Managing Innovation for Sustainability

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MANAGING INNOVATION FOR SUSTAINABILITY

A DYNAMIC CAPABILITIES APPROACH

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Managing Innovation for Sustainability
A dynamic capabilities approach

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Chapter 1
General Introduction

1. Introducing the Topic

In the last two decades, there has been a growing interest and need for corporate sustainability in companies (Kiron et al., 2012). Corporate sustainability is a systematic management effort by corporations aimed at improving the economic, environmental and social performance of companies in a balanced way (cf. Dyllick & Hockerts, 2002). This philosophy has been coined as the 'triple bottom line' of business by Elkington (1998). It is argued that companies need to adopt sustainable business practices if they want to retain their legitimacy; i.e., their social license to operate (e.g., Bansal & Clelland, 2004). Sustainable innovation is the focal point by which companies can deliver evidence of their commitments to the triple bottom line and improve their sustainability performance (Hall & Vredenburg, 2003; Hart & Milstein, 2003; Porter & van der Linde, 1995; Schaltegger & Wagner, 2011; Sharma & Ruud, 2003). Sustainable innovations can be defined as innovations that consist of new or modified processes, practices, systems, and products which benefit the natural environment and so contribute to ecological sustainability (Oltra & Saint Jean, 2009). Accordingly, there has been a large increase of interest in innovation for sustainability; i.e., sustainable innovation, in the last decade (Boons et al., 2013; Hart & Milstein, 2003; Porter & van der Linde, 1995). Sustainable innovation has been proposed as a 'breakthrough discipline for innovation' (Fussler, 1996), as a 'source of creative destruction' (Hart & Milstein, 1999: 23), as well as the beginning of the 'next industrial revolution' (Senge & Carstedt, 2001: 24). Bossink (2013: 1) defines sustainable innovation as the development of new initiatives at the firm "to sustain, improve and renew the environmental, social and societal quality of its business processes and the products and services these business processes produce." In contrast to conventional, market-driven innovation, sustainable innovation should incorporate the added constraints of environmental and social criteria into the innovation process in addition to the economic benefits of innovation (Hall & Vredenburg, 2003).

In the environmental issues, firms have to reduce the size of their ecological footprint; more significantly, through the waste and emissions generated by production processes (Bansal, 2005). As well, firms can reduce their 'cradle-to-grave' impact of their products (Hart, 1995). Products are designed to use fewer materials, toxic or otherwise, and to be disassembled for recycling or reuse at the end of their life (Bansal, 2005). In the social dimension, firms require embracing the economic, legal, ethical, and discretionary expectations of all stakeholders as their corporate social responsibility, not only financial shareholders (Carroll, 1979). Firms that integrate sustainability into their strategy consider needs and expectations of their stakeholders to create value for and through them (Hall & Vredenburg, 2003). Addressing social issues also include the decision not to produce socially undesirable products, and not to engage in relationships with unethical partners (Bansal, 2005). Regarding the economic dimension of sustainable innovation, firms can increase the created value of their products and services by improving the effectiveness of those goods and services. Value is also created by producing new and different products that are desired by consumers, by lowering the costs of inputs, or by realizing production efficiencies (Bansal, 2005). Therefore, sustainable innovation is usually more complex and ambiguous than conventional innovation as typically a relatively wide range of sustainability constraints and stakeholders is integrated into the innovation process (Hall & Vredenburg, 2003). Put differently, conventional innovation management practices are often inadequate to accommodate the highly complex and uncertain nature of sustainable innovation (Hall & Vredenburg, 2003; Seebode et al., 2012).

Much of the literature on sustainable innovation focuses on antecedents and motivations of companies and organizations (later on companies) for engaging with sustainable innovation (e.g., Horbach et al., 2012; Rehfeld et al., 2007). There is plenty of discussion regarding the need for sustainable innovation (e.g., Hall & Vredenburg, 2003; Hall & Wagner, 2012). However, a particularly critical gap in the literature pertains to the lack of insights into how companies develop and manage innovation for sustainability (e.g., Bos-Brouwers, 2010; Ketata et al., 2015; Seebode et al., 2012). Many studies point to company resources and competencies as key factors affecting innovation activities of the firms (e.g., Barney, 1991; Verona & Ravasi, 2003). Eisenhardt and Martin (2000) argue that innovation requires new knowledge, resources, and competencies that are specific to its particular context. Sustainable innovation often involves a considerable departure from the present knowledge base and is 'competency-destroying' (Hall & Clark, 2003; Hall & Vredenburg, 2003). Therefore, companies usually do not have the required knowledge, resources, and competencies for innovating towards sustainability (Dangelico et al., 2013; Hall & Vredenburg, 2003). Hence, to better understand how companies manage and develop innovation for sustainability, insight should be provided into how companies develop and rebuild their resource bases for innovating towards sustainability (Hofmann et al., 2012; Ketata et al., 2015; Seebode et al., 2012). Following this line of reasoning, in this research, five studies are provided that build on this premise. Adopting a dynamic capabilities approach, the research aims to provide new insights into firms' sustainable innovation activities. More specifically, the main research question that has guided this research is, ''How do companies develop and accumulate the required resources and competencies for innovating towards sustainability?''

2. Theoretical Foundation and Relevance

This research adopts a dynamic capabilities approach to explain theoretically and to investigate empirically how companies develop and accumulate the required resources and competencies for innovating towards sustainability. Helfat et al. (2007: 4) define dynamic capabilities as “the capacity of an organization to purposefully create, extend or modify its resource base.” Dynamic capabilities are about learning, building and creating the most appropriate resource base for the next organizational phase of development or new challenges they are facing (Ambrosini & Bowman, 2009).

According to the resource-based view of the firm (Barney, 1991), resources and competencies play a key role in supporting companies’ competitive advantage and innovation processes. van Kleef and Roome (2007) argue that the shift of focus in business from competitiveness alone to sustainability and competitiveness impacts firms’ resources and competencies for innovation. Therefore, companies have to reconsider their core activities to integrate, coordinate, build, and reconfigure their resources and competencies in the case of innovations for sustainability (Dangelico, 2016). This reconsideration can be conceptualized as a shift from ‘business-as-usual’ to ‘doing things differently’ (Nidumolu et al., 2009). Doing so, firms need to review their established routines and practices to ask whether their existing models for handling sustainable innovation are sufficient. These new configuration activities suggest that the dynamic capabilities approach can provide new insights into the companies’ innovation for sustainability. The resource-based view of the firm has neglected the influence of selection environment on the firms’ performance (Eisenhardt & Martin, 2000). The dynamic capabilities concept has emerged as an extension of the resource-based view of the firm to encapsulate the evolutionary nature of firms’ resources and competencies (Teece et al., 1997).

The dynamic capabilities approach has an explicit focus on how companies perform innovation activities and reconfigure their organizational and managerial processes and routines in pursuit of evolutionary fitness (e.g., Helfat et al., 2007). Lee and Kelley (2008) also argue that the dynamic capabilities approach can provide a useful theoretical lens for investigating innovation at the organizational level. Dynamic capabilities are a set of strategic activities aimed at enabling companies to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape, rapidly changing business environments (Teece et al., 1997). Thus, one common theme of both dynamic capabilities and innovation is that they are associated with changes (Eisenhardt & Martin, 2000; Zahra et al., 2006). Dynamic capabilities facilitate not only the ability of an organization to recognize a potential technological shift but also its ability to adapt to change through innovation (Hill & Rothaermel, 2003). Hence, the dynamic capabilities approach, with its emphasis on adaptation within ambiguous and dynamic markets, is particularly well suited to the study of innovation for sustainability which is highly complex and ambiguous (Dangelico et al., 2013). It is also argued that dynamic capabilities exhibit commonalities across firms; i.e., routines (Eisenhardt & Martin, 2000). However, such commonalities have not been systematically identified yet for firms' innovation for sustainability. Accordingly, this study has been done to understand how companies develop and deploy the required resources and competencies for innovating towards sustainability. Particularly, this study provides a dynamic perspective on how managerial and organizational capabilities act as antecedents to effectuate companies' resources and competencies for innovating towards sustainability.

3. Chapters' Overview

The following chapters provide five different studies on the topic of this dissertation and a final chapter, i.e., General Conclusions aims to answer the overall research question. Table 1.1 represents an overview of the studies.

First, Chapter 2 reviews the findings of previous studies, which have been conducted over the last years on the different types of resources and competencies that companies need to develop and acquire for innovating towards sustainability. Accordingly, this chapter synthesizes the findings of the reviewed studies through a dynamic capabilities approach and their underlying organizational routines in order to develop a conceptual model for future research studies.

Chapter 3 aims to test—a slightly adjusted version of—the conceptual model described in Chapter 2. In this study, Chapter 3 moves beyond the findings of Chapter 2 by explaining which of the previously organizational routines seem to be the most important ones, based on empirical data from a representative survey on the innovation activities of German enterprises.

Chapter 4, adopting a corporate perspective, investigates the organizational and managerial capabilities through which a company can coevolve resources and competencies around an innovation opportunity for sustainability. This study aims to contribute to a further theoretical and practical understanding of how capabilities are deployed by firms to create and implement system-level changes for innovating towards sustainability.

Chapter 5 argues that companies' dynamic capabilities for innovating towards sustainability consist of more than an aggregation of organizational routines. Dynamic capabilities may sometimes be rooted in particular organizational routines. However, they are also commonly rooted in creative managerial and entrepreneurial actions of the companies. Furthermore, routines cannot explain necessarily how innovations for sustainability are identified, prioritized, and selected. Accordingly, having a mere understanding of the organizational routines is not enough for a successful management of innovation for sustainability. Therefore, Chapter 5 intends to identify the dynamic capabilities of firms for innovating towards sustainability and how these capabilities develop, emerge or evolve within the companies to manage innovation for sustainability.

Chapter 6 investigates how companies' collaborations with NGOs influence organizational change and innovation towards sustainability. It is argued that moving toward sustainability needs a socio-technical transition, which not only entails new technologies but also changes in markets and governing institutions. Therefore, sustainability is a complex and multi-dimensional concept that cannot be addressed by any single corporate action (e.g., van den Bergh et al., 2011). Particularly, firms may engage in unique collaborations including collaboration with environmental NGOs as potential innovation partners for sustainability (Holmes & Smart, 2009). Hence, Chapter 6 explores how such a partnership arises and evolves, and observes in what way these dynamics influence the innovation process, with a particular emphasis on which contingencies contribute to its viability.

Finally, Chapter 7 presents general conclusions of the five preceding chapters, aiming to answer the overall research question that has been provided at the beginning of this dissertation. This Chapter also points out the theoretical and managerial implications of this dissertation's findings and discusses limitations and future research avenues.

Table 1.1 An overview of studies

Chapter	Aim	Title	Research Question	Research Approach	Data Source
1	General Introduction	———	———	———	———
2	Conceptual Study	A Review of Companies' Resources and Competencies for Innovating towards Sustainability	- What resources and competencies do companies need to innovate for sustainability?	Systematic review	- Existing literature
3	Empirical Study	Organizational Routines and Capabilities for Managing Innovation towards Sustainability	- What are the organizational routines and capabilities through which companies can innovate towards sustainability?	Quantitative approach- A representative survey on the innovation activities of German enterprises	- Cross-sectional data from the German part of the Community Innovation Survey conducted in 2009
4	Empirical Study	Firms' Capabilities for Sustainable Innovation: The Case of Biofuel for Aviation	- What are the organizational and managerial capabilities through which companies can coevolve resources and competencies around an innovation opportunity for sustainability?	Qualitative approach- A retrospective longitudinal case study	- Semi-structured interviews - Archival data
5	Empirical Study	Investigating Firms' Dynamic Capabilities for Innovating towards Sustainability	- What are the dynamic capabilities of companies for innovating towards sustainability? - How do these capabilities develop, emerge or evolve within the companies to manage innovation for sustainability?	Qualitative approach- A multiple-case study	- Semi-structured interviews - Archival data
6	Empirical Study	Business-NGO Collaboration for Innovating toward Sustainability: KLM and WNF Creating a New Market for Sustainable Biofuels for Aviation	- How do companies' collaborations with NGOs influence organizational change and innovation towards sustainability?	Qualitative approach- A retrospective longitudinal case study	- Semi-structured interviews - Archival data - Focus group
7	General Conclusions	———	———	———	———

Chapter 2
A Review of Companies' Resources and Competencies for Innovating towards Sustainability[1]

Abstract

One increasingly important way for companies to contribute to the achievement of environmental sustainability objectives is through innovating for sustainability, i.e., sustainable innovation. It is argued that sustainable innovation often involves a departure from the present knowledge base and is competency-destroying. Therefore, to better understand how companies manage and develop innovation for sustainability, insight should be provided into the resources and competencies that companies need for innovating towards sustainability. With this aim, a systematic review of the relevant body of knowledge on innovation for sustainability is conducted to answer the question of what resources and competencies companies need to innovate for sustainability. The review analyses, discusses and synthesizes theoretical foundations of previous empirical studies to investigate and explicate the contribution of companies' resources and competencies for innovating towards sustainability. It also consolidates the companies' resources and competencies for innovating towards sustainability into three theoretically distinct capabilities; i.e., sensing, seizing, and reconfiguring, to describe the function and effectiveness of the companies' resources and competencies in managing innovation for sustainability. This study highlights how companies' resources and competencies should be, become and/or develop in order to integrate and enhance sustainability in their innovation activities. Furthermore, it develops several avenues for further investigation.

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[1] Earlier versions of this chapter were presented at the XXV ISPIM Innovation Conference 2014, Dublin, Ireland and R&D Management Conference 2015, Pisa, Italy.

A version of this chapter is under review at the journal of Business Strategy and the Environment.

1. Introduction

Environmental sustainability is an increasingly important issue for today's companies (Nidumolu et al., 2009). The quest for environmental sustainability has been one of the drivers behind the redesigning of existing products and the production processes (Shrivastava, 1995b) to create shared value for business and society (Porter & Kramer, 2011). Accordingly, one increasingly important way for companies to contribute to the achievement of environmental sustainability objectives is through innovating for sustainability; i.e., sustainable innovation (Hall & Vredenburg, 2003; Schaltegger & Wagner, 2011). Sustainable innovation is seeking to arrive at 'win-win' situations where economic performance and sustainable development are advanced simultaneously in a balanced way (Carrillo-Hermosilla et al., 2010). Sustainable innovation is defined as an innovation that consists of new or modified processes, practices, systems or products which not only delivers a value-added economic performance but also benefits the natural environment (Bos-Brouwers, 2010; Oltra & Saint Jean, 2009).

Sustainable innovation is perceived to be more challenging than conventional, market-driven, innovation because it adds additional layers of complexity; i.e., integrating sustainability into the innovation process (Hall & Vredenburg, 2003; Noci & Verganti, 1999). Hall and Vredenburg (2003) argue that sustainable innovation often involves a departure from the present knowledge base and is 'competency-destroying.' Hence, companies usually do not have the required knowledge, resources, and competencies for innovating towards sustainability (Dangelico et al., 2013; Hall & Vredenburg, 2003). To better understand how companies manage and develop innovation for sustainability, insight should be provided into the resources and competencies that companies need for innovating towards sustainability (e.g., De Marchi, 2012; Ketata et al., 2015). A resource can be defined as an "input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis" (Helfat & Peteraf, 2003: 999). According to Lundvall et al. (2002), knowledge is the most important resource in the modern economy. Miller et al. (2007) also argue that knowledge is one of the most important inputs into the innovation process. A competency or capability is an ability to accomplish something by deploying and coordinating a set of tangible or intangible resources (e.g., Grant, 1996).

During the last two decades, many studies have focused on the different types of knowledge, resources, and competencies that companies need to innovate for sustainability (e.g., Cainelli et al., 2015; De Marchi, 2012; Ghisetti et al., 2015; Vickers, 2000). This prompts the need to analyze and synthesize the findings of these studies that have been conducted over the years. Hence, we perform a systematic review to address the research question of what resources and competencies companies need to innovate for sustainability.

To date, no review study exists focusing on the companies' resources and competencies for innovating towards sustainability. Two prior reviews have paid attention to the literature on firm-level determinants of innovation for sustainability (del Rio et al., 2015; Hojnik & Ruzzier, 2016). de Medeiros et al. (2014) and Dangelico (2016) also identify antecedents and success factors for environmentally sustainable product innovation development. Some literature reviews have focused on the nature of sustainable innovation and its change over time (Klewitz & Hansen, 2014; Schiederig et al., 2012). This study aims to review the academic literature on firm-level resources and competencies for innovating towards sustainability and contribute to a deeper understanding of how companies manage innovation for sustainability.

The rest of this paper is structured as follows. In the next section, we emphasize the main peculiarities of sustainable innovation and discuss terms that can be used to address it. The following section presents the research method that is applied to conduct the review. Then we analyze the literature on the companies' resources and competencies for innovating towards sustainability and organize findings of the study according to the theoretical foundations that have been used in the reviewed publications. Next section synthesizes the key findings of the study through a dynamic capabilities approach. Finally, the last section provides the main conclusion of the study, proceeds with the contribution of the study to research and practice, the review's limitations, and future research directions.

2. Sustainable Innovation: Concept and Peculiarities

Before reviewing the literature, a clarification of the concept of 'sustainable innovation' is needed to understand which literature must be included in our analysis. Throughout the literature, cleaner production, clean technology, responsible innovation, eco-innovation, ecological innovation, environmental innovation, green innovation, environmentally sustainable innovation, sustainable innovation, sustainability-driven innovation, sustainability-oriented innovation, innovation for sustainable development are among the terms that have been used to refer to innovation with an environmental sustainability focus (Hojnik & Ruzzier, 2016; Varadarajan, 2017). In this study, we use the term sustainable innovation with the caveat that most innovations for sustainability reflect the two main consequences; i.e., fewer adverse effects on the environment and more efficient use of resources.

Larson (2000: 305) defines sustainable innovation as "the innovative and potentially transformative corporate activities that generate new products and processes that challenge existing practices.'' Its potential to transform technology, products and markets discern sustainable innovation as an area of entrepreneurial opportunity and a force of 'creative destruction' as defined by Schumpeter (1934). Seebode et al. (2012) also argue that sustainable innovation usually involves significant system-level changes around emergent and radically different solutions. Thus, innovation for sustainability often needs to move beyond incremental adjustments (Nill & Kemp, 2009; Sartorius, 2006). This radicalness has specific implications regarding the actors involved in the innovation process, as well as the need to build up a new market for the innovation (Boons et al., 2013). Accordingly, the literature has emphasized a higher level of complexity if innovation is motivated by sustainability goals (van Geenhuizen & Ye, 2014). This complexity is not necessarily related to the higher-level novelty of process or product technology but also is linked to uncertainty and variety in the traditional technological or market domain the companies usually compete in (Cainelli et al., 2015). Companies are therefore likely to have a higher need for different types of knowledge, resources, and competencies for innovating towards sustainability while remaining competitive (e.g., Cainelli et al., 2015; De Marchi, 2012; Ghisetti et al., 2015).

3. Research Method

This study employs a systematic review methodology. A systematic review uses an explicit algorithm to collect all empirical evidence and perform a critical appraisal of the literature, with the aim to answer a specific research question (Tranfield et al., 2003). The systematic review includes three parts, that is: data collection, data analysis, and synthesis of data. The systematic review improves the quality of the review process and synthesizes the findings in a transparent and reproducible manner (Tranfield et al., 2003).

3.1. Data collection

Studies to be included in the review are identified by searching the research database of Web of Science. This database is one of the most comprehensive databases of peer-reviewed journals in the sciences and social sciences. The database is searched using combinations of selected keywords. The aim is to search for articles that contain both (1) 'resources,' ‘knowledge,’ ‘competencies,’ or ‘capabilities,’ and (2) one of the terms that have been used in section 2 to refer to innovation with an environmental sustainability focus. To guarantee quality and to reduce the sample to a manageable amount, we concentrate on the articles of the peer-reviewed academic journals in the English language. Regarding the timeframe covered, the articles that have been published within the period of 1987 to April 2017 are included in the study. We select the date of 1987 as a start date because the concept of sustainable development has been taken up a significant importance for a better future during the past decades since the Brundtland Report, *Our Common Future* (Brundtland, 1987). We also limit our search to subject areas of ‘Business,’ ‘Management,’ ‘Economics,’ ‘Environmental Sciences & Studies,’ and ‘Green Sustainable Science Technology.’ The keywords are used as a selection criterion for the topic (title, keywords, or abstract), resulting in an initial sample of 542 papers.

The study selection process takes place in several steps. First, the titles and abstracts of the retrieved articles are reviewed for a first analysis of their relevance to the research question and the non-relevant articles are excluded. After this process, 106 potentially relevant articles are maintained and included in the full-text search. The full text is reviewed for an in-depth analysis of relevance. 43 of the reviewed studies are assessed as relevant studies after the full-text analysis. During the selection process, the focus is on empirical studies which adopted a managerial/organizational perspective to investigate companies’ resources and competencies for innovating towards sustainability. Further, according to Webster and Watson’s guidelines (2002), a citation search is performed to check for other articles potentially relevant to the research question and this leads to the identification of 15 relevant articles. At the end of the process, 58 articles are included in the systematic review. Finally, this set of publications is critically appraised and evaluated to structure and synthesize the review.

3.2. Data analysis

The resulting articles are further pursued in both the descriptive and thematic analysis. For the descriptive analysis, data from the full text are extracted for each study. We select categories that describe the papers regarding author(s), journals covered, years of publication, titles, types of the methodology applied, country/countries where the study is conducted.

For the thematic analysis, we use qualitative analysis techniques of pattern matching and explanation building (cf., Yin, 2009) to review the selected studies. The aim is to investigate what resources and competencies companies need to innovate for sustainability and to organize findings according to the theoretical lenses of the selected studies.

3.3. Data synthesis

Data synthesis is a collective process for summarizing and integrating the findings of the selected studies on a topic or research questions (Tranfield et al., 2003). Webster and Watson (2002) categorize reviews into two types: First, a mature topic where an accumulated body of research exists on that topic. In this case, researchers would conduct a comprehensive literature review and then propose a conceptual model that synthesizes and extends existing research. Second, reviewers could tackle an emerging issue that would benefit from exposure to prospective theoretical foundations. The reviewers' contribution would arise from the fresh theoretical foundation proposed in developing a conceptual model. We categorize innovation for sustainability as an emerging topic, and thus we use the second category to synthesize the findings of the selected studies. Hence, we adopt a dynamic capabilities approach as a theoretical lens to propose a conceptual model based on the review study's findings.

4. Findings

4.1. Descriptive analysis

In this section, a descriptive analysis of our selected studies is provided. Figure 2.1 reports the names of journals where the reviewed studies have been published. The journal where most studies included in the systematic review have been published is Business Strategy and the Environment, followed by Journal of Cleaner Production, Research Policy, and Ecological Economics.

