number of product SOIs is concentrated around the technology category, rather than final products.

Table 31. Sorting of firms by product SOI outcomes

	No SOI		Incremental SOI		Radical SOI	
Product SOI	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Technologies that improve the social or environmental performance	79	46,5	72	42,4	19	11,2
Consumer products that improve the social or environmental performance	102	60	60	35,3	8	4,7
Products sold to other businesses that improve the social or environmental performance	104	61,2	51	30,6	14	8,2

Along with marketing SOI, service SOI is the category where companies in the sample have been the less active, as displayed in Table 32. Radical SOIs in this category are scarce and the great majority of the firms has not introduced service SOIs in the last year. However, the category in which more SOIs have been introduced is that of basic services.

Table 32. Sorting of firms by service SOI outcomes

	No SOI		Incremental SOI		Radical SOI	
Service SOI	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Maintenance or after-sale services that improve the social or environmental performance	117	68,8	47	27,6	6	3,5
Professional services (consultancy, advisory…) that improve the social or environmental performance	111	65,3	48	28,2	11	6,5
Basic services, that improve the social or environmental performance (i.e. waste clean-up, efficient electricity distribution, etc.)	87	51,2	71	41,8	12	7,1

Finally, regarding marketing SOIs, they have not been widely introduced by the respondent firms in the last year, as shown in Table 33. However, it must be noted that the radical / incremental SOI ratio is the highest for this form of innovation.

Table 33. Sorting of firms by marketing SOI outcomes

	No SOI		Incremental SOI		Radical SOI	
Marketing SOI	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Changes to the design or packaging of a good or service to reduce its environmental or social impact	106	62,4	53	31,2	11	6,5
New media or techniques for good or service promotion highlighting sustainability (green branding)	102	60	57	33,5	11	6,5
New methods for good or service placement or sales channels that seek to create markets for sustainable innovations	119	70	36	21,2	15	8,8

This preliminary analysis of the SOI outcomes of the respondent firms shows that radical SOI is scarcer than incremental SOI in all forms of innovation outcome; however, some categories achieve better outcomes. Process SOI is the form of innovation that yields more results in the studied companies, whereas service and particularly marketing SOIs are rarer. However, although process SOI is the category that produces more radical SOIs in absolute terms, the ratio to incremental SOIs in larger in the case of marketing SOIs. Notably, there are many firms that do not yield any kind of innovation in some of the categories, and perhaps quite surprisingly, the ratios of no innovation in the product and service categories are relatively high. The characterisation of the sample suggests that the majority of the firms is still in an early or medium stage of adoption of SOI practices, where changes that affect the whole business model and organisational culture and routines (organisational and marketing SOIs) are only starting to be taken. On the contrary, SOIs affecting operational matters such as process SOIs or sustainability-oriented technologies are more widespread; however, product and service SOIs, which have a direct market impact, are only present in less than half of the studied companies.

In order to assess the overall SOI performance and in terms of incremental or radical nature, three aggregated index variables were developed, the first one, adding up the responses for all SOI outcome items; the second, aggregating the responses for incremental SOI in all categories, and the third, summing up the responses for radical SOI in all categories. Table 34 describes the sample observing these index variables.

Table 34. Descriptive statistics for SOI general, incremental and radical indexes

	N	Minimum	Maximum	Mean	Std. Deviation
SOI Index	170	0,00	28,00	8,0235	6,19692
SOI Incremental Index	170	0,00	15,00	5,6706	4,20169
SOI Radical Index	170	0,00	13,00	1,1765	2,41385
Valid N (listwise)	170				

These results confirm the evidence presented in the previous tables that the firms in the sample are not in a very advanced stage of implementation of SOI practices, since the average is far from the maximum. However, the variation among companies will allow examining the extent to which the dynamic capabilities for SOI identified in the qualitative study of the research are related to high SOI outcomes, as investigated in the Section 6.3.

6.3. Capabilities for SOI

The qualitative study of the dissertation yielded interesting results concerning the development of dynamic capabilities for SOI in three strategic dimensions (sustainability driven market sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership). However, the insight obtained in the qualitative study cannot be translated into a quantitative study of cross-sectional nature such as the present. Therefore, although the preliminary results of the qualitative study resulted in the inclusion of a set of scales for market, organisation and networking related capabilities in the survey, the analysis of the obtained data aims to respond to different research sub-questions. These capabilities such as alliance capabilities have often been portrayed as "dynamic capabilities" in the literature (Lawson and Samson, 2001; Wang and Ahmed, 2007; Wu et al., 2013). However, examining their dynamic effect is not possible due to the cross-sectional nature of study; therefore, capabilities at the moment of the survey are examined, since the dynamicity of such capabilities cannot be assessed.

The ready-scales selected for the survey instrument are market responsiveness, and knowledge assimilation, and, when it comes to alliance capabilities; alliance proactiveness and alliance portfolio coordination. Market responsiveness is the capability of the firm to rapidly adapt to evolving market demands (Atuahene-Gima, Slater and Olson, 2005; Garrett et al., 2009). Knowledge assimilation represents the firm's ability to develop processes and routines to analyse, interpret and understand knowledge acquired from the external environment of the firm (Flatten et al., 2011; Szulanski, 1996). Alliance proactiveness refers to the ability of the firm to identify potential, valuable partners and support with empirical evidence the impact that partnering with them might have on market performance (Sarkar et al., 2009; Schilke

and Goerzen, 2010). Lastly, alliance portfolio coordination is concerned with the integration of a firm's strategic alliances into its structure (Goerzen, 2005; Schilke and Goerzen, 2010).

The hypotheses are tested individually using linear regression. Firm size, measured by turnover, is introduced as a control variable, since it has been identified by previous literature as a determinant of innovativeness (Chandy and Tellis, 2000). In addition, firm age (measured in years) is also controlled for, since the rate and magnitude of innovation activities may vary when they enter a rather exploitative phase (Henderson and Clark, 1990; Huergo and Jaumandreu, 2004). In order to control for industry, three dummies for manufacturing, trade and logistics and services were created by aggregating the responses classified under the NACE Rev. 2 classification (Eurostat, 2008) – see Footnotes 8, 9 and 10-. The manufacturing dummy is used as the benchmark, since it is the most numerous group as illustrated in Table 23. R&D intensity is also deployed as a control variable, since it may affect the number of SOIs introduced. Sustainability orientation is also used as a control variable since the sustainability culture in the firm greatly explains sustainability outcomes in the firm, either in innovation or other aspects: it has been it is a relevant factor influencing new product development in SOI (Claudy, Peterson and Pagell, 2016). The turnover, firm age and radical SOI variables underwent logarithmic transformation so as to ensure a normal distribution.

The studied hypotheses examine the success of SOI outcomes in consideration of the relationship of the firm with its external environment and the integration of the acquired competences and knowledge into the firm's capabilities set.

6.3.1. Market responsiveness and knowledge assimilation

Based on the idea of examining a variable assessing the relationship of the firm with its environment and how the integration in the firm is carried out, and on the ground of the qualitative insights suggesting that both internal and external factors concur in capability development, the first section of the quantitative study tests the influence of market responsiveness (Garret et al., 2009) and knowledge assimilation (Flatten et al., 2011) on incremental and radical SOI.

Table 35. Correlations between SOI indexes, market responsiveness and knowledge assimilation

		Market Responsiveness	Knowledge Assimilation
Incremental SOI Index	Pearson Correlation	**,266****	**,197****
	Sig. (2-tailed)	,000	,010
	N	170	170
Radical SOI Index	Pearson Correlation	**,246****	**,307****
	Sig. (2-tailed)	,001	,000
	N	170	170

** Correlation is significant at the 0.01 level (2-tailed).

As observed in Table 35, market responsiveness and knowledge assimilation are positively correlated to both incremental and radical SOI. The next table presents the results for incremental SOI (Table 36).

Table 36. Results of the regression of market responsiveness and knowledge assimilation for incremental SOI

Model	Dependent: Incremental SOI	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1,777	3,646		-,487	,627
	Firm Age	-,484	,521	-,068	-,929	,354
	Sales	,268	,202	,099	1,328	,186
	R&D Intensity	,120	,320	,031	,374	,709
	Trade DUMMY	-,350	,754	-,037	-,465	,643
	Services DUMMY	,921	,833	,084	1,106	,270
	Sustainability Orientation	,829	,191	,339	4,337	**,000*** **
2	(Constant)	-2,133	3,645		-,585	,559
	Firm Age	-,480	,520	-,067	-,923	,358
	Sales	,219	,206	,081	1,062	,290
	R&D Intensity	,024	,325	,006	,073	,942
	Trade DUMMY	-,238	,754	-,025	-,316	,753
	Services DUMMY	,984	,832	,090	1,183	,239
	Sustainability Orientation	,757	,198	,310	3,819	**,000*** **
	Market Responsiveness	,559	,348	,177	1,605	,110
	Knowledge Assimilation	-,187	,305	-,066	-,615	,539

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

As observed in Table 36, neither market responsiveness nor knowledge assimilation are relevant for incremental SOI outcomes. This holds true for radical SOI as well, as illustrated in Table 37.

Table 37. Results of the regression of market responsiveness and knowledge assimilation for radical SOI

Model		Unstandardized Coefficients		Standardized Coefficients		
Dependent: Radical SOI		B	Std. Error	Beta	t	Sig.
1	(Constant)	-13,245	2,206		-6,004	,000
	Firm Age	,595	,315	,132	1,888	**,061***
	Sales	,282	,122	,165	2,308	**,022****
	R&D Intensity	,295	,194	,119	1,524	,129
	Trade DUMMY	,765	,456	,127	1,678	**,095***
	Services DUMMY	,652	,504	,094	1,294	,197
	Sustainability Orientation	,536	,116	,346	4,638	**,000*****
2	(Constant)	-13,373	2,203		-6,071	,000
	Firm Age	,590	,314	,131	1,878	**,062***
	Sales	,239	,124	,140	1,922	**,056***
	R&D Intensity	,227	,196	,092	1,158	,248
	Trade DUMMY	,831	,456	,138	1,823	**,070***
	Services DUMMY	,668	,503	,096	1,327	,186
	Sustainability Orientation	,478	,120	,309	3,988	**,000*****
	Market Responsiveness	,265	,211	,132	1,259	,210
	Knowledge Assimilation	,021	,184	,011	,112	,911

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

The results show that neither market responsiveness nor knowledge assimilation are statistically relevant for the development of SOIs. However, these models show that sustainability orientation is a very relevant variable in the development of SOIs, illustrating how a sustainability-oriented corporate culture is important in determining the inclusion of sustainability objectives in innovation. Other control variables such as firm age, size and sector were also relevant in the case of radical SOI; however, R&D intensity was not relevant for the development of incremental or radical SOIs.

In any case, we may observe that these two capabilities are correlated to sustainability orientation (as indicated in Table 38), suggesting that they are present in

sustainability-oriented companies. Therefore, they are somehow related to SOI; even if they are not sufficiently strong predictors of SOI outcomes.

Table 38. Correlation of capabilities for SOI and sustainability orientation

		Sustainability orientation
Market responsiveness	Pearson Correlation	**,370****
	Sig. (2-tailed)	,000
	N	170
Knowledge assimilation	Pearson Correlation	**,348****
	Sig. (2-tailed)	,000
	N	170

** Correlation significant at the 0.01 level (2-tailed).

These results suggest that market responsiveness and knowledge assimilation are features present in sustainability-oriented companies.

6.3.2. Alliance proactiveness and alliance portfolio integration

As the qualitative study of this dissertation showed, networking is of utmost importance for the development of SOIs. This has also been signaled by previous literature on SOI (Ayuso et al., 2011, Castiaux, 2012; Van Kleef and Roome, 2007). Following the logic of examining aspects relating to the relationship of the firm with its partners and how this is translated into the firm; the following models examine the influence of alliance proactiveness (Sarkar et al., 2009) and alliance portfolio integration (Schilke and Goerzen, 2010) on SOI outcomes, representing the capabilities needed at the alliance pre-formation and post-formation stages (Wang and Ragagopalan, 2015). Table 39 shows to what extent alliance capabilities and SOI indexes are correlated:

Table 39. Correlations between alliance capabilities and SOI indexes

		Alliance proactiveness	Alliance portfolio coordination
Incremental SOI Index	Pearson Correlation	**,365****	**,405****
	Sig. (2-tailed)	,000	,000
	N	170	170
Radical SOI Index	Pearson Correlation	**,337****	**,301****
	Sig. (2-tailed)	,000	,000
	N	170	170

** Correlation is significant at the 0.01 level (2-tailed).

Table 40. Regression results of alliance-related capabilities on incremental SOI

Model		Unstandardized Coefficients		Standardized Coefficients		
Dependent: Incremental SOI		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1,777	3,646		-,487	,627
	Firm Age	-,484	,521	-,068	-,929	,354
	Sales	,268	,202	,099	1,328	,186
	R&D Intensity	,120	,320	,031	,374	,709
	Trade DUMMY	-,350	,754	-,037	-,465	,643
	Services DUMMY	,921	,833	,084	1,106	,270
	Sustainability Orientation	,829	,191	,339	4,337	**,000*** **
2	(Constant)	5,821	4,020		1,448	,150
	Firm Age	-,801	,510	-,112	-1,570	,118
	Sales	,009	,207	,003	,044	,965
	R&D Intensity	-,258	,323	-,066	-,801	,424
	Trade DUMMY	-,239	,736	-,025	-,324	,746
	Services DUMMY	,427	,812	,039	,526	,599
	Sustainability Orientation	,594	,194	,243	3,067	**,003** **
	Alliance proactiveness	,321	,462	,076	,695	,488
	Alliance port. coordination	1,189	,466	,283	2,551	**,012** **

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

As observed in Table 40, alliance proactiveness is not relevant for incremental SOI, while alliance portfolio coordination is. On the contrary, in the case of the development of radical SOIs, alliance proactiveness is statistically relevant while alliance portfolio coordination is not, as observed in Table 41. In this case, sustainability orientation, industry and firm age are also relevant:

Table 41. Regression results of alliance-related capabilities for SOI

Model		Unstandardized Coefficients		Standardized Coefficients		
Dependent: Radical SOI		B	Std. Error	Beta	t	Sig.
1	(Constant)	-13,245	2,206		-6,004	,000
	Firm Age	,595	,315	,132	1,888	**,061***
	Sales	,282	,122	,165	2,308	**,022** **
	R&D Intensity	,295	,194	,119	1,524	,129
	Trade DUMMY	,765	,456	,127	1,678	,095*

	Services DUMMY	,652	,504	,094	1,294	,197
	Sustainability Orientation	,536	,116	,346	4,638	**,000*** **
2	(Constant)	-11,649	2,497		-4,665	,000
	Firm Age	,618	,317	,137	1,948	**,053***
	Sales	,209	,128	,122	1,627	,106
	R&D Intensity	,219	,200	,088	1,091	,277
	Trade DUMMY	,962	,457	,160	2,103	**,037****
	Services DUMMY	,520	,504	,075	1,032	,304
	Sustainability Orientation	,482	,120	,311	4,007	**,000*** **
	Alliance Proactiveness	,697	,287	,262	2,430	**,016****
	Alliance Port. Coordination	-,311	,289	-,117	-1,075	,284

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

These results suggest that in the case of alliance-related capabilities, the post-formation stage capabilities, or how the firm organises and integrates the boons of participating in alliances are more relevant for incremental SOI. However, radical SOI requires proactivity on the side of the firm, in order to find the right partners for the development of completely novel SOIs. This is summarised in Figure 28:

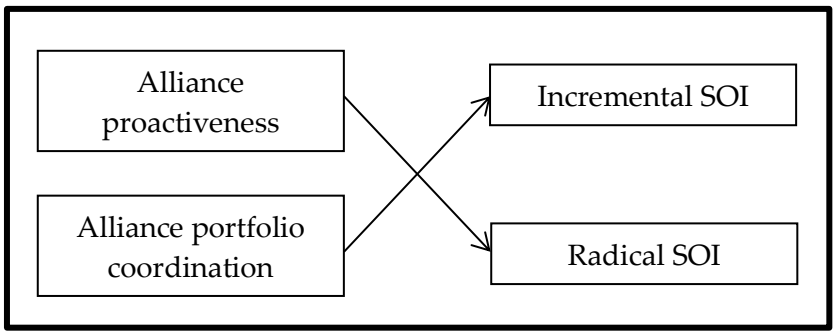

Figure 28. Relationship between alliance related capabilities and SOI

6.4. Knowledge search strategies for SOI

Due to the systemic nature of SOI (Loorbach et al., 2010) and the inclusion of various socio-economic and environmental demands in the innovation process (Harms et al., 2013; Tyl, Vallet, Bocken and Real, 2015), the engagement in SOI activities tends to blur the limits of the organisation. The aim of this section is to see how this openness of the organisation for SOI reflects on the internal and external knowledge search strategies of the firm. As observed in the previous section, alliance proactiveness is of major importance for the development of SOIs, reflecting increasing organisational openness as engagement in SOI activities increment. Knowledge assimilation has also

been shown to be of utmost relevance for SOI; thus the importance of exploring the impact of internal and external knowledge search strategies for SOI.

6.4.1. The relevance of diversity knowledge search strategies for SOI

Therefore, knowledge relevant to SOI activities, due to its systemic nature, is dispersed among different agents and levels (Adams et al., 2016; Geels, 2010). Previous literature (see Wassmer et al., 2014; for a review) has exposed how, with the aim complementing their capabilities and aligning their strategic goals with society and the environment, companies have partnered with multiple non-traditional partners. As compared with 'traditional' innovation, it might be argued that SOI requires searching for knowledge from non-traditional sources of innovation ideas so as to create sustainable value beyond the boundaries of the firm. Such partners include non-governmental organisations (NGOs) (Austin, 2000; Dahan, Doh, Oetzel and Yaziji, 2010; London, Rondinelli and O'Neill, 2005; Seitanidi and Crane, 2008), environmental organisations (Rondinelli and London, 2003), the government or government-related administrations (Ammenberg and Hjelm, 2003; Amundsen, 2000; Delmas and Montes-Sancho, 2010) or universities (Agrawal 2001; Perkmann and Walsh, 2007).

For innovation in general, empirical evidence shows that extending the breadth of knowledge search strategies improves innovation outcomes (Belderbos et al., 2004; Henttonen et al., 2011; Laursen and Salter, 2006). When distinction is made between internal and external sources of knowledge for R&D, Cassiman and Veugelers (2006) find that they are complementary activities; however, for basic R&D (normally carried out by universities or research centres) companies are more sensitive to external knowledge. Henttonen et al. (2011) found that knowledge search strategies involving market-driven, science-driven and generic-knowledge-drives were effective to improve the innovation outcomes (all except the intermediary-driven). Mina et al. (2014) found differences in knowledge search strategies depending on the industry.

Nevertheless, which types of knowledge search strategies are valuable for SOI has not been widely explored in the literature, despite Adams et al. (2012) signaling integrated thinking and knowledge management as key activities for engagement in SOI. De Marchi and Grandinnetti (2013) compared the knowledge search strategies of eco-innovators with those of non-green innovators; showing that eco-innovators rely more on knowledge search strategies outside their own supply chain, including universities, research institutions and competitors. Absorptive capacity has also shown to be relevant in integrating external knowledge for the development of eco-innovations (Guisetti et al., 2015). This section complements these studies by looking at the broad diversity of possible knowledge search strategies, and evaluating the distinct

impact that they might on different forms of SOI outcomes (process, product and service).

In any case, along with human capital, knowledge is a major resource needed for the development of advanced organisations (Eisenhardt and Santos, 2006), and as expressed in Section 6.3.1., knowledge assimilation is a capability related SOI outcomes. Knowledge is a micro-foundation and resource necessary for the development of dynamic capabilities (Felin and Hesterly, 2007) and extant literature has discussed its importance from a resource-based perspective (Martín-de-Castro, Delgado-Verde, López-Sáez, and Navas-López, 2010; Reed, Lubatkin and Srinivasan, 2006; Sveiby, 2001). Mothe, Nguyen-Thi and Triguero (2015) show that searching for external knowledge is positively associated with the development of environmental innovation. Thus, it is important to explore which are the knowledge search strategies that best serve as resources for engagement in different forms of SOI. The evaluated conceptual model is summarised in Figure 29:

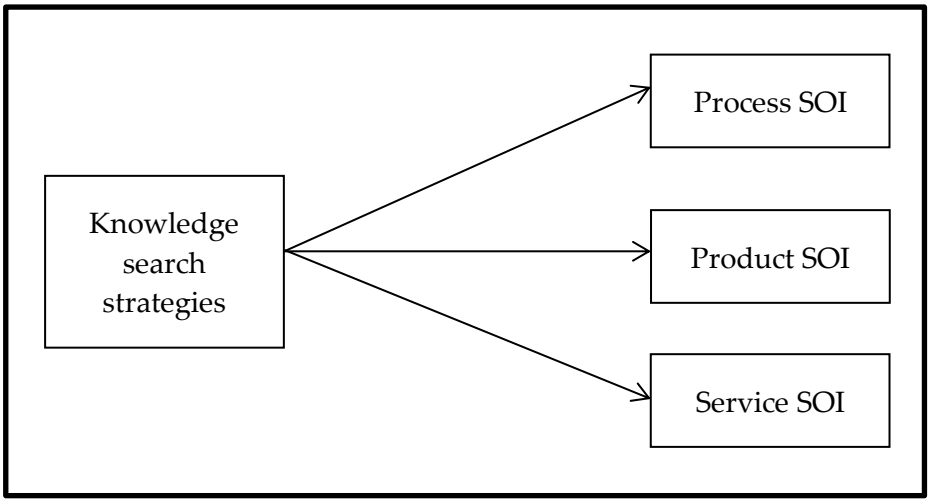

Figure 29. Conceptual model for knowledge search strategies for SOI

6.4.2. Variable development

The results of the qualitative study of the study suggested that different forms of SOI outcomes required different resources and capabilities. In searching for how these are influenced by different knowledge search strategies, instead of using the general SOI index as dependent measure, factor analysis (with free rotation) was conducted among all the formative items that composed the innovation forms in the survey (process, organisational, product, service and marketing), as explained in Section 3.6. The resulting categories are process SOI, product SOI and service SOI, as illustrated in Table 42.

Table 42. Factor components of process, product and service SOI

	Component		
	1 (Process)	2 (Product)	3 (Service)
Methods of manufacturing	**,686**	-,337	,082
Logistics, delivery of distributing methods	**,727**	-,195	,005
Supporting activities for processes	**,680**	-,441	,034
Business practices for organising procedures	**,690**	-,337	,141
Methods of organising work responsibilities and decision making	**,658**	-,321	,195
Methods of organising external relations	**,726**	,012	,065
Technologies	**,695**	-,237	-,020
Customer products	,640	**,304**	-,129
Products sold to other businesses	,607	**,171**	-,159
Maintenance or after-sale services	,569	,461	**,320**
Professional services	,631	,400	**,381**
Basic services	,650	,184	**,349**
Changes to the design or packaging	,572	**-,096**	-,551
New media or techniques for good or service promotion	,685	**,305**	-,393
New methods for good or service placement or sales channels	,715	**,259**	-,320

Extraction Method: Principal Component Analysis.
3 components extracted.

Regarding knowledge search strategies, from the 22 binary variables for different sources of knowledge extracted from previous literature (Henttonen et al., 2011; Laursen and Salter, 2006) and extended to cover all possible relevant knowledge sources for SOI, forced to four factor analysis was performed. After removing some of the variables that did not fit in any of the factors, four knowledge search strategies emerged:

1) *Market-related* (including own board of directors, own marketing department, own manufacturing department, own sales department, clients, competitors, and fairs and exhibitions), concerned with finding opportunities in the business environment, reflecting how the companies operate in their markets, and creating new markets and new business models.
2) *Research-related* (including own R&D department, commercial laboratories and R&D enterprises, universities or other higher education institutions and government research organisations) grounded on the acquirement of new knowledge in order to build from these knowledge, technologies artifacts and ideas.

3) *Standard-related* (including technical standards, health and safety standards and environmental standards) based on the vigilance of regulation as it demands new requirements from firms
4) *Society-related* (including NGOs, other public sector and trade associations) based on the scanning of the wider environment and stakeholders that may affect or be affected by the firm 'activities, business models and markets.

The factor components are shown in Table 43:

Table 43. Factor components of knowledge search strategies

	Component			
	1 Market	**2 Standards**	**3 Societal**	**4 Research**
Own board of directors	**,337**	,281	,089	,076
Own R&D department	,159	-,061	-,112	**,723**
Own marketing department	**,664**	-,017	,093	,123
Own manufacturing department	**,463**	,234	,076	,271
Own customer-interface / sales employees	**,608**	,220	-,012	,151
Clients or customers	**,579**	,195	,037	,027
Competitors	**,521**	,148	,245	-,216
Commercial laboratories/	,142	,191	,025	**,724**
Universities or higher education institutes	,013	,032	,456	**,534**
NGOs	,154	-,110	**,603**	-,024
Government research organisations	-,143	,303	,568	**,399**
Other public sector	,034	,282	**,720**	,099
Trade associations	,187	-,188	**,548**	-,174
Fairs, exhibitions	**,656**	-,004	,012	,035
Technical standards	,198	**,752**	-,085	,060
Health and safety standards and regulations	,152	**,817**	-,003	,019
Environmental standards and regulations	,180	**,808**	,112	,085

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 8 iterations.

Four index variables were formed for each of the knowledge search strategy (by summing up the binary variables together for each strategy). They all had normal distributions except for societal-related knowledge search strategies, onto which logarithmic transformation was performed.

6.4.3. Results

In order to analyze the relationship between the four knowledge search strategies and SOI outcomes in process, product and service, linear regression analyses in two steps were conducted for each of the dependent variables, as illustrated in Tables 44, 45 and 46. Considering the F values, the models for product and process SOI showed a good, significant fit. For these two models, the addition of the independent variables increased the explanatory power of the models, as illustrated by their R^2 values. However, this is not the case for service SOI, where no significant knowledge search strategies were found.

Table 44. Results of regression analysis of process SOI and knowledge sources

Model	Dependent: Process SOI	Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	R^2	(Constant)	-,995	,415		-2,397	,018
	0,157	Turnover	,073	,023	,238	3,239	**,001*** **
		Firm Age	,006	,059	,007	,097	,923
		Trade Dummy	,090	,086	,083	1,046	,297
		Services Dummy	,095	,095	,076	1,001	,318
		R&D Intensity	,137	,034	,307	3,983	**,000*** **
2	R^2	(Constant)	-,554	,421		-1,315	,190
	0,265	Turnover	,038	,023	,124	1,668	,097*
		Firm Age	,015	,057	,018	,255	,799
		Trade Dummy	,101	,082	,094	1,233	,219
		Services Dummy	,085	,093	,068	,917	,361
		R&D Intensity	,099	,037	,223	2,660	**,009*** **
		Market	,014	,021	,053	,688	,492
		Research	,043	,030	,122	1,413	,160
		Standards	,126	,034	,284	3,683	**,000*** **
		Societal	-,004	,020	-,014	-,196	,845

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

When it comes to process SOI, R&D related knowledge sources are somehow important, but standards take a major stance when it comes to the development of such innovations. Process SOI seems to be driven mainly by the response to regulation, as this is the most significant factor affecting its development. In this case, market-related

knowledge sources are not relevant, arguably because of the lack of visibility and direct benefits in use of process SOIs for consumers and clients.

Table 45. Results of regression analysis of product SOI and knowledge sources

Model	Dependent: Product SOI	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	R^2 (Constant)	-,912	,405		-2,253	,026
	0,145 Turnover	,057	,022	,191	2,577	**,011****
	Firm Age	,002	,058	,002	,033	,974
	Trade Dummy	,105	,084	,100	1,255	,211
	Services Dummy	,137	,093	,113	1,482	,140
	R&D Intensity	,136	,034	,314	4,039	**,000*****
2	R^2 (Constant)	-,521	,418		-1,247	,214
	0,229 Turnover	,029	,023	,096	1,257	,211
	Firm Age	-,005	,057	-,007	-,095	,925
	Trade Dummy	,119	,082	,114	1,459	,146
	Services Dummy	,115	,092	,095	1,251	,213
	R&D Intensity	,081	,037	,187	2,179	**,031****
	Market	,039	,020	,152	1,910	**,058***
	Research	,062	,030	,182	2,061	**,041****
	Standards	,052	,034	,122	1,538	,126
	Societal	,000	,020	-,001	-,015	,988

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

Product SOI, on the contrary, seems to be driven by other knowledge search strategies: market-related and research related knowledge sources are statistically significant in the development of product SOIs. Market players are important sources of future developments when it comes to products; hence, firms use the knowledge they acquire from these sources to guide the product development direction. By doing so, they reduce the risk of the innovation, since responding to market demands will more surely result in successful commercialization. R&D related knowledge sources are also significant for product SOI; this is explained by the need to incorporate new technical, advanced knowledge into new products. In fact, this is the most impactful factor in the development of product SOI.

Table 46. Results of regression analysis of service SOI and knowledge sources

Model Dependent: Service SOI		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1 R^2	(Constant)	-,964	,426		-2,265	,025
0,135	Turnover	,059	,023	,190	2,558	**,011****
	Firm Age	,056	,061	,068	,914	,362
	Trade Dummy	,211	,088	,192	2,391	**,018****
	Services Dummy	,393	,097	,310	4,041	**,000*****
	R&D Intensity	,036	,035	,081	1,033	,303
2 R^2	(Constant)	-,745	,458		-1,626	,106
0,153	Turnover	,046	,025	,149	1,861	**,065***
	Firm Age	,057	,062	,070	,923	,357
	Trade Dummy	,213	,089	,194	2,379	**,019****
	Services Dummy	,377	,101	,297	3,735	**,000*****
	R&D Intensity	,024	,041	,052	,578	,564
	Market	-,008	,022	-,029	-,353	,725
	Research	,024	,033	,066	,716	,475
	Standards	,047	,037	,105	1,264	,208
	Societal	,005	,022	,019	,242	,809

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

As service SOI is concerned, none of the knowledge sources appear to be significant. However, the significance of the industry dummies (particularly the industry dummies), and the non-significance of R&D intensity, as compared with process and product SOIs, suggests that service SOI presents very particular characteristics and is driven by a knowledge search strategy unexplored in this research. The results of this section are summarised in Figure 30.

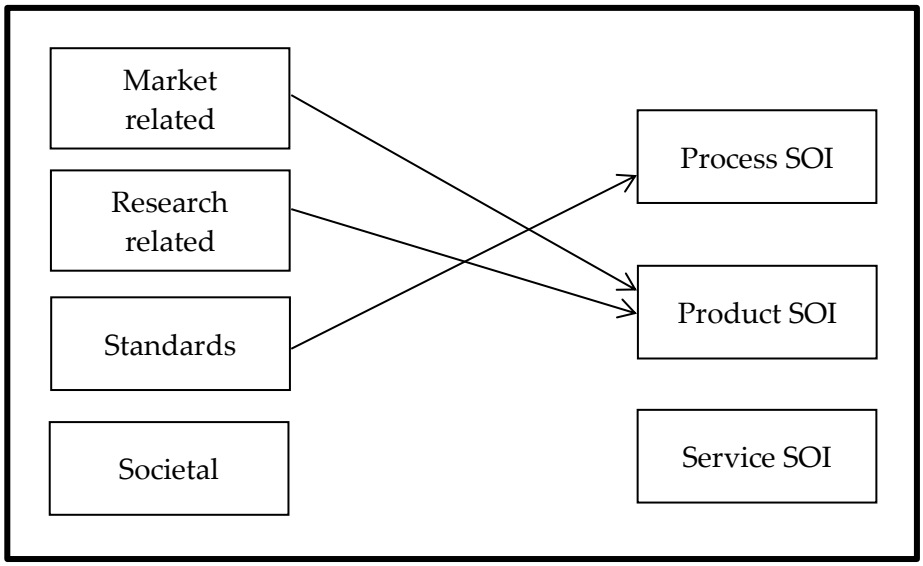

Figure 30. Summary of results of the relationship between knowledge search strategies and forms of SOI outcome

6.5. The relationship between SOI and firm performance

Although SOI includes the creation of economic value through novelty, it is worth exploring whether, beyond the value created by each of the SOIs, engaging in such activities is somehow associated with an improved firm performance. As previously discussed in Chapter 2, although the issue whether innovation may or may not be profitable for the firm has not been so widely discussed, whether sustainability pays off has been a commonplace theme of the sustainability management field. Despite mixed empirical evidence (Wood, 2010), the literature has set that sustainability performance creates a virtuous circle in which intangibles are fed by sustainable behaviour and these, in turn, affect financial performance positively (Hull and Rothenberg, 2008; Surroca et al., 2010), and that strategic sustainability provides with a competitive advantage (Hart, 1995; Hart and Dowell, 2011; Porter and van der Linde, 1995). However, the existence of these discrepancies when the sustainability element is involved provides with the rationale to examine the relationship between engagement in different forms of SOI and firm performance. Therefore, a contingency perspective is offered in which the different forms of SOI outcomes are compared with groups of low and high financial and customer performance and sustainability behaviour.

Regarding SOI and firm performance, there are scarce previous studies and they offer mixed results. In the research by Guisetti and Rennings (2014) only certain types of SOI were found to be profitable, and, in any case, this could not be pre-established, since those not profitable in the short run could become so in the future due to regulatory and market changes. In fact, the environment was also found to play a part

in the profitability of sustainability in the study by Kim et al. (2015), whereby CSR activities are only profitable in high-level competition conditions. Przychodzen and Przychodzen (2015) show that returns for shareholders are higher for eco-innovative firms in emerging economies. In addition, Huang and Li (2015) observe that green product and process innovation have a positive effect on the firm's organisational and environmental performance. Siegel (2010) advocates for the introduction of process SOIs that imply strategic activities to improve the firm's market performance.