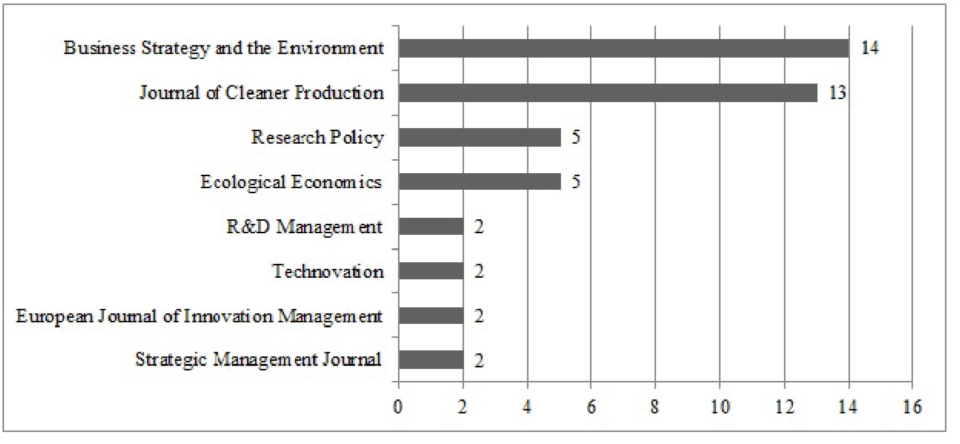

Figure 2.1 The names of journals where the reviewed studies have been published (n=58; included if>1)

Figure 2.2 reports types of the methodology that have been used in the reviewed studies. The most important source of empirical evidence in the reviewed studies is a quantitative approach where the survey has been used as a research strategy for data collection (39 studies corresponding to 67%). 15 of the reviewed studies are based on the Community Innovation Survey (CIS), one of the most used datasets in innovation studies, which has attracted the majority of attention in the innovation literature (e.g., Laursen & Salter, 2006). Studies using qualitative approaches are also of importance with 15 articles (corresponding to 26%). Case studies (single and multi-case studies) are the applied research strategy of qualitative papers for gathering data. Four articles have used a mixed methods approach as a research strategy for data collection (corresponding to 7%).

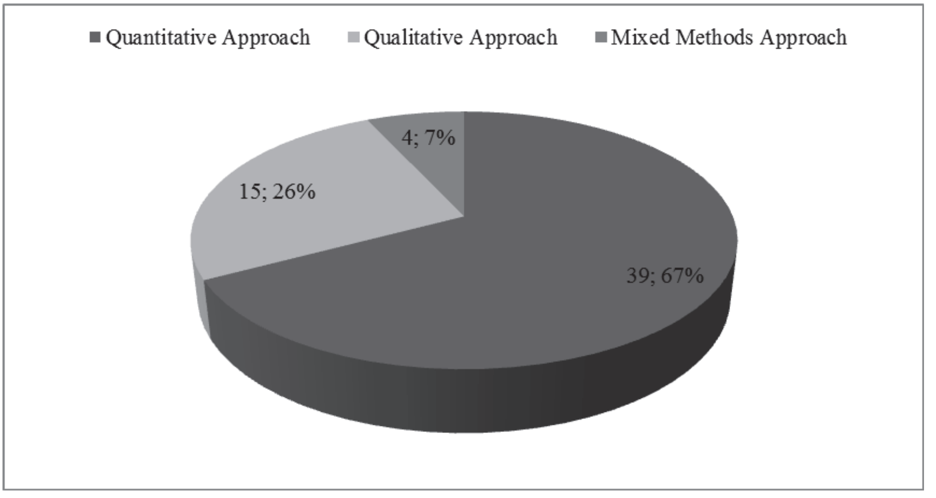

Figure 2.2 Types of the methodology applied in the reviewed studies

Regarding countries where the reviewed studies have been conducted, the top five most represented countries are Spain (seven articles), USA (six articles), Germany (five articles), the Netherlands (five articles), and Brazil (four Articles). As a general result, the majority of studies have been conducted in European countries.

4.2. Thematic analysis

We present and organize the findings of the review study based on the theoretical foundations of the selected studies. Table 2.1 provides a concise overview of theoretical foundations of the reviewed studies.

Table 2.1 Theoretical foundations on companies' resources and competencies for innovating towards sustainability

Theoretical foundations	Main findings	Studies
The resource-based view of the firm	• This approach emphasizes the importance of firms' internal resources or competencies for innovating towards sustainability; however, dealing with such innovations for firms on their own is not an easy task. • Eco-organizational innovations facilitate the development of innovation for sustainability as they contribute to the strategic renewal of organizational knowledge and resources. • Firms' innovation for sustainability is not only a function of internal firm decisions but also a response to the business environment.	Aragon-Correa and Leyva-de la Hiz (2016); Berrone et al. (2013); Bonte and Dienes (2013); Cainelli et al. (2015); Cheng et al. (2014); Dangelico et al. (2013); Doran and Ryan (2016); Kammerer (2009); Halme and Korpela (2014); Lee and Min (2015); Meyskens and Carsrud (2013); Sharma and Vredenburg (1998); Weigelt and Shittu (2016); Ziegler and Seijas Nogareda (2009).
Innovation theory	• For innovating towards sustainability, companies need new knowledge, competencies, and technologies, which can be developed through three procedures; i.e., 'in-house strategy,' 'cooperation strategy,' and 'external strategy.'	Bos-Brouwers (2010); del Rio et al. (2017); del Rio et al. (2015); De Marchi (2012); Doran and Ryan (2012); Ghisetti et al. (2015); Horbach (2008); Kesidou and Demirel (2012); Lee et al. (2010); Marzucchi and Montresor (2017); Rehfeld et al. (2007); Souto and Rodriguez (2015); Triguero et al. (2013); Wong (2013).
Absorptive capacity theory	• Firms on their pathway to sustainable innovation need to take in new impulses from outside and translate these into innovations. Hence, firms gain access to and integrate relevant sustainability-related knowledge to their innovation activities.	Hammar and Löfgren (2010); Ketata et al. (2015); Klewitz et al. (2012); Lopes et al. (2017); Segarra-Ona et al. (2016).

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Continued

Dynamic capabilities approach	• Dynamic capabilities help firms to adjust their resource variety and reconfigure their internal and external competencies for innovating towards sustainability.	Albort-Morant et al. (2016); Chassagnon and Haned (2015); Hofmann et al. (2012); Pace (2016); Pinkse and Dommisse (2009); Seebode et al. (2012).
An evolutionary approach to innovation	• Companies should develop the new knowledge base and learning processes for innovating towards sustainability compared to conventional innovation.	Blum-Kusterer and Hussain (2001); Carrillo-Hermosilla et al. (2010); del Rio et al. (2015); Green et al. (1994); Horbach et al. (2013).
Organizational learning theory	• Organizational learning describes the complex and iterative processes through which firms acquire environmental knowledge to create and redefine values/culture and existing practices for innovating towards sustainability.	van Hoof (2014); Vickers (2000); Vickers and Cordey-Hayes (1999); Wagner (2008).
Entrepreneurship theory	• Companies need entrepreneurial and potentially transformative corporate activities to disrupt existing practices and mobilize resources for innovating towards sustainability.	Arnold and Hockerts (2011); Larson (2000).
Other theoretical approaches	• Innovation for sustainability often needs main changes in the corporate management practices, the supply chain, and the company's relationships with other actors of the value chain. • The main barrier to innovation for sustainability is the lack of knowledge about innovation opportunities for sustainability and possible environmental and economic feasibility of such innovations. • Cross-functional collaboration, supplier involvement, design for environment, and market-focus innovation are critical success factors for innovating towards sustainability.	Azzone and Noci (1998); Bocken et al. (2014); Dangelico and Pujari (2010); Jabbour et al. (2013); Lee and Kim (2011); Neto et al. (2017); Pujari (2006); Saez-Martinez et al. (2016); Severo et al. (2017).

4.2.1. The resource-based view of the firm

The resource-based view of the firm proposes an internal analysis of innovation which emphasizes the significance of firms' internal resources and competencies in explaining the innovation behavior of the companies (Barney, 2001). This theory highlights that many factors influence innovative processes, not only factors external to the firm, but also its internal resources and, particularly, its experience, its knowledge base, and its technological capabilities. In line with this perspective, Lee and Min (2015) examine the role of green research and development investment in eco-innovation. This study indicates that companies should engage and organize unique organizational resources and capabilities for superior corporate environmental performance. Particularly, the study confirms that green R&D investment enables companies to achieve superior environmental performance.

In another study, Doran and Ryan (2016) apply a combination of the resource-based view of the firm and stakeholder theory to investigate how two supply-side drivers, namely R&D expenditure and knowledge linkages, influence the different types of environmental innovation. They argue that companies with a high engagement in both internal and external R&D activities may possess more potential for innovating towards sustainability. Furthermore, Doran and Ryan (2016) assume that good access to external information and knowledge is a critical driver of environmental innovation. These knowledge linkages (i.e., with consumers, suppliers, competitors, and universities) help companies to meet stakeholders' demands. In line with this study, Cainelli et al. (2015) enter the 'black box' of the firm and provide evidence that the resources employed by a firm to develop environmental innovation differ from conventional innovation. Particularly, their results speak for a greater importance of all internal, external and hybrid resources for innovating towards sustainability compared to conventional innovation. Consistent with this study, Halme and Korpela (2014) investigate what resources SMEs need to develop responsible innovation. They indicate that environmental technology innovation calls for more abundant resource combinations. The most common resource combination includes equity, research and development cooperation, networks, industry knowledge and reputation.

Meyskens and Carsrud (2013) empirically examine the role of partnership diversity in early stage green-tech ventures by adopting a resource-based view of the firm. This study argues that partnership diversity allows green-tech ventures accumulate and combine necessary resources as a result of their different types of partnership with distinct sectors. Similarly, Dangelico et al. (2013) indicate that the integration of environmental issues at the manufacturing process level is improved by the acquisition of knowledge from a range of external sources such as universities and research centers, policymakers, and conferences. Furthermore, this study highlights that the integration of environmental issues at the product design level largely benefits from acquiring new technical know-how and using external knowledge sources through formal collaborations with actors within the supply chain. Dangelico et al. (2013) also display that the acquisition of new technical know-how and assets provide new opportunities for sustainability. In the same vein, Bönte and Dienes (2013) distinguish three different process innovation strategies for environmental innovation. First, firms may follow an in-house strategy and develop their innovations mainly within the company ('in-house strategy'). Second, they may opt for an external strategy and innovations may be mainly developed by external partners ('external strategy'). Third, they may opt for a cooperation strategy and develop innovations together with external partners ('cooperation strategy'). Bönte and Dienes (2013) indicate that companies which follow the external strategy tend to have a lower probability of developing environmental process innovations. However, their results do not support that those companies which follow a cooperation strategy experience greater environmental innovation performance.

Our review shows that eco-organizational innovation facilitates the development of innovation for sustainability as it contributes to the strategic renewal of organizational knowledge and resources. For instance, Cheng et al. (2014) examine the relative and inter-relationship effects of three types of eco-innovation (process, product, organizational). Their findings show that companies should consider the interdependence and co-evolutionary relationships between different types of eco-innovation for innovating towards sustainability. In particular, Cheng et al. (2014) indicate that eco-organizational innovation, i.e., new management practices and structural renewal, facilitates and contributes to providing an environment conducive for the development of eco-product and eco-process innovation. However, Ziegler and Seijas Nogareda (2009) do not find a significant relationship between the adoption of voluntary environmental programs such as environmental management system (EMS) and environmental innovation. This finding is in contrast with the hypothesis that an EMS enables the development of strategic resources which can have a positive influence on environmental innovation (e.g., Horbach, 2008; Rehfeld et al., 2007; Wagner, 2008). Ziegler and Seijas Nogareda (2009) also emphasize the importance of companies' internal resources for innovating towards sustainability. In the same vein, Kammerer (2009) argues that market considerations play an important role in the development of environmental product innovation. Accordingly, the study supports that green products should have private environmental benefits for the customer (e.g., energy savings) besides their public benefits. Companies may use environmental improvements to differentiate their products from others as a green marketing strategy to gain a competitive advantage.

The review also indicates that firms' innovation for sustainability is not only a function of internal firm decisions but also a response to the business environment. For instance, Sharma and Vredenburg (1998) ground the resource-based view of the firm within the domain of corporate environmental responsiveness. They argue that proactive innovative environmental strategies lead to the development of firm-specific capabilities for innovating towards sustainability. These capabilities are stakeholder integration, higher-order learning, and continuous innovation. However, the study does not find any specific capability or learning process in firms with reactive environmental strategies. In another article, Weigelt and Shittu (2016) study the interaction between regulatory mandates and competition on a focal firm’s new resource investments in the context of renewable energy technologies. They demonstrate that resource redeployment and reconfiguration is not merely a function of internal firm decisions but a response to external forces such as regulatory mandates and competition. Berrone et al. (2013) also examine the role of organizational slack and resources in how companies respond to green institutional pressures. They find that regulatory and normative pressures concerning environmental issues engender heterogeneous organizational responses. This study shows that similar ‘green’ institutional pressures lead to unique and differentiated environmental innovation on the part of firms. These differences are contingent on the firms’ past environmental performance and internal resources. In line with this study, Aragon-Correa and Leyva-de la Hiz (2016) propose a mixture of institutional theory and the resource-based view of the firm to examine the complementary potential of a firm’s environmental innovations and other innovations in the firm and the industry. They assume that the existence of non-environmental innovations by a firm is positively related to the number of its environmental innovations. However, institutional theory argues that a company gets a positive influence from its innovations when the fields of the firm's environmental innovations are consistent with those of the industry. Aragon-Correa and Leyva-de la Hiz (2016) show that environmental innovation and non-environmental innovation by a firm are related, emphasizing the commonalities of internal resources that create conventional and environmental innovation. This study also supports the findings of Berrone et al. (2013) who confirm the combined influence of institutional and internal resources on the development of innovation for sustainability.

4.2.2. Innovation theory

Innovation theory stresses the relevance of technology push and market pull factors for the explanation of innovation activities. There is a consensus that technology push factors are particularly important in the initial phase of new product development, whereas market factors become more important in the diffusion phase (De Marchi, 2012; Rehfeld et al., 2007). Our review indicates that for innovating towards sustainability, companies need new knowledge, competencies, and technologies, which can be developed through three procedures; i.e., 'in-house strategy,' 'cooperation strategy,' and 'external strategy.' Drawing insights from innovation theory, Rehfeld et al. (2007) show that some environmental, organizational measures can promote environmental product innovation. They argue that EMS implementation can bring a company to review its existing procedures to find possibilities for improvement on environmental product innovation. It is also found that companies need to stimulate the demand for environmental products by getting the prices economically viable. In line with this study, De Marchi (2012) investigates the relationship between companies' R&D cooperation strategies and their propensity to innovate for sustainability. This study shows that for innovating towards sustainability, companies need to cooperate with external partners to a greater extent than for conventional innovation. De Marchi (2012) also argues that environmental innovations due to their complexity and market uncertainties are affected significantly by absorptive capacity of the firms. The study concludes that internal prior knowledge is important to select and develop external inputs for successful development of environmental innovation.

In another study, Souto and Rodriguez (2015) study the factors that hinder firms to develop environmental innovations and how they still manage to achieve these innovations. The study finds that the lack of qualified staff, limited information on technology, lack of information on markets, difficulty in finding cooperation partners for innovation, and uncertain demand for environmental innovations are the main problems of the companies for innovating towards sustainability. They argue that the creation of an innovation system that constitutes a favorable context for environmental innovation cooperation is a way to overcome these barriers. In the same vein, Marzucchi and Montresor (2017) investigate the knowledge drivers of firms' eco-innovations. Their results provide novel insights about the knowledge-base of the companies for eco-innovations. The study shows that companies need to follow a 'hybrid' mode in eco-innovating. Accordingly, the companies need knowledge and competencies from both the world of science (research) and the world of business (market) for innovating towards sustainability. In the same vein, del Rio et al. (2017) show that knowledge capital accumulated by the firm through R&D and knowledge flow from cooperation and networking activities are the main drivers of new firms to eco-innovate, vs. older firms. It is also found that product eco-innovations do not require greater internal innovation capabilities than process eco-innovations. External knowledge flows from knowledge institutions are relevant only for product eco-innovations, whereas knowledge flows internal to the firm are a driver of process eco-innovations.

Horbach (2008) enlarge innovation theory and propose the term environmental innovation theory to include institutional and political factors as environmentally specific determinants of eco-innovation. The analysis shows that the improvement of technological capabilities ('knowledge capital') by R&D triggers environmental innovations. Other studies have also adopted this theoretical foundation in their empirical analysis of eco-innovations (Doran & Ryan, 2012; Ghisetti et al., 2015; Lee et al., 2010; Triguero et al., 2013).

Doran and Ryan (2012) investigate the factors which drive eco-innovation. This study shows that backward linkages to suppliers and consultants are most common partnerships for eco-innovating. In another study, Ghisetti et al. (2015) focus on the open innovation mode of companies for environmental innovations. The study demonstrates that knowledge sourcing has a positive impact on environmental innovations. It is confirmed that companies could benefit from an open innovation mode for innovating towards sustainability. However, it is found that due to cognitive constraints in processing knowledge inputs, broadly acquired external knowledge can become difficult to manage and, after a certain point, even discourage firms from innovating towards sustainability.

Lee et al. (2010) show that technology-forcing regulations are successful in forcing not only the introduction but also the development of advanced emissions control systems. Furthermore, the study indicates that automakers are not just assembling subcomponents into a system, but also they are system integrators that coordinate the value chain for developing new emissions control systems. It is also found that automakers' in-house R&D is a crucial factor for their continued success as the locus of innovation for developing the complex systems. In the same vein, Triguero et al. (2013) indicate that those entrepreneurs who collaborate with research institutes and universities eco-innovate more. It is also found that for innovating towards sustainability, companies need to increase the market demand for green products. Furthermore, the analysis shows that there is a complementarity across the three types of eco-innovation; i.e., product, process and organizational innovation. In line with these studies, Wong (2013) shows that knowledge sharing in green innovation differs from conventional innovation. In green innovation, manufacturers are required to meet not only the environmental regulations and green expectations but also those of the final markets. Wong (2013) argues that the lack of experience in companies for dealing with environmental issues, learning and locating innovation opportunities for dealing creatively with environmental issues is a key factor for innovating towards sustainability.

In another study, Kesidou and Demirel (2012) investigate the drivers of eco-innovations in UK firms by drawing insights from innovation theory and the environmental economics literature. The environmental economics literature highlights the key role that environmental regulations play in stimulating eco-innovations. Kesidou and Demirel (2012) argue that companies initiate to innovate for sustainability to satisfy the minimum customer and societal requirements. However, investments in eco-innovations are increased by other factors such as firms' organizational capabilities and stricter environmental regulations. The paper also indicates that higher levels of environmental stringency may enhance eco-innovation in less innovative companies which often adopt a reactive strategy towards eco-innovations to lessen production costs of complying with environmental regulations. However, more innovative companies, which are often more proactive towards eco-innovation, may increase their investments in eco-innovation for strategic reasons to gain a competitive advantage in the market. Bos-Brouwers (2010), combining insights from innovation theory and corporate sustainability, shows that many sustainable innovations within SMEs are directed at the improvement of technological processes (eco-efficiency) to lower costs of production. It is also found that SMEs often have a lack of knowledge about sustainability issues. Thus, these companies need to cooperate with knowledge institutes, suppliers, and customers for innovating towards sustainability. The study shows that SMEs have behavioral advantages such as informal and entrepreneurial leadership style and flexible organization capacities through which companies can compensate their resource shortcomings.

4.2.3. Absorptive capacity theory

Our review indicates that absorptive capacity theory (Cohen & Levinthal, 1990) is mostly used as a theoretical foundation to provide an external analysis of firms' innovation sourcing strategies for sustainability. Absorptive capacity refers to the ability of an organization to take in new impulses from outside and translate them into innovations for sustainability. The review shows that sustainable innovation may require knowledge and competencies which do not belong to the core competencies of the firms. Accordingly, companies need initiatives to acquire knowledge outside their organizational boundaries as a possible solution on their pathway to sustainable innovation. For instance, Hammar and Löfgren (2010) explain how firms' absorptive capacity impacts the decision of companies to adopt abatement technologies. Their study finds that the probability of a firm to invest in clean technologies increases if the company has expenditures for R&D related to the environmental issues (green R&D). Hammar and Löfgren (2010) also argue that R&D investments facilitate companies in identifying available environmental technologies. This argument is consistent with Cohen and Levinthal (1990: 153) who argue that ''firms invest in R&D not only to pursue directly new process and product innovation but also develop and maintain their broader capabilities to assimilate and exploit externally available information."

In another study, Klewitz et al. (2012) offer evidence that SMEs with low absorptive capacity should collaborate with innovation intermediaries such as local authorities and consultancies. This collaboration strengthens SMEs' absorptive capacity through providing direct support at the level of information and knowledge gatherings as well as employee training, and hence, supports the implementation of eco-innovations. In line with this study, Lopes et al. (2017) argue that through open innovation routines, companies can manage and leverage new knowledge of ideas and practices to promote sustainable innovations. They find that companies often resort to organizational routines and processes; i.e., absorptive capacity, to reconfigure their resource bases to adapt to market changes. Furthermore, Lopes et al. (2017) show that open innovation routines promote recognition of the value of external information and apply it for commercial purposes.

Ketata et al. (2015) also argue that sustainable innovation activities are the result of a fit between external demands and internal absorptive capacities to leverage them. Accordingly, their study finds that firms need to invest in internal absorptive capacities and to draw potential innovation impulses from external sources. The internal absorptive capacities help the companies to spot promising opportunities for innovating towards sustainability, connect them to existing knowledge stocks and exploit them effectively. In that sense, Ketata et al. (2015) indicate that investments in employee training turn out to be more important than technological R&D. The employee training includes not only the ability to collect impulses but also to set priorities and choose the crucial ones. Their study also shows that companies should follow an open logic in their innovation for sustainability. In the same vein, Segarra-Ona et al. (2016) argue that for innovating towards sustainability firms need to rely on external information sources and their abilities to identify, assimilate and apply external knowledge. They show that the close relationship with market sources including suppliers, competitors, and clients is a key factor for innovating towards sustainability.

4.2.4. Dynamic capabilities approach

The review study shows that dynamic capabilities (Teece et al., 1997) help firms to adjust their resource variety and reconfigure their internal and external competencies for innovating towards sustainability. For example, Pinkse and Dommisse (2009) display that the adoption of clean and energy-efficient technologies depends on the ability of companies to develop dynamic capabilities for this purpose. They argue that innovation for sustainability needs a path-dependent accumulation of institutional and technological knowledge and integration of diverse stakeholder interests. Their findings indicate that companies which actively gather information and build internal technical capacity are more likely to adopt energy-efficient technologies. Pinkse and Dommisse (2009) also show that communicating the advantages of clean technologies to potential customers is a valuable capability to create a customer-oriented market for the clean technologies. In the same vein, Seebode et al. (2012) draw a dynamic capabilities approach to develop an understanding of new approaches to innovation management required for innovating towards sustainability. They argue that sustainable innovation often involves working with different knowledge components– new technologies, new markets, new environmental or regulatory conditions– and particularly, it needs to work at a systems level. Therefore, for successful management of innovation for sustainability, companies need to renew their routines and practices to deal with a changing context they face.

In another study, Hofmann et al. (2012) indicate that the adoption of advanced technologies, collaboration with customers and suppliers, and innovative capacity for product innovations are three capabilities that support firms' efforts to successfully implement environmental management. In line with this study, Chassagnon and Haned (2015) investigate which different forms of innovation leadership increase the propensity of firms to develop environmental innovations. They delineate innovation leadership as a dynamic capability of innovative firms to seize innovation opportunities for sustainability. Chassagnon and Haned (2015) also argue that firms which are consistently 'innovation leaders' are those that can more easily benefit from first movers advantages when innovating for sustainability. This argument is consistent with the Porter hypothesis; i.e., companies that are concerned by environmental issues need to focus their innovation efforts on one direction to adapt to the competitive business environment (Porter & van der Linde, 1995).