The variables for the measurement of forms of SOI are the ones described in the previous Sections 6.3. and 6.4.1.2. Regarding the performance measures, three aspects of firm performance are evaluated: financial performance, customer performance and sustainability performance. The first two measures are extracted from the study of Hooley et al. (2005), looking at market, financial and customer performance. After performing factor analysis, two factors clearly emerged: one with the items for market and financial performance and another with the items of customer performance. Because of the measures for market and financial performance are so closely correlated, the three-item measure for financial performance and the four-item measure for customer performance are kept for analysis. When it comes to sustainability performance, the principles of the sustainable company by Epstein and Buhovac (2014) are assigned with a 7-Likert scale so as to create a formative scale describing sustainability behavior.

Due to the cross-sectional nature of the study and the self-reported, subjective and relative features of the measures (the respondents were asked about their perception of financial, customer and sustainability performance as compared with competitors and the last year) it would not be prudent to try to establish causal relations between different forms of SOI outcomes and the firm's financial, customer and sustainability performance. Therefore, in order to respond to the research question whether different SOI outcomes are related to different types of frm performance, independent sample T-tests were used to examine the mean differences in each of the forms of SOI outcomes, as illustrated in Tables 47, 48 and 49.

Table 47. Results of the T-test for financial performance and SOI outcomes by form

		Process SOI	**Product SOI**	**Service SOI**
Low financial performance	Mean	**0,52**	**0,33**	**0,39**
	n	97	97	97
	Std. Deviation	0,45	0,39	0,42
High financial performance	Mean	**0,79**	**0,59**	**0,51**
	n	73	73	73
	Std. Deviation	0,47	0,51	0,56

	Mean Difference	-0,26	-0,26	-0,12
	Sig. (two-tailed)	**0,000*** **	**0,000*** **	0,115

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

Table 47 shows the results for the study of the relationship between different forms of SOI and financial performance, illustrating the differences between the low and high financial performance groups. Looking at the statistical significance of each of the forms of SOI, it seems like high financially performing firms are more engaged in process and product SOI but not service SOI. Regarding process SOIs, due to their 'invisibility' for the average consumer, their positive association with financial performance may be linked to efficiency and quality gains resulting in higher ROI and profit margins due to cheaper or more quality production costs. This might be explained by the different nature of each of the types of SOI. Incrementally new sustainable products have to be more durable and efficient, responding directly not only to sustainability-related customer demands, but also to other customer needs, such as quality, performance and efficient use of resources at location of use (i.e., electric or water use). Disruptive product SOI also taps into new markets and responds to previously unanswered demands. For these reasons, product SOIs may improve the sales performance of firms, hence increasing their financial performance. It is noteworthy that there seems to be no relationship between service SOI and financial performance. This might be explained by the traditionally lower perceived environmental impact of services (except in some industries such as tourism): for this reason, the average consumer might not consider sustainability when purchasing services; hence not affecting financial performance. It might also be the case that service SOI has no relationship with financial performance but does with long-term value creation, which has not been observed in this dissertation.

Table 48. Results of the T-test for customer performance and SOI outcomes by form

		Process SOI	**Product SOI**	**Service SOI**
Low customer performance	Mean	**0,49**	**0,31**	**0,34**
	n	83	83	83
	Std. Deviation	0,43	0,38	0,39
High customer performance	Mean	**0,80**	**0,58**	**0,54**
	n	87	87	87
	Std. Deviation	0,48	0,50	0,55
	Mean Difference	-0,31	-0,27	-0,20
	Sig. (two-tailed)	**0,000*** **	**0,000*** **	**0,007*** **

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

When it comes to customer performance, it is notable that there is a statistically significant difference between lowly and highly performing percentiles in all forms of SOI outcomes, as displayed in Table 48. In addition, as compared with financial performance, the differences between percentiles are greater. This suggests that SOI, in any of its forms, is a manner in which long-term customer value is created, since it seems to have a positive relationship with the loyalty and satisfaction of clients. The reason for this could be that, although customers seem not be ready to pay more for sustainable services (see Table 47), implementing process, product and service SOIs may improve the reputation or quality that customers perceive of the company; hence improving their loyalty and satisfaction towards the firm in question.

When it comes to the differentiation of SOI by magnitude, it is worth observing whether incrementalism or radicalness have any relationship with the different aspects of firm performance. As illustrated by Tables 47, 48, and 49, firms that have a high financial, customer or sustainability performance have better outcomes for both incremental and radical SOI, showing a positive relationship between SOIs of any magnitude and firm performance.

Table 49. Results of the T-test for financial performance and SOI outcomes by magnitude

		Incremental SOI	**Radical SOI**
Low financial performance	Mean	**4,96**	**0,78**
	n	97	97
	Std. Deviation	4,04	1,95
High financial performance	Mean	**6,62**	**1,70**
	n	73	73
	Std. Deviation	4,26	2,85
	Mean Difference	-1,66	-0,92
	Sig. (two-tailed)	**0,01*** **	**0,02** **

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

Table 50. Results of the T-test for customer performance and SOI outcomes by magnitude

		Incremental SOI	**Radical SOI**
Low customer performance	Mean	**4,86**	**0,59**
	n	87	87
	Std. Deviation	4,04	1,65
High customer performance	Mean	**6,52**	**1,80**
	n	83	83
	Std. Deviation	4,23	2,90

	Mean Difference	-1,66	-1,21
	Sig. (two-tailed)	**0,010*** **	**0,001*** **

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

Table 51. Results of the T-test for sustainability performance and SOI outcomes by magnitude

		Incremental SOI	**Radical SOI**
Low sustainability performance	Mean	**4,40**	**0,34**
	n	85	85
	Std. Deviation	3,74	0,97
High sustainability performance	Mean	**6,94**	**2,01**
	n	85	85
	Std. Deviation	4,27	3,0
	Mean Difference	-2,54	-1,67
	Sig. (two-tailed)	**0,000*** **	**0,000*** **

*** Significant at the 0.01 level (2-tailed).

** Significant at the 0.05 level (2-tailed).

* Significant at the 0.1 level (2-tailed).

6.6. Discussion of results

The results in this chapter have complemented the information provided by the qualitative insight and provided with some more information regarding SOI and the knowledge search strategies needed for its development, and the association of SOI with different types of firm performance. This section will discuss such results under the light of previous literature and the theoretical framework of this thesis in order to build the joint interpretation of results of the qualitative and quantitative studies of the thesis to be presented in the next chapter. Figure 31, below, sums up the results of the quantitative study of the dissertation.

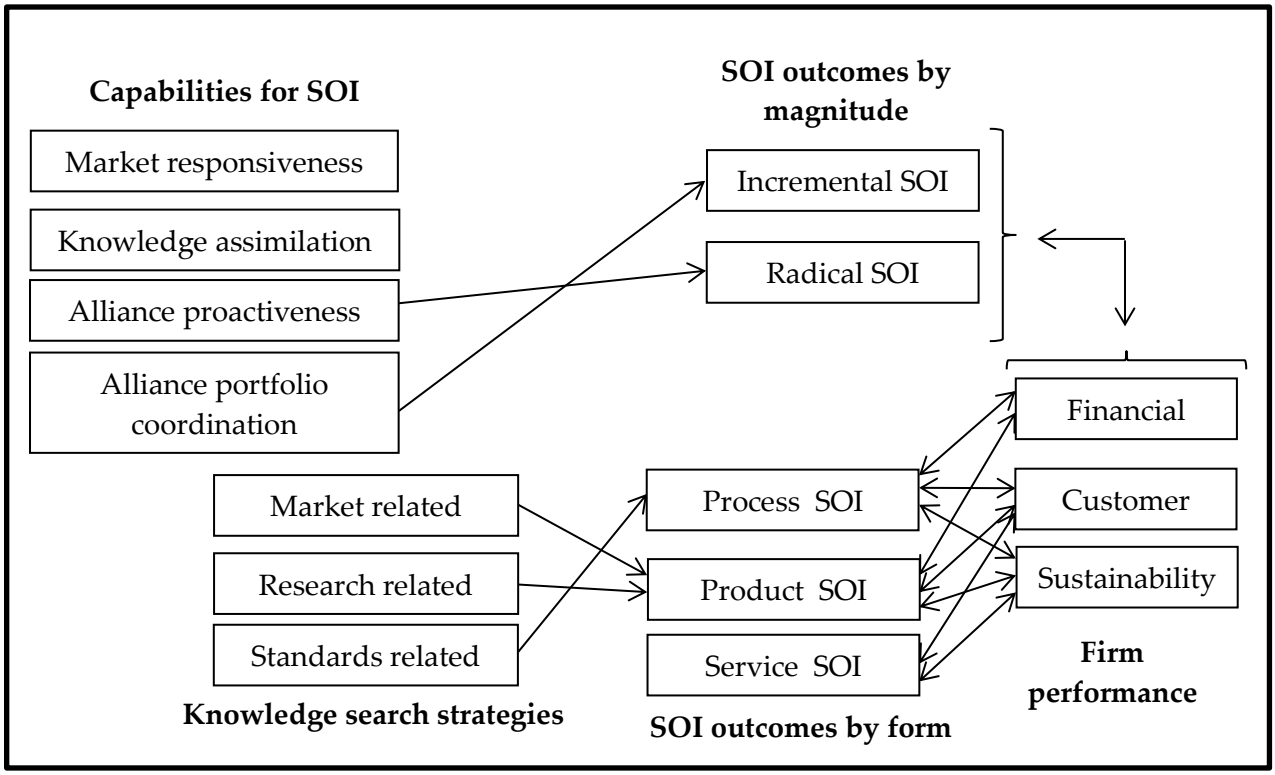

Figure 31. Summary of results of the quantitative study

6.6.1. The importance of alliances for SOI

Entering into alliances and relating to the external environment has been shown to be relevant by previous literature on SOI. Either from the capabilities perspective (Ayuso et al., 2011; Castiaux, 2012; Van Kleef and Roome, 2007) or rather looking at the effect of entering in partnerships for SOI outcomes (Guisetti et al., 2015; Nidumolu et al., 2014; Wassmer et al., 2014), research has affirmed that SOI has a clear collaborative component that must be taken into consideration when looking at SOI, as also confirmed by the other studies in this thesis (see Sections 4.3.2. and 5.2.3.2.). This is translated in two different results of the quantitative section of the dissertation. The first one is the relevance of alliance-related capabilities for the development of SOIs, and the second, the importance of both internal and external knowledge search strategies for SOI, which will be further discussed in the next section.

Coming to the issue of the relevance of alliance capabilities for SOI; it must be mentioned that from the capabilities studied in this dissertation these were the only statistically relevant ones. Market responsiveness and knowledge assimilation, on the contrary, do not appear to be statistically relevant for SOI. Although sustainability-oriented market sensing and seizing and sustainability embeddedness (which includes the assimilation of sustainability related knowledge) were shown to be important to the development of SOIs in the qualitative study of the thesis; the limited coverage of the selected variables does not imply that the results from the qualitative section are

refuted by the results of the quantitative study. From the in-depth analysis of the case studies, it is derived that responding to market needs in the development of SOI aid their economic viability and that the assimilation of sustainability-related knowledge is a pre-requisite for the inclusion of social and environmental goals in innovation. Nevertheless, there are complex processes behind this that have not been captured in the quantitatively evaluated direct relationship.

On the other hand, the study of the relationship between alliance-related capabilities and SOI has yielded interesting results. As indicated by these results, alliance proactiveness is statistically relevant for radical SOI, as alliance portfolio coordination is for incremental SOI. This suggests that the pre-formation stage is more relevant for the development of radical SOIs, this is when the firm's capabilities come into action. The reason for this might lie in the fact that firms need a more entrepreneurial action to carry out completely novel SOIs, looking for partners complementing their knowledge. Interestingly, the post-formation stage of the alliance seems to be more relevant for incremental SOI; signifying that alliance portfolio coordination capability is more important to maintain and exploit the yields of the jointly developed SOIs.

6.6.2. Access to SOI-related knowledge as a strategic resource

Knowledge has become an increasingly important for modern companies, to the extent of the conceptualization of the 'knowledge-based view of the firm' (Eisenhardt and Santos, 2006; Felin and Hesterly, 2007). Easterby-Smith and Prieto (2008) identify the close connection between knowledge and dynamic capabilities. Knowledge is a strategic resource of the firm and accessing, acquiring and exploiting it is of utmost important for SOI and innovation in general (Grant, 1996). As identified in the qualitative study, environmental dynamism is also a factor influencing the development of dynamic capabilities and learning processes.

When it comes to SOI, it has been argued that it requires a certain degree of openness so as to incorporate social and environmental interests in the innovation process (Adams et al., 2012; 2016; Driessen and Hillebrand, 2013). This also applies to knowledge search strategies, since knowledge has shown to be a central resource for the development of SOIs. Integrating internal and external knowledge sources in the innovation process connects the firm to its wider environment. In fact, as observed in the sample, both internal and external agents participate in the same types of knowledge search strategies, showing how company boundaries become increasingly blurred, as a sign of the firm's embeddedness in a wider system rather than performing in isolation.

Although collaboration seems to be paramount in the development of SOIs, as highlighted by the importance of alliance proactiveness as a dynamic capability, for process SOI standards were the most relevant knowledge search strategies, showing that the respondent companies adopt mostly a laggard approach to process SOI, adjusting to regulation rather than coming up with new ideas, although the importance of regulation-induced SOIs should not be underestimated (Ashford and Hall, 2011). Other knowledge search strategies might not be important for process SOI, since the advances made in this regard are hardly noticeable to the average client of the firm. On the other hand, the study shows that firms that lean on market and R&D related strategies yield more product SOIs, suggesting that these two search strategies are particularly useful in maximizing the product SOI outcomes. Market-related strategies help to avoid risk in commercialization, while R&D related strategies provide firms with the necessary knowledge to advance the technicalities of developing sustainable products.

However, it is notable that societal knowledge sources, including NGOs, institutions from the public sectors and trade associations were not relevant for the development of any form of SOI, at least for the sample. The opposite evidence was collected from the companies participating in the qualitative study of the study: although this was not the focal point of the investigation, collaboration and idea development from suggestions from NGOs and other civil society agents often came up as relevant for certain SOI developments. Nevertheless, the companies in the qualitative sample were selected for the fact that they belonged to a group of very advanced companies as it comes to SOI. Therefore, the contrasting evidence from the qualitative and quantitative samples seems to indicate that societal knowledge sources are perceived as relevant and aligned with their strategic goals only by companies that have fared far along their engagement in SOI. Thus, the fact that societal sources have not been shown as relevant for SOI in this sample does not neglect the findings in previous literature (Ayuso et al., 2006; Holmes and Smart, 2009), but rather suggest that, when it comes to SOI, average performers have not still incorporated societal interests as a knowledge source. Another possible explanation is that, at an early stage of SOI activities implementation, societal actors may play lobbyist and vigilant roles for firms, but do not provide them with actually new ideas that can be readily applied for SOI. Hence, the role of societal actors in firms' SOI (if not as knowledge providers) opens an area for further investigation.

6.6.3. The question of service SOI

After contemplating the results of the quantitative study of the dissertation, it is apparent that many of the questions regarding service SOI remain unexplained. First of all, it is a form of SOI that has not been widely implemented by the firms in the sample,

showing that there is not enough knowledge on how to engage in service SOI, or that is a form of SOI that requires advanced capabilities for its development.

In any case, none of the models for knowledge search strategies worked for service SOI. Despite the claim that integrating the interests of multiple agents in the innovation process nurtures SOI; none of the sources, internal or external, appeared to be relevant for the development of service SOI. This implies that there is an avenue for further research regarding service SOI; since the relevance of control variables was very different to those of product and process SOI; suggesting that service SOI is very particular and guided by rules and knowledge search strategies not contemplated in this study.

In addition, when evaluating the relationship of service SOI with different types of firm performance, no statistically significant relationship between service SOI and high or low financial performance was found. The reason for this might lie in the geographical limitation of the sample, since the Basque Country region, despite having very high productivity rations, shows a better performance in the manufacturing sector than in the services sector (Mas and Navarro, 2012). Therefore, one reason for not finding as much service SOI engagement and it not being related to financial performance may be that the services industries are not as advanced in relation to the manufacturing industries in the region. However, these results may also be related to methodological limitations, such as the quality of the measure for service SOI itself, since it is newly developed and has not been otherwise validated in other studies in terms of reliability, validity and content.

Nevertheless, the inability to find meaningful results for many aspects of service SOI indicates that it is guided by particular rules that have not been researched extensively and are not covered by existing constructs. This calls for research on service SOI in particular, looking at the particularities that seem to drive it, different from those of process and product SOI. This may include investigations on the bundling of service SOIs with other forms of SOI (product-service systems, servitization of business models), how they are developed and their impacts on firm performance.

In any case, the fact that service SOI is associated with higher levels of customer and sustainability performance of the firms could be established, indicating that the value created by service SOI may be captured only in the long-term, or that is more widely distributed across the firm's system and a smaller share of that value is captured by the firm in the form of an improved financial performance.

Chapter 7

Conclusions

7.1. Introduction

The aim of this chapter is to present and discuss the main contributions of the dissertation, highlighting the implications that the conclusions drawn from this research have for both theory and practice. The main aim of the thesis was to find out how firms engage in SOI from an organisational perspective. First, the review of the literature indicated that there are five components to SOI as a complex adaptive system (operational, collaborative, organisational, instrumental and holistic) and that these relate to each other under the system and complexity rules of self-reinforcement, non-linearity and emergence towards convergence in the holistic component. Second, the results of the qualitative study showed that firms develop evolving dynamic capabilities in three strategic dimensions – sustainability-oriented market sensing and seizing, sustainability embeddedness and sustainability-based talent, team-building, networking and leadership-. These dynamic capabilities are ordered in an ascending complexity hierarchy in incremental, renewing and regenerative capabilities. In addition, it was also apparent that the environment of the firm has an influence in how these dynamic capabilities are developed. Third, it was observed that, in order to successfully engage in SOI, these dimensions have different levels of relevance depending on the SOI outcome by magnitude (incremental or radical). Fourth, different knowledge search strategies have been indicated to be effective for different type of SOI outcomes (process, product or service). Finally, evidence was provided to show that there is a close relationship between different forms of SOI and the firm's financial and customer performance.

The structure of this chapter runs as follows. Next, Section 7.2. will provide with a summary of the results of the thesis, answering each of the research sub-questions and discussing how these contribute to building a framework to respond to the main research question of the thesis. Section 7.3. will deal with the main contributions of the thesis to the realm of theory; while Section 7.4. will do so for the realm of practice. After that, Section 7.5. will recapitulate on the main limitations of the investigation, and Section 7.6. will explore new avenues for research derived from the present research.

7.2. Answering the research questions

7.2.1. Summary of results of the whole thesis

As illustrated in Figure 2 (Chapter 1), the main research question of the thesis was how firms engage in SOI. Apart from identifying the research gaps that nurtured the formulation of the research questions to be responded empirically, the literature

review on SOI yielded some first results, based on a systemic view of the firm. These suggest that SOI is built around five different components: operational, collaborative, organisational, instrumental and holistic, the first four pivoting around an evolution towards the fifth one, which entails the previous.

In addition to this, in order answer to the identified research questions, the two branches of the study (qualitative and quantitative) provided answers to the sub-questions that have operationalised the dissertation. The summary of results is illustrated in Table 47.

Table 52. Summary of results of the dissertation

Sub-research question	Study	Main results
Which are the ontological components of SOI; and how do they relate to each other?	Literature review	There are five ontological components of SOI: operational, collaborative, organisational, instrumental and holistic. They relate to each other as a complex adaptive system, following rules of self-reinforcement, non-linearity and emergence.
Which dynamic capabilities enable the engagement of firms in SOI?	Qualitative	There are three dimensions of dynamic capabilities for SOI: sustainability-oriented market-sensing and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership.
How are dynamic capabilities for SOI structured in different levels?	Qualitative	Each of the dimensions of dynamic capabilities follows a path-dependent, self-reinforcing evolution along three levels (incremental, renewing and regenerative) affected by environmental conditions.
How are capabilities for SOI relevant for incremental and radical SOI outcomes?	Quantitative	Market responsiveness and knowledge assimilation were not found to be sufficiently strong predictors of SOI outcomes, but are relevant features of sustainability-oriented companies.
How are alliance capabilities for SOI relevant for incremental and radical SOI outcomes?	Quantitative	Alliance proactiveness is relevant for radical SOI and alliance portfolio coordination is relevant for

		incremental SOI.
What knowledge search strategies favour engagement in SOI?	Quantitative	Standards-related knowledge search strategies are relevant for process SOI; while market-related and research-related knowledge search strategies are relevant for product SOI. None of the studied knowledge search strategies are relevant for service SOI.
When does SOI pay off?	Quantitative	Process and product SOI are relevant for financial, customer and sustainability performance, while service SOI is relevant for customer and sustainability performance but not for financial performance.

7.2.2. A firm-centred systemic model of SOI

Based on the results summarised in the previous section, it is possible to construct a model of SOI that integrates the findings of the dissertation and responds to the main research question; *how do firms engage in SOI?* The main arguments that support this claim are based on the responses to the research questions found in the dissertation, and are summarised as follows:

a) *SOI at the organisational level is supported by the development of dynamic capabilities in three different dimensions*. These are sustainability-oriented market-sensing and seizing, sustainability-embeddedness and sustainability-based talent, team-building, networking and leadership. When firms first embark in a SOI journey, their starting point regarding existing capabilities for SOI is different, their strengths and resources lie at different dimensions. Therefore, as this research shows that the development of dynamic capabilities is path-dependent, assuming that the gradual integration of SOI-related activities and form of engagement in SOI would be the same for all companies would not seem correct. This suggests that there are certain patterns of development but that a single path of progression cannot be established.

   In addition, the three dimensions of dynamic capabilities for SOI have self-reinforcing properties. In other words, the evolution in each of these dimensions, particularly when the highest degree of development (regenerative dynamic capabilities) is achieved, nurtures the development of

the others. Consequently, some patterns towards progression towards regenerative dynamic capabilities in the three dimensions can be established, but how this happens depends on the idiosyncrasy of each firm and will be organisationally embedded.

b) *Because of the role of external or deliberate processes, the SOI journey is non-linear*. It must be reminded that the firm, in its development towards system-building – the holistic component of SOI – will not only be affected by the path-dependent processes entailed in the evolution of dynamic capabilities. On the one hand, as observed in the empirical investigation, environmental changes greatly affect the development of such dynamic capabilities for SOI; that is, the economic, social, technological or regulatory environment, and not only the intra-organisational processes of the firm, will guide the gradual engagement in SOI. On the other hand, we must to take into consideration that the firm, as a social system, is built by a series of individuals who will make decisions based on the limited information available, decisions which may leapfrog or hold back the progression towards holistic SOI at any given point. Therefore, it is important to understand that the journey towards holistic SOI will be non-linear. Moreover, the findings in the quantitative section indicate that different capabilities are necessary for different types of SOI outcomes (incremental or radical), suggesting that the firm's orientation towards innovation will also affect the development of dynamic capabilities for SOI and their associated activities.

c) *External dynamic and changing environments affect the way in which the firm engages in SOI*. Finally, the investigation has shown that, even if the focus of the study has been placed on the organisational aspects of the firm, external environmental dimensions keep appearing as important for the development of SOI. First, it has been shown that the external environment and changes in affect the development of dynamic capabilities; second, the importance of networking as a dimension of dynamic capabilities for SOI has been evidenced, and third, external knowledge search strategies are relevant in SOI yields of the firm. Therefore, how the firm is ingrained in its system is relevant when studying engagement in SOI even from an internal, organisational perspective.

All this considered the main research question – *how do firms engage in SOI?* – is answered as follows, and summarised in Figure 32:

Firms engage in SOI in a non-linear, path-dependent journey whereby dynamic capabilities in the strategic dimensions of sustainability-oriented market-sensing

and seizing, sustainability embeddedness and sustainability based talent, team-building, networking and leadership are developed in increasing levels of complexity (incremental, renewing and regenerative). The development of such dynamic capabilities for SOI is affected not only by the internal path-dependent processes and deliberate decisions taken at the organisational level, but also by change occurred in the economic, social and environmental systems in which the firm is embedded, and the knowledge it is able to obtain from it.

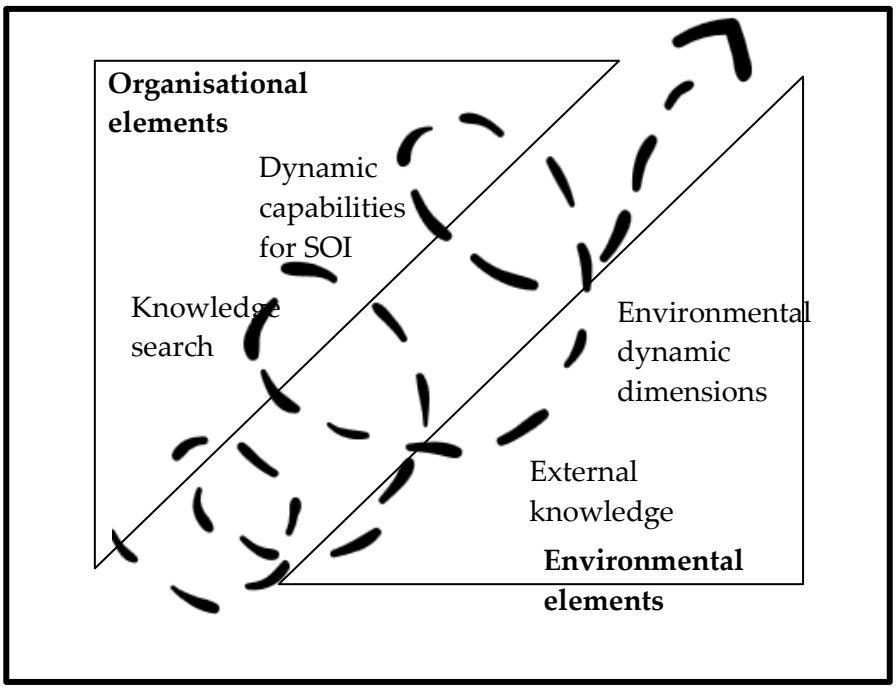

Figure 32. Model of SOI journey

7.3. Theoretical contributions

The theoretical implications of the thesis touch upon the main field of study of the dissertation, SOI, as well as the theoretical foundations that ground this research: innovation management, business sustainability, system theory and dynamic capabilities. The following sub-sections discuss the main conceptual implications of these contributions for each of these corpuses of research.

7.3.1. Implications for SOI research

The thesis contributes to the field of SOI research in multiple ways: (1) elaborating SOI theory from the systems and complex adaptive systems theory, explaining the main ontological components of SOI and the relationships between them; (2) identifying three hierarchies or levels of dynamic capabilities for SOI that are reinforced across three strategic dimensions of SOI; (3) observing that market

responsiveness and knowledge assimilation are relevant features of sustainability-oriented companies; (4) demonstrating the relevance of alliance capabilities in the pre-formation and post-formation stages for incremental and radical SOI; (5) examining the specific knowledge search strategies that yield best results for product, process and service innovation; and (6) illustrating the positive relationship between SOI outcomes and performance.

First, it provides with an elaborated model of engagement in SOI based on the complex adaptive systems theory; which differentiates from previous models (Adams et al., 2016; Carrillo-Hermosilla et al., 2010) highlighting the path-dependent, non-linear and emergent nature of the SOI journey in the manner in which the five ontological components of SOI (operational, collaborative, organisational, instrumental and holistic) interrelate. This opens the avenue for studying SOI rather from the systems theory perspective (Keskin et al., 2013; Van de Ven et al., 2008) than as a stage-gate process of development. In addition, it contributes with the understanding that both internal and external elements are important for the development of SOI, even at a firm level. This highlights the need to study SOI in its system context even when the focal point is the firm or an internal process. The results of the dissertation also indicate that, because of the multi-dimensional and non-linear nature of SOI, several considerations must be accounted for when determining the degree of engagement of the firm, since different degrees of development may be found in each dimension. Therefore, system theory, and specially complex adaptive system theory, helps to advance and elaborate theory on SOI providing new insight on how to deal with complexity and degrees of disorder that characterise SOI. Furthermore, this approach grounds further research on the engagement in SOI at the firm level, but taking into consideration the embeddedness of the firm in socio-technological systems for sustainability. It also provides the rationale for interdisciplinary research in the field of SOI due to its multiple ontological components, in order to respond more holistically to research questions related to how SOI unravels.

Second, in studying dynamic capabilities for SOI, the dissertation contributes to SOI research by finding the three main dimensions in which dynamic capabilities for SOI are developed: sustainability-oriented market-sensing, sustainability embeddedness and sustainability-based talent, team-building, networking and leadership. These findings provide with an overarching framework for more detailed study of the dynamic capabilities within each of these dimensions, in line with recent research carried out by Ayuso et al. (2011); Castiaux (2012) or Ketata et al. (2015). Therefore, this dissertation adds to theory in different novel ways (Whetten, 1989):

a) Framing the similarities of a multi-level and evolving hierarchical model of SOI capabilities.

b) Highlighting the impact of SOI strategic dimensions on the evolution of dynamic capabilities.
c) Framing differences across firms, illustrating the role that path-dependency plays on the SOI organisational journey.
d) Identifying the self-reinforcing behaviour across multi-level SOI dynamic capabilities and the three strategic SOI capability dimensions.

Third, the study of the influence of capabilities on SOI outcomes yielded interesting results. Despite the correlation between market responsiveness and knowledge assimilation with both incremental and radical SOI, the effect of these capabilities on SOI could not be demonstrated. However, it was shown that both of them are associated to sustainability-oriented companies. When coming to examine alliance capabilities, alliance proactiveness was found to be relevant for radical SOI, while alliance portfolio coordination was relevant for incremental SOI. This reinforces SOI research that distinguishes between the capabilities necessary for incremental and radical SOI (Carayannis et al., 2015) but also reinforces the existing literature that highlights the importance of alliances and collaboration for the development of SOIs (Ayuso et al., 2011; Guisetti et al., 2015), contributing to this research from the capabilities perspective.

Fourth, by studying knowledge search strategies, the thesis digs deeper on the networking dimension of SOI, throwing interesting results regarding the dissimilar yields in terms of SOI outcome by form –process, product or service- that each knowledge search strategies create. These results add to the very little investigation on knowledge search strategies for SOI done to date, focused on finding out the reliance of sustainability-oriented innovators on internal or external sources of knowledge (De Marchi and Grandinetti, 2013). Considering the importance given to knowledge search strategies for innovation in previous research (Belderbos et al., 2004; Henttonen et al., 2011; Laursen and Salter, 2006) and the need to incorporate sustainability concerns in the this research helps to expand the knowledge on how firms engaged in SOI obtained the necessary knowledge.

Finally, the thesis also shows how SOI matters for financial, customer and sustainability performance. This brings up the strategic dimension of SOI and contributes to the literature focused on when SOI pays off (Przychodzen and Przychodzen, 2015; Varadarajan, 2015). In particular, the positive contribution of SOI in every form for customer performance calls for more research on SOI and marketing, reputation, quality and customer satisfaction issues. Therefore, although the direct effect of SOI on performance could not be examined because of the cross-sectional nature of the study, the positive relationship observed calls for further research.

7.3.2. Implications for innovation management research

Showing that incremental and radical SOI are sustained by different sets of dynamic capabilities, this thesis supports claims that radical and incremental innovation require different organisational processes that are to be combined in the organisation either through integration or differentiation (Carayannis et al., 2015; Cembrero, 2013; Jansen et al., 2006). The view that different forms of innovation require distinct enablers is also confirmed by the findings on knowledge search strategies, which are not the same for each form of innovation outcome.

Another contribution of the dissertation to innovation management research lies on the systems theory approach, which has more often been applied to business sustainability, but offers an interesting way of approximating innovation as well (O'Connor, 2008; Van de Ven et al., 2008). By looking at the innovation process in this manner, it is possible to observe both the internal and external factors that take part in it, avoiding the traditional differentiation between 'closed-lab' and open innovation (De Marchi, 2012; Guisetti et al., 2015).

7.3.3. Implications for business sustainability research

Regarding business sustainability, the implications of this thesis are twofold. The findings about sustainability embeddedness as a dimension of dynamic capabilities for SOI confirms previous literature in that, in order to be strategically successful, sustainability must be aligned with company goals and be intersecting for all aspects, activities and departments of the firm (Aragón-Correa and Sharma, 2003; Bansal, 2005; Etzion, 2007; Gladwin et al., 1995; Hart, 1995; King and Lenox, 2002; Porter and Kramer, 2011; Porter and Van der Linde, 1995; Prahalad and Hart, 2001). Mere green-washing or occasional sustainability-related projects will not suffice if the aim is to develop sustainably from a triple-bottom line perspective (Elkington, 1998). In fact, the second contribution to the business sustainability literature resides in the long-standing discussion on how the inclusion of environmental and social goals in the firm affects financial performance (Kim et al., 2015; Orlitzky et al., 2003; Ramanathan, 2016; Surroca et al., 2010; Wood, 2010). In the case of SOI, it has been shown that it is positively related to customer performance, and in the case of process and product SOI, also to financial performance.