Albort-Morant et al. (2016) show that dynamic capabilities affect the improvement of green innovation performance. Their study supports that dynamic capabilities influence green innovation performance by reconfiguring relationship-learning capabilities as a type of ordinary capabilities. Relationship-learning activities are ongoing joint activities between the customer and the supplier organizations aimed at sharing information, making sense of information, and integrating acquired information to improve the success of potential relationships. In a similar study, Pace (2016) argues that the innovation adoption process occurs through a number of different stages in which firms are required to deploy a portfolio of capabilities. In the initiation stage of adoption, companies need to identify the problem and gather information and knowledge to make a decision about adopting an energy efficient technology. This could entail capabilities to recognize the requirements for a technology and explore technological options; i.e., sensing. Then, companies need activities in the implementation stage that facilitate putting technology into use. The implementation stage requires capabilities to select the most appropriate technology option and make the technology operational through a process of learning; i.e., seizing. In the implementation stage, companies may also reinvent or modify the technology according to the adopter's needs.

4.2.5. An evolutionary approach to innovation

The review indicates that sustainable innovation needs a new knowledge base and learning processes compared to conventional innovation. For example, drawing insights from evolutionary economics theory (cf. Nelson & Winter, 1977), Green et al. (1994) argue that the 'green' issue is a major change in the companies' selection environments. New 'green' regulations or anti-pollution taxes change the selection environment in which a company operates. This change opens new opportunities for the companies by demanding greener processes and products. The study shows that the new, greener selection environment has stimulated many companies to reconfigure their technological bases for environmental innovations. This reconfiguration involves spending more on R&D, reorganizing R&D aims, recruiting new skilled staff, and seeking to collaborate with customers and suppliers, new manufacturing-related processes, and training. However, the study indicates those environmental innovations that are the result of a 'major' change in technologies need higher changes in the reorganization of R&D aims, collaboration with suppliers, and manufacturing-related processes than those innovations with a 'modification' to existing technologies. Similarly, Blum-Kusterer and Hussain (2001) demonstrate that both extra-firm and intra-firm factors are significant in determining the eco-innovation process. It is found that regulation is the most significant driver for innovating towards sustainability. Blum-Kusterer and Hussain (2001) also show that eco-innovation goes beyond technological change, and it also needs changes in management and organizational structure of the innovative companies. Furthermore, the study indicates that organizational changes towards sustainability which are instigated by regulation are often more sudden than for the changes of other factors such as market conditions and voluntary agreements.

In another study, Horbach et al. (2013) highlight that many factors affect innovative processes for sustainability, not only factors external to the firm such as regulations, but also its internal resources and, particularly, its knowledge base and its technological capabilities. This study shows that eco-innovations are often characterized by relatively new technologies and regulatory constraints. Thus, companies need to call into question their processes and knowledge bases for adapting to the new challenges.

Furthermore, the study supports that eco-innovations need more external sources of knowledge and information compared to conventional innovations. In the same vein, del Rio et al. (2015) show that companies are influenced by internal and external factors for making the decision to eco-innovate. The study argues that eco-innovation is not developed and implemented in isolation, but it needs to align technology and related knowledge and skills, networks of actors, and institutions. Furthermore, the study indicates that for eco-innovation, companies need to have a high internal technological capability and combine internal and external information sources, particularly in cooperation with knowledge partners. Carrillo-Hermosilla et al. (2010) also argue that eco-innovations with greater market focus have a better chance of market acceptance and success. Furthermore, their study highlights that the success and the capacity of eco-innovations to provide new business opportunities depend on the involvement of different stakeholders in their development for wiring up the innovation system.

4.2.6. Organizational learning theory

Organizational learning describes the complex and iterative processes through which firms acquire environmental knowledge to create and redefine values/culture and existing practices of the company for innovating towards sustainability. Vickers and Cordey-Hayes (1999) find that firms need organizational learning around cleaner production as a response to environmental pressures. Their study shows that organizational learning is stimulated by four key drivers; i.e., regulations, green market pressures, quality and technical efficiency considerations, and values/culture within companies. Vickers and Cordey-Hayes (1999) emphasize the importance of good linkages with external sources of knowledge, including regulators and suppliers of clean technologies. They also argue that the development of cleaner technology requires organizations to be receptive to a broader than usual set of information from a variety of sources to sensitize to green business opportunities. In line with this study, Vickers (2000) discusses that the movement of firms toward sustainability requires that proactive firms engage in organizational learning. Particularly, their study shows that the participation of all divisions and levels is a key aspect of an evolutionary development of cleaner production. As well, Vickers (2000) indicates that employees training and empowerment and their involvement in cleaner production have a particularly important role in uncovering opportunities for waste minimization and pollution reduction. Another finding of this study is that companies need to reorganize R&D, with a drive towards the more cross-functional team, and involve the supplier in the product design and development. In another study, Wagner (2008) confirms that an EMS fosters environmental innovation. This study also shows that managerial activities including market research on the potential of environmental innovations and eco-labelling activities have a positive effect on environmental product innovation. In these activities, market research is the most important managerial activity for innovating towards sustainability, followed by eco-labelling to inform consumers on environmental effects of products and production processes. Market research on 'green' products provides a better understanding of the profitable demand for product innovations with environmental benefits and enables companies to identify the customer needs. In the same vein, van Hoof (2014) identifies that organizational learning is an essential element for successful implementation of cleaner production. This study argues that organizational learning is a means to foster sustainability by institutionalizing new thinking in the companies. Accordingly, companies need innovative behavior at the different organizational levels for practical adaptation of cleaner production efforts; i.e., acquisition of new knowledge, new collaborative actions, and new decision-making procedures. Accordingly, the knowledge base of the company for cleaner production is regularly expanded and renewed as continuous improvements are implemented.

4.2.7. Entrepreneurship theory

Our systematic review shows that companies need entrepreneurial and potentially transformative corporate activities to disrupt existing practices and mobilize resources for innovating towards sustainability. For instance, Larson (2000) investigates how environmental sustainability considerations can be successfully integrated into the business strategy of companies. This study finds that environmentally related opportunity and the process through which entrepreneurs innovate for sustainability is a result of the cultivation and leadership of a network of actors in the value chain. It is also found that a vision of sustainability for the company is like a roadmap to the future, showing what products and services should be developed and what new resources and competencies will be needed to get there. Furthermore, Larson (2000) indicates that companies need entrepreneurial leadership for mobilizing resources and competencies in a network organization. In the same vein, Arnold and Hockerts (2011) investigate what entrepreneurial activities companies need for the integration of sustainable innovation into their core business. It is found that companies can increase their strategic awareness and estimate the potential benefits of sustainable innovation by adopting an entrepreneurial vision for sustainability and integrating sustainability as an explicit goal in the design process of products. Arnold and Hockerts (2011) also find that target-setting across all units, top-down management, intra-organizational training, firm internal platforms and networks, eco-labeling and a plain communication strategy of the sustainable profit are the main entrepreneurial activities for restructuring production processes and products towards more sustainability.

4.2.8. Other theoretical approaches

The review indicates that some studies have used literature streams to investigate what resources and competencies companies need for innovating towards sustainability. These literature streams are mostly specific to the environmental context, such as corporate environmental management (Azzone & Noci, 1998; Jabbour et al., 2013; Neto et al., 2017; Severo et al., 2017), green product development (Dangelico & Pujari, 2010; Lee & Kim, 2011; Pujari, 2006), firms' technological trajectories (Saez-Martinez et al., 2016), and the literature stream of the front-end of innovation (Bocken et al., 2014a).

Azzone and Noci (1998) show that companies adopt three different patterns of strategic sustainability behavior to integrate green issues into their business activities; i.e., a reactive, an anticipatory, and an innovation-based pattern of sustainability behavior. The study identifies that these distinct behaviors need a variety of resources and green competencies. The reactive behavior mainly involves reactions to external stimuli emerging from governments and regulators. The anticipatory behavior often considers environmental initiatives as a primary source of future competitive advantage for the company. Reactive and anticipatory strategies are more likely to lead to the acquisition or development of new green technologies or the modification of existing products in an environmental sense; i.e., incremental innovations. The innovation-based behavior sees the environmental variable as the most important competitive priority and involves the introduction of new technologies that radically improve the environmental performance of current technologies or the creation of new market needs. Furthermore, Azzone and Noci (1998) indicate that the development of an innovative environmental program often needs main changes in the corporate management system, the organization of supply chain, and the company's relationships with other stakeholders of the value chain. In the same vein, Jabbour et al. (2013) show that companies with proactive environmental management use functional and cross-functional green teams more intensively than companies with reactive environmental management to identify sustainability opportunities.

In another study, Neto et al. (2017) find that management's lack of knowledge about cleaner production techniques and possible environmental and economic feasibility of cleaner production implementation is the main barrier for cleaner production. In line with this study, Severo et al. (2017) also find that the presence of cleaner production and environmental management practices within firms facilitates companies to produce new environmentally sustainable products. Thus, companies can minimize their environmental impacts by making use of environmental management technologies such as environmental management system, life cycle analysis (LCA), and cleaner production.

Based on green product innovation literature, Pujari (2006) explores the activities through which companies integrate environmental concerns into new product development. This study identifies that cross-functional collaboration between new product development professionals and environmental specialists, supplier involvement, design for environment/life cycle analysis, and market focus have significant impacts on the performance of environmental new product development. Similarly, Lee and Kim (2011) show that integrating suppliers in green product development is an important process to achieve commercial and environmental competitiveness in the market. In the same vein, Dangelico and Pujari (2010) highlight that green product development needs knowledge from a variety of sources including regulations, new environmental technologies, and low environmental impact materials. Furthermore, the study shows that green product development often includes the use of new technologies or the replacement of one critical component with a completely new one to reduce the overall environmental impact of the product. As well, findings indicate that formalizing an environmental strategy and target for products is an important activity to guide companies in the development of green products. Life cycle analysis (LCA) is another important activity of the companies for assessing the environmental impact of the new products at each stage of the product's lifecycle. Developing customer awareness about the benefits of green products and creating credibility through eco-labels or third party certification are new marketing activities to achieve the market success.

Bocken et al. (2014a) investigate the Front End of Eco-Innovation (FEEI) to understand how SMEs develop and recognize new ideas and opportunities for eco-innovations. This study shows that external sources of knowledge and information such as customers and suppliers are more important for eco-innovations than for conventional innovations to generate novel ideas, but the internal generation of eco-innovation ideas is also important. Furthermore, it is found that companies use systematically eco-design tools such as LCA during the innovation process. The study also indicates that multidisciplinary teams with high creativity and environmental knowledge should be engaged in the FEEI process. In line with this study, Saez-Martinez et al. (2016) examine the effect of a firm's technological trajectory and its current research and development strategy on the eco-innovation of the company. A firm's technological trajectory refers to the knowledge, accumulated competencies, and a learning environment in which the company operates and develops its innovation activities. This study indicates that the development of new technologies allows companies to generate new market opportunities for sustainability. However, it is found that market-focused companies innovate more for sustainability. These companies recognize market opportunity from cooperation with market players and use formal appropriability mechanisms to capture the rents generated by their eco-innovations.

5. Discussion

5.1. The explanatory power of theoretical foundations that have been used in the reviewed studies

Based on the previously presented literature review, we find that literature on innovation for sustainability has benefited from a wide range of theoretical foundations to explicate why and how companies innovate towards sustainability. Particularly, our review explains what resources and competencies companies need to innovate for sustainability. Table 2.2 provides an overview of the explanatory power of theoretical foundations that have been used in the reviewed studies to serve as a theoretical lens on the companies' resources and competencies for innovating towards sustainability.

The resource-based view of the firm provides a powerful theoretical lens for understanding the role of resources and competencies in supporting firms' innovation processes. The initial focus of this view has been on distinctive resources and competencies being internal to the firm (Barney, 1991). In later years, scholars pointed to the importance of external resources. In particular, when companies do not have the resources and competencies to innovate on their own, they seek access to the necessary resources through inter-organizational relationships, alliances, and networks (Cainelli et al., 2015). It is argued that the more diverse the knowledge and competencies needed to develop an innovation process; the more companies need to rely on external resources to succeed, either by collaborating with other organizations or by acquiring them. Accordingly, many reviewed studies have adopted the resource-based view of the firm because it has focused on the importance of specific resources and competencies in innovating towards sustainability (e.g., Aragon-Correa & Leyva-de la Hiz, 2016). However, the resource-based view of the firm has been criticized for not being able to explain why companies respond to environmental issues and how resources are deployed to innovate towards sustainability (Berchicci & Bodewes, 2005; Cheng et al., 2014).

According to innovation theory, companies' innovation for sustainability is explained at the microeconomic level of the individual market by means of factors from supply and demand sides. In other words, technology push and market pull factors have usually been identified as the main drivers of innovation in the general theory of innovation (Rehfeld et al., 2007). Focusing on the determinants of innovations for sustainability, it is also necessary to consider the influence of environmental policy and other institutional factors as a diver of innovating towards sustainability (e.g., Horbach, 2008). Innovation theory generally assumes that changes in the behavior of the company arise from an exogenous shock to the system; e.g., a cost-reducing innovation or an expected regulation. Therefore, companies move directly to the new equilibrium state, e.g., a profit-maximizing production process or a first-mover advantage. Accordingly, companies' internal technological capabilities for sustainability have been triggered by R&D investment and education of the employees on sustainability. Internal technological capabilities are more relevant for innovating towards sustainability than for conventional innovation (del Rio et al., 2015). It is also found that sustainable innovation requires knowledge inputs from different and heterogeneous sources, possibly more so than conventional innovations (Marzucchi & Montresor, 2017). However, the innovation theory is less able to provide an in-depth insight into the mechanisms underlying sustainable innovation. It also cannot explain fully how 'learning' takes place in the companies during the process of innovation for sustainability (Bos-Brouwers, 2010; Rehfeld et al., 2007).

Table 2.2 The explanatory power of theoretical foundations to serve as a theoretical lens

Theoretical foundations	Explanatory power to serve as a theoretical lens
The resource-based view of the firm	This approach provides a powerful theoretical lens for understanding the role of specific resources and competencies in supporting firms' innovation processes. However, the resource-based view of the firm has been criticized for not being able to explain why companies respond to environmental issues and how resources are deployed to innovate towards sustainability.
Innovation theory	It argues that companies' technological capabilities for sustainability have been triggered by R&D investment and education of the employees on sustainability. However, the innovation theory is less able to provide an in-depth insight into the mechanisms underlying sustainable innovation. It also cannot explain fully how 'learning' takes place during the process of innovation for sustainability.
Absorptive capacity theory	Absorptive capacity is the most frequently used theoretical foundation for providing an external analysis of firms' knowledge sourcing strategies for sustainable innovations. However, it has focused less on how companies develop and modify their organizational routines and processes through which they can identify, assimilate and exploit the knowledge coming from external sources for innovating towards sustainability.
Dynamic capabilities approach	The dynamic nature of business environment requires firms to continuously extend and modify their resources and competencies to innovate and create new competitive advantages. It is argued that dynamic capabilities enable companies to reconfigure their resources and competencies for managing the interface between their business activities and the natural environment. A dynamic capabilities approach has focused on how companies innovate and change so as to maintain evolutionary fitness.

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Continued

An evolutionary approach to innovation	An evolutionary approach to innovation rejects the conventional economic notion of profit-maximizing behavior by the firm. Instead, this approach argues that the behavior of a company is governed by its current decision rules, which relates its actions to various environmental stimuli. Accordingly, the evolutionary approach stresses the interaction between the internal and external factors in the innovation process for sustainability. However, the evolutionary approach to innovation is not enough comprehensive to integrate the strategy and innovation literature and provide an umbrella framework that highlights the most critical capabilities which companies need for innovating towards sustainability
Organizational learning theory	Organizational learning theory can be used to enrich the debate on change processes for cleaner production or eco-design at the organizational level. Organizational learning explains the change in the behavior of the company or its members that is triggered by a change in the underlying 'theory in use.' However, this theory requires well accepted and sharply defined sets of microfoundations that allow flows of learning among individuals, groups, and the organization as a whole to describe the means by which companies learn to innovate towards sustainability.
Entrepreneurship theory	Entrepreneurship theory views sustainability as a source of change in society and seeks to answer the questions of how and why sustainable innovation takes place. It can explain the dynamics of innovation for sustainability. Particularly, entrepreneurship theory investigates how innovation opportunities for sustainability are created and realized through various modes of organizing. However, entrepreneurship theory does not pay particular attention to managerial and leadership skills of the companies to design, develop, implement, and modify their routines for reconfiguring the companies' resources and competencies.

Absorptive capacity theory can provide some insights on how companies effectively integrate external and internal sources of existing and new knowledge for innovating towards sustainability. Absorptive capacity not only focuses on the acquisition and assimilation of external knowledge but also includes a firm's ability to process knowledge internally (Cohen & Levinthal, 1990). It is argued that companies with a higher level of absorptive capacity exhibit better organizational learning and organizational ambidexterity (Rothaermel & Alexandre, 2009). Accordingly, it is found that internal capabilities including internal R&D and employee training not only generate new knowledge and eventually innovations, but also increase the 'absorptive capacity' of the companies for innovating towards sustainability (e.g., Ketata et al., 2015). Through the lens of absorptive capacity theory, the reviewed studies have extended the open innovation paradigm to the analysis of innovation for sustainability (Ghisetti et al., 2015; Lopes et al., 2017). In particular, this theory has enabled researchers to explain how companies move beyond the company's boundaries to suppliers, customers, and other influential stakeholders to scan, acquire, and implement external knowledge. However, the absorptive capacity theory is especially relevant for innovating towards sustainability that often appears outside of a company's technological expertise (Shrivastava, 1995a). It has focused less on how companies develop and modify their organizational routines and processes through which they can identify, assimilate and exploit the knowledge coming from external sources for innovating towards sustainability (Ketata et al., 2015).

The dynamic nature of their business environment requires firms to continuously extend and modify their resources and competencies to innovate and create new competitive advantages. It is argued that dynamic capabilities enable companies to reconfigure their resources and competencies for managing the interface between their business activities and the natural environment (e.g., Aragon-Correa & Leyva-de la Hiz, 2016).

Dynamic capabilities emphasize appropriating, adapting, integrating, and reconfiguring internal and external organizational resources and competencies to match the requirements of changing business environments (e.g., Cheng et al., 2014). Thus, a dynamic capabilities approach has focused on how companies innovate and change so as to maintain evolutionary fitness. Evolutionary fitness references the selection environment by helping to shape the environment (Teece, 2009). The dynamic capabilities approach argues that in addition to the resources themselves, firms need capabilities to manipulate and deploy resources in order to integrate sustainability value into their innovation activities. The dynamic capabilities approach could be particularly suitable to study dynamic environments such as that characterizing environmental sustainability. The dynamic capabilities approach could also be useful for understanding the relative influence of different dimensions of external turbulence in the business environment, such as market, technological, and regulatory on innovating towards sustainability (Dangelico et al., 2013). It is argued that certain capabilities may be required in order to successfully implement innovations for sustainability.

An evolutionary approach to innovation depicts corporate behavior as a learning process, wherein innovations for sustainability are defined not by absolute efficiency but also by historical precedents. Accordingly, the evolutionary approach to innovation rejects the conventional economic notion of profit-maximizing behavior by the firm (Blum-Kusterer & Hussain, 2001). Instead, this approach argues that the behavior of a company is governed by its current decision rules, which relates its actions to various environmental stimuli (Nelson et al., 1976). Hence, the evolutionary approach to innovation views that both intra-firm and external factors to the organization stimulate eco-change. It is argued that innovation for sustainability arises through a systemic process that refers to the interconnectedness and dynamic interaction between different actors and internal and external factors influencing the innovation process (Carrillo-Hermosilla et al., 2010). Accordingly, this approach would suggest that companies that participate in learning networks are more likely to innovate towards sustainability due to co-evolution than those that do not participate (Blum-Kusterer & Hussain, 2001). This is because networking reduces efforts for the 'trial-and-error' nature of innovation for sustainability, and links the companies' behavior to socio-technical concerns. However, the evolutionary approach to innovation is not enough comprehensive to integrate the strategy and innovation literature and provide an umbrella framework that highlights the most critical capabilities which companies need for innovating towards sustainability (cf., Teece, 2007).

In the context of the business and the natural environment literature, the importance of organizational learning as a means for achieving cleaner production has been a recurrent theme (e.g., Vickers, 2000; Vickers & Cordey-Hayes, 1999). Particularly, organizational learning theory has been used to enrich the debate on change processes for cleaner production or eco-design at the organizational level. Organizational learning explains the change in the behavior of the company or its members that is triggered by a change in the underlying 'theory in use'; i.e., a set of values and causal beliefs that the members of the company share (Argyris & Schön, 1996). Accordingly, organizational learning theory with a particular focus on the knowledge dimension can explicate how companies change and organize knowledge, value, and routines around their activities for innovating towards sustainability (cf., Siebenhüner & Arnold, 2007). Organizational learning theory also emphasizes the influence of internal communication and project work, multi-stakeholder dialogues, and partnerships as crucial mechanisms for fostering innovation for sustainability (Arnold & Hockerts, 2011). In this theory, attention has been paid to the governance, incentive structures, and organizational routines that enable learning and the generation of new knowledge for innovating towards sustainability. In sum, this theory describes the complex and iterative processes through which companies acquire knowledge to create and redefine their mental models for innovating towards sustainability. However, this theory requires well accepted and sharply defined sets of microfoundations that allow flows of learning among individuals, groups, and the organization as a whole to describe the means by which companies learn to innovate towards sustainability (cf., Shrivastava, 1983).

Entrepreneurship researchers emphasize the concepts of opportunity, innovation, as well as the processes and modes of organizing through which entrepreneurs achieve their goals. Entrepreneurship theory views sustainability as a source of change in society and seeks to answer the questions of how and why sustainable innovation takes place (Larson, 2000). In particular, it can explain the dynamics of innovation for sustainability. Entrepreneurship theory focuses on the innovation process in a sustainability-driven context. It investigates how innovation opportunities for sustainability are created and realized through various modes of organizing (Keskin et al., 2013). It can also illustrate how innovating entrepreneurs or companies interact with and exert their potential influence on the system context for their innovation (Janssen & Moors, 2013). Accordingly, entrepreneurship theory links entrepreneurship as a classical driver of innovation to the concept of innovation systems. The concept of corporate entrepreneurship also focus on how companies rejuvenate, renew, and redefine organizations, markets, or industries for innovating towards sustainability (Börjesson et al., 2014). However, entrepreneurship theory does not pay particular attention to managerial and leadership skills of the companies to design, develop, implement, and modify their routines for reconfiguring the companies' resources and competencies (cf., Teece, 2014).

5.2. Synthesis of findings

We discuss and synthesize the findings of this review through the theoretical lens of the dynamic capabilities approach. The dynamic capabilities approach enables us to explain theoretically how companies renew and expand their resource bases for innovating towards sustainability. We begin with a discussion that the dynamic capabilities approach can provide a comprehensive framework to explain companies' resources and competencies for innovating towards sustainability as follows.

First, the study shows that sustainable innovation needs a new knowledge base, technological capabilities, and learning processes compared to conventional innovation (e.g., Blum-Kusterer & Hussain, 2001; Carrillo-Hermosilla et al., 2010; Lee & Min, 2015). It is argued that sustainable innovation is often beyond the core competencies of most companies and is more resource intensive in comparison with conventional innovation (Dangelico et al., 2013; Hall & Vredenburg, 2003). Moreover, companies need different types and combinations of types of knowledge, resources, and competencies for sustainable innovation (Cainelli et al., 2015; De Marchi, 2012; Ghisetti et al., 2015; Halme & Korpela, 2014). Accordingly, the review highlights that companies need to renew and expand their knowledge bases to adapt to environmental sustainability challenges (Green et al., 1994; Horbach et al., 2013; van Hoof, 2014). It is also found that there are three different innovation sourcing strategies for innovating towards sustainability; i.e., 'in-house strategy,' 'cooperation strategy,' and 'external strategy' (e.g., Bönte & Dienes, 2013; Bos-Brouwers, 2010; Ghisetti et al., 2015). These strategies are categorized according to the degree of involvement of external partners in the development of innovations. Put differently, the review shows that companies have different sources to renew and expand their knowledge bases for sustainable innovation by leveraging internal and external resources and competencies. The companies not only must be able to create knowledge within their boundaries but also need to look elsewhere for new ideas and expertise to prevent knowledge base rigidity and to encourage restructuring their competencies. Thus, the companies' challenge is to identify, develop, and deploy the key resources and competencies required for innovating towards sustainability. Drawing the concept of dynamic capabilities as a theoretical lens of the study, we argue that in addition to the resources themselves, firms need capabilities to manipulate and deploy resources in order to integrate sustainability value in their innovation activities. The concept of dynamic capabilities is an extension of the resource-based view of the firm (Barney, 1991). Helfat et al. (2007: 4) define dynamic capabilities as "the capacity of an organization to purposefully create, extend or modify its resource base." Thus, the dynamic capabilities are about learning, building and creating the most appropriate resource base for the next organizational phase of development or new challenges they are faced (Ambrosini & Bowman, 2009).