7.3.4. Implications for systems theory

The thesis adds to the applications of systems theory or perspective to organisations (Anderson, 1999; Eisenhardt and Piezunka, 2011; Mitleton-Kelly, 1997;

Senge and Sterman, 1992) and the innovation process (Hobday, 2005; Van de Ven et al., 2008). It extends on how the theory of systems, their components and relations to other systems may be used to untangle the complexity of interrelationships that characterises firms and their operations (Schneider et al., 2016). In this sense, it provides a view on how the firm as a system undergoes a path of organisational transformation through SOI engagement, this path having non-linear self-reinforcing properties (Ritala et al., 2016; Sydow et al., 2009). This adds to the literature of systems theory applied to innovation processes as well (Keskin et al., 2013; Van de Ven et al., 2008), showing that when multiple actors and contingent factors intervene in such process, systems theory may provide with a broader understanding to bring them together. The dissertation adopts systemic view of the causes of creation (Heidegger, 1954) finding relationships of self-reinforcement, non-linearity and emergence among components of SOI: operational, collaborative, organisational, instrumental and holistic. In this regard, this research is consistent with studies on the organisation and complexity theory (Anderson, 1999; Eisenhardt and Piezunka, 2011), which highlights the path-dependence and complex relationships in organisational evolution.

7.3.5. Implications for dynamic capabilities research

Drawing on previous classifications of dynamic capabilities in hierarchical order (Ambrosini et al., 2009; Winter, 2003), the thesis builds a model of dynamic capabilities for SOI based on a three-levelled ordering (incremental, renewing and regenerative dynamic capabilities) of increasing complexity, driven by path-dependence and environmental change. The classification also differentiates among dimensions on dynamic capabilities for SOI based on their goals (sustainability-oriented market sensing and seizing, sustainability-embeddedness and sustainability-based talent, team-building, networking and leadership). In doing so, it resonates with Teece's (2007) framework of sensing, seizing and reconfiguring dynamic capabilities; however, the findings in the qualitative study of the study show that in the case of SOI further distinction is needed as some important aspects of dynamic capabilities for SOI are not included in such framework.

The research also shows that, despite some patterns of common development as suggested by Eisenhardt and Martin (2000), dynamic capabilities are organisationally embedded and distinct for each firm (Felin et al., 2012; Ritala et al., 2016). Moreover, the findings indicate that different dimensions of dynamic capabilities are relevant for each magnitude of SOI outcome, which calls for alignment of organisational dynamic capabilities with deliberate strategic decision-making.

7.4. Managerial implications

Regarding managerial implications, the results of the thesis may help operationalise SOI in firms in the following manners. First, this research shows the evolutionary and path-dependent nature of dynamic capabilities for SOI in three strategic dimensions. In this sense, managers need to develop an action plan for SOI that draws on the existing resources of the firm, drawing on the resources needed to gradually develop competencies regarding sustainability-oriented market sensing and seizing, embedding sustainability in the firm's strategy and activities and finding talent, leaders and alliances that sustain the sustainability grounding of the firm. Therefore, the research suggests that in order to develop SOIs, managers must analyse the firm and assess which is the starting situation regarding resources and capabilities in these three strategic dimensions, in order to develop an strategy an action plan that builds on the existing strengths to gradually incorporate resources and competencies in other strategic dimensions.

Research shows that the required capabilities will develop in self-reinforcing processes but also as a result of deliberate decisions of managers. Therefore, in addition to the assessment, it is important that managers develop a strategy for SOI that takes into consideration not only the starting situation of the company, but also the SOI strategic goals that are to be achieved in the five components (operational, collaborative, organisational, instrumental and holistic). This will be necessary to align the innovation strategy of the firm (incremental, radical or ambidextrous) with the capabilities and firm activities that can be developed with the available resources and access to resources. In this regard, it is observed, as an example, which alliance capabilities are more necessary for incremental and radical SOI; consequently, depending on the innovation strategy of the firm, managers may aim for proactiveness in alliance formation in the case of radical SOI; or sustaining and making the most of existing alliances in the case of incremental SOI.

In this sense, aligning strategy with the aims of the forms has been proven important in the case of knowledge search. Distinct knowledge search strategies have been found to be differently relevant for different SOI outcomes (process, product and service). Thus, in a context of limited resources for knowledge search, these strategies must be aligned with the SOI goals of the firm, since extending such knowledge search across a wide array of knowledge sources might not prove as effective as concentrating on those knowledge sources relevant to the desired outcome.

A notable finding for practice is that SOI is related to better customer and sustainability performance, and in the case of process and product SOI, also to financial performance. Therefore, the findings in this thesis suggest that it is worth to embark in

SOI projects despite their increased complexity not only as a commitment to environmental and social sustainability but also as a form of providing the firm with improved financial and customer performance.

Finally, the thesis shows that applying systems theory to SOI might be useful to understand the components on which the challenges and solutions are classified into, the dynamic capabilities to be developed at the firm level and the myriad of environmental factors that have an impact on potential managerial decisions regarding SOI. Embracing the complexity of the firm as a system (embedded in wider systems) may help to diagnose and improve SOI related managerial decisions. Therefore, the break-up into five components of SOI is useful for managers in terms of defining work areas and operationalising the complex relationship between departments, persons and projects that make up the firm.

7.5. Limitations

The thesis has several limitations, which must be acknowledged at this point, and taken into consideration when drawing conclusions and generalisations from the findings presented along the dissertation.

First, a sampling limitation must be recognized. The fact that all of the sample companies (both in the qualitative and quantitative samples) are located in the Basque Country region limits the generalisability of the results to other institutional contexts; particularly because of the influence that environmental circumstances have shown to have on the objects of study. It has also been noted in previous chapters that the geographically limited sample might have affected the results regarding service SOI, which is not very much developed in the region (Mas and Navarro, 2012). In order to tackle this limitation, extra caution has been taken when deriving analytical generalisations from the cross-case comparison.

Nevertheless, the results on service SOI may be related to another limitation of the study, the quality of the measures for SOI in the questionnaire, since these have been newly developed and have not been tested and validated in other studies in terms of reliability, validity and content. However, it is noteworthy that the measures adopted to measure SOI are based on the definitions by the Oslo Manual (OECD and Eurostat, 2005), and that pre-testing of the questionnaire suggested that it was comprehensible by the respondents.

A major limitation of the research design is its cross-sectional nature, which may present problems due to its weaker internal validity as compared with longitudinal studies. Due to this limitation, it is not possible to determine absolutely unambiguous

relationships of causality despite the regression results (Bryman, 2008). In order to establish full causality, a longitudinal study that introduced time-effects and objective measures of performance (such as number of SOIs introduced or turnover in a series of years) would have needed to be developed. However, thanks to the random sampling strategy and the satisfactory response rate, replicability and external validity are strong.

In addition to its cross-sectional nature, another limitation of the quantitative study of the thesis is the fact that data is self-reported, which may bias responses towards socially desirable outcomes. Although objectives measures such as number of patents or investment in R&D are often used to measure innovation and objective measures are obtained for business sustainability from databases containing data from larger companies, self-reported measures are often utilized in the case of research on smaller firms because of the unavailability of other data. Moreover, in the case of SOI the lack of established measures calls for this form of measures for the purposes of this thesis.

7.6. Suggestions for further research

The thesis has been focused on the implementation of SOI at the organisational level; but without completely setting aside different dimensions of the interconnection between the organisation and the economic and socio-technical systems. However, due to the interest that these factors raise for the study of SOI, there are avenues for further research about the SOI journey at multiple levels:

- At the individual level, a major topic for further study is related to the effect that SOI leaders and intrapreneurs may cause in the organisational journey; in essence, how deliberate action by an individual creates a favourable culture and promotes SOI.
- At the project level, looking at SOI in individual innovation projects and identifying the particular challenges and complexities that may arise in those.
- At the network level, looking at SOI ecosystems of firms and other institutional actors working together for the development of SOI. These ecosystems may be delimited in geographical, technological or goal-seeking terms.
- At the socio-technical system level, it would be interesting to study the effects of SOI on the wider system, looking at economic, social, and environmental indicators of change in performance and behaviour.

- At the public policy level, it is necessary to develop further research on how public institutions aid or hinder SOI, what is the role of regulation and how it can be improved to sustain widespread SOI.
- At the Earth system governance level, whether SOI is actually making a contribution to the enhancement of Earth systems, and if so, what kind of contribution this is, would be an open avenue for study. Considering that more efficiency and reduced costs could lead to more consumption, assessing the efficacy of SOI to tackle environmental issues from an Earth systems perspective is necessary. Therefore, future research could be directed towards examining whether SOI is contributing to the decoupling of environmental degradation and economic growth.

As indicated in the previous section, a major limitation of the thesis is its cross-sectional nature. Longitudinal studies both at the qualitative and quantitative levels would provide with further insight on how engaging in SOI and organisational and system-level transitions are related.

Finally, as noted in Section 6.6.3., service SOI seems to be driven by other parameters that have not been studied in this thesis (in terms of knowledge search strategies and relationship with performance). Therefore, it seems that more research must be performed on SOI in services, since the factors and effects of this form of SOI have not been cleared by the results of this thesis in the way it has been done for process and product SOI.

Chapter 8

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Appendix 1

Interview protocols

A.1.1. Protocol for semi-structured interviews with company managers[11]

Interviewee:
Company:
Date:

First, thank the interviewee for her time. Explain what SOI is, the objectives of the project and why she is being interviewed.

1. How is innovation defined in the firm?

    a. What is the role of innovation in the firm?
    b. Please explain which your model of innovation is.
    c. How is innovation organised?

2. How is sustainability defined in the firm?

    a. Which are its objectives?
    b. Why is it important?
    c. What is its role in the firm?

3. On which pillars are the sustainability strategy and the innovation policies grounded?

    a. Organisational structure
    b. General or process management
    c. Transversal or departments
    d. How team and project leaders are related

4. How are sustainability and innovation integrated in the core business strategy?

5. How is the integration of sustainability criteria in innovation processes different to other companies?

6. Which do you think are the factors for success of innovation in the firm?

7. Which effects (direct and indirect) has the sustainability orientation of innovation have over the economic performance of the firm?

8. Does your firm have collaboration relationships with other agents? Which?

9. How is the integration of sustainability criteria in the innovation process reflected?

[11] Items ordered by letters in colour grey are suggestions for further development of the response of the interviewee in case she does not explain them by formulating the first heading, or if the response is not very clear.

a. New products or services
b. Improvements on existent products or services
c. Business models
d. Value chain or LCA
e. Processes
f. Markets
g. Others

10. Are the SOI projects the core business of the firm, or a business line that is testing the waters?

11. Which resources and capabilities are vital to develop innovations in the firm? (Explain what resources and capabilities are)

12. Which resources and capabilities are vital to develop SOIs in the firm?

13. Which sustainability criteria are accounted for?

    a. Environmental: LCA, CO2 emissions, materials…
    b. Social: fair trade, labour, inclusive technologies, user participation…

14. Where do new SOI ideas come from? Please draw the process of generation of new initiatives.

15. Where do ideas come from? Are they guided by a technology push or a market pull?

16. What percentage of the innovations of the firms is originated in each of the following options?

    a. The purpose of developing a new, sustainable product, service or process
    b. The purpose of responding to unsolved challenges
    c. Wanting to take advantage of new opportunities.
    d. The development of a new technology or solution in the firm, for which a market must be found

17. What is the role of the stakeholders in the innovation process? Is there any platform of ongoing collaboration, or partnerships with any of them?

18. What methodologies are followed for innovation?

    a. Eco-design
    b. Staged gate
    c. Design thinking
    d. Others

19. Do you measure the degree of innovation or sustainability through any indicator?

Close interview. Thank and ask for any additional comments.

A.1.2. Protocol for semi-structured interviews with project managers

Interviewee:
Company:
Date:
Project:
Opening / closing dates:
Budget:
Number of people involved:

First, thank the interviewee for her time. Explain what SOI is, the objectives of the project and why she is being interviewed.

1. Please briefly describe the project.

2. How was the decision of initiating the innovation project taken? Where did ideas come from? How is the agent who gave the idea related to the project?

3. How was the decision of who takes part in the project taken? And who are internal and external stakeholders that are not part of the project integrated?

4. Was a milestone-based itinerary followed? Which one? Is there any standard procedure?

5. Please draw a project development diagram.

6. Which are the criteria for an idea to become a project?

    a. Economic performance analysis
    b. Risk assessment
    c. Market need assessment
    d. Environmental or social criteria
    e. Gut feeling

7. How are social and environmental criteria accounted for during the project? Is there any procedure to integrate them?

8. What is the weight of these aspects? Can they prevent a product from entering the market?

9. What elements, roles and resources are necessary to develop the project?

10. What methodologies (design thinking, eco-design, biomimicry or others) were applied, of any? Are they different for other projects?

11. What units / departments of the firm participated in the project?

12. Was a post mortem analysis done?

    a. Successful: analysis of the success factors, performance associated to the project
    b. Failed: project audit

13. *(For the failed project only)* When was it decided not to continue with the project, or that it was not faring as it should? Which were the factors?

    a. It was not aligned with technology
    b. We used a technology that was not sufficiently established
    c. It was not aligned with the market
    d. The market changed unexpectedly
    e. The alleged distribution channels appeared to be incorrect

14. How many betas were developed before entering the market / desisting?

15. What level of specification was reached until it was brought to the market /desisted?

16. When is a project considered to be ready for marketing? Which are the criteria?

17. Which were the keys of the success of the project? / Why do you think the project failed?

Close interview. Thank and ask for any additional comments.

A.1.3. Protocol for semi-structured interviews with company managers. Original in Spanish

Entrevistado:
Empresa:
Fecha:

Primero, agradecer al entrevistado por su tiempo. Explicarle qué es innovación orientada a la sostenibilidad, los objetivos del proyecto y por qué se le está entrevistando.

1. ¿Cómo se define innovación en su empresa?

    a. ¿Cuál es el rol de la innovación en la empresa?
    b. ¿Cuál es el modelo de innovación?
    c. ¿Cómo se organisa la innovación?

2. ¿Cómo se define sostenibilidad en su empresa?

    a. ¿Cuáles son sus objetivos?
    b. ¿Por qué es importante?
    c. ¿Cuál es su rol en la empresa?

3. ¿Cuáles son los pilares sobre los que se sustenta su estrategia de sostenibilidad? ¿Cuáles son los pilares sobre los que se sustentan sus políticas de innovación?

    a. Estructura organisacional
    b. Gestión general y/o por procesos
    c. Transversal o por departamentos
    d. Cómo se relacionan los directores de equipo y proyectos con la dirección general

4. ¿Cómo se integran la sostenibilidad y la innovación en su estrategia empresarial?

5. ¿Cómo se diferencia la integración de criterios de sostenibilidad en los procesos de innovación respecto a otras empresas?

6. ¿Cuáles cree que son los factores de éxito de la innovación en su impresa?

7. ¿Qué efectos (directos e indirectos) tiene la sostenibilidad de la innovación sobre el rendimiento económico de la empresa?

8. ¿Tiene su empresa relaciones de colaboración con otros agentes? ¿Cuáles?

9. ¿En qué se refleja la incorporación de criterios de sostenibilidad en la innovación de su empresa?

a. Nuevos productos o servicios
b. Mejoras sobre productos o servicios existentes
c. Modelo de negocio
d. Cadena de valor o ciclo de vida del producto
e. Procesos
f. Mercados
g. Otros

10. ¿Son los proyectos de innovación orientada a la sostenibilidad un eje estratégico prioritario para la empresa (core business) o una nueva línea de trabajo que se está tanteando?

11. ¿Qué recursos y capacidades son vitales para el desarrollo de innovaciones en la empresa? (Explicar qué son los recursos y capacidades)

12. ¿Qué recursos y capacidades son vitales para el desarrollo de innovaciones orientadas a las sostenibilidad en la empresa?

13. ¿Cuáles son los criterios de sostenibilidad que se tienen en cuenta?

    a. Ambientales: ciclo de vida del producto, emisiones de CO_2, materiales desechables /biodegradables…
    b. Sociales: comercio justo, condiciones de trabajo, tecnologías inclusivas, participación del usuario final…

14. ¿De dónde viene las nuevas ideas de innovación orientada a la sostenibilidad? Por favor dibuje el proceso de generación de nuevas iniciativas.

15. ¿De dónde proceden las nuevas ideas de innovación orientada a la sostenibilidad? ¿Se guían más por ideas propias (technology push) o por la demanda de mercado (market pull)?

16. ¿Qué porcentaje de las innovaciones de la empresa tiene su origen en alguna de las siguientes opciones?

    a. El propósito de desarrollar un nuevo producto, servicio o proceso sostenible
    b. El propósito de responder a problemas no resueltos
    c. El deseo de aprovechar nuevas oportunidades
    d. El desarrollo de una nueva tecnología o solución en la empresa para la que se debe encontrar un nuevo mercado

17. ¿Cuál es rol de los stakeholders de su empresa durante el proceso de innovación? ¿Existe alguna plataforma de colaboración permanente o partenariado con alguno de ellos?'