Second, it is argued that the concept of dynamic capabilities is mainly originated from an evolutionary theory of economic change (Nelson & Winter, 1982) and processes of creative destruction and innovation-based competition (Schumpeter, 1934). Hence, the dynamic capabilities approach places emphasis on the process and change nature of innovation for sustainability. It also encapsulates the evolutionary nature of firms' resources and competencies for innovating towards sustainability. According to van Kleef and Roome (2007), the shift of focus in business from competitiveness alone to sustainability and competitiveness impacts firms' resources and competencies for innovating towards sustainability. Thus, companies have to reconsider their organizational routines and practices in the case of innovations for sustainability (Dangelico, 2016; Nidumolu et al., 2009). This reconsideration can be conceptualized as a shift from 'business-as-usual' to 'doing things differently' (Nidumolu et al., 2009). Therefore, companies should reconsider their core activities. We conclude that the dynamic capabilities approach provides a valuable focus on change processes within the company. Dynamic capabilities enable companies to develop their innovation capability by going beyond current routines to solve problems differently (Zahra et al., 2006). Dynamic capabilities not only allow companies to exploit their existing resources and organizational competencies but also help them to develop and maintain their resources and competencies to adapt to changes in their business environment (Teece, 2007; Teece et al., 1997). Teece et al. (1997: 516) define dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments." Dynamic capabilities also enable companies to shape the ecosystem around their business and develop new products and processes in response to the threats and opportunities in the marketplace (Teece, 2007). Thus, dynamic capabilities consider the influence of selection environment on the firms' performance (Eisenhardt & Martin, 2000). Accordingly, the dynamic capabilities approach has an explicit focus on how companies perform innovation activities and reconfigure their organizational and managerial processes and routines in pursuit of evolutionary fitness (Helfat & Peteraf, 2009). This implies that dynamic capabilities can play a key role as a theoretical foundation for understanding how a firm innovates towards sustainability.

Many scholars have offered their own definitions of dynamic capabilities since Teece et al.'s (1997) original contribution. These definitions are mostly adaptations of Teece et al.'s original definition. For example, Eisenhardt and Martin (2000: 1107) define dynamic capabilities as 'the firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change' and 'the organizational and strategic routines by which firms achieve new resources and configurations as markets emerge, collide, split, evolve, and die'. According to Zahra et al. (2006: 918), dynamic capabilities are 'the abilities to reconfigure a firm's resources, and routines in the manner envisioned and deemed appropriate by its principal decision-maker.'

The scholars have adopted an universalization approach to define the dynamic capabilities concept. They have combined different theoretical perspectives of the evolutionary theory of economic change (Nelson & Winter, 1982) and processes of creative destruction and innovation-based competition (Schumpeter, 1934) into the one concept; i.e., dynamic capabilities. In other words, a synthesizing practice can be seen in their efforts. This approach has shown a consensus about the dynamic capability construct. The definitions reflect that dynamic capabilities are organizational processes in the most general sense and that their role is to change the firm's resource base.

After this period of universalization, Teece (2007) has categorized dynamic capabilities into three clusters of capabilities. (1) Sensing: identification and assessment of an innovation opportunity for sustainability; (2) Seizing: mobilization of internal and external resources and competencies to address an opportunity and capture value from doing so; and (3) Reconfiguring: continued renewal of resources to keep the resource base of the company in line with the challenge of sustainability demands. We adopt this threefold classification of firm-level dynamic capabilities to conceptualize how companies develop and renew their resources and competencies for innovating towards sustainability. It explicitly introduces a bundle of practices or 'Microfoundations' for each category of dynamic capabilities. 'Microfoundations' are defined by Teece (2007: 1319) as "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines" that form the organizational basis of dynamic capabilities. In other words, the concept of dynamic capabilities is operationalized by microfoundations. This simplification and operationalization of the dynamic capabilities construct enable us to suggest some propositions in order to get a better understanding of firms' dynamic capabilities in the context of innovation for sustainability.

Sensing. The review highlights that innovation for sustainability, similar to conventional innovation is an opportunity-driven innovation. Porter and van der Linde (1995: 115) argue that "companies must start to recognize the environment as a competitive opportunity- not as an annoying cost or a postponable threat." Neto et al. (2017) find that the lack of knowledge about cleaner production techniques and possible environmental and economic feasibility of cleaner production implementation is the main barrier to cleaner production. Souto and Rodriguez (2015) also show that the lack of qualified staff, limited information on environmental technologies, lack of information on markets, difficulty in finding cooperation partners for innovation, and uncertain demand for innovative goods and services are the main barriers to companies for innovating towards sustainability. Wong (2013) argues that learning and locating innovation opportunities for environmental sustainability is a critical step for innovating towards sustainability. Accordingly, companies need certain organizational routines to recognize innovation opportunities for sustainability; i.e., sensing. Sensing is a set of dynamic capabilities that involves gaining knowledge about the external and internal business environment to make strategic decisions about the future development paths (Feiler & Teece, 2014).

It is found that having an adequate internal base of knowledge and skills to recognize and address sustainability issues is crucial for realizing sustainable innovation. For example, Vickers (2000) argues that employees training and empowerment, and their involvement in cleaner production have a particularly important role in uncovering opportunities for waste minimization and pollution reduction. Ketata et al. (2015) also show that opportunity recognition for sustainability is linked to investments in technological R&D and employee training. Furthermore, Hammar and

Löfgren (2010) find that R&D investments facilitate companies to identify available environmental technologies. Saez-Martinez et al. (2016) indicate that the development of new technologies enables companies to generate new market opportunities for sustainability. Making use of environmental management technologies such as an environmental management system (EMS) and life cycle analysis (LCA) also enable companies to identify innovation opportunities for sustainability (Dangelico & Pujari, 2010; Severo et al., 2017). EMS implementation can bring a company to review and monitor its existing procedures and environmental impact to find possibilities for improvement on environmental sustainability (Razumova et al., 2015; Wagner, 2008). LCA helps companies to sense market benefit potentials and environmental impact of the products (specifically material and energy savings) (Bocken et al., 2014a; Dangelico & Pujari, 2010).

The review also shows that external sources of knowledge and information are more important for sustainable innovations than for conventional innovations to generate novel ideas (Bocken et al., 2014a; Horbach et al., 2013). In the same vein, Segarra-Ona et al. (2016) and Pinkse and Dommisse (2009) indicate that companies which actively gather information from external sources are more likely to innovate for sustainability. It is found that in the case of innovation for sustainability, companies should be receptive to a broader than usual set of information from a variety of sources (Dangelico et al., 2013; Vickers & Cordey-Hayes, 1999). Companies are also exposed to innovation opportunities that arise from market sources (e.g., customers and suppliers) and knowledge sources (e.g., universities and research institutes) (Horbach et al., 2013; Saez-Martinez et al., 2016; Wagner, 2008). Accordingly, sensing capabilities enable companies to overcome information deficits about environmental impacts and possible solutions for them within organizations. Hence, the following proposition is suggested:

***Proposition 1**: Firms with greater sensing capabilities are prone to innovate more towards a greater degree of sustainability.*

Seizing. Seizing capabilities involve activities to translate the recognized opportunities into new products, processes, or services, which requires investment in implementation and commercialization activities (Teece, 2007). During implementation, companies need to make decisions about which products, processes, or services should be developed and which resources should be mobilized. The review indicates that companies need to have high internal capabilities to select, develop, and combine internal and external information sources for the successful development of sustainable innovation (De Marchi, 2012; del Rio et al., 2015). R&D activities and employee training are internal capabilities which influence firms' innovation for sustainability (Cainelli et al., 2015; Ketata et al., 2015). It is found that companies which engage higher in green R&D activities possess more potential for innovating towards sustainability and achieve superior environmental performance (del Rio et al., 2017; Doran & Ryan, 2016; Hammar & Löfgren, 2010; Lee & Min, 2015). Our review also highlights that employee training on specialized aspects of environmental sustainability issues is a key resource for companies to innovate for sustainability (Cainelli et al., 2015; Dangelico et al., 2013; Green et al., 1994). Employees can understand and integrate sustainability issues in the innovation process. It is also found that the participation of all divisions and levels; particularly, the cross-functional collaboration between new product development professionals and environmental specialists is a key factor for the development of sustainable innovation (Pujari, 2006; Vickers, 2000). Furthermore, the review finds that sustainable innovation often includes the adoption of new technologies, or the replacement of one critical component with a completely new one to provide new opportunities for sustainability (Dangelico & Pujari, 2010; Hofmann et al., 2012; Pinkse & Dommisse, 2009). Thus, companies need capabilities to select the most appropriate technology option and put the technology into use (Pace, 2016). Dangelico et al. (2013) also highlight that companies can integrate environmental issues into new product development by acquiring new technical know-how and assets from external knowledge sources.

Larson (2000) indicates that environmentally related opportunity and the process through which the companies innovate for sustainability is a result of the cultivation and leadership of a network of actors in the value chain. Thus, to seize the innovation opportunities for sustainability, companies need to cooperate with external partners to a greater extent than for conventional innovation (De Marchi, 2012). Hofmann et al. (2012) also argue that green innovators need to mobilize inter-organizational cooperation more intensively than other innovators for their innovative activities. Furthermore, Meyskens and Carsrud (2013) find that partnership diversity enables green innovators to accumulate and combine necessary resources and competencies as a result of their different types of partnership with distinct sectors. Halme and Korpela (2014) also show that environmental innovations need more abundant resource combinations. Accordingly, external partners facilitate the development process of sustainable innovation by providing resource combinations and complementing deficiencies of resources. Marzucchi and Montresor (2017) argue that companies need to follow a 'hybrid' mode in their open innovation approach to sustainability. Put differently, the companies need knowledge and competencies of both market partners and knowledge partners. The more types of partners a company cooperates with, the more likely it is to effectively innovate for sustainability (e.g., Cainelli et al., 2015; Dangelico et al., 2013). It is found that cooperation with suppliers (Bos-Brouwers, 2010; De Marchi, 2012; Doran & Ryan, 2012; Hofmann et al., 2012; Lee & Kim, 2011), customers (Bos-Brouwers, 2010; Hofmann et al., 2012), universities and research institutes (Bos-Brouwers, 2010;

Triguero et al., 2013), and consultants (Doran & Ryan, 2012; Klewitz et al., 2012) are the most important partnerships for innovating towards sustainability. Accordingly, seizing capabilities enable companies to translate the recognized opportunity into eco-friendly products, processes, or services. This discussion leads us to suggest the following proposition:

> ***Proposition 2****: Firms with greater seizing capabilities are prone to innovate more towards a greater degree of sustainability.*

Reconfiguring. Reconfiguring capabilities are organizational routines to leverage or adapt the resources and competencies of the company in order to create a better 'fit' with its changing environment (Teece, 2007). Seebode et al. (2012) argue that for successful management of sustainable innovation, companies often need to renew their routines and practices to deal with a changing context they face. Green et al. (1994) and del Rio et al. (2015) also show that innovation for sustainability has stimulated many companies to align their technological bases, skills, and networks of actors with sustainable innovation demands. This reconfiguration may involve spending more on R&D, reorganizing R&D aims with a drive towards the more cross-functional team, recruiting new skilled staff, seeking to collaborate with customers and suppliers, new manufacturing processes, and training (Green et al., 1994; Vickers, 2000). It is also argued that eco-innovation goes beyond technological change and needs changes in the corporate management system, the reorganization of the supply chain, and the company's relationships with other stakeholders of the value chain (Azzone & Noci, 1998; Blum-Kusterer & Hussain, 2001). In particular, van Hoof (2014) shows that for cleaner production, companies need innovative behavior at different organizational levels; i.e., acquisition of new knowledge, new collaborative actions, and new decision-making procedures. In other words, eco-organizational innovations facilitate the development of innovation for sustainability as they contribute to the strategic renewal of organizational knowledge and resources (Cheng et al., 2014; Triguero et al., 2013). The review also shows that companies need new marketing methods and strategies to commercialize sustainable innovation. Kammerer (2009) argues that market considerations play a key role in the development of environmental innovation. Dangelico and Pujari (2010) indicate that creating credibility through eco-labels or third party certification are new marketing activities to enhance the market success of green products. Companies can highlight the environmental improvements of their products to differentiate them from other products as a green marketing strategy to gain a competitive advantage (Kammerer, 2009). Accordingly, the companies should develop customer awareness about the benefits of their products by communicating the advantages of these products to potential customers (Dangelico & Pujari, 2010; Pinkse & Dommisse, 2009). The review supports that innovation for sustainability should have private environmental benefits for the customer (e.g., energy savings) further to their public benefits. Companies can also stimulate and increase the market demand for green products by getting the prices economically viable (Rehfeld et al., 2007; Triguero et al., 2013). The above discussion leads us to the following proposition:

***Proposition 3**: Firms with greater reconfiguring capabilities are prone to innovate more towards a greater degree of sustainability.*

Our review shows that companies' decision for innovating towards sustainability is not only a function of internal factors but also a response to the business environment such as regulatory mandates and market demands (Sharma & Vredenburg, 1998; Weigelt & Shittu, 2016). We find that companies adopt different strategic sustainability behaviors towards innovation; ranging from a reactive to a proactive sustainability behavior (Azzone & Noci, 1998; Kesidou & Demirel, 2012; Sharma & Vredenburg, 1998). The reactive behavior mainly involves reactions to external stimuli such as regulatory mandates (Azzone & Noci, 1998). Companies with reactive sustainability behavior are more likely to develop and acquire new green technologies or modify existing products in an environmental sense; i.e., incremental innovations (Azzone & Noci, 1998; Kesidou & Demirel, 2012). Companies with proactive behavior often consider environmental initiatives as a source of competitive advantage. Accordingly, the companies introduce new technologies that radically improve the environmental performance of current technologies or create new market needs (Azzone & Noci, 1998; Kesidou & Demirel, 2012). Radicalness implies uncertainty, complexity, and risk of the innovative efforts; thus, it demands more learning and unlearning activities compared to incremental innovation (Berchicci & Bodewes, 2005). Carrillo-Hermosilla et al. (2010) also argue that radical changes are competency-destroying changes which often need the replacement of existing components- or entire systems- and the creation of new networks. Accordingly, it is found that these sustainability behaviors stimulate companies to engender heterogeneous organizational resources and competencies for innovating towards sustainability (Azzone & Noci, 1998; Kesidou & Demirel, 2012; Sharma & Vredenburg, 1998). For example, Green et al. (1994) indicate that those environmental innovations which are the result of a 'major' change in technology need higher changes in the reorganization of R&D aims, collaboration with suppliers, and manufacturing-related processes than those innovations with a 'modification' to existing technologies. Sharma and Vredenburg (1998) also demonstrate that proactive sustainability behavior towards innovation leads to the development of firm-specific capabilities in the company. Their study finds that companies with proactive sustainability behavior towards innovation develop higher capabilities for stakeholder integration, higher-order learning, and continuous innovation compared to companies with reactive sustainability behavior. Furthermore, it is found that proactive companies towards innovation for sustainability use functional and cross-functional green teams more intensively than reactive companies towards innovation for sustainability (Jabbour et al., 2013). Thus, it is expected that companies with proactive sustainability behavior towards innovation need greater reconfiguring capabilities than companies with reactive sustainability behavior for innovating towards sustainability. Studies also show that capabilities should not be considered without their context (Priem & Butler, 2001). Helfat et al. (2007: 7) debate that capabilities become tailored to the settings in which they function. Kim and Pennings (2009) also argue that due to the path-dependent and context-bound nature of capabilities, companies need to develop and deploy capabilities differently in diverse contexts (Kim & Pennings, 2009). Hence, we propose that:

> ***Proposition 4:*** *Firms with a proactive strategic sustainability behavior towards innovation need to develop and deploy greater reconfiguring capabilities for innovating towards a greater degree of sustainability than firms with a reactive strategic sustainability behavior*.

Accordingly, based on the reviewed studies, we present a conceptual model and associated propositions that describe three types of capabilities which companies need to develop and renew their resources and competencies for innovating towards a greater degree of sustainability. The model and propositions can serve as a point of departure for future research (see Figure 2.3).

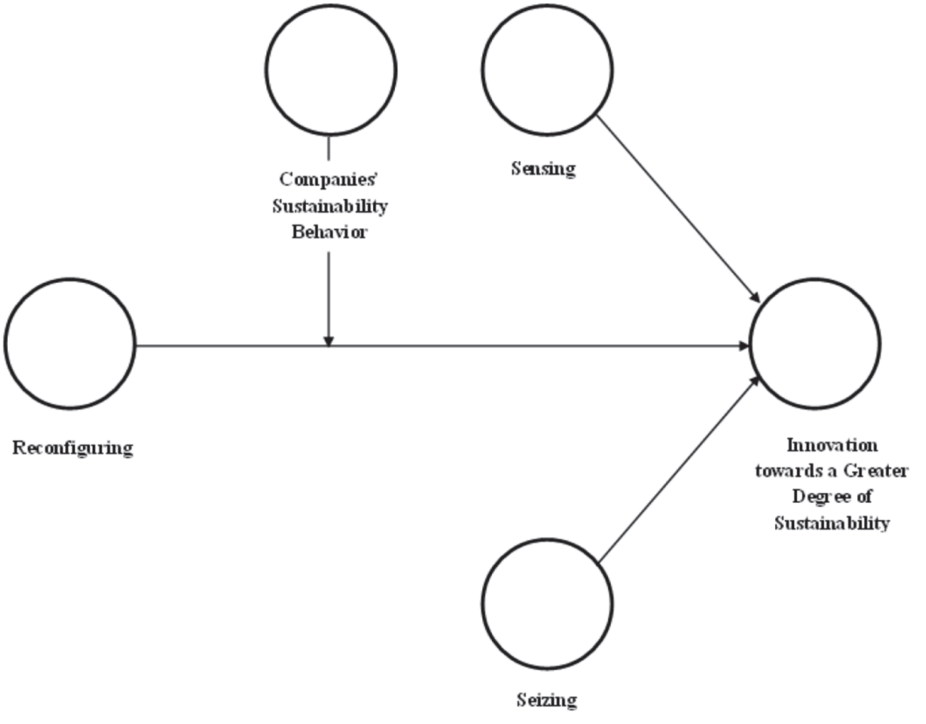

Figure 2.3 Conceptual model and propositions

6. Conclusions and Implications

This study scrutinizes the literature on companies' resources and competencies for innovating towards sustainability to provide a better understanding of how companies manage and develop innovation for sustainability. After synthesizing the findings of 58 reviewed studies, we come to the following conclusions. First, compared to conventional innovation, companies need new knowledge, competencies, and technologies for innovating towards sustainability, which can be developed through three innovation sourcing strategies; i.e., 'in-house strategy,' 'cooperation strategy,' and 'external strategy.' Second, the dynamic nature of sustainable innovation requires firms to have both learning and unlearning activities around their existing routines and practices in order to contribute to the strategic renewal of organizational knowledge and resources. Third, firms' resource base redeployment and reconfiguration is not only a function of internal firm decisions but also a response to external forces such as regulatory mandates and market demands.

Our review also contributes to theory and practice by providing an in-depth analysis of companies' resources and competencies for innovating towards sustainability. The study analyses, discusses and synthesizes theoretical foundations of previous empirical studies to investigate and explicate the contribution of companies' resources and competencies for innovating towards sustainability. We also consolidate the companies' resources and competencies for innovating towards a greater degree of sustainability into three theoretically distinct strategic capabilities. These strategic capabilities can describe the function and effectiveness of the companies' resources and competencies in managing innovation for sustainability. This integrated theoretical framework which coherently merges the insights from different approaches has been built to provide a holistic picture of the companies' resources and competencies for sustainable innovation and their interactions with the business environment. For practitioners, companies aiming to innovate for sustainability, this study highlights how companies' resources and competencies should be, become and/or develop in order to integrate and enhance sustainability in their innovation activities. Thus, it provides useful directions for companies' innovation sourcing strategies.

The main limitation of our review study is that we consulted only articles published in the research database of Web of Science, potentially omitting relevant studies that have not published in this database. However, this bias is likely to be insignificant as this database can be expected to cover all important journals. Furthermore, a citation search has also been performed to check for other articles which potentially are relevant to the research question of our study.

Furthermore, this study develops several avenues for further investigation. The first and main opportunity for further research is theoretical. Most of the reviewed studies have been used established organizational and managerial theories as a theoretical lens of study. However, they lack an integrated theoretical approach to providing a complete picture of how companies develop and renew their resources and competencies for innovating towards sustainability. Second, previous articles have investigated companies' resources and competencies separately (e.g., De Marchi, 2012; Ketata et al., 2015). Further research is needed to study empirically these resources and competencies in combination simultaneously. Thereby, it can contribute to a more holistic appreciation of organizational resources and competencies for innovating towards a greater degree of sustainability. Third, the review indicates that sustainable innovation often arises through a systemic process which refers to the interconnectedness and dynamic interaction between different actors of the value chain. It is also argued that some internal and external factors influence the innovation process. Accordingly, companies need to wire up system-level changes for innovating towards sustainability. These premises invite us to explore through which organizational and managerial capabilities companies can coevolve resources and competencies around an innovation opportunity for sustainability.

Chapter 3
Organizational Routines and Capabilities for Managing Innovation towards Sustainability[2]

Abstract

During the last two decades, companies are increasingly seeking to integrate sustainability concerns into their business activities. There is a pervasive consensus that innovation is an important means to contribute to sustainability. To date, few studies clearly draw on established organizational and managerial theories to investigate how companies can manage innovation for sustainability. To innovate for sustainability, companies need to shift their focus from competitiveness alone to competitiveness and sustainability. Doing this, the primary challenge of the companies is to identify, develop, and deploy the critical resources and competencies required for innovating towards a greater degree of sustainability. This raises questions about the organizational routines and capabilities needed to effect innovation and change toward sustainability. This study adopts the dynamic capabilities approach to argue theoretically and to investigate empirically what the specific organizational routines and capabilities are that increase the degree of sustainability within firms' innovation activities. Cross-sectional data from the Community Innovation Survey of German manufacturing and service companies is used for testing the hypotheses advanced in this paper. Results from PLS-SEM analyses show three capabilities are necessary to effectuate companies' resources and competencies for innovating towards a greater degree of sustainability; i.e., sensing, seizing, and reconfiguring. The study also identifies and confirms the most appropriate and necessary organizational routines for innovating towards sustainability. Furthermore, it is found that the importance of the capabilities for innovating towards sustainability is context-dependent. These findings have important theoretical and practical implications for managing innovation towards sustainability.

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[2] A version of this chapter was presented at the Academy of Management Annual Meeting (AOM) 2017, Atlanta, Georgia, United States.

1. Introduction

During the last two decades, companies are increasingly seeking to integrate sustainability concerns into their business activities (Hall & Vredenburg, 2003; Smith et al., 2010). Many scholars recognize sustainability with the environmental responsibility dimension of business, often it is known as 'corporate sustainability' (e.g., Sharma & Henriques, 2005; Shrivastava, 1995a). There is a pervasive consensus that innovation is an important means to contribute to sustainability; i.e., sustainable innovation (e.g., Anttonen et al., 2013; Schaltegger & Wagner, 2011).

Sustainable innovation integrates the goals of innovation and sustainable development (Hall & Vredenburg, 2003). Sustainable innovation is the development and implementation of a new production process, new product, service, management method, or business model that is novel to the organization and results in a reduction of environmental risk, pollution and other negative impacts of resource use compared to alternatives (Klewitz & Hansen, 2014; Rennings, 2000). Thus, for innovating towards sustainability, companies incorporate environmental concerns alongside economic ones (Hall & Vredenburg, 2003). The integration of sustainability concerns adds complexity to organizational processes. This integration induces the companies to redirect the focus of innovation and to change the existing practices (Dangelico et al., 2013; Nidumolu et al., 2009). Put differently, sustainable innovation is an entrepreneurial opportunity for transforming technology, products, and markets into sustainable ones (Senge & Carstedt, 2001). Therefore, sustainable innovation is more complex and ambiguous in comparison with conventional innovation. Having a high degree of uncertainty and complexity, Hall and Vredenburg (2003) argue that the current approaches to managing innovation are not sufficient for innovating towards sustainability.

Innovating for sustainability is often beyond the core competencies of most companies and is more resource intensive in comparison with conventional innovation (Dangelico et al., 2013; van Kleef & Roome, 2007). The companies are likely to have a higher need for resources and competencies to be able to innovate for sustainability while remaining competitive (Cainelli et al., 2015; Dangelico, 2016). Thus, the companies' challenge is to identify, develop, and deploy the key resources and competencies required for innovating towards sustainability.

A vast amount of literature exists on the performance implications of sustainable innovation (e.g., Hall & Vredenburg, 2003; Kiron et al., 2012) as well as its drivers and barriers (e.g., Bos-Brouwers, 2010; Horbach et al., 2012; Rennings, 2000). However, managing innovation for sustainability has received little theoretical and empirical attention in the literature. To date, few studies clearly draw on established organizational and managerial theories to investigate how companies manage innovation for sustainability (Seebode et al., 2012). The previous studies mostly emphasize the role of resources and competencies, internally or externally, in innovating for sustainability and forming the basis of competitive advantage. However, these studies do not adequately address what capabilities companies need to renew and modify their resources and competencies for innovating towards sustainability. These studies emanate from the perspectives of the resource-based view (RBV) (Kammerer, 2009; Ziegler & Seijas Nogareda, 2009), entrepreneurship theory (Larson, 2000; Stafford et al., 2000), organizational learning theory (Vickers, 1999; Vickers, 2000) and absorptive capacity theory (Clarke & Roome, 1999; Hansen & Klewitz, 2012; Ketata et al., 2015).

Capabilities can be defined as "a firm's capacity to deploy resources usually in combination, using organizational processes, to effect a desired end" (Amit & Schoemaker, 1993: 35). Winter (2003) argues that capabilities are an aggregation of routines. Routines as the building blocks of capabilities are repetitive patterned activities that are learned and evolved through experience to confront new problems. According to Zollo and

Winter (2002), routines refer to how companies cope with innovation, adaptation, and change. Therefore, we argue that companies need certain organizational routines and capabilities to deal with the increased complexity of managing innovation for sustainability.

This study adopts the dynamic capabilities approach to explain theoretically and to investigate empirically what the organizational routines and capabilities are through which companies can innovate towards a greater degree of sustainability. Dynamic capabilities are defined as a firm's "ability to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape, rapidly changing environments" (Teece, 2012: 1395). The dynamic capabilities approach has an explicit focus on how companies perform innovation activities and reconfigure their organizational and managerial processes in pursuit of evolutionary fitness (e.g., Helfat et al., 2007). Lee and Kelley (2008) also argue the dynamic capabilities perspective can provide a useful theoretical lens for investigating innovation at the organizational level. Furthermore, the dynamic capabilities approach, with its emphasis on adaptation within ambiguous and dynamic markets, is particularly well suited to the study of innovation for sustainability, which is highly complex and ambiguous (Dangelico et al., 2013). Hence, the dynamic capabilities approach is apropos to gain a better insight into the managing of innovation for sustainability.

Using cross-sectional data from the Community Innovation Survey of Germany, the dynamic capabilities approach helps to extend the current literature on managing innovation for sustainability both theoretically and empirically. Particularly, the study provides recommendations on the organizational routines and capabilities through which companies can innovate towards sustainability. This study also contributes to the literature on sustainable innovations from a methodological standpoint. We can provide empirical evidence based on large-scale survey data from both

German manufacturing and service firms which increase the generalizability of the tested hypotheses and concepts. Previous findings in the literature have been derived based on manufacturing companies' samples (e.g., De Marchi, 2012; Ketata et al., 2015).

The paper is organized as follows. In the next section, our conceptual considerations focusing on the specificities of sustainable innovation are provided. After that, drawing on the dynamic capabilities approach, hypotheses are presented. We then provide a description of our data and measures used in the empirical analysis. Afterward, the results of the analyses will be discussed. Finally, we explain the implications and the limitations of our study and suggest possible future research.

2. Theoretical Background and Hypotheses

2.1. Sustainable innovation

Innovation for sustainability as an 'industrial revolution' has forced firms to change the way they think about products, production processes, technologies and business models (Senge & Carstedt, 2001). Nidumolu et al. (2009) argue that companies need to do things differently to be able to innovate for sustainability. Doing this, the companies should review their established routines and practices to ask whether existing models for handling sustainable innovation are sufficient or they are forced to abandon existing ones or develop new routines and practices (Seebode et al., 2012). Accordingly, Hall and Vredenburg (2003) contend that innovation management practices of conventional innovation are not fully applicable to sustainable innovation projects. Sustainable innovation often differs from conventional innovation as it needs a technological frontier on which companies are still inexperienced in that area. As well, market and technological uncertainties of sustainable innovation are higher as there are no widespread-accepted standards either regarding specific technological solutions or of measures to evaluate the environmental performance of products and processes. The complexity and uncertainty of innovation for sustainability pose a challenge for the strategic management of firms engaging in its development (De Marchi, 2012). van Kleef and Roome (2007) argue that in sustainable business management, capabilities should be developed to deal with a broader range of actors than in innovation for competitiveness. Therefore, sustainable innovation requires firms to enhance and renew their routines and capabilities for integrating environmental knowledge and competencies into the innovation process (Dangelico et al., 2013; van Kleef & Roome, 2007). Van Kleef and Roome's paper (2007) invokes the necessity of a research agenda to support a better understanding of the capabilities that are required by a business to innovate in ways that are more environmentally sustainable. Dangelico (2016) also shows that some distinctive capabilities are required for sustainable innovation in comparison with conventional innovation. She suggests that it would be interesting to investigate whether there is a difference between sustainable innovation and conventional innovation regarding the relative importance of these capabilities. Thus, little is known about what routines and capabilities fuel sustainable innovations.

2.2. Organizational routines and capabilities for innovating towards sustainability

To innovate towards sustainability, companies need to shift their focus from competitiveness alone to competitiveness and sustainability (van Kleef & Roome, 2007). The development of innovation for sustainability frequently involves a departure from the present knowledge base and is thus competency-destroying (Hall & Vredenburg, 2003). Sustainable innovation should be done in a different way, whether technologically and organizationally (Carrillo-Hermosilla et al., 2010). Likewise, Kiron et al. (2013a) argue that sustainable innovation falls along a rich spectrum- from doing things differently to doing entirely different things. Therefore, companies have to reconsider their core activities to integrate, coordinate, build, and reconfigure their resources and competencies in the case of innovations for sustainability (Dangelico, 2016). These new configuration activities suggest that the dynamic capabilities approach can provide new insights into the companies' innovation for sustainability.

Dynamic capabilities have an explicit focus on how companies perform innovation activities (Helfat et al., 2007). They enable organizations to renew competencies and to strategically manage the internal and external organizational resources required to maintain performance in the face of changing business conditions (Teece et al., 1997). The dynamic capabilities facilitate not only the ability of an organization to recognize a potential technological shift but also its ability to adapt to change through innovation (Hill & Rothaermel, 2003). It is argued that dynamic capabilities exhibit commonalities across firms; i.e., routines (Eisenhardt & Martin, 2000). However, such commonalities have not been systematically identified yet for firms' innovation for sustainability. In this regard, the dynamic capabilities approach highlights the importance of activities directed at innovating towards a greater degree of sustainability.

Teece (2007) has categorized the dynamic capabilities into three clusters of capabilities; i.e., sensing, seizing, and reconfiguring. Sensing refers to the identification and assessment of an opportunity for sustainability. Seizing involves the mobilization of internal and external resources/competencies to address an opportunity and capture value from it. Reconfiguring refers to continued renewal and orchestration of resources to keep the resource base of the company in line with the shifts in the business environment. This study adopts this threefold classification of firm-level dynamic capabilities to conceptualize the innovation management practices for sustainability concerning capabilities and their underlying routines. We argue that firms with greater dynamic capabilities are prone to innovate more towards a greater degree of sustainability. Underpinning these three generic capabilities, the literature uses routines as the 'microfoundations' of capabilities (e.g., Parmigiani & Howard-Grenville, 2011). Microfoundations are defined by Teece (2007: 1319) as "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines," form the organizational routines of these capabilities. Accordingly, routines are the key organizational mechanism through which firms' tasks are accomplished. As a result, we propose a routine-based model of firms' capabilities for innovating towards sustainability. We attempt to investigate what organizational routines and capabilities are useful to innovate towards a greater degree of sustainability. Figure 3.1 shows our research model's hypothesis framework (i.e., structural model).

Moderators: Environmental turbulence, Firms' strategic sustainability behaviors

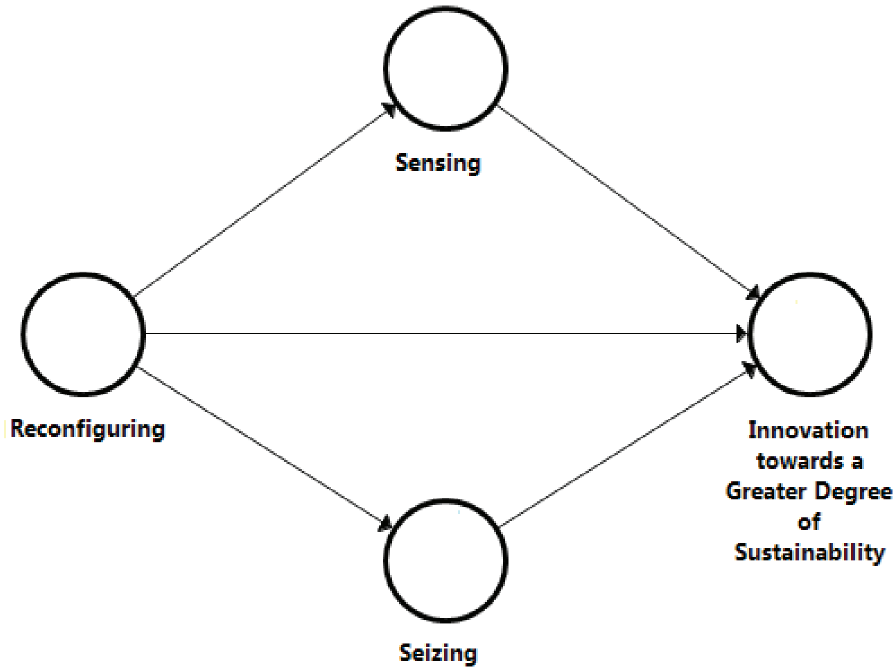

Figure 3.1 Research model

2.2.1. Sensing

Porter and van der Linde (1995) argue that companies need to recognize the environmental issue as a competitive opportunity- not as an additional cost or a deferrable threat. Bos-Brouwers (2010) finds that the majority of SMEs have moved beyond compliance-driven regulations for sustainability activity. Many sustainable innovations are directed to create value (business opportunity) in addition to improving the eco-efficiency of their business activities. This suggests that the companies should view sustainable innovation as a business opportunity. The companies identify opportunities because of two classes of factors (Teece, 2009). First, as companies can have differential access to existing information. Second, as emphasized by Schumpeter (1934), new knowledge and information can create opportunities. Hence, firms need sensing capabilities to scan and monitor the operating environments for identifying sustainability opportunities and making a strategic decision about them. Sensing involves gaining knowledge about customer needs, competitors, exploring technological opportunities, probing markets, listening to suppliers, and scanning and exploring other elements of the business ecosystem (Teece, 2007). Vickers (1999) discusses that cleaner production and technology as a response to environmental pressures should be receptive to a broader than usual set of information from a variety of sources including from government, suppliers, and the market. Also, firms particularly SMEs should possess the capability to cope with all the information they receive and act strategically upon them. The literature argues that for innovating towards sustainability, external sources of knowledge and information are more important than for conventional innovation (e.g., Bocken et al., 2014a; Horbach et al., 2013). The incorporation of environmental concerns into the product development process requires organizational routines that enhance explorative activities to identify and create new knowledge while exploiting a firm's internal knowledge (Lenox & Ehrenfeld, 1997). Therefore, companies need to develop knowledge links with a wide range of external parties to explore innovative solutions to environmental problems. Porter and van der Linde (1995) as well as Llerena (1999) argue that identifying profitable innovation opportunities is one of the organizational failure possibilities in environmentally sustainable innovation; they show that the existence of procedures such as Environmental Management System (EMS) implementation can help firms to identify their environmental impact and to alleviate this failure. According to Porter and van der Linde (1995: 99), companies do not identify the potential of environmentally sustainable innovations since they are "… still inexperienced in dealing creatively with environmental issues." Thus, sensing capabilities help companies to overcome incomplete information about environmental challenges and solutions for them within organizations. Hence, the following hypothesis is proposed:

Hypothesis 1: *Firms with greater sensing capabilities are prone to innovate more towards a greater degree of sustainability*.

2.2.2. Seizing

Once a new opportunity, technological or market is recognized, it needs to be addressed through new products, processes, or services (Teece, 2009). Accordingly, in addition to capabilities that help companies to identify opportunities, the companies need another capability to seize the recognized opportunities (Harreld et al., 2007). Companies must be able to act on the recognized opportunities and profit from or 'exploit' the opportunity. Seizing involves the mobilization of resources to capture value from opportunities (Teece, 2012). It must be addressed through implementing new products, processes, or services. From a dynamic capabilities perspective, a firm's ability to develop and implement innovations is embedded in interrelated activities directed at generating, acquiring, and combining a wide variety of resources and competencies (e.g., Teece, 2007). This needs investments in development and commercialization activities (Teece, 2009). In this regard, firms' innovation-related activities are a successful means of the companies for seizing the innovation opportunities for sustainability (Bönte & Dienes, 2013; Ketata et al., 2015).

The initial focus of researchers for supporting a firm's innovation processes has been on distinctive resources and competencies being internal to the firm (Barney, 1991). The empirical literature has put an emphasis on firms' internal R&D activities and employee training as critical internal capabilities of the companies for innovating towards sustainability (e.g., del Rio et al., 2015; Ketata et al., 2015). According to Bönte and Dienes (2013), firms may adopt an 'external strategy' for their innovation for sustainability; i.e., letting their innovation be developed entirely by other enterprises or institutions. For instance, companies may contract out their R&D activities to third parties, or they may obtain knowledge from external sources, like the acquisition of patents or licenses (Bos-Brouwers, 2010).

For sustainability opportunities to be converted into commercialized innovations, market demand must exist or be created for a new product or process (Berkhout, 1996). A new or improved product is implemented when it is introduced on the market. New processes are implemented when they are brought into actual use in the firm's operations. Market launch of environmentally sustainable innovations allows companies to introduce the sustainability performance of new products in their marketing strategies (e.g., Iles & Martin, 2013). In particular, prototyping and demonstration projects enable companies to test, improve and transform a technology prototype into a marketable product (Bossink, 2015; Bossink, 2017).

Furthermore, addressing opportunities involves developing technological competencies, complementary assets, and capturing co-specialization benefits (Teece, 2009). Given the complexity of innovation for sustainability, firms need to collaborate with outside organizations to the firm to improve and complement the companies' resources for innovation (Becker & Dietz, 2004). Bos-Brouwers (2010) finds that cooperation for sustainable innovation gives firms the ability to compensate for the lack of resources. The more types of partners a firm cooperates with, the more likely it is to effectively develop an environmentally friendly product or process innovation. (e.g., Cainelli et al., 2015; Dangelico et al., 2013). Klewitz et al. (2012) also argue that companies need to collaborate with parties outside their organizational boundaries such as customers, suppliers, universities, research institutes, or consultancies for better dealing with sustainability challenges. This discussion leads us to suggest the following hypothesis:

Hypothesis 2: *Firms with greater seizing capabilities are prone to innovate more towards a greater degree of sustainability.*

2.2.3. Reconfiguring

Evidence from both SMEs and large companies confirms that successful innovation is not just the result of technological breakthroughs. It is also deeply dependent on how firms can renew organizational resources and competencies in response to various demands from changing environments (Adner & Helfat, 2003). These renewal activities as reconfiguring capabilities allow quick response to a variety of unpredictable contingencies and demand changes (Teece, 2007). Reconfiguring capabilities enable a company to maintain its evolutionary fitness and, if necessary, to soften the rigidities that develop over time from asset accumulation and current routines (Helfat et al., 2007; Teece, 2007).

As an innovation for sustainability often needs to move beyond incremental adjustments, it requires radical changes which are disruptive for both customers and manufacturers (Boons et al., 2013). Thus, there is a mandate for the companies to completely revamp their organizations to establish an entirely different set of practices and routines for innovating towards sustainability (cf. Teece, 2009). Sustainable innovation in this sense includes organizational changes and modifications in any stage of innovation development process: from a product's or service's design to its marketing strategy (Blum-Kusterer & Hussain, 2001). For example, Wagner (2008) discusses that innovation for sustainability often needs changes or renewal of production/manufacturing processes. According to Azzone and Noci (1998), the development of sustainable innovation requires three main categories of shifts in the business processes and the corporate organization. It needs changes in (1) the activities of the corporate value chain; (2) the management practices, (3) the external relations with the outside actors including customers, suppliers, and public institutions to achieve a higher integration. For example, the literature puts an emphasis on establishing cross-functional teams as a new management practice for providing support to innovation for sustainability (Dangelico, 2016; Jabbour et al., 2013). Dangelico et al. (2013) also show that the creation of collaborative networks with actors within and outside the supply chain plays a key role in the integration of environmental sustainability issues into the manufacturing process.

Like conventional innovation, the ability to commercialize sustainable innovation is crucial for companies that want to innovate for sustainability. Wagner (2008) argues that informing customers/clients on environmental effects of products and production processes induces additional demand and increases the motivation of firms for innovating towards sustainability. Facilitating its commercialization; companies need to stimulate the demand for sustainable innovation by getting the prices economically viable (Rehfeld et al., 2007). Therefore, companies should implement new marketing concepts or strategies which require significant changes in product design, labeling, product placement, product promotion or pricing. Hence, the following hypothesis is proposed:

Hypothesis 3: *Firms with greater reconfiguring capabilities are prone to innovate more towards a greater degree of sustainability.*

2.2.4. The mediating role of sensing and seizing capabilities

Reconfiguring capabilities are underpinned by activities that enable the renewal and orchestration of resources and competencies to match the requirements of the changing environment (Helfat et al., 2007; Teece, 2007). Reconfiguring capabilities facilitate processes reflecting the sensing and seizing of opportunities. Reconfiguring capabilities enable companies to sense and seize innovation opportunities more thoroughly and expeditiously.

Having an adequate internal base of knowledge and skills to recognize and address sustainability issues is crucial for realizing sustainable innovation (Ketata et al., 2015). Thus, Green et al. (1994) and del Rio et al. (2015) argue that companies need to align their technological bases and skills with sustainable innovation demands. This reconfiguration may involve spending more on R&D, reorganizing R&D aims with a drive towards the more cross-functional team, recruiting new skilled staff, new manufacturing processes, and training (Green et al., 1994; Vickers, 2000). It is also argued that external sources of knowledge and information are more important for sustainable innovations than for conventional innovations to generate novel ideas (Bocken et al., 2014a; Horbach et al., 2013). Scanning, search, and exploration activities across markets and technologies enable the companies to sense and shape opportunities in the business environment (Teece, 2007). Therefore, to strengthen the sensing capabilities of companies for recognizing innovation opportunities for sustainability, the companies need to reconfigure their innovation process to interact more frequently with external actors in the business environment. As companies open their boundaries, a vast array of new opportunities for adapting internal resources and competencies emerges (Santos & Eisenhardt, 2005). This approach also facilitates the companies to identify sustainability issues, seek legitimacy for innovation, and enhance their problem-solving capacity (e.g., Roome, 2001; van Kleef & Roome, 2007). Accordingly, for innovating towards sustainability, companies require to maintain a close relation with external actors including customers, suppliers and R&D institutions, and to observe best practices in the industry (Bos-Brouwers, 2010). Accordingly, we can argue that reconfiguring capabilities facilitate the recognition of innovation opportunities for sustainability as they contribute to the strategic renewal of organizational knowledge and resources.

Assessing the complexity of sustainable innovations, it is possible to argue that sustainable innovation is often characterized by higher levels of novelty, uncertainty, and variety in the traditional technological or market domain within which the companies usually compete (Cainelli et al., 2015). Hence, to seize the innovation opportunities for sustainability, companies need to minimize internal conflict for greater internal innovation resources and to maximize complementary and co-specialized resources. Larson (2000) also indicates that sustainable innovation is a result of the cultivation and leadership of a network of actors in the value chain. Reconfiguring capabilities allow entrepreneurial firms to modify or renew their existing routines and organizational processes for mobilizing the required resources and competencies for innovating towards sustainability. For example, the creation of collaborative networks as a resource co-specialization strategy is an effective and efficient way to achieve sustainability objectives in product development and production processes. It enables companies to share complementary resources and competencies for innovating towards sustainability (Dangelico et al., 2013). Hence, to seize the innovation opportunities for sustainability, companies need to possess high orchestration competencies for limiting conflict and effectuating cooperation inside and outside of the companies. Accordingly, reconfiguring capabilities facilitate companies to translate the recognized innovation opportunity for sustainability into eco-friendly products, processes, or services. We therefore hypothesize:

> **Hypothesis 4**: *The effect of firms' reconfiguring capabilities on innovating towards a greater degree of sustainability is mediated by sensing and seizing capabilities of the companies.*
>
> **H4a:** *Greater reconfiguring capabilities help a firm to increase its sensing capabilities for discovering the innovation opportunities for sustainability.*
>
> **H4b:** *Greater reconfiguring capabilities help a firm to increase its seizing capabilities for implementing and commercializing the innovation opportunities for sustainability.*

2.3. Moderating effects

Studies show that capabilities should not be considered without their context (Priem & Butler, 2001). Helfat et al. (2007: 7) argue that capabilities become tailored to the settings in which they function. Therefore, due to the path-dependent and context-bound nature of capabilities, firms need to develop and deploy capabilities and their underlying routines differently in diverse contexts (Kim & Pennings, 2009).