18. ¿Qué metodologías se aplican para la innovación?

    a. Eco-diseño
    b. Tecnologías

c. Design thinking
d. Otros

19. ¿Miden su grado de sostenibilidad o de innovación mediante algún indicador?

Cerrar entrevista. Agradecer y preguntar por cualquier comentario adicional.

A.1.4. Protocol for semi-structured interviews with project managers. Original in Spanish

Empresa:
Proyecto:
Fecha inicio / fin proyecto:
Presupuesto:
Número de personas involucradas:

Primero, agradecer al entrevistado por su tiempo. Explicarle qué es innovación orientada a la sostenibilidad, los objetivos del proyecto y por qué se le está entrevistando.

1. Describa brevemente el proyecto.

2. ¿Cómo se decide iniciar el proyecto de innovación? ¿De dónde vienen las ideas? ¿Cómo se involucra al agente que dio la idea durante el desarrollo del proyecto?

3. ¿Cómo se decide quién participa en el proyecto? ¿Y cómo se integra a los stakeholders internos y externos de la empresa que no forman parte directamente del equipo?

4. ¿Se siguió un itinerario de proyecto, con diferentes milestones? ¿Cuál? ¿Existen uno o varios procedimientos estándar?

5. ¿Puede hacer un esquema del desarrollo del proyecto?

6. ¿Cuáles son los criterios para que una idea pase a desarrollarse en un proyecto?

    a. Análisis de rendimiento financiero
    b. Evaluación de riesgos
    c. Evaluación de necesidad de mercado
    d. Criterios ambientales y sociales
    e. Gut feeling

7. ¿Cómo se tienen en cuenta los aspectos sociales y ambientales durante el proyecto? ¿Existe algún procedimiento para integrarlos?

8. ¿Qué peso tienen estos aspectos? ¿Pueden influir que salga al mercado el proyecto?

9. ¿Qué elementos, recursos y roles son necesarios para desarrollar el proyecto?

10. ¿Qué metodologías (design thinking, eco-diseño, biomimética u otras) se aplican – si se aplica alguna - durante el proyecto de innovación? ¿Varían para cada proyecto?

11. ¿Qué unidades/departamentos de la empresa estaban involucrados en el proyecto?

12. ¿Se realizó un análisis posterior para evaluar el resultado del proyecto?

    a. Favorable: análisis de los factores de éxito, rendimiento asociado al proyecto
    b. Desfavorable: auditoría del proyecto (tecnología, necesidad de mercado, equipo, canales de distribución…)

13. (*En el proyecto desfavorable*) ¿cuándo se decidió no continuar con el proyecto, o que no marchaba como debería? ¿Cuáles fueron los factores?

    a. La innovación estuvo desalineada con la tecnología
    b. Utilizamos una tecnología que no estaba suficientemente establecida
    c. La innovación estuvo desalineada con el mercado
    d. El mercado cambió de manera inesperada
    e. Los supuestos de canales de distribución mostraron estar errados

14. ¿Cuántas soluciones / betas se aplicaron antes de desistir / llevar a mercado?

15. ¿Qué nivel de especificación se alcanzó hasta llevar a mercado / desistir?

16. ¿En qué momento se considera que un proyecto está listo para salir al mercado? ¿Cuáles son los criterios?

17. ¿Cuáles fueron las claves del éxito del proyecto? / ¿Por qué cree que falló el proyecto?

Cerrar entrevista. Agradecer y preguntar por cualquier comentario adicional.

Appendix 2

Activities of SOI

Activities of SOI according to the Adams et al. (2012) systematic review

Table 53. List of activities of SOI deployed to determine the qualitative sample
Source: adapted from Adams et al. (2012)

Operational optimization	Organisational transformation	Systems building
Collaborations and relationships – Co-operate and network externally to compensate for lack of resources or lack of expertise and to enhance legitimacy and social licence to operate. Collaborators may include regulators, suppliers and knowledge institutions – Collaborate internally and across functions to integrate SOI across the firm and enhance opportunities for new product success – Work with customers to identify their sustainability concerns (and thus opportunities for adding value) and to enhance legitimacy and the social licence to operate	**Systemic relationships** – New opportunities can be explored at the interfaces of previously unrelated industries – Collaborations become increasingly interdependent – New innovation platforms can be tested: e.g. reverse innovation, jugaad innovation and resource-constrained innovation	**Apply a whole-systems focus to influence the redesign of institutions and infrastructures and the reconceptualization of the business purpose**. – Derive new value propositions from entire socio-technical and ecosystem value network to make a positive impact with an inclusive business – Engage in institutional dialogues to "change the rules of the game" – Reframe the purpose of the firm: suffuse and infuse all dimensions of TBL into the organisation – Initiate, mobilize, lead and inspire systems change – Apply equal weight to all aspects of the TBL in organisational thinking and decision-making

Capacity and climate – Exploit existing innovation capabilities to facilitate the adoption of incremental innovations – Empower the top team to set the direction of and climate for SOI and ensure clarity of the innovation purpose – Codify and formalize SOI targets and policies; integrate sustainability goals into existing technical specifications – Monitor performance against specific SOI criteria	**Capacity and climate** – Ensure that the top management team and line managers are seen as having a commitment to sustainability; communicate the values and goals of sustainability; set goals and targets that reach beyond operational and eco-efficiencies – Ensure reward systems and incentives reflect the focus on sustainability – Revisit and reframe the – business model and modes of governance to acknowledge the firm's commitment to sustainability – Integrate sustainability metrics into financial reporting; adopt transparent sustainability reporting – Exploit organisational slack – Extend search activities into unfamiliar fields: use peripheral vision to search for weak signals – Unlearn outdated capabilities	

Process innovation – Design for sustainability: Redesign existing processes through incremental innovation: e.g. use tools to support SOI by addressing single issues such as pollution control; modify and redesign processes to address resource use, waste and pollution – Use available tools such as environmental management systems and life cycle analysis to integrate sustainability into processes – Adopt sustainable supply chain management practices and ensure suppliers are operating sustainably	**Process innovation** – Adopt new process platforms such as closed-loop manufacturing and cradle-to-cradle innovation – Develop new networks into the wider social, economic, legislative systems and, particularly, into supply chains; develop long-term collaborative approaches with external partners – Start from a vision of the future and work backward, rather than moving forward from the present; set audacious goals even when the route may be unclear	
Product innovation – Use design tools to redesign products to address sustainability considerations: e.g. dematerialization – Reduce materials' impacts and products' energy consumption – Design "green" from the outset: e.g. integrate recovery, reuse and disposal thinking early in the design process; set targets early – Ensure functionality is not compromised	**Product innovation** – Adopt a servitization strategy: supplement or replace products with services – Search for product innovation ideas in new areas: e.g. use biomimicry and engage with bottom-of-the-pyramid customers – Be attentive to disruptive and systems-changing innovation happening elsewhere – Learn lessons from local firms and from new innovation platforms such as frugal innovation	

Knowledge management – Exploit existing knowledge management capabilities to identify and access relevant knowledge; reframe internal communications to a focus on sustainability; unlearn existing knowledge that contradicts the firm's sustainability principles – Fill competence gaps through training, targeted recruitment and the import of expertise; integrate diverse elements of TBL considerations across the firm by issuing guidelines and monitoring compliance		

Appendix 3

Qualitative data analysis procedures

A.3.1. Coding cycles: example from a transcription passage

In order to better illustrate how the codification process was conducted; an excerpt from one of the transcripts is used as an example of the evolution of codes from descriptive to aggregate to axial coding, using captures from the NVivo software. In the images, the original text in Spanish is shown. The text in English is translated as follows:

[Talking eco-design] *That's right, yes. So, at the same that there was this, we saw that in Europe people were talking about this: what we did was to see which model, that is, how we could apply this to our product design. And then we found a standard, which is the eco-design UNE standard that used to be 150000.3, I believe. So, what we did was to implement this eco-design management system into the organisation; in fact, we were the first company in the industry at the national level to get certified in the eco-design standard. That standard is already an ISO standard, which is [inaudible]. No, that is the R&D one, which we also have, 14001 is the environmental management one, that we also have, the 140006… Well, XXX will tell you so, because as we have so many systems sometimes… But the idea is that, to introduce the concept of life-cycle, that is what we want to systematise in our product design, we incorporate the eco-design standard being the first company in the industry to do so. Once this is done, a new reflection emerged, how we can translate to the final client these improvements in product and service we have. So then, we saw that we were talking about year 2007 already, because already in year 1992 we had discovered something called European Eco-Label, which existed since 1992 but was really unknown, because we had not worked with it or anything. But we saw that it was a good element to be able to translate it to our final client, which is not a consumer, we always work with businesses.*

The first round of descriptive coding for this passage was conducted as illustrated in Figure 33. At this initial stage, coding is very detailed and almost every line or sentence belongs with a code. It is done in open-minded, descriptive manner. As observed in Figure 33, seven descriptive codes emerge from this passage:

- Benchmarking
- Eco-design
- Best practice adoption
- Product development
- Cradle-to-grave
- Market access
- Educate clients

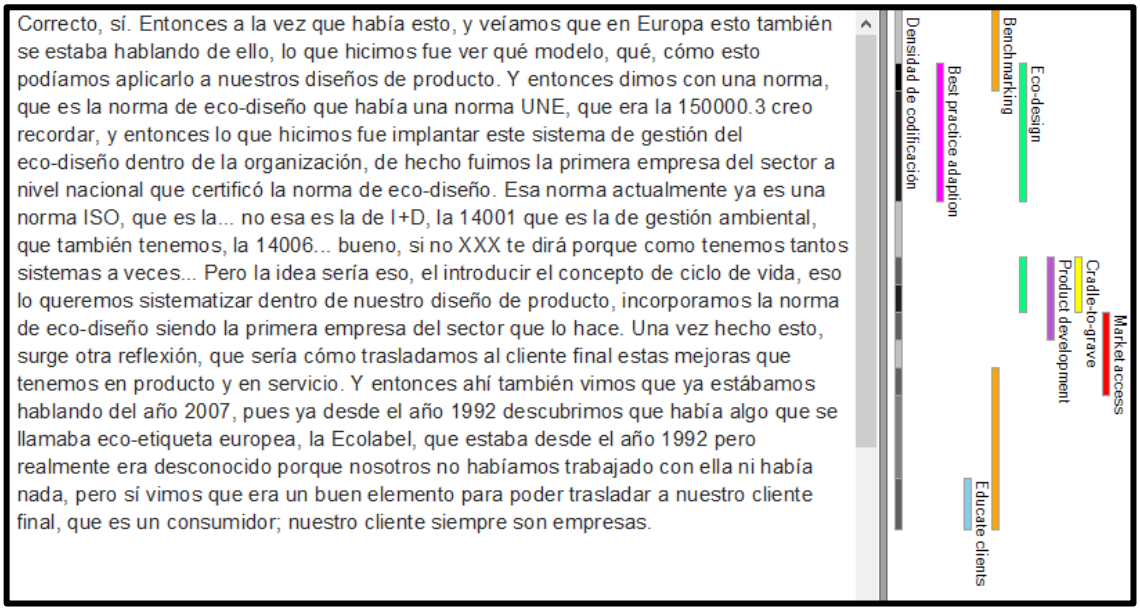

Figure 33. Example of descriptive open coding
Source: elaborated by the author

After the initial coding, the focused coding stage, which involves the axial and selective coding, starts. The codes, after re-visiting the literature once the initial coding is done, are aggregated into categories based on higher conceptual levels, making connections between categories. Figure 34 shows the axial coding for the example passage.

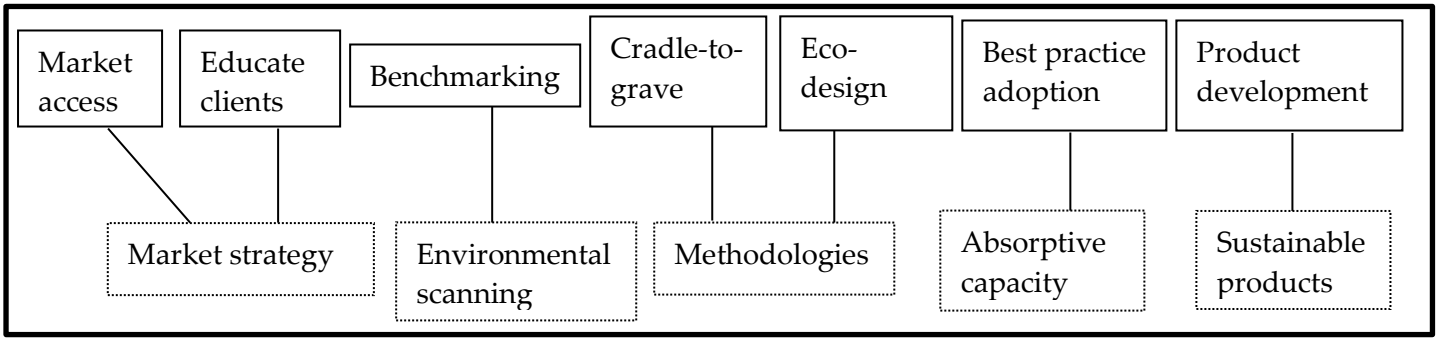

Figure 34. Example of axial coding
Source: elaborated by the author

The final stage of selective coding consists of selecting core categories among those created during the axial coding, and refining the categories. In this case, 'market strategy' falls under the 'create and find new markets based on sustainability trends'. 'Environmental scanning' remains the same category; 'methodologies' under 'sustainability-oriented knowledge' and 'absorptive capacity' remains as a core category and 'sustainable products' is integrated into the core category 'alignment of innovation, sustainability and strategy'. Once the core categories have been refined, they are ordered according to literature.

A.3.2. Lists of codes in each round of coding

A.3.2.1. List of codes in open coding

Table 54. List of descriptive codes in open coding
Source: elaborated by the author

Code	Number of appearances
Team	99
Market orientation	92
Sustainability vision	81
Integration of strategy, innovation and sustainability	76
Culture	72
Client responsiveness	71
Methodologies	63
Market access	62
Alignment of strategy	55
Openness to outside	55
Organisational structure	54
Product development	53
Co-creation with clients	51
External financial input	51
Open innovation	51
Business model	49
Analysis & diagnosis	49
Innovation for competitiveness	48
Co-creation with universities & research centres	47
Technology	46
Communication	46
Differentiation	42
Digital support	41
Funnel strategy	39
Direct social impact	38
International company	37
Long-term strategy	36
Leadership	34
Training	34
Knowledge	33
Co-creation with suppliers	33
Transformation	33
Creativity	33
Own tools	33
Innovation process	32
Eco-design	30
Competition monitoring	28

Sustainability as efficiency	28
Employee engagement	28
Educate clients	28
Supply chain	28
Commitment of leadership	27
Environment	27
Benchmarking	27
Systematise innovation	27
Goal-setting	26
Create value from sustainability	25
Regulation	24
Partnerships	23
Tech monitoring	23
Organisational slack	23
Traction	23
European projects	22
Co-creation with competitors	22
Sustainable business unit	22
History	22
Continuous improvement	22
Awards (recognition)	21
Entrepreneurship	21
Centralised sustainability	20
Failure	20
SME vs. MNE	20
Inclusive technologies	19
Integration of sustainability	19
Added value	18
Formal process of strategy making	18
Own technology	18
Decentralised strategy	18
Own software	18
Priorisation	18
Measurements	18
Indicators	17
Sustainability as an investment criterion	16
Responsibility	16
Quality	16
Diffusion efforts	15
Collaboration with public administration	15
Create markets	15
Generation of ideas	15
Cradle-to-grave	14
Best practice adaption	14
Sustainable products	13
Bottom-up organisation	13

Co-creation with NGOs	13
Technology push	13
Employees	12
Action Plan	12
Risk taking	12
Evolution	12
New ventures	12
Centralised innovation	11
Know your strength	11
Centralised investment strategy	11
Risk management	11
Internal bargaining	11
Rent seeking	11
Resource optimisation	11
Quality of product	11
Trust	11
Physical proximity	10
Resources	10
Marketing	10
Solution seeking	9
Shared responsibility	9
Lifecycle	9
IT tools	9
Sustainability strategy	9
Commitment of employees	9
Organisational innovation	9
Anticipate change	9
Diversified portfolio	8
Servitisation	8
Shared strategy	8
Transparency	8
Holistic design	8
Social demand	8
Co-creation with public administration	7
Innovation projects	7
Generational aspects	7
Size	7
Positive change	7
Green brand	7
Impact minimization	7
Activism	7
Market demand	7
Safety	6
Holistic innovation	6
Locations	6
Design	6

Sustainability criteria in design	6
Coordination of departments	6
Branding	6
Sacrifices	6
Unsystematised innovation	6
Joint venture	6
Information gathering for strategy making	5
Independent business units	5
Stakeholder management	5
Integrated reporting	5
Awareness	5
Smart cities	5
Rapid implementation	5
Re-investment	5
Price	5
Turning point	5
Shared risks	4
Intrapreneurship	4
Emerging markets	4
Motivation	4
Permeability	4
Final price	4
Raw materials	4
Exploration vs. exploitation	4
Collaboration with competitors	3
Collaboration with NGOs	3
Resilience	3
Shared leadership	3
Ethics	3
Slow fashion	3
Adapt to the changing environment	3
Innovation manager	3
Process innovation	3
Co-creation	3
Bottom of the pyramid	3
Stagnation	3
Economic performance	3
Systematisation of management	2
Exports	2
Transport	2
Targets	2
Local production	2
Systematise sustainability	2
Dynamism	2
Change as a constant	2
Principled sustainability	2

Set examples	2
Shareholder pressure	2
Spin-off	1
Idea generation	1
Own production	1
Informal innovation team	1
Curiosity	1
Governance	1

A.3.2.2. List of categories in axial coding

Table 55. List of categories yielded by axial coding
Source: elaborated by the author

Absorptive capacity
Certifications
Commitment
Competition
Environmental scanning
Digital support
Evolution and development
Financial input
Goal-setting and measurement
Market strategy
Entrepreneurship / Intrapreneurship
Methodologies
Open innovation
Organisational structure
Sustainable products
Resilience and organisational slack
Visibility
Sustainable business models
Organisational resilience
Team
Leadership
Client responsiveness
New markets
Differentiation strategy
Alignment of strategy, innovation and sustainability
Generational aspects
Partnerships
Networking and openness
Collaboration
Innovation system

Stakeholder management
Clean technologies
Environmental management systems
Intellectual capital
Laws and regulations
Socio-environmental challenges and trends

A.3.2.3. List of codes in selective coding

Table 56. List of categories after selective coding
Source: elaborated by the author

Sustainable business models
Organisational resilience
Social capital and leadership
Client responsiveness
Create and find new markets based on sustainability trends
SOI-based differentiation
Absorptive capacity
Alignment of strategy, innovation and sustainability
Generational aspects
Collaboration for SOI development
Participation in partnerships and networking
Managing the innovation system and stakeholders
Environmental scanning
Sustainability-oriented knowledge
Certifications and management systems
Intellectual capital
Laws and regulations
Socio-environmental challenges and trends
Competitive economy

Appendix 4

Survey questionnaire

A.4.1. Survey questionnaire: original in English[12]

Over the phone introduction	Internet-based survey introduction
Good morning, I'm Edurne Iñigo, and I'm calling from the University of Deusto. As part of part of my doctoral research thesis on sustainable innovation, I am conducting a survey that should take 10-12 minutes to complete. Thanks to your contribution, we will be able to understand better what businesses need to perform sustainable innovation. Be assured that all answers you provide will be kept in the strictest confidentiality; only statistical generalizations, not individual responses, will be reported. Would you like to take part in the survey? Thank you so much for your contribution. First of all, let me explain that sustainable innovation is the improvement or introduction of a new product, service, process, organisational structure or routine or business model which results not only in economic gains, but also social or environmental benefits.	This questionnaire on sustainable innovation (innovations that, on top of producing an economic benefit for the firm, pursue a positive social or environmental impact) is part of my doctoral thesis in the University of Deusto. Thanks to its results, we will be able to help companies to improve their social and environmental performance through innovation. The questionnaire takes around 10 minutes to complete. We greatly appreciate your time, which is indispensable to be able to continue with the study. All answers are strictly confidential, and only statistical generalisations will be published. Thank you so much for taking part!

SURVEY BEGINS HERE

1. Name of the firm (A1)

2. Postcode (A2)

3. Industry (tick one as appropriate) (A3)
   First ask, if it does not fit, read out the categories
   Classification NACE Rev.2, Eurostat, high level aggregation

[12] Statements in grey are notes for the researcher, not visible for the respondent

Agriculture, forestry and fishing		1
Manufacturing, mining and quarrying and other industry		2
Construction		3
Wholesale and retail trade, transportation and storage, accommodation and food service activities		4
Information and communication		5
Financial and insurance activities		6
Real estate activities		7
Professional, scientific, technical, administration and support service activities		8
Public administration, defence, education, human health and social work activities		9
Other services		10

4. Year of foundation (A4)

5. Turnover (A5)

6. Number of employees (tick one as appropriate) (A6)
   Size
   Based on European Commission Recommendation 2003/361/EC

1-9		1	Micro-entities
10-49		2	Small companies
50-249		3	Medium-sized companies
≥250		4	Large business

A. **Characterisation of the firm**
   Control variables

7. Position of the person filling in the questionnaire (tick one as appropriate) (A7)
   Ask for the following respondents, in this order: innovation manager, CEO, sustainability manager, project manager, other

Innovation / technology/ R&D / product development manager		1
Sustainability / CSR / environmental manager		2
CEO		3

Project manager		4
Other		5

8. Average percentage of turnover invested in research and development (R&D) in the during the last three years (tick one as appropriate) (A8)
   R&D intensity
   Ask for number first, then read out percentages
   The 2014 EU Industrial R&D Investment Scoreboard (European Commission)

0% - 0.09%		1	Low R&D intensity
1% - 1.9%		2	Medium-low R&D intensity
2% - 4.9%		3	Medium-high R&D intensity
≥5%		4	High R&D intensity

9. To what extent is sustainability a core issue for your business? Rate from 1 (our business is not concerned with sustainability) to 7 (sustainability is at the core of our business): (A9)
   Sustainability orientation
   Self-developed

1	2	3	4	5	6	7

B. Business environment

10. To what extent do you agree with the following statements? (1=strongly disagree; 7= strongly agree)
    From Joshi and Sharma, 2004 – customer turbulence

Customers' preferences for product or service features have changed quite a bit over time. (B1)	1	2	3	4	5	6	7
We are witnessing demand for our products from customers that never bought them before. (B2)	1	2	3	4	5	6	7
New customers tend to have product-related needs that are different from those of our existing customers. (B3)	1	2	3	4	5	6	7

11. To what extent do you agree with the following statements? (1=strongly disagree; 7= strongly agree)
    From Joshi and Sharma, 2004 – competitor turbulence

Our competitors are constantly changing their product	1	2	3	4	5	6	7

features. (B4)							
Our competitors are constantly changing their sales strategies. (B5)	1	2	3	4	5	6	7
New competitors are entering our industry. (B6)	1	2	3	4	5	6	7

12. To what extent do you agree with the following statements? (1=strongly disagree; 7= strongly agree)
    From Joshi and Sharma, 2004 – technological turbulence

The technology in our industry is changing rapidly. (B7)	1	2	3	4	5	6	7
It is unlikely that today's technological standard will still be dominant five years from now. (B8)	1	2	3	4	5	6	7
Technological breakthroughs contribute to the development of new product ideas in our industry. (B9)	1	2	3	4	5	6	7

C. Sustainable innovation activities

Measures of the dependent variable by types of innovation
Self-developed based on the Oslo Manual (OECD, 2005)

Process sustainable innovation

13. During the last year, did your company introduce (tick as appropriate):

	No (0)	Yes, significantly improved ones (1)	Yes, completely new ones (2)
Methods of manufacturing or producing goods or services that improve the environmental or social impact of the company (C1)			
Logistics, delivery or distribution methods for your inputs, goods or services that improve the environmental or social impact of the company (C2)			
Supporting activities for your processes that improve the environmental or social impact of the company, such as maintenance systems or operations for purchasing, accounting, or computing (C3)			

14. Who developed these process innovations? (C4)

Mainly your company		1
Mainly your enterprise together with other enterprises or institutions		2
Mainly other enterprises or institutions		3

Organisational sustainable innovation

15. During the last year, did your company introduce (tick as appropriate):

	No (0)	Yes, significantly improved (1)	Yes, completely new (2)
Business practices for organising procedures in a sustainable way (i.e. sustainable supply chain management, business reengineering, lean production, environmental management systems, etc.) (C5)			
Methods of organising work responsibilities and decision making to improve the environmental and social impact (i.e. sustainability education/training systems, creation of sustainability task forces, etc.) (C6)			
Methods of organising external relations with other firms or public institutions to foster sustainability (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc) (C7)			

16. Who developed these organisational innovations? (C8)

Mainly your company		1
Mainly your enterprise together with other enterprises or institutions		2
Mainly other enterprises or institutions		3

Product sustainable innovation

17. Did your company introduce any product sustainable innovation during the last year? (Determine and tick off accordingly)

18. During the last year, did your company introduce:

	No (0)	Yes, significantly improved (1)	Yes, completely new (2)
Technologies that improve the social or environmental performance (C9)			
Consumer products that improve the social or environmental performance (C10)			
Products sold to other businesses that improve the social or environmental performance (C11)			

19. Who developed these product innovations? (C12)

Mainly your company		1
Mainly your enterprise together with other enterprises or institutions		2
Mainly other enterprises or institutions		3

Service sustainable innovation

20. Did your company introduce any service sustainable innovation during the last year? (Determine and tick off accordingly)

21. During the last year, did your company introduce:

	No (0)	Yes, significantly improved (1)	Yes, completely new (2)
Maintenance or after-sale services that improve the social or environmental performance (C13)			
Professional services (consultancy, advisory…) that improve the social or environmental performance (C14)			
Basic services, that improve the social or environmental performance (i.e. waste clean-up, efficient electricity distribution, etc.) (C15)			

22. Who developed these service innovations? (C16)

Mainly your company		1
Mainly your enterprise together with other enterprises or institutions		2
Mainly other enterprises or institutions		3

Marketing innovations

23. During the last year, did your company introduce:

	Yes (0)	Yes, significantly improved (1)	Yes, completely new (2)
Changes to the design or packaging of a good or service to reduce its environmental or social impact (C17)			
New media or techniques for good or service promotion highlighting sustainability (green branding) (C18)			
New methods for good or service placement or sales channels that seek to create markets for sustainable innovations? (C19)			

24. Who developed these marketing innovations? (C20)

Mainly your company		1
Mainly your enterprise together with other enterprises or institutions		2
Mainly other enterprises or institutions		3

D. Business strategy

25. Which of the following statements describes your company best? (D1)
Measure for business strategy. Based on Miles et al., 1978.

A. Is innovative and growth oriented, searches for new markets and new growth opportunities, encourages risk taking.		1 - Prospector
B. Protects current markets, maintains stable growth, serves current customers		2 – Defender

C. Maintains current markets and current customer satisfaction with moderate emphasis on innovation		3 – Analyzer
D. No clear strategy, reacts to changes in the environment, drifts with events		4 - Reactor

Extracted from Barney & Griffin, 1992

E. Structures

26. To what extent do you think the following statements apply to your company? (1=don't apply at all; 7=completely apply)

Measure for external connectivity

Based on Sarkar et al., 2009 – alliance proactiveness

We actively monitor our environment to identify partnering opportunities. (E1)	1	2	3	4	5	6	7
We routinely gather information about prospective partners from various forums (e.g., trade shows, industry conventions, databases, publications, internet, etc.). (E2)	1	2	3	4	5	6	7
We are alert to market developments that create potential alliance opportunities. (E3)	1	2	3	4	5	6	7
We strive to preempt our competition by entering into alliances with key firms before they can. (E4)	1	2	3	4	5	6	7
We often take the initiative in approaching firms with alliance proposals. (E5)	1	2	3	4	5	6	7

F. Capabilities

27. To what extent do you think the following statements apply to your company? (1=don't apply at all; 7=completely apply)

Determine if the company has innovation alliances

Measure for alliance portfolio management capability

Based on Schilke & Goerzen, 2010 (alliance portfolio coordination)

We ensure an appropriate coordination among the activities of our different innovation alliances. (F1)	1	2	3	4	5	6	7
We determine areas of complementarity in our innovation alliance portfolio. (F2)	1	2	3	4	5	6	7
We ensure that mutual dependencies between our innovation alliances are identified. (F3)	1	2	3	4	5	6	7
We determine if there are overlaps between our different innovation alliances. (F4)	1	2	3	4	5	6	7

28. To what extent do you think the following statements apply to your company? (1=don't apply at all; 7=completely apply)
Measure for market responsiveness
Self-developed, based on Garret et al., 2009

We are able to react quickly to changing market demands. (F5)	1	2	3	4	5	6	7
We compete on the basis of our ability to quickly react to changing market demands. (F6)	1	2	3	4	5	6	7
We adapt and improve our products and/or services based on identified demands from our customers. (F7)							

29. To what extent the following statements fit the communication structure in your company? (1= no fit at all; 7=completely fit)
Measure for absorptive capacity
Based on Flatten et al., 2011 – assimilation

In our company ideas and concepts are communicated cross-departmentally. (F8)	1	2	3	4	5	6	7
Our management promotes cross-departmental support to solve problems. (F9)	1	2	3	4	5	6	7
In our company there is a quick information flow, e.g., if a business unit obtains important information it communicates this information promptly to all other business units or departments. (F10)	1	2	3	4	5	6	7
Our management demands periodical cross-departmental meetings to share new developments, problems, and achievements. (F11)	1	2	3	4	5	6	7

G. Knowledge search strategy

Measure for source of SOI ideas
Self-developed (internal and NGOs); Lauren and Salter, 2006 (external)

30. During the last five years, which of the following sources have provided your company with new ideas for sustainable innovation?

	Yes (1)	No (0)
Own board of directors (G1)		
Own R&D department / employees (G2)		
Own marketing department / employees (G3)		
Own manufacturing department / employees (G4)		

Own customer-interface / sales employees (G5)		
Suppliers of equipment, materials, components or software (G6)		
Clients or customers (G7)		
Competitors (G8)		
Consultants (G9)		
Commercial laboratories / R&D enterprises (G10)		
Universities or other higher education institutes (G11)		
NGOs (G12)		
Government research organisations (G13)		
Other public sector (e.g., business links, government offices) (G14)		
Private research institutes (G15)		
Professional conferences, meetings (G16)		
Trade associations (G17)		
Technical / trade press, computer databases (G18)		
Fairs, exhibitions (G19)		
Technical standards (G20)		
Health and safety standards and regulations (G21)		
Environmental standards and regulations (G22)		

H. Performance

Other performance measures

31. During the last year, how do you find the following issues to have fared in your company? (1=much worse; 7=much better)

    Measure for market performance

    Hooley et al., 2005 – market performance

Sales volume achieved compared to competitors (H1)	1	2	3	4	5	6	7
Market share compared to competitors (H2)	1	2	3	4	5	6	7

32. During the last year, how do you find the following issues to have fared in your company? (1=much worse; 7=much better)

    Measure for financial performance

    Hooley et al., 2005 – financial performance

Overall profit level achieved compared to competitors (H3)	1	2	3	4	5	6	7
Profit margins compared to competitors (H4)	1	2	3	4	5	6	7
Return on investment (ROI) compared to competitors (H5)	1	2	3	4	5	6	7

33. During the last year, how do you find the following issues to have fared in your company? (1=much worse; 7=much better)

    Measure for customer performance

Hooley et al., 2005 – customer performance

Levels of customer loyalty compared to competitors (H6)	1	2	3	4	5	6	7
Levels of customer loyalty compared to last year (H7)	1	2	3	4	5	6	7
Levels of customer satisfaction compared to competitors (H8)	1	2	3	4	5	6	7
Levels of customer satisfaction compared to last year (H9)	1	2	3	4	5	6	7

34. During the last year, to what extent do the following statements apply to your company? (1=don't apply at all; 7=completely apply)
Measure for sustainability behaviour
Based on Epstein and Buhovac, 2014

Ethics: The company establishes, promotes, monitors, and maintains ethical standards and practices in dealings with all of the company stakeholders (H10)	1	2	3	4	5	6	7
Governance: The company manages all of its resources conscientiously and effectively, recognizing the of managers to act in favor of the interests of all company stakeholders (H11)	1	2	3	4	5	6	7
Transparency: The company informs in a timely manner about its products, services, and activities, thus permitting stakeholders to make informed decisions (H12)	1	2	3	4	5	6	7
Business relationships: The company engages in fair-trading practices with suppliers, distributors, and partners (H13)	1	2	3	4	5	6	7
Financial return: The company compensates providers of capital with a competitive return on investment and the protection of company assets (H14)	1	2	3	4	5	6	7
Community involvement: The company fosters a mutually beneficial relationship between the company and community, being sensitive to the culture, context, and needs of the community in which it operates (H15)	1	2	3	4	5	6	7
Value of products and services: The company respects the needs, desires, and rights of its customers and strives to provide the highest levels of product and service values (H16)	1	2	3	4	5	6	7
Employment practices: The company engages in human-resource practices that promote personal and professional employee development, diversity, and empowerment (H17)	1	2	3	4	5	6	7

Protection of the environment: The company strives to protect and restore the environment and promote sustainable development with products, processes, services, and other activities (H18)	1	2	3	4	5	6	7

A.4.2. Survey questionnaire: back-translated version in Spanish

Cuestionario telefónico[13]	Cuestionario en versión web
Buenos días, soy Edurne Iñigo, y llamo de la Universidad de Deusto. Como parte de tesis doctoral sobre innovación sostenible, estoy realizando una encuesta que suele llevar entre 10 y 12 minutos en completarse. Gracias a su contribución, podremos entender mejor qué necesitan las empresas para llevar a cabo innovación sostenible. Las respuestas que proporcione son estrictamente confidenciales, y sólo se publicarán generalizaciones estadísticas, no respuestas individuales. ¿Le gustaría participar en la encuesta? Muchas gracias por su contribución. Primero, déjeme explicarle lo que entendemos por innovación sostenible: la mejora o introducción de un nuevo producto, servicio, proceso, estructura organisacional, rutina o modelo de negocio que resulta no sólo en beneficios económicos, sino también en beneficios sociales o ambientales.	Esta encuesta sobre innovación sostenible (innovaciones que además de producir un beneficio económico para la empresa, persiguen un impacto social o ambiental positivo) forma parte de mi tesis doctoral en la Universidad de Deusto. Gracias a sus resultados podremos ayudar a las empresas a mejorar su desempeño social y ambiental a través de la innovación. La encuesta toma alrededor de 10 minutos en completarse. Apreciamos mucho vuestro tiempo, que es imprescindible para poder continuar con el estudio. Todas las respuestas son completamente confidenciales, y sólo generalizaciones estadísticas serán publicadas. ¡Muchas gracias por participar!