2.3.1. The moderating role of environmental turbulence

The context of innovations for sustainability can be described as a dynamic environment. The argument in support of this peculiarity of sustainable innovation is that innovation for sustainability is, often, more complex and ambiguous than conventional innovation (De Marchi, 2012). This peculiarity is not essentially related to the process or product technologies but is linked to its externalities– what Rennings (2000) called the “double externality problem.” It induces the key role of existing environmental laws and other regulatory factors to overcome the low incentive to innovate for sustainability. In the case of innovation for sustainability, companies require satisfying various stakeholders who may occasionally have conflicting motivations, purposes, and emphasis on sustainability demands (Dangelico et al., 2013). Thus, the integration of sustainability with innovation adds complexity to the organizational processes. The literature also argues that uncertainty is one of the barriers to innovation for sustainability, and it is influenced by the increased difficulty in accessing information about technologies and markets (e.g., Souto & Rodriguez, 2015). This uncertainty can be concluded from continuous new types of environmental regulations, uncertain subsidies and incentives, and apparently high demand for sustainable products but with an unpredictable readiness to pay higher prices for them by customers (Dangelico et al., 2013). Uncertainties and complexities related to innovation opportunities for sustainability may affect and even change the position of an organization regarding market competition. Particularly in the dynamic capabilities approach, the importance of considering environmental turbulence to match resources and competencies to the environment has been emphasized (Eisenhardt & Martin, 2000; Teece et al., 1997). The environmental turbulence consists of two primary sources: (i) market turbulence- uncertainty in market demands on customer preferences and competitor moves; and (ii) technological turbulence- as the degree and predictability of technological change (Hanvanich et al., 2006). Both high technological and market turbulence are expected to increase the importance of being able to reconfigure organizational processes. For example, in the case of the high turbulent environment, constant changes in technologies or customer needs may induce firms to reconfigure their resource base to respond to market changes via innovation (Jansen et al., 2006). Doing so, innovative firms need to sense new market trends and seize opportunities earlier than key competitors doing so. Therefore, reconfiguring capabilities enable companies to renew and reconfigure their resources and competencies to support the ongoing development of valuable products and services. Turbulent environments breed new opportunities (Pavlou & El Sawy, 2011). In a high turbulent environment, opportunities fleet quickly, and threats from competitors always become stronger (Li & Liu, 2014). This environmental turbulence induces firms to carry out frequent and complex changes to gain first-mover advantages and capture value from doing so. Thus reconfiguring capabilities can take a more prominent role. When faced with the low turbulent environment, firms are not required to reconfigure their resource base to achieve external fit because they can use their existing routines, resources, and competencies (Wilden et al., 2013). Hence, they rely less on reconfiguring capabilities to match environmental change. This discussion implicates a moderating role of environmental turbulence. Based on these observations, we hypothesize:

Hypothesis 5: *In high turbulent environments, firms need to develop and deploy greater reconfiguring capabilities for innovating towards a greater degree of sustainability than for firms in low turbulent environments.*

H5a: *In high turbulent environments, firms need to develop and deploy greater reconfiguring capabilities to increase their sensing capabilities for discovering the innovation opportunities for sustainability than for firms in low turbulent environments.*

H5b: *In high turbulent environments, firms need to develop and deploy greater reconfiguring capabilities to increase their seizing capabilities for implementing and commercializing the innovation opportunities for sustainability than for firms in low turbulent environments.*

2.3.2. The moderating role of firms' strategic sustainability behaviors

Firms have different strategic sustainability behaviors which range from reactive to proactive behaviors. They relate to a continuum from incremental to radical innovation in products and processes (Klewitz & Hansen, 2014). For many firms, the compliance with environmental regulations is the first steps for innovating towards sustainability. In this context, their innovation is mostly reactive (Adams et al., 2012). Reactive strategies are more likely to lead to incremental innovation as they mostly respond to external stimuli (i.e., new environmental regulations) (Jabbour & Santos, 2006; Noci & Verganti, 1999). Accordingly, some incremental changes in processes and routines can be expected of these companies. They are further characterized by a low interaction with external actors (Klewitz & Hansen, 2014). On the other hand, firms having proactive sustainability behavior seek innovative solutions to environmental challenges (Noci & Verganti, 1999). Proactiveness refers to the capacity of the companies to anticipate future needs and changes in the business environment (Jantunen et al., 2005). This behavior can lead to market disruptive and radical innovation for sustainability (Aragón-Correa et al., 2008). Proactive strategic behavior towards innovation is characterized by a firm's initiative to go beyond regulation and to realize sustainability issues and markets for innovation as competitive advantages (Aragón-Correa et al., 2008; Hart, 1995). By adopting this behavior, firms transform their operations, structures, and routines to meet stakeholders' interests (Könnölä & Unruh, 2007). For the more proactive strategic sustainability behaviors, companies need to renew their innovation process to interact more frequently with external actors, engaging in collaboration practices beyond the firm level (Klewitz & Hansen, 2014). It facilitates the companies to identify sustainability opportunities and to access new or complementary resources for capturing the value from the recognized opportunities (e.g., van Kleef & Roome, 2007). Thus, it is expected that firms with proactive strategic sustainability behaviors towards innovation need stronger reconfiguring capabilities than firms having reactive strategic sustainability behaviors for innovating towards sustainability. We hypothesize that:

Hypothesis 6: *Firms with a proactive strategic sustainability behavior towards innovation need to develop and deploy greater reconfiguring capabilities for innovating towards a greater degree of sustainability than firms with a reactive strategic sustainability behavior.*

H6a: *Firms with a proactive strategic sustainability behavior towards innovation need to develop and deploy greater reconfiguring capabilities to increase their sensing capabilities for discovering the innovation opportunities for sustainability than firms with a reactive strategic sustainability behavior.*

H6b: *Firms with a proactive strategic sustainability behavior towards innovation need to develop and deploy greater reconfiguring capabilities to increase their seizing capabilities for implementing and commercializing the innovation opportunities for sustainability than firms with a reactive strategic sustainability behavior.*

3. Methods

3.1. Data

For the empirical part of this analysis, we use cross-sectional data from the German part of the Community Innovation Survey (CIS) conducted in 2009. Germany is a lead market for sustainable innovation as it has a large tradition of societal, political and regulatory awareness for environmental challenges (Beise & Rennings, 2005; Ketata et al., 2015). This dataset provides information about innovation activities of manufacturing and service companies between 2006 and 2008. We restrict our analysis to firms that introduced and commercialized successfully at least one product or process innovation during the observation period. These two types of technological innovations are central to the ability of companies to create competitive advantage (Damanpour, 2010), and play a fundamental role in enhancing the sustainability performance of the companies (e.g., Bocken et al., 2014a; Bönte & Dienes, 2013). While product innovations require the development of new eco-friendly goods or services; process innovations change the way a company produces and delivers its products or services to reduce environment externalities (Rennings, 2000). The prospective benefits of process innovations are quality improvements and cost savings.

To differentiate the successful product and process innovators, variables related to innovation propensity and innovation commercialization/effectiveness were used for both types of innovations. Following previous research (e.g., De Marchi, 2012), a dummy variable was included that indicates whether a firm has introduced any new or significantly improved products/services during the years 2006 to 2008 (1 = yes; 0 = no). The success of the firm that produces a new product depends on its market acceptance. Therefore, the product innovation success was conceptualized whether the new product has contributed to the firm's turnover (1 = yes; 0 = no) (cf. Aschhoff & Sofka, 2009). Regarding the process innovation, a dummy variable was listed in the CIS that indicates whether a firm has implemented any new or significantly improved processes during the years 2006 to 2008 (1 = yes; 0 = no). The success of a process innovation depends on its effectiveness. On a dichotomous scale (1 = yes; 0 = no), firms were requested to indicate whether process innovation introduced by the company during 2006-2008 has reduced the average cost (per unit/operation) or has led to the quality improvements (cf. Piening & Salge, 2015).

Restricting the sample to successful innovators as a reference group helps us to focus on the degree of sustainability within innovation activities of the companies. As a result, we have provided empirical evidence for 2642 German firms and their innovation activities in both manufacturing and service sectors. 21 different industry sectors are selected to analyze a heterogeneous sample and therefore increase the generalizability of the findings. Table 3.1 provides the distribution of sustainable innovators by industry.

Table 3.1 Innovative firms, sustainable innovators, non-sustainable innovators per industry

Industry	Tot. No. of successful innovative firms	Num. of Innovator above mean sustainability scale	% of Innovator above mean sustainability scale	Num. of Innovator Below/equal mean sustainability scale	% of innovator Below/equal mean sustainability scale
Mining	21	14	66.7	7	33.3
Food & Tobacco	134	93	69.4	41	30.6
Textiles	85	45	52.9	40	47.1
Wood & Paper	181	114	63.0	67	37.0
Chemicals	146	98	67.1	48	32.9
Plastics	96	59	61.5	37	38.5
Glass & Ceramics	67	45	67.2	22	32.8
Metals	217	141	65.0	76	35.0
Machinery	292	174	59.6	118	40.4
Electrical Equipment	221	115	52.0	106	48.0
Medical and Other Instruments	189	81	42.9	108	57.1
Transport Equipment	112	65	58.0	47	42.0
Furniture	76	47	61.8	29	38.2
Energy/Water	39	23	59.0	16	41.0
Manufacturing Sector	**1876**	**1114**	**59.4**	**762**	**40.6**
Wholesale	54	29	53.7	25	46.3
Retail Automobile	17	11	64.7	6	35.3
Banking & Insurance	119	29	24.4	90	75.6
IT & Telecommunications	203	53	26.1	150	73.9
Technical Services	240	105	43.8	135	56.3
Firm-Related Services	120	24	20.0	96	80.0
Real Estate & Renting	13	7	53.8	6	46.2
Service Sector	**766**	**258**	**33.7**	**508**	**66.3**
Total	**2642**	**1372**	**51.9**	**1270**	**48.1**

3.2. Measures

3.2.1. Measuring innovation towards a greater degree of sustainability

In the survey, firms are requested to evaluate various effects of their product and process innovations introduced during the years of study. For measuring innovation towards sustainability (Y), we rely on three different outcomes. Firms are asked to evaluate the impact of these innovations on the reduction of materials and energy per unit/operation (Y1), reduction in environmental load (Y2), and the improvement of health and safety (Y3). Companies assess the importance of these effects on a 4-point Likert scale, i.e., (a) Not relevant, (b) Low, (c) Medium, and (d) High. We put a caveat on this measurement since it measures actual innovation outcomes, and not necessarily intended ones. However, the caveat should be kept in mind when interpreting the results because actual outcomes may not be perfectly correlated with intended ones (cf. Ketata et al., 2015). Firms' innovation towards sustainability takes the value 3, 2, 1, and 0 if, in the period 2006–2008, the company reported 'high' to 'not relevant' importance of the effects. This question is therefore used to construct a sustainability scale for separating firms that introduced sustainable innovations from firms that did not. A higher scale value indicates a greater degree of sustainability of the innovations developed by the companies. Put differently, we investigate what the specific organizational routines and capabilities are that increase the degree of sustainability within firms' innovation activities.

3.2.2. Measuring capabilities

For measuring the capabilities, we started with Teece's (2007) conceptualization of dynamic capabilities; i.e., sensing, seizing and reconfiguring. We also used relevant existing literature to explore a large number of organizational routines which companies may use to realize these capabilities. As capabilities are difficult or even impossible to observe (Rothaermel & Deeds, 2006), we measured them indirectly with a set of indicators (i.e., organizational routines) listed in the CIS. Thus, we created three pools of indicators (i.e., organizational routines) that capture the theoretical definition of the target capabilities. To deal with the potential impact of a large number of indicators, we followed Cenfetelli and Bassellier (2009) approach who propose to group the indicators into two or more distinctive constructs. Hence, we grouped the indicators from a theoretical and conceptual perspective. Following Jarvis et al. (2003) approach for measurement model operationalization, a reflective-formative hierarchical component model and the repeated indicator approach (Mode B) was employed to measure the capabilities and their lower order dimensions. Accordingly, the capabilities constructs have two levels of analysis; i.e., first-order and second-order analyses, which form a "Hierarchical Measurement Model." The first-order level relating the manifest indicators (i.e., organizational routines) to the lower level dimensions, and the second-order level relating the latent dimensions to the higher order components; i.e., capabilities which form a "Structural Model." In the repeated indicator approach, the higher order components (capabilities) have been constructed by the latent variables that represent all the manifest indicators of underlying latent dimensions (cf. Becker et al., 2012). Figure 3.2 shows the first-order and the second-order level of our hierarchical measurement model. With the assessment of the measurement model, we can proceed with the evaluation of the structural model and hypotheses.

For sensing (A), we used an existing scale to assess the sources of information to the firm's innovation activities listed in the CIS as a proxy to measure firm's ability to scan or monitor the internal and external environment of the company (cf. Arbussà & Coenders, 2007). We used the answers to the questions about the importance of information sources to the innovations, from internal sources (A1); from market sources (A2); from institutional sources (A3); and from public sources (A4). In Table 3.2, we list the indicators to measure sensing capabilities.

For seizing (B), the measure is constructed as a combination of organizational activities through which new products or processes have been developed and commercialized. This construction follows partly from those of Wilden et al. (2013) and Ketata et al. (2015). On a dichotomous scale (1 = yes; 0 = no), firms were requested whether they have developed their internal capabilities for sustainable innovation (B1); or have adopted the best practices in the sector (B2). The companies were also asked whether they have done market introduction activities to facilitate the commercialization of the innovations (B3). Cooperation for innovation activities is a complementary measure for capturing the seizing capabilities. Companies were requested whether they have cooperated on any of their innovation activities with other partners within or outside the value chain for implementing new products or processes including cooperation with market partners (B4) and knowledge partners (B5). In Table 3.2, we list the indicators to measure seizing capabilities.

For reconfiguring (C), we relied on an existing scale (Jantunen et al., 2005; Wilden et al., 2013), which are based on the renewal activities listed in the CIS. This scale assesses activities such as the implementation of new marketing methods or strategies (C1), the adoption of new management practices and renewal of business processes (C2), and the development of new manufacturing-related processes (C3). The feature of these renewal activities is that they have not been used before in the firm and they are the result of strategic management decisions. In Table 3.2, we list the indicators to measure reconfiguring capabilities.

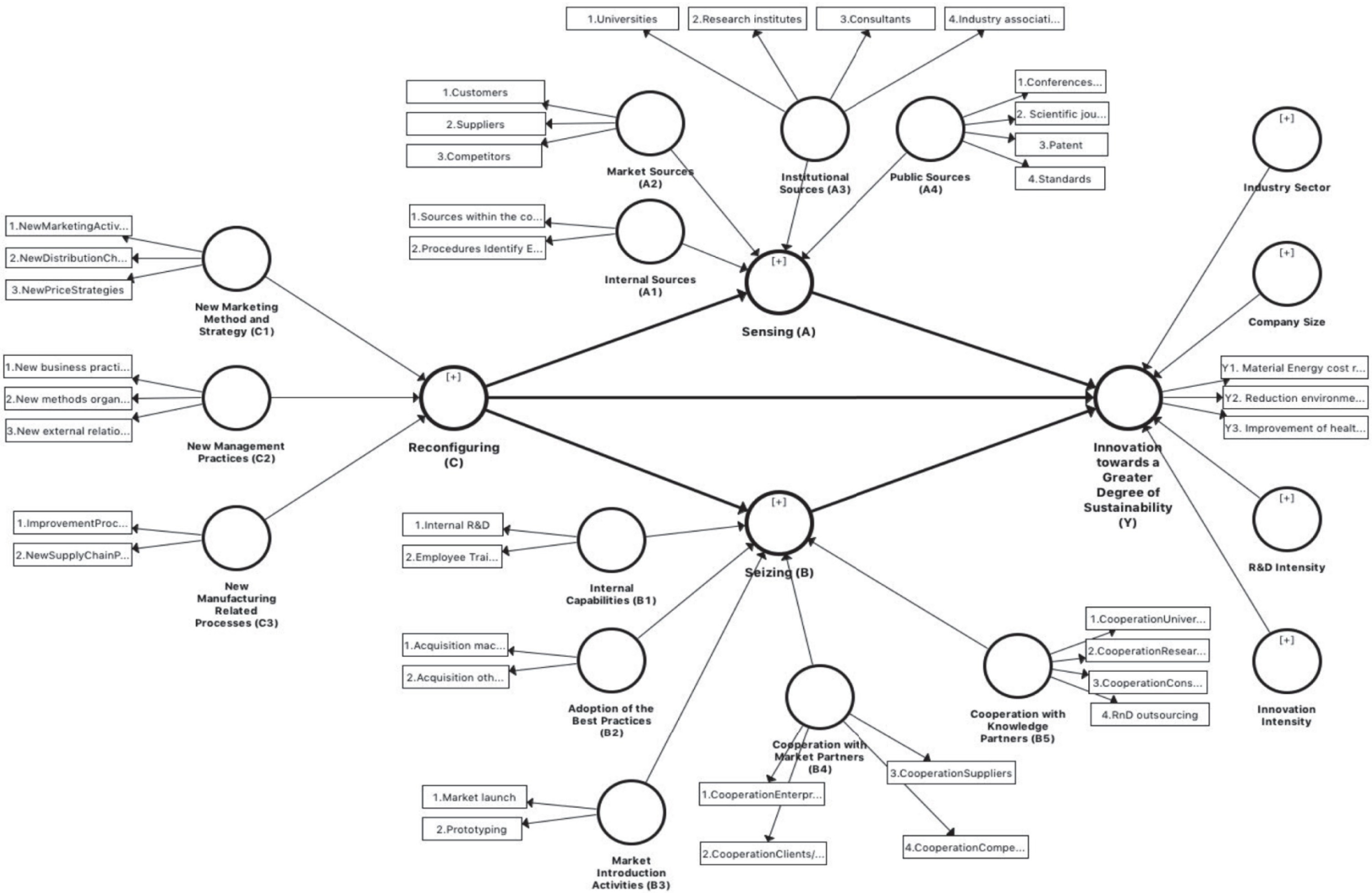

Figure 3.2 Hierarchical measurement model

3.2.3. Moderating variables

Environmental turbulence. The level of environmental turbulence for each firm is computed as the mean of six items adapted from those used in the previous studies (e.g., Jaworski & Kohli, 1993; Piening & Salge, 2015; Protogerou et al., 2012). Respondents were asked to assess the competitive situation in their primary market by indicating the extent to which the following items describe their environment turbulence on a 4-point Likert-type scale (applies not at all= 0, applies very little= 1, applies somewhat= 2, applies fully=3). The items are as follows: (1) "Major threat to market position because of entry of new competitors", (2) "Products/services are quickly outdated", (3) "Products from competitors are easily substituted for those of your enterprise", (4) "Competitor's actions are difficult to predict", (5) "Trend demand is difficult to predict", and (6) "Strong competition from abroad". Then, for the purpose of conducting a multi-group analysis, we dichotomized the level of environmental turbulence into two categories based on a mean split; i.e., "high" and "low" environmental turbulence.

Firms' strategic sustainability behaviors. For assessing the strategic sustainability behaviors of the companies towards innovation, we used a dummy (Yes/No) answer to the question of "did your enterprise introduce an environmental innovation in response to existing environmental regulations, current or expected market demand from customers, or voluntary codes or industry agreements (self-commitment)." The sustainability behavior of a company towards innovation was considered proactive if the company has introduced its environmentally sustainable innovation in response to market demand or following its vision or self-commitment (Aragón-Correa et al., 2008; Hart, 1995; Klewitz & Hansen, 2014). The sustainability behavior was interpreted as reactive if a company does not perceive the existence of a market for new products or processes, and the company's innovation has been in response to existing environmental regulations (Aragón-Correa et al., 2008; Hart, 1995; Klewitz & Hansen, 2014).

3.2.4. Control variables

We controlled companies' size as a structural characteristic of the companies that may influence the estimation results of our core variables. Extant literature suggests that larger firms may have a higher motivation and resources to introduce sustainable innovation (e.g., Cainelli et al., 2015; Klewitz & Hansen, 2014). Therefore, we included in the analysis the variable Company Size, measured as the natural logarithm of the number of employees. Other control variables including firms' R&D intensity, innovation intensity, and industry were also included to check for other potentially important antecedents of the firms for sustainable innovation activities. Possessing higher R&D and innovation intensity enables firms to continuously develop valuable market offerings (Hollenstein, 1996). R&D intensity is the ratio of R&D expenditure to total sales and innovation intensity is the ratio of total innovation expenditure over sales. The industry was included as a dummy variable (0 for service companies and 1 for manufacturing companies). Manufacturing companies have a higher innovation propensity relatively to service companies (e.g., Gilli et al., 2014). In particular, manufacturing companies have shown early responsiveness to environmental sustainability issues (Dangelico et al., 2013). Also, there are increasing legal, market and financial pressures on manufacturing companies to develop sustainable products and production processes (Lee & Kim, 2011; Maxwell & van der Vorst, 2003).

3.3. Analytical procedures

We used PLS-SEM to simultaneously assess the large number of constructs and their interrelationships in our theoretical model (cf. Henseler et al., 2009). Accordingly, we applied PLS path modeling to estimate the theoretical model using the software application SmartPLS (Ringle et al., 2015). As the primary objective of applying structural modeling is prediction and explanation of our target construct; i.e., the innovation towards a greater degree of sustainability, PLS-SEM is, therefore, the preferred method of our study (cf. Henseler et al., 2009). Since PLS-SEM uses variance analytic calculation instead of reproducing an empirical covariance matrix, it does not provide statistical inference to assess the holistic structural model's goodness (Hair et al., 2013). We, thus, followed the PLS specific evaluation process (Henseler et al., 2009): First, we assessed the hierarchical measurement model (the first-order constructs), and then interpreted the path coefficients and evaluated the significances by bootstrapping (5000 subsamples and individual-level changes preprocessing) at the structural model level. We applied the path weighting scheme as the estimation scheme of the research model. Currently, this weighting scheme is recommended because it is the only scheme that explicitly takes into account the causal order and the direction of relationships as specified in the predictive path mode (Ringle et al., 2009).

For moderating effects, as moderating variables are categorical, the study used a categorical approach or multi-group analysis as the analytical procedure for the analysis of moderating effects. Categorical moderators are assumed to potentially affect all relationships of the model (cf. Hair et al., 2013).

4. Model Estimation and Results Evaluation

4.1. First-order hierarchical measurement model results

We begin with the evaluation of the first-order constructs. Since all the first-order constructs are modeled as reflectively measured constructs, the evaluation process starts with assessing the reliability of indicators. As can be seen in Table 3.2, all the indicator loadings are above the 0.53, higher than the minimum acceptable level for outer loadings; i.e., 0.40 (Hair et al., 2013). Therefore, the indicators in the reflective measurement models have satisfactory levels of indicator reliability. Then, the construct reliability of the first-order constructs is evaluated by calculating the composite reliability of each construct. Values between 0.70 and 0.90 can be regarded as satisfactory levels (Hair et al., 2013). The composite reliability values, ranging between 0.72 and 0.91, make evident that all the constructs have high levels of internal consistency reliability (see Table 3.2). Also, we use the average variance extracted (AVE) (Chin, 2010) for assessing the constructs' convergent validity. As can be seen in Table 3.2, all AVE values are higher than the critical threshold value of 0.50, providing evidence of the construct measures' convergent validity. Finally, we use the Fornell-Larcker criterion to assess the discriminant validity of the constructs (Hair et al., 2013). It requires that the square root of each construct's AVE should be higher than its highest correlation with any other constructs. The analysis indicates that discriminant validity has been established (see Table 3.3).

Table 3.2 Hierarchical measurement model results

Second-order constructs	First-order constructs	Indicators (Routines)	Loading	Composite reliability	AVE
	Innovation towards a Greater Degree of Sustainability (Y)	Material or Energy cost reduction (scale range: 0–3) (Y1)	0.80	0.91	0.78
		Reduction in environmental load (scale range: 0–3) (Y2)	0.89		
		Improvement of health/safety (scale range: 0–3) (Y3)	0.86		
Sensing (A) **VIF= 1.33**	**Internal sources (A1)** Weights= 0.406 Sig. (t-value)= 9.60 VIF= 1.07	1- Sources within the company or enterprise group (scale range: 0–3)	0.62	0.72	0.56
		2- Having procedures in place to regularly identify the company's environmental impacts (dummy)	0.80		
	Market sources (A2) Weights= 0.277 Sig. (t-value)= 5.79 VIF= 1.19	1- Clients or customers (scale range: 0–3)	0.69	0.79	0.55
		2- Suppliers of equipment, materials, components, or software (scale range: 0–3)	0.74		
		3- Competitors or other enterprises in the sector (scale range: 0–3)	0.71		
	Institutional sources (A3) Weights= 0.233 Sig. (t-value)= 4.13 VIF= 1.61	1- Universities or other higher education institutions (scale range: 0–3)	0.81	0.84	0.58
		2- Government research institutes (scale range: 0–3)	0.83		
		3- Consultants, commercial labs, or private R&D institutes (scale range: 0–3)	0.59		
		4- Professional and industry associations (scale range: 0–3)	0.65		

Continued

Continued

	Public sources (A4) Weights= 0.505 Sig. (t-value)= 9.16 VIF= 1.67	1- Conferences, trade fairs, exhibitions (scale range: 0–3)	0.67	0.82	0.54
		2- Scientific journals and trade/technical publications (scale range: 0–3)	0.68		
		3- Patent specifications (scale range: 0–3)	0.78		
		4- Standards and standardization boards/documents (scale range: 0–3)	0.70		
Seizing (B) **VIF= 1.38**	**Internal capabilities (B1)** Weights= 0.535 Sig. (t-value)= 5.81 VIF= 1.33	1- In-house research and experimental development (internal R&D)- (dummy)	0.64	0.72	0.57
		2- Professional development measures for innovation projects (Employee Training)- (dummy)	0.82		
	Adoption of the best practices (B2) Weights= 0.540 Sig. (t-value)= 6.45 VIF= 1.14	1- Acquisition of machinery, facilities and software to realize innovation projects (dummy)	0.80	0.77	0.63
		2- Acquisition of other external knowledge (dummy)	0.73		
	Market introduction of innovations (B3) Weights= -0.135 Sig. (t-value)= 1.59 VIF= 1.22	1- Market launch of innovations- marketing activities, including market research, directly related to innovation projects (dummy)	0.87	0.87	0.77
		2- Preparations for the introduction of product or process innovations, such as design, prototype manufacturing (dummy)	0.82		
	Cooperation with market partners (B4) Weights= 0.241 Sig. (t-value)=2.11 VIF=1.54	1- Cooperation with other companies within the enterprise group (dummy)	0.76	0.83	0.55
		2- Cooperation with clients or customers (dummy)	0.77		
		3- Cooperation with suppliers of equipment, materials, components, or software (dummy)	0.74		
		4- Cooperation with competitors or other enterprises in the sector (dummy)	0.53		

Continued

Continued

	Cooperation with knowledge partners (B5) Weights= 0.181 Sig. (t-value)=1.77 VIF=1.64	1- Cooperation with universities or other higher education institutions (dummy)	0.77	0.82	0.54
		2- Cooperation with government research institutes (dummy)	0.69		
		3- Cooperation with consultants, commercial labs, or private R&D institutes (dummy)	0.63		
		4- Awarding of R&D contracts to third parties (R&D outsourcing)- (dummy)	0.70		
Reconfiguring (C) **VIF= 1.16**	**New marketing methods and strategies (C1)** Weights= 0.153 Sig. (t-value)= 2.40 VIF= 1.12	1- New media or techniques for product promotion, introduction of brands (dummy)	0.73	0.79	0.55
		2- New methods for product placement or sales channels (incl. new ways to present products and services)- (dummy)	0.77		
		3- New methods of pricing goods and services (dummy)	0.66		
	New management practices (C2) Weights= 0.725 Sig. (t-value)=13.76 VIF= 1.13	1- New business practices for organizing procedures (i.e., supply chain management, knowledge management, etc.)- (dummy)	0.78	0.80	0.57
		2- New methods of organizing work responsibilities and decision making (i.e., teamwork, decentralization, etc.)- (dummy)	0.76		
		3- New methods of organizing external relations with other firms or public institutions (i.e., first use of alliances, partnerships, outsourcing, etc.) - (dummy)	0.67		
	New manufacturing-related processes (C3) Weights= 0.431 Sig. (t-value)= 6.13 VIF= 1.06	1- New development or significant improvement of process technology- (scale range: 0–3)	0.58	0.88	0.79
		2- Source inputs, allocate supplies within the firm, deliver products (supply chain processes)- (dummy)	0.82		

Table 3.3 Discriminant validity assessment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Adoption of the Best Practices	**0.80**												
(2) Cooperation with Knowledge Partners	0.18	**0.74**											
(3) Cooperation with Market Partners	0.13	0.59	**0.75**										
(4) Institutional Sources	0.17	0.44	0.28	**0.76**									
(5) Internal Capabilities	0.29	0.33	0.25	0.28	**0.76**								
(6) Internal Sources	0.08	0.18	0.20	0.16	0.21	**0.75**							
(7) Market Introduction Activities	0.17	0.28	0.21	0.16	0.38	0.18	**0.88**						
(8) Market Sources	0.13	0.11	0.15	0.31	0.19	0.18	0.18	**0.75**					
(9) New Management Practices	0.22	0.15	0.17	0.19	0.21	0.16	0.13	0.14	**0.76**				
(10) New Manufacturing-Related Processes	0.16	0.10	0.09	0.08	0.12	0.11	0.13	0.08	0.21	**0.89**			
(11) New Marketing Method and Strategy	0.15	0.08	0.07	0.10	0.13	0.06	0.19	0.11	0.30	0.19	**0.75**		
(12) Public Sources	0.18	0.31	0.24	0.60	0.28	0.19	0.21	0.37	0.14	0.09	0.10	**0.74**	
(13) Innovation towards a Greater Degree of Sustainability	0.15	0.11	0.11	0.29	0.15	0.24	0.05	0.25	0.15	0.13	0.06	0.34	**0.89**

Note: The diagonal elements (in bold) are the square root of the AVEs; non-diagonal elements are latent variable correlations.

Finally, as the data for all the model variables came from a one-time survey, common method variance might affect some hypothesized relations in the PLS path model. To assess the potential existence of common method bias, Harman's (1976) single-factor test was applied. The first factor accounts for only 15% of the overall variance, which shows that common method variance likely does not influence the results (Podsakoff & Organ, 1986). Thus, the first-order hierarchical measurement model assessment substantiates that all the first-order construct measures are reliable and valid. Based on these findings, we next evaluate the results of the second-order hierarchical measurement model.

4.2. Second-order hierarchical measurement model results

To evaluate the psychometric properties of the first-order constructs that have been modeled as formative indicators at the second-order measurement level, we test indicators relevance and multicollinearity to evaluate the measures' goodness (Chin, 2010). Internal sources, market sources, institutional sources, and public sources are formative indicators for measuring sensing capabilities. The formative indicators for measuring seizing capabilities are the development of internal capabilities, adoption of the best practices, market introduction of innovations, cooperation with market partners, and cooperation with knowledge partners. New marketing methods and strategies, new management practices, and new manufacturing-related processes are the formative indicators for measuring reconfiguring capabilities.

Concerning indicators relevance, the estimated second-order weights' significance is determined by means of bootstrapping. Table 3.2 shows that the significance of outer weights of all the indicators forming our second-order constructs exceeds the critical threshold of $t>1.96$, except for the market introduction of innovations (1.59) and cooperation with knowledge partners (1.77). The outer weight of cooperation with knowledge partners is considered significant with the significance level of 10%. Hence, all of the indicators are significant except the market introduction of innovations. Although the market introduction of innovations as a second-order level indicator is not significant; however, the outer loadings of its underlying indicators on seizing capabilities are significant. Therefore, the indicators should be retained in the measurement model.

Finally, the degree of multicollinearity among the formative indicators is evaluated by calculating the variance inflation factor (VIF) for each indicator (Henseler et al., 2009). As can be seen in Table 3.2, VIF value for all of the indicators is lower than 5. It is concluded that there is no potential multicollinearity between the indicators. This assessment provides evidence that the measurement model is appropriate; thus, we can proceed with the evaluation of the structural model.

4.3. Structural model results

To test the structural model and hypotheses, first, we need to assess the structural model for collinearity issues (Hair et al., 2013). Therefore, we examine multicollinearity at the structural model level by calculating the inner VIFs. It shows that there is no multicollinearity problem at the structural model level because all VIF values of the predictors (i.e., capabilities) in the structural model are lower than 5 (see Table 3.2). Then, we evaluate the coefficients of determination (R^2 values) for the key target construct (Innovation towards a greater degree of sustainability) to measure the model's predictive accuracy. R^2 is calculated as the squared correlation between the key construct's actual and predicted values (Hair et al., 2013). As R^2 for the key target construct has a high value of 0.268, we conclude that the estimation fit the data well. Cohen (1992) describes R^2 values of 0.02, 0.13, and 0.26 as small, medium, and large respectively. This finding is also supported by calculating the model's predictive power; i.e., Q^2 value

(Geisser, 1974) of the key target construct. Applying the blindfolding procedure (Henseler et al., 2009), we calculate the Q^2 value of the target construct (0.237), which is larger than 0, confirming the predictive power of the PLS path model.

To assess the structural model relationships and hypotheses, the path coefficients and their significance levels are evaluated. As can be seen in Table 3.4, the effects of sensing and seizing capabilities on innovating towards a greater degree of sustainability have significant values of 0.359 and 0.073 respectively ($p < 0.01$). Thus, both Hypotheses 1 and 2 are empirically supported. Regarding the Hypothesis 3, as can be seen in the Research Model, reconfiguring capabilities have a direct effect on innovating towards a greater degree of sustainability. Also, there is an indirect effect between the two constructs via the mediating constructs of sensing and seizing capabilities. The direct effect captures the residual effect (i.e., the part of the effect that is not mediated). Therefore, the total effect which is calculated as the sum of direct and indirect effects can indicate the relevance of reconfiguring capabilities on innovating towards a greater degree of sustainability. Accordingly, it is found that the total effect of reconfiguring capabilities on innovating towards a greater degree of sustainability (β = 0. 0.190, $p < 0.01$) is accepted as significant with the significance level of 1%. In line with Hypotheses 4a and 4b, reconfiguring capabilities positively influence sensing ($\beta = 0.244$, $p < 0.01$) as well as seizing capabilities ($\beta = 0.317$, $p < 0.01$).

Table 3.4 Significance testing results of the structural model- path coefficients

Hypotheses	Relationships	β (path coefficients)	t Values	p Values	Findings
Control variable	**Company Size -> Innovation towards a Greater Degree of Sustainability**	-0.046	2.51	0.01	Significant effect
Control variable	**Industry Sector -> Innovation towards a Greater Degree of Sustainability**	0.253	14.94	0.00	Significant effect
Control variable	**Innovation Intensity -> Innovation towards a Greater Degree of Sustainability**	0.083	2.98	0.00	Significant effect
Control variable	**R&D Intensity -> Innovation towards a Greater Degree of Sustainability**	-0.181	6.71	0.00	Significant effect
(1)	**Sensing -> Innovation towards a Greater Degree of Sustainability**	0.359	18.37	0.00	Supported
(2)	**Seizing -> Innovation towards a Greater Degree of Sustainability**	0.073	3.73	0.00	Supported
(3) Direct effect	**Reconfiguring -> Innovation towards a Greater Degree of Sustainability**	0.079	4.54	0.00	Supported
(3) Total effect	**Reconfiguring -> Innovation towards a Greater Degree of Sustainability**	0.190	10.64	0.00	Supported
(4a)	**Reconfiguring -> Sensing**	0.244	12.75	0.00	Supported
(4b)	**Reconfiguring -> Seizing**	0.317	17.78	0.00	Supported

Note: The t values near 1.65, 1.96, and 2.58 are considered with the significance level of 10%, 5% and 1%, respectively (Two-sided test).

To test the mediating role of sensing and seizing capabilities suggested in Hypothesis 4, we follow the approach proposed by Hair et al. (2013), who built on Preacher and Hayes (2004) recommendations for testing mediation effects. To test the proposed mediation effects for significance, first, we assess the significance of the direct effects of reconfiguring capabilities on innovating towards sustainability without including the mediator constructs (i.e., sensing and seizing capabilities) in the PLS path model. Although this is not a necessary condition, this kind of situation makes the mediator analysis much easier to understand and interpret. We find that the direct effect without including the mediator constructs is significant ($\beta = 0.167$, $p < 0.01$) (see Table 3.5). Then, we include the mediators in the PLS path model and assess the significance level of the indirect effects. As the indirect effects are also significant, we conclude that sensing ($\beta = 0.087$, $p < 0.01$) and seizing capabilities ($\beta = 0.023$, $p < 0.01$) mediate the relationship between reconfiguring capabilities and firms' innovation towards a greater degree of sustainability.

For assessing the strength of these mediations, the Variance Accounted For (VAF) for each mediator is calculated (Hair et al., 2013). VAF evaluates the size of the indirect effect in relation to the total effect. In that way, we determine the extent to which the variance of the key target construct (innovation towards sustainability) is directly explained by reconfiguring capabilities and how much of the target construct's variance is explained by the indirect effect of reconfiguring capabilities via sensing and seizing capabilities. As can be seen in Table 3.5 (Mediators analysis results), we find that 52.5% of reconfiguring capabilities' effect on innovating towards a greater degree of sustainability is explained via the sensing capabilities mediator. As the VAF level is higher than 20% but lower than 80%, this situation can be considered as partial mediation. As well, 22.5% of reconfiguring capabilities' effect on innovating towards a greater degree of sustainability is explained via the seizing capabilities mediator. Since the VAF level is higher than 20% but lower than 80%, it is concluded that almost a partial mediation takes place for the effect of reconfiguring capabilities on innovating towards a greater degree of sustainability by seizing capabilities. Accordingly, Hypothesis 4 is empirically supported.

Table 3.5 Mediators analysis results (Hypothesis 4)

Relationships	Direct Effect (t Value)	Indirect Effect (β)	STDEV	t Value (Ind.)	VAF (Indirect effect/ Total effect)	Findings
Reconfiguring -> Innovation towards a Greater Degree of Sustainability (without including the mediators in the model)	0.167 (9.16)	-	-	-	-	
Reconfiguring -> Sensing-> Innovation towards a Greater Degree of Sustainability	-	0.087	0.008	10.04	**52.5**	Partial Mediation
Reconfiguring -> Seizing-> Innovation towards a Greater Degree of Sustainability	-	0.023	0.006	3.64	**22.5**	Partial Mediation

Note: The *t* values near 1.65, 1.96, and 2.58 are considered with the significance level of 10%, 5% and 1%, respectively (Two-sided test).

4.4. Importance-Performance Matrix Analysis (IPMA)

We utilize the Importance-Performance Matrix Analysis (IPMA) of PLS path model to expand the analysis to the latent constructs, and the indicator level facilitates identifying the most important organizational routines of the capabilities. IPMA is a post hoc analysis. The IPMA provides researchers the opportunity to deepen their PLS-SEM analysis and, thereby, gain additional results and findings (Hair et al., 2013). The IPMA contrasts the total effects (importance), and the average values of latent constructs scores (performance) for a specific criterion construct to identify predecessors that have a relatively high importance for the target construct and their related performance. Furthermore, by using the indicators' total effects on the target construct, we can interpret the indicators' relative contribution to forming the composite variable (i.e., the target construct) in the PLS path model (Ringle & Sarstedt, 2016).

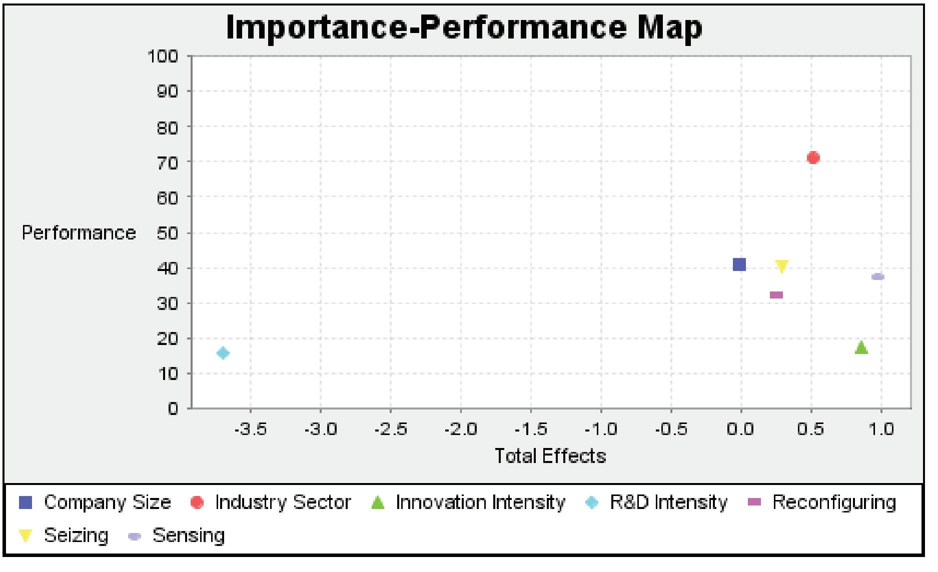

Figure 3.3 IPMA results of capabilities on innovating towards sustainability

As can be seen in Figure 3.3, we find that sensing capabilities have a higher important effect on innovating towards a greater degree of sustainability than seizing and reconfiguring capabilities. Furthermore, the total effect of seizing capabilities on innovating towards a greater degree of sustainability is slightly higher than for reconfiguring capabilities. However, it becomes apparent that the performance of sensing capabilities on innovating towards a greater degree of sustainability is lower than that of seizing capabilities. Therefore, managerial actions should focus on improving the performance of the sensing capabilities. Table 3.A1 provides more information about IPMA results.

The IPMA results also reveal that internal sources of the companies are of primary importance for sensing the opportunities and gaining information to innovate for sustainability. Public sources have the second highest total effect (importance) on the companies for gaining information and knowledge for sustainable innovation activities. However, their performance is lower than market sources. Institutional sources have the lowest importance and performance for sensing capabilities of the firms to innovate for sustainability. On the indicators of different sources, having procedures in place to regularly identify the company's environmental impacts is the most important internal source of the companies. In market sources, suppliers of equipment and materials have the highest impact on the firms' sensing capabilities. Though the total effect of clients or costumers is slightly lower than suppliers, their performance in sensing the sustainability opportunity is much higher than tapping suppliers. Regarding the role of institutional sources in sensing capabilities, the two highest total effects belong to government research institutes, and professional and industry associations respectively. On the other hand, universities have the highest performance compared to the other routines related to the institutional sources. Patent specifications, and standards and standardization boards/documents are the most important routines among public sources. However, conferences, trade fairs, exhibitions perform better than patent specifications and standards in enhancing the firms' sensing capabilities for sustainable innovation activities.

About seizing capabilities, internal capabilities including in-house research and development (internal R&D activities), and employee training have the highest impact and performance on seizing capabilities of the firms for sustainable innovation activities (see Table 3.6). In this sense, employee training is more important than internal R&D activities. Adoption of the best practices in the sectors is of similar importance but has a lower performance. It is found that acquisition of machinery and facilities related to innovation projects has a higher impact and performance than the acquisition of other external knowledge including patents and licenses. Comparing the importance of cooperation partners, we explored that cooperation with market partners plays a higher important role in the development of innovation for sustainability. It is found that for innovating towards a greater degree of sustainability, cooperation with suppliers of equipment and materials is much more important than cooperation with clients or customers. On knowledge partners, we find that government research institutes and consultants or private R&D institutes have a higher impact than universities in the development of innovation for sustainability. However, universities perform much better. Therefore, managerial action needs to focus on improving the performance of the cooperation with government research institutes and consultant companies. Awarding R&D contracts to other enterprises particularly research institutes (outsourcing R&D) has the best performance as a strategy for firms to maintain close ties with the knowledge partners for sustainable innovation activities.

About reconfiguring capabilities, new management practices have the highest impact and performance on the development of sustainable innovation activities. On the indicators of new management practices, it is found that they have almost the same total effect on reconfiguring capabilities. However, new business practices for organizing procedures such as supply chain management and knowledge management perform better than other organizational routines. New manufacturing-related processes have the second highest impact on the development of sustainable innovation activities. It is found that new supply chain processes, and new development or significant improvement of process technologies have significant total effects on the development of innovation for sustainability. Comparing routines related to new marketing methods and strategies, there are no significant differences between the total effects of organizational routines in enhancing the firms' reconfiguring capabilities. However, new methods for product placement or sales channels perform slightly better than other routines.

4. 5. Categorical moderators' effects

In addition to the assessment of the main and mediation effects, we also evaluate the moderation effects proposed in Hypotheses 5 and 6. For analyzing PLS-MGA measurement results, the p values lower than 0.05 and higher than 0.95 are considered significant with a significance level of 5%. A primary concern when comparing path coefficients across groups is to ensure that the construct measures are invariant across the groups. Measurement invariance is required to ensure that the categorical moderators' effect is restricted to the path coefficients (i.e., the structural relations) and does not entail group-related differences in the measurement models (Hair et al., 2013; Henseler et al., 2016). Therefore, the assessment of measurement invariance is an important issue when conducting PLS-SEM multi-group analyses. Using PLS-SEM for the path coefficients analyses, we apply Henseler et al. (2016) procedure to assess the measurement invariance of composite models (MICOM). The first step, the configural invariance assessment, consists of a qualitative assessment of the composites' specification across all the groups to ensure that the same number of constructs and identical indicators associated with each construct, exists in all the groups. Accordingly, we conclude that the configural invariance has been established. The next step is the assessment of compositional invariance, i.e., the prescription for condensing the indicator variables into composites (latent variables) is the same for all groups. The compositional invariance is established when- despite possible differences in the weights- the scores of a composite remain the same across groups. Thus, the correlation between the composite scores across groups should not be significantly different. To statistically test for compositional invariance, a permutation test over the correlation of the composite scores in both groups is used (Henseler et al., 2016). The permutation test shows that none of the correlation values (*c values*) are significantly different. It is therefore concluded that compositional invariance has been established for all composites (latent variables) across groups. Having established configural and compositional invariance in Steps 1 and 2, the path coefficient estimates of the structural relationships across the groups can be compared by using a multi-group analysis. Tables 3.A2 and 3.A3 show the results of permutation tests between groups of moderating variables.

4.5.1. The moderating role of environmental turbulence

As shown in Table 3.6, the resulting p values ($\beta_{diff=}$ 0.004, p value= 0.543) indicate that there is no significant difference between the effect of reconfiguring capabilities on innovating towards a greater degree of sustainability when the firms innovate for sustainability in the different levels of high and low environmental turbulences. Thus, Hypothesis 5 is not supported. As well, it shows that reconfiguring capabilities have a higher impact on the firms' sensing ($\beta_{diff=}$ 0.066, p value= 0.044) and seizing capabilities ($\beta_{diff=}$ 0.112, p value= 0.001) in high environmental turbulences than that of in low environmental turbulences. Thus, Hypotheses 5a and 5b are supported empirically.

4.5.2. The moderating role of firms' strategic sustainability behaviors

As can be seen in Tables 3.7, Hypotheses 6, 6a, and 6b are not supported. However, interestingly, the results indicate that the proposed effects of reconfiguring capabilities are stronger for the firms' with reactive strategic sustainability behaviors than for firms with proactive behaviors towards innovation. It means that the effect of reconfiguring capabilities on innovating towards a greater degree of sustainability is significantly higher for firms with reactive strategic sustainability behaviors than for firms with proactive behaviors (β_{diff}= 0.086, p value= 0.968). It is also found that the direct effect of firms' reconfiguring capabilities on innovating towards a greater degree of sustainability is not significant (β= 0.004, p value=0.846). However, its total effect on innovating towards a greater degree of sustainability via enhancing firms' sensing and seizing capabilities is significant (β= 0.113, p value=0.001). Furthermore, it is found that the impact of reconfiguring capabilities on the firms' sensing (β_{diff}= 0.086, p value= 0.947) and seizing capabilities (β_{diff}= 0.085, p value= 0.951) are significantly higher for companies with reactive strategic sustainability behaviors towards innovation.

Table 3.6 PLS-MGA results- Environmental turbulence as a categorical moderator

Hypotheses	Relationships	Group 1: High Turbulence		Group 2: Low Turbulence		Path Coefficients-diff (| Group 1- Group 2|)		Findings
		Path Coefficients	p Values	Path Coefficients	p Values	Path Coefficients-diff	p Values	
Control variable	**Company Size -> Innovation towards a Greater Degree of Sustainability**	-0.039	0.090	-0.053	0.043	0.014	0.349	NS effect
Control variable	**Industry Sector -> Innovation towards a Greater Degree of Sustainability**	0.262	0.000	0.244	0.000	0.018	0.300	NS effect
Control variable	**Innovation Intensity -> Innovation towards a Greater Degree of Sustainability**	0.139	0.001	0.039	0.208	0.100	0.031	Significant effect
Control variable	**R&D Intensity -> Innovation towards a Greater Degree of Sustainability**	-0.245	0.000	-0.138	0.000	0.107	0.977	Significant effect
(5)	**Reconfiguring -> Innovation towards a Greater Degree of Sustainability**	0.076	0.003	0.080	0.002	0.004	0.543	Not supported
(5a)	**Reconfiguring -> Sensing**	0.275	0.000	0.209	0.000	0.066	0.044	Supported
(5b)	**Reconfiguring -> Seizing**	0.364	0.000	0.252	0.000	0.112	0.001	Supported

Note: The p values lower than 0.05 and higher than 0.95 are considered significant with a significance level of 5% (Two-sided test).
NS: Not Significant.

Table 3.7 PLS-MGA results- Firms' strategic sustainability behaviors as a categorical moderator

Hypotheses	Relationships	Group 1: Proactive Innovation		Group 2: Reactive Innovation		Path Coefficients-diff (∣ Group 1- Group 2∣)		Findings
		Path Coefficients	p Values	Path Coefficients	p Values	Path Coefficients-diff	p Values	
Control variable	**Company Size -> Innovation towards a Greater Degree of Sustainability**	-0.060	0.079	-0.109	0.016	0.049	0.192	NS effect
Control variable	**Industry Sector -> Innovation towards a Greater Degree of Sustainability**	0.195	0.000	0.237	0.000	0.041	0.768	NS effect
Control variable	**Innovation Intensity -> Innovation towards a Greater Degree of Sustainability**	0.066	0.141	0.008	0.813	0.058	0.148	NS effect
Control variable	**R&D Intensity -> Innovation towards a Greater Degree of Sustainability**	-0.126	0.013	-0.167	0.007	0.041	0.302	NS effect
(6)	**Reconfiguring -> Innovation towards a Greater Degree of Sustainability**	0.004	0.846	0.089	0.039	0.086	0.968 [a]	Not supported
(6a)	**Reconfiguring -> Sensing**	0.259	0.000	0.345	0.000	0.086	0.947 [a]	Not supported
(6b)	**Reconfiguring -> Seizing**	0.224	0.000	0.309	0.000	0.085	0.951 [a]	Not supported

Note: The p values lower than 0.05 and higher than 0.95 are considered significant with a significance level of 5% (Two-sided test).
NS: Not Significant.
[a] Although Hypotheses 6, 6a, and 6b are not supported. However, the results indicate that the proposed effects of reconfiguring capabilities are stronger for the firms' with reactive strategic sustainability behaviors towards innovation than for firms with proactive behaviors towards innovation.

5. Discussion

While there is a significant amount of studies on the necessity and drivers of sustainable innovation at the firm level; research on managing innovation for sustainability is still in its infancy (Arnold & Hockerts, 2011; Berchicci & Bodewes, 2005; Bocken et al., 2014a). Management practices of conventional innovation are not entirely applicable to sustainable innovation activities. Also, the management practices of innovation for sustainability have received much less theoretical and empirical attention than conventional innovation. Firms often do not have the resources and competencies required to develop sustainable innovation (Dangelico et al., 2013). Therefore, the main challenge of the companies is to identify, develop, and reconfigure their resources and competencies to accomplish sustainable innovations (e.g., Cainelli et al., 2015). The aim of this study was to argue theoretically and to investigate empirically which organizational routines and capabilities are useful for firms to innovate towards greater sustainability. This gap in the literature is addressed by drawing on the dynamic capabilities approach to provide a coherent theoretical framework for the study.

In summary, our results confirm Hypotheses 1, 2, and 3. Consistent with Hypothesis 1, it is supported that firms with greater sensing capabilities are prone to innovate more towards a greater degree of sustainability. Sensing capabilities allow companies to scan and monitor the business environments for identifying innovation opportunities for sustainability and making a strategic decision about them. In particular, this study shows that the development of innovation for sustainability requires organizational routines that help companies to overcome incomplete information about environmental issues and to explore novel solutions for them. In line with Hypothesis 2, our results support that firms with greater seizing capabilities are prone to innovate more towards a greater degree of sustainability. Seizing capabilities help companies to build and improve competencies and deploy resources from internal and external sources to achieve marketplace acceptance. It is argued that the seizing of opportunities needs organizational routines that help companies to engender and support innovation for sustainability, which deals more with the implementation and commercialization of innovation. Consistent with Hypothesis 3, the study supports that firms with greater reconfiguring capabilities are prone to innovate more towards a greater degree of sustainability. Reconfiguring capabilities allow companies to renew, realign and redeploy their existing resources/competencies for addressing the requirements of innovation for sustainability. Reconfiguring capabilities comprise organizational routines for adjusting and changing the patterns of previously utilized innovation processes to enhance the development of innovation for sustainability. Our results indicate that 52.5% and 22.5% of reconfiguring capabilities' total effect on innovating towards a greater degree of sustainability are explained by the indirect effect mediated by sensing and seizing capabilities respectively. Hence, in line with Hypothesis 4, it is supported that the effect of reconfiguring capabilities on innovating towards a greater degree of sustainability is partially mediated by sensing and seizing capabilities of the firm.

In addition to the evaluation of the main and mediation effects, we also assessed the moderation effects proposed in Hypotheses 5 and 6. Contrary to Hypothesis 5, it is found that there is no significant difference between the effects of reconfiguring capabilities on innovating towards a greater degree of sustainability in low and high turbulent environments. It means that regardless of environmental turbulence, companies need reconfiguring capabilities for innovating towards a greater degree of sustainability. However, we found support for Hypotheses 5a and 5b. In line with Hypothesis 5a, the study supports that in high turbulent environments, the positive effect of reconfiguring capabilities on the sensing capabilities of a firm for discovering the innovation opportunities for sustainability is stronger than for low turbulent environments. As well, in high turbulent environments, the positive effect of reconfiguring capabilities on the seizing capabilities of a firm for implementing and commercializing the innovation opportunities for sustainability is stronger than for low turbulent environments. It is concluded that in high turbulent environments, reconfiguring capabilities play a more important role in enhancing sensing and seizing capabilities of the firms for innovating towards a greater degree of sustainability. Put differently, companies, operating in a high turbulent environment, need greater reconfiguring capabilities for sensing and seizing innovation opportunities for sustainability. Contrary to Hypothesis 6, we found that reconfiguring capabilities have a stronger positive effect on innovating towards a greater degree of sustainability within firms' with reactive strategic sustainability behavior than for firms with proactive strategic sustainability. This finding holds true for Hypotheses 6a and 6b as well. The study shows that the effect of reconfiguring capabilities on the sensing and seizing capabilities of the firms for innovating towards a greater degree of sustainability is significantly higher for firms with reactive strategic sustainability behavior than for firms with proactive strategic sustainability behavior. It is concluded that although companies with proactive strategic sustainability behavior towards innovation also need reconfiguring capabilities for innovating towards a greater degree of sustainability. However, reconfiguring capabilities have more significant effects for firms with reactive strategic sustainability behavior to address existing demands for sustainable products and technologies in the market.

Accordingly, our analyses show that three capabilities of sensing, seizing and reconfiguring play important roles in innovating towards greater sustainability. Furthermore, the results explore some peculiarities about the organizational routines (i.e., building blocks of the capabilities) that are important and useful to enhance firms' capabilities for innovating towards a greater degree of sustainability. The study further develops the argument that the effects of capabilities on innovating towards sustainability are context-dependent. These results are discussed in more detail as follows:

5.1. Sensing

For innovating towards sustainability, firms need capabilities to scan the business environment to find out about technological developments, industry and business trends, market demands, and the environmental impacts of their business activities. In other words, this study shows that the development of sustainable innovation requires gaining access to knowledge and information from different sources in the business environment. This alertness to the information and knowledge from a variety of sources allows companies to discover opportunities for sustainable innovation activities. This aspect has also been pointed out in the existing literature. The literature argues that for realizing sustainable innovation, companies need to recognize the potential of sustainability opportunities (e.g., Horbach et al., 2012; Porter & van der Linde, 1995). As companies have a lack of information and are still inexperienced in sustainability issues, they need to tap a wide range of external parties to explore sustainability opportunities and novel solutions to environmental problems. This finding is further supported by Lenox and Ehrenfeld (1997) who argue that the development of environmentally sustainable products requires organizational routines that improve explorative activities for identifying and generating new knowledge for sustainability. Therefore, sensing capabilities include organizational routines for gathering data, communicating information, and finding resources and strategic partners for identifying sustainability opportunities.

With regard to the organizational routines of companies for sensing capabilities, it is found that four types of information sources are important for innovating towards greater sustainability. These sources are internal sources, market sources, institutional sources, and public sources. It means that both internal and external information sources are useful for firms to innovate for sustainability. However, we find that internal sources are the most important source of companies for gaining information to innovate for sustainability. In particular, the existence of procedure such as EMSs and environmental audits in companies help them to identify the environmental impacts and overcome incomplete information about their business activities. The study also finds that the effect of public sources on innovating towards greater sustainability is more important than the market and institutional sources respectively. However, market sources perform better than other sources in innovating towards greater sustainability. Consequently, it shows that managerial activities should focus more on internal sources to improve sensing capabilities of the companies for sustainable innovation activities. From public sources, patent specifications have the greatest importance in providing information for firms' sustainable innovation activities. Aragon-Correa and Leyva-de la Hiz (2016) argue that environmental patents provide an important and objective opportunity to analyze environmentally sustainable innovation outcomes and thus stimulate companies to imitate and adopt those inventions. With respect to market sources, companies get information mostly from suppliers for innovating towards sustainability. Dangelico et al. (2013) argue that suppliers may provide strategic information about environmental technologies, new environmentally friendly materials, and valuable suggestions for implementing environmental projects to reduce environmental impacts of companies. These inputs help companies to be proactive and to find sustainability opportunities in their business environment. Among the institutional sources, government research institutes serve as the most important source of companies for gaining information about sustainability issues. Confirming this finding, Horbach et al. (2013) explain that environmentally sustainable innovation often needs new technologies where more basic research is needed. As well, in the case of innovation for sustainability, the beneficial environmental impact of innovations makes their development and diffusion always socially desirable. In other words, sustainable innovation often provides high environmental and social returns while its private returns for the innovative companies is unclear (Rennings, 2000). Hence, government research institutes as government actors maybe have a specific role in the development and diffusion of sustainable technologies (cf. Alkemade & Suurs, 2012).

5.2. Seizing

For innovating towards sustainability, it is not enough to find out about technological developments or business trends; firms also need capabilities to exploit and profit from the recognized sustainability opportunities – that lead them to implement sustainable innovations. Seizing capabilities allow firms to mobilize internal and external resources and competencies to the firms for implementing and commercializing the innovation opportunities. We argue that companies' innovation capabilities help the companies to seize the innovation opportunities and improve sustainability performance. In line with this argument, the existing literature points out that for seizing the opportunities, firms need to respond to and exploit opportunities by implementing new products or production processes (Lieberherr & Truffer, 2014; Teece, 2007). As a result, the study finds that seizing capabilities involve the development of internal capabilities, adoption of the best practices in the sectors, and cooperation with market and knowledge partners allowing companies to innovate for sustainability.

This study finds that internal capabilities including internal R&D activities and employee training have the greatest importance for sustainable innovations. Ketata et al. (2015) argue that internal capabilities allow companies to spot promising sustainability opportunities, to set priorities and choose the important ones, and exploit them successfully. In this context, employees training have been recognized more important than R&D activities for supporting the introduction of sustainable innovations. Cainelli et al. (2015) show that employee training is not only important to transfer technological knowledge but also to increase awareness about the importance of dealing with environmental impacts and inspiring employees to address environmental challenges. Beyond internal capabilities, adoption of the best practices in the sectors is the second most important organizational routine of firms for innovating towards sustainability. In that sense, we find that acquisition of machinery and equipment from external suppliers is more important and more efficient than the acquisition of external knowledge (i.e., patents or non-patented inventions, know-how or other types of knowledge developed by external partners). The literature confirms that machinery and equipment acquisition is highly correlated with the probability to develop new products or processes that reduce environmental impacts (Dangelico et al., 2013; Horbach et al., 2012). Furthermore, it argues that machinery and equipment acquisition is more relevant in stimulating the introduction of sustainable innovation than conventional innovation. However, on the contrary to the results found in France by Horbach et al. (2013) and in Spain by Cainelli et al. (2015), we find that acquisition of knowledge developed by external partners is also significantly useful for innovating towards sustainability.

Our results also show that as cooperation with different types of actor increases, the companies innovate more towards a greater degree of sustainability. The existing literature confirms that given the systemic and complex character of sustainable innovation, cooperation with external partners is even greater than for the introduction of conventional innovation (Bos-Brouwers, 2010; De Marchi, 2012). Cooperation allows companies to compensate the lack of resources or lack of expertise externally and to enhance legitimacy and social license to operate (Adams et al., 2012). Put differently, cooperation with external partners helps companies to combine a wide variety of resources and competencies and look beyond their boundaries to capture co-specialization benefits (cf. Teece, 2007). Halila and Rundquist (2011) argue that sustainable innovation often stems from the original combination of heterogeneous resources and competencies endowed by different organizations. Moreover, our results show that market partners the firms co-innovate with are more important than knowledge partners. In particular, it is found that companies within the enterprise group and suppliers are more valuable partners to co-innovate for sustainability. De Marchi (2012) shows that cooperation with suppliers is more relevant than for conventional innovation whereas cooperation with customers/clients is not significantly important for innovating towards sustainability. However, this study finds that cooperation with customers/clients is also important and effective for innovating towards greater sustainability.

Concerning cooperation with knowledge partners, we find that cooperation with consultants, commercial labs, or private R&D institutes has the highest importance for innovating towards sustainability. Tether and Tajar (2008) contend that consultants and private R&D institutes as sources of particular expertise are akin to that found in universities and public research institutes. However, consultants and private R&D institutes are more experienced players in innovation activities. Consequently, as many companies are still inexperienced in dealing with sustainability issues; cooperation with consultants who have experienced similar innovation projects can be valuable to gain access to the essential skills for innovating towards a greater degree of sustainability.

5.3. Reconfiguring

Our results demonstrate that reconfiguring capabilities play an important role in innovating towards greater sustainability. The study shows that reconfiguring capabilities enhance sensing capabilities of the firms for discovering the innovation opportunities for sustainability; as well as seizing capabilities for implementing and commercializing the opportunities for innovating towards sustainability. Hall and Vredenburg (2003) argue that the current approaches to managing innovation are not enough to deal with the additional constraints of sustainability demands. Therefore, this study shows that for innovating towards sustainability, the innovation should be done differently, whether technologically and organizationally. Accordingly, companies need organizational routines that enable the renewal, orchestration, and configuration of the resources/competencies to keep the resource base in line with the demands of changing environments (Helfat et al., 2007). Additionally, the study provides strong support for the mediating role of sensing and seizing capabilities. It is found that the effect of reconfiguring capabilities on innovating towards greater sustainability is mediated partially by sensing and seizing capabilities of the firms. It means that reconfiguring capabilities indirectly contributes to the development of innovation for sustainability, and the effect of reconfiguring capabilities on sensing capabilities is higher than for seizing capabilities for innovating towards sustainability. It means that reconfiguring capabilities, in addition to positive direct effects on innovating towards greater sustainability, are required to enhance firms' sensing and seizing capabilities for innovating towards a greater degree of sustainability. The study explores that reconfiguring capabilities of companies for sustainable innovation include three strategic renewals of organizational processes; i.e., new marketing methods and strategies, new management practices, and new manufacturing-related processes.

This study shows that companies need new marketing approaches emphasizing the sustainability focus of their innovation activities to expand markets for environmentally sustainable goods or services. The existing literature argues that sustainability innovative firms can demonstrate to the market the sustainability advantages of their products or services through demonstrations and marketing (e.g., Berkhout, 1996; Bossink, 2015; Bossink, 2017). For example, Dangelico (2016) finds that eco-labeling is a communication strategy for presenting and placing the sustainable products and services in the market to inform their advantages relative to other products or services. On the other hand, although sustainable innovation sometimes creates new market opportunities due to its price advantages and cost-saving issues (Beise & Rennings, 2005). However, Visser et al. (2008) argue that it is often a difficult challenge to develop affordable environmentally sustainable products in price. Thus, it is important to create links and positive trade-offs between the environmentally friendly attributes of sustainable innovation and other critical factors of competitive advantages such as price. We argue that changing the revenue model is a good strategy to provide new methods for pricing goods and services (cf. Boons et al., 2013).

We also find that in the case of innovations for sustainability a lot of new management practices; i.e., 'management innovation' (Birkinshaw et al., 2008) is needed. New management practices include new business practices for organizing procedures, new methods of organizing work responsibilities and decision making, and new methods of organizing external relations with other firms or public institutions. Following Mol and Birkinshaw (2009), we define 'management innovation' as the introduction of new management practices to a firm resulting from the firm's internal context and the external search for new resources and competencies to enhance the firm's performance. Our results show that management innovation is the most important and effective strategic renewal of organizational processes through which the companies can innovate more towards sustainability. This finding shows that the development of sustainable innovation can be beyond technological breakthroughs and needs some important non-technological elements of innovative organizational activities. This is in agreement with the finding of Klewitz and Hansen (2014) who argue that innovating for sustainability is an integrative and interactive process between product, process, and organizational level changes.

Regarding the organizational routines, new business practices for organizing procedures are the most important new management practices of the companies for innovating towards sustainability. For example, the existing literature argues that the integration of environmental issues into the traditional supply chain management facilitates the introduction of sustainable innovation (e.g., Gold et al., 2010; Seuring & Müller, 2008). Sustainable supply chain management often affects the external coordination of the firm, including changes in the interaction with suppliers, and involves a closer relationship between the members of the supply chain to accelerate the creation of new opportunities for better sustainability performance.

New methods of organizing work responsibilities and decision making (i.e., teamwork, decentralization, etc.) are the other new management practices of the companies for innovating towards greater sustainability. For example, the existing literature emphasizes the introduction of environmental departments or cross-functional teams that coordinate and integrate different resources and competencies for the sustainable innovation project within the company (Berchicci & Bodewes, 2005; Dangelico, 2016; Jabbour et al., 2013). These teams are comprised of employees from more than one organizational area that enables the organizations to address the complex and interdisciplinary issue of sustainability by combining different resources/competencies inside the company.

The other new management practices to better facilitate sustainable innovation are new methods of organizing external relations and collaborations with other firms, public institutions, suppliers or customers. Klewitz and Hansen (2014) argue that interacting more strongly with the heterogeneity of external innovation actors constitutes an important aspect of an innovative activity for sustainability. Innovation towards sustainability often needs to renovate the whole innovation system, and needs to take into account social, ecological and economic aspects (Carrillo-Hermosilla et al., 2010). Therefore, from the companies' perspective, the companies should renew their relationships with other stakeholders. Particularly, with the government, and engage with more diverse actors including competitors and lobby groups to stimulate and redirect the focus of innovations towards sustainability (Carrillo-Hermosilla et al., 2010; Dangelico & Pujari, 2010).

New manufacturing-related processes involve new supply chain processes and new development or significant improvement of process technologies. This finding is in agreement with Porter and van der Linde (1995) who argue that firms need to develop and qualify their productive systems and new product development processes for sustainable innovation. Particularly, to configure the value proposition of the firms towards sustainability, it is essential to change the supply chain processes (Boons et al., 2013). Accordingly, sustainability issues should be integrated into the activities of firms for delivering a product from raw material through to the customer, including sourcing raw materials and parts, manufacturing and assembly, and delivery. Furthermore, the development of sustainable innovation often requires the modification or development of new technologies; i.e., machinery, devices, equipment, logistic systems, etc. Shrivastava (1995a) argues that for innovating towards sustainability, firms need to redesign their production processes, requiring acquisition and installation of new technologies. Similarly, Hellström (2007) finds that the improvement of existing technologies gradually is not enough to develop sustainable innovation, rather, technological products and systems must be significantly reconstructed.

5.4. Environmental turbulence as a moderator

The study shows that the hypothesized moderating role of environmental turbulence on the positive effect of reconfiguring capabilities on the firms' sensing and seizing capabilities is supported. However, no support was found for the moderating role of environmental turbulence on the positive effect of reconfiguring capabilities on innovating towards greater sustainability. These findings indicate that regardless of the level of turbulence that companies are confronted with, reconfiguring capabilities are required for innovating towards sustainability. However, reconfiguring capabilities play a more important role in enhancing firms' sensing and seizing capabilities for innovating towards sustainability in high environmental turbulence than for low environmental turbulence. In line with our findings, Wilden et al. (2013) argue that as companies operate in low environmental turbulence, they rely less on the capabilities to reconfigure their resources and competencies to achieve external fit. Therefore, we can conclude that reconfiguring capabilities are more effective in the case of innovations for sustainability at a high degree of environmental turbulence. This finding is also consistent with the literature (Eisenhardt & Martin, 2000; Teece et al., 1997), which argues that environmental turbulence moderates the relationship between dynamic capabilities and performance.

5.5. Firms' strategic sustainability behaviors towards innovation as a moderator

Our directional hypothesized moderating role of strategic sustainability behaviors towards innovation is not supported. However, it is empirically explored that the proposed effects of reconfiguring capabilities are stronger for the firms with reactive strategic sustainability behavior than for the firms with proactive strategic sustainability behavior. Our findings support that regardless of the firms' strategic sustainability behaviors towards innovation, reconfiguring capabilities are required for innovating towards sustainability. Firms with the reactive approach innovate more incrementally than radically by adapting products and their manufacturing processes to new environmental regulations. The literature often highlights that environmental regulations represent the most important factor in triggering the sustainable innovation process (e.g., Blum-Kusterer & Hussain, 2001; Cainelli et al., 2015; Dangelico, 2016). Porter and van der Linde (1995: 115) argue that "companies must start to recognize the environment as a competitive opportunity." Accordingly, existing or expected environmental regulations may also provide an opportunity for new businesses to be created. The threat of regulation can also act as a significant stimulant for inducing a proactive innovation. Kammerer (2009) shows that a high level of regulatory stringency incentivizes companies to innovate for sustainability. In line with Porter and van der Linde's hypothesis (1995), for gaining a 'first