EL CUESTIONARIO COMIENZA AQUÍ

A. Caracterización de la empresa

1. Nombre de la empresa (A1)

[13] Although the questionnaire was always administered in Spanish to be truthful to the meaning kept from the original through back-translation; when the phone was answered in Basque language the first communication was done in Basque. This was also the case when arranging the completion of the self-administered web-based questionnaire over the phone, although the survey as such was always completed in Spanish.

2. Código postal (A2)

3. Sector (A3)

Agricultura, ganadería, silvicultura y pesca	1
Manufactura, minería y canteras, otra industria	2
Construcción	3
Venta mayorista y minorista, transporte y logística, hostelería y servicios alimentarios	4
Información y comunicación	5
Actividades financieras y de seguros	6
Actividades inmobiliarias	7
Actividades profesionales, científicas, técnicas, de administración y servicios de soporte	8
Administración pública, defensa, educación, salud humana y trabajo social	9
Otros servicios	10

4. Año de fundación (A4)

5. Facturación (A5)

6. Número de empleados (A6)

1-9	
10-49	
50-249	
≥250	

7. Cargo de la persona que responde a la encuesta (A7)

Responsable de Innovación / Tecnología / I+D / Desarrollo de Producto	1
Responsable de Sostenibilidad / Responsabilidad Social Corporativa / Medio Ambiente	2
Director General	3
Responsable de Proyecto	4
Otros	5

8. Porcentaje medio de facturación invertido en Investigación y Desarrollo e Innovación (I+D+i) durante los últimos tres años (A8)

0% - 0.09%	
1% - 1.9%	
2% - 4.9%	
≥5%	

9. ¿Hasta qué punto es la sostenibilidad importante para su negocio? 1= no es relevante para nuestro negocio, a 7=es un valor central para el negocio (A9)

1	2	3	4	5	6	7

B. Entorno para los negocios

10. Indique hasta qué punto está de acuerdo con las siguientes afirmaciones de 1= muy en desacuerdo, a 7=muy de acuerdo

Las preferencias de los clientes sobre las características de los productos o servicios han cambiado bastante a lo largo del tiempo. (B1)	1	2	3	4	5	6	7
Clientes que nunca los habían comprado antes demandan nuestros productos o servicios. (B2)	1	2	3	4	5	6	7
Las necesidades relativas a productos de los nuevos clientes tienden a ser diferentes de las de nuestros clientes existentes. (B3)	1	2	3	4	5	6	7

11. Indique hasta qué punto está de acuerdo con las siguientes afirmaciones de 1= muy en desacuerdo, a 7=muy de acuerdo

Nuestros competidores están cambiando las características de sus productos constantemente. (B4)	1	2	3	4	5	6	7
Nuestros competidores están cambiando sus estrategias de venta continuamente. (B5)	1	2	3	4	5	6	7
Nuevos competidores están entrando en nuestro sector. (B6)	1	2	3	4	5	6	7

12. Indique hasta qué punto está de acuerdo con las siguientes afirmaciones de 1= muy en desacuerdo, a 7=muy de acuerdo

La tecnología está cambiando rápidamente en nuestro sector. (B7)	1	2	3	4	5	6	7
Es improbable que el estándar tecnológico de hoy sea aún dominante de aquí a 5 años. (B8)	1	2	3	4	5	6	7
Los avances tecnológicos contribuyen al desarrollo de nuevas ideas de producto en nuestro sector. (B9)	1	2	3	4	5	6	7

C. Actividades de innovación sostenible

Innovación sostenible en procesos

13. A lo largo del último año, su empresa introdujo:

	No	Sí, significativamente mejorados	Sí, completamente nuevos
Métodos de manufactura o producción de bienes o servicios que mejoran el impacto social o medioambiental de la empresa (C1)			
Logística, reparto o métodos de distribución para sus bienes o servicios que mejoran el impacto social o medioambiental de la empresa (C2)			
Actividades de apoyo para sus procesos que mejoran el impacto social o medioambiental de la empresa (por ejemplo, sistemas de mantenimiento u operaciones para la compra, contabilidad o cómputo) (C3)			

14. ¿Quién desarrolló estas innovaciones? (C4)

Principalmente su empresa	
Principalmente su empresa junto a otras empresas o instituciones	
Principalmente otras empresas o instituciones	

Innovación sostenible organisacional

15. A lo largo del último año, su empresa introdujo:

	No	Sí, significativamente mejorados	Sí, completamente nuevos
Prácticas empresariales para organisar los procedimientos de una manera sostenible (p.e. gestión sostenible de la cadena de abastecimiento, reingeniería empresarial, producción Lean, sistemas de gestión medioambiental, etc.) (C5)			
Métodos para organisar las responsabilidades de trabajo y la toma de decisiones para mejorar el impacto medioambiental o social (p.e. sistemas de educación/formación en sostenibilidad, creación de equipos especiales de sostenibilidad, etc.) (C6)			
Métodos de organisar las relaciones externas con otras empresas o instituciones públicas para promover la sostenibilidad (p.e. alianzas y asociaciones, contratación) (C7)			

16. ¿Quién desarrolló estas innovaciones? (C8)

Principalmente su empresa	
Principalmente su empresa junto a otras empresas o instituciones	
Principalmente otras empresas o instituciones	

Innovación sostenible en producto

17. A lo largo del último año, su empresa introdujo:

	No	Sí, significativamente	Sí, completamente

		mejorados	nuevos
Tecnologías que mejoran el desempeño social o medioambiental (C9)			
Bienes de consumo que mejoran el desempeño social o medioambiental (C10)			
Productos vendidos a otras empresas que mejoran el desempeño social o medioambiental (C11)			

18. ¿Quién desarrolló estas innovaciones? (C12)

Principalmente su empresa	
Principalmente su empresa junto a otras empresas o instituciones	
Principalmente otras empresas o instituciones	

Innovación sostenible en servicios

19. A lo largo del último año, su empresa introdujo:

	No	Sí, significativamente mejorados	Sí, completamente nuevos
Servicios de mantenimiento o post-venta que mejoran el desempeño social o medioambiental (C13)			
Servicios profesionales (consultoría, asesoría, etc.) que mejoran el desempeño social o medioambiental (C14)			
Servicios básicos que mejoran el desempeño social o medioambiental (limpieza de residuos, distribución eléctrica eficiente…) (C15)			

20. ¿Quién desarrolló estas innovaciones? (C16)

Principalmente su empresa	

Principalmente su empresa junto a otras empresas o instituciones	
Principalmente otras empresas o instituciones	

Innovación sostenible en marketing

21. A lo largo del último año, su empresa introdujo:

	No	Sí, significativamente mejorados	Sí, completamente nuevos
Cambios en el diseño o embalaje de un bien o servicio para reducir su impacto medioambiental o social (C17)			
Nuevos medios de comunicación o técnicas de promoción de bienes o servicios que promocionaran su sostenibilidad (C18)			
Nuevos métodos de emplazamiento o canales de distribución de bienes o servicios que buscaran crear mercados para innovaciones sostenibles (C19)			

22. ¿Quién desarrolló estas innovaciones? (C20)

Principalmente su empresa	
Principalmente su empresa junto a otras empresas o instituciones	
Principalmente otras empresas o instituciones	

D. Estrategia empresarial

23. ¿Cuál de las siguientes afirmaciones describe mejor su empresa? (D1)

E. Es innovadora y orientada al crecimiento, busca nuevos mercados y nuevas oportunidades de crecimiento, alienta la toma de riesgos.	
F. Protege los mercados actuales, mantiene un crecimiento estable, sirve a sus actuales clientes.	
G. Mantiene los mercados actuales y la satisfacción de los	

clientes actuales con un énfasis moderado en la innovación	
H. No tiene una estrategia clara, reacciona a los cambios a su entorno, sigue el rumbo de los acontecimientos	

E. Estructuras

24. ¿Hasta qué punto considera que las siguientes afirmaciones son aplicables a su empresa? (1=no son aplicables en absoluto; 7=son completamente aplicables)

Vigilamos activamente nuestro entorno para identificar oportunidades de asociación. (E1)	1	2	3	4	5	6	7
Recopilamos información sobre posibles socios de varios fórums de forma rutinaria (por ejemplo, ferias de comercio, convenciones del sector, bases de datos, publicaciones, Internet, etc.) (E2)	1	2	3	4	5	6	7
Estamos alerta acerca de desarrollos de mercado que creen oportunidades de potenciales alianzas (E3)	1	2	3	4	5	6	7
Nos esforzamos por adelantarnos a nuestros competidores entrando en alianzas con empresas claves antes de que ellos puedan hacerlo. (E4)	1	2	3	4	5	6	7
A menudo tomamos la iniciativa en la aproximación a empresas a través de propuestas de alianza (E5)	1	2	3	4	5	6	7

F. Capacidades

25. ¿Hasta qué punto considera que las siguientes afirmaciones son aplicables a su empresa? (1=no son aplicables en absoluto; 7=son completamente aplicables)
Determinar si hay alianzas de innovación en la empresa

Nos aseguramos de que haya una coordinación apropiada entre las actividades de nuestras diferentes alianzas de innovación. (F1)	1	2	3	4	5	6	7
Determinamos áreas de complementariedad en nuestro portfolio de alianzas de innovación. (F2)	1	2	3	4	5	6	7
Nos aseguramos de que las dependencias mutuas entre nuestras alianzas de innovación estén identificadas. (F3)	1	2	3	4	5	6	7
Determinamos si hay superposiciones entre nuestras alianzas de innovación. (F4)	1	2	3	4	5	6	7

26. ¿Hasta qué punto considera que las siguientes afirmaciones son aplicables a su empresa? (1=no son aplicables en absoluto; 7=son completamente aplicables)

Somos capaces de reaccionar rápidamente a las cambiantes demandas del mercado. (F5)	1	2	3	4	5	6	7
Competimos utilizando nuestra habilidad para reaccionar rápidamente a las cambiantes demandas del mercado. (F6)	1	2	3	4	5	6	7
Adaptamos y mejoramos nuestros productos y/o servicios teniendo en cuenta las demandas identificadas en nuestros clientes. (F7)	1	2	3	4	5	6	7

27. ¿Hasta qué punto encajan las siguientes afirmaciones en la estructura de comunicación de su empresa? (1= no encajan en absoluto; 7=encajan completamente)

En nuestra empresa las ideas y conceptos son comunicadas interdepartamentalmente. (F8)	1	2	3	4	5	6	7
Nuestro equipo de gestión fomenta el apoyo interdepartamental para resolver problemas. (F9)	1	2	3	4	5	6	7
En nuestra empresa hay un flujo rápido de información, p.e., si una unidad de negocio obtiene información importante se lo comunica puntualmente a todas las demás unidades de negocio o departamentos. (F10)	1	2	3	4	5	6	7
Nuestro equipo de gestión organisa reuniones interdepartamentales periódicas para compartir nuevos desarrollos, problemas y logros. (F11)	1	2	3	4	5	6	7

G. Estrategia de búsqueda de conocimiento

28. A lo largo de los últimos cinco años, ¿cuáles de las siguientes fuentes han dado a su empresa nuevas ideas de innovación sostenible?

	Sí	No
Propia Junta Directiva (G1)		
Propio departamento / empleados de I+D+i (G2)		
Propio departamento / empleados de marketing (G3)		
Propio departamento / empleados de manufactura (G4)		
Propio departamento / empleados de atención al cliente o ventas (G5)		
Proveedores de equipamiento, materiales, componentes o software (G6)		
Clientes (G7)		
Competidores (G8)		
Consultores (G9)		
Laboratorios comerciales / Empresas de I+D+i (G10)		
Universidades u otros centros de educación superior (G11)		
ONGs (G12)		

Organisaciones de investigación del Gobierno (G13)		
Otros del sector público (G14)		
Institutos privados de investigación (G15)		
Conferencias profesionales, reuniones (G16)		
Cámaras de Comercio (G17)		
Prensa técnica o del sector, bases de datos electrónicas (G18)		
Ferias, exposiciones (G19)		
Estándares técnicos (G20)		
Estándares y regulaciones de Salud y Seguridad (G21)		
Estándares y regulaciones de Medio Ambiente (G22)		

H. Desempeño

29. A lo largo del último año, ¿cómo cree que han ido los siguientes aspectos en su empresa? (1=mucho peor; 7=mucho mejor)

Volumen de ventas logrado en comparación con sus competidores (H1)	1	2	3	4	5	6	7
Cuota de mercado en comparación con sus competidores (H2)	1	2	3	4	5	6	7

30. A lo largo del último año, ¿cómo cree que han ido los siguientes aspectos en su empresa? (1=mucho peor; 7=mucho mejor)

Nivel general de beneficio logrado en comparación con los competidores (H3)	1	2	3	4	5	6	7
Márgenes de beneficio en comparación con los competidores (H4)	1	2	3	4	5	6	7
Retorno de la inversión (ROI) en comparación con los competidores (H5)	1	2	3	4	5	6	7

31. A lo largo del último año, ¿cómo cree que han ido los siguientes aspectos en su empresa? (1=mucho peor; 7=mucho mejor)

Niveles de lealtad del cliente en comparación con los competidores (H6)	1	2	3	4	5	6	7
Niveles de lealtad del cliente en comparación con el año anterior (H7)	1	2	3	4	5	6	7
Niveles de satisfacción del cliente en comparación con los competidores (H8)	1	2	3	4	5	6	7
Niveles de satisfacción del cliente en comparación con el año anterior (H9)	1	2	3	4	5	6	7

32. A lo largo del último año, ¿hasta qué punto son aplicables las siguientes afirmaciones a su empresa? (1=no son aplicables en absoluto; 7=son completamente aplicables)

La empresa establece, promociona, vigila y mantiene estándares y prácticas éticas en sus transacciones con todos los grupos de interés (*stakeholders*) de la empresa. (H10)	1	2	3	4	5	6	7
La empresa gestiona todos sus recursos de forma consciente y efectiva, reconociendo el deber de actuar en favor de los intereses de todos los grupos de interés (*stakeholders*) de la empresa. (H11)	1	2	3	4	5	6	7
La empresa informa adecuadamente sobre sus productos, servicios y actividades, permitiendo así a los grupos de interés (*stakeholders*) hacer decisiones informadas (H12)	1	2	3	4	5	6	7
La empresa establece prácticas justas de comercio con proveedores, distribuidores y socios (H13)	1	2	3	4	5	6	7
La empresa compensa a sus proveedores de capital con un retorno sobre la inversión competitivo y la protección de los activos de la compañía (H14)	1	2	3	4	5	6	7
La empresa establece una relación de beneficio mutuo entre la empresa y la comunidad, siendo sensible a la cultura, contexto y necesidades de la comunidad en la que opera. (H15)	1	2	3	4	5	6	7
La empresa respeta las necesidades, deseos y derechos de sus clientes y se esfuerza por ofrecer los más altos niveles de valor en producto y servicio. (H16)	1	2	3	4	5	6	7
La empresa tiene prácticas de recursos humanos que promueven el desarrollo personal y profesional del empleado. (H17)	1	2	3	4	5	6	7
La empresa se esfuerza en proteger y recuperar el medio ambiente y promover el desarrollo sostenible con productos, procesos, servicios y otras actividades (H18)	1	2	3	4	5	6	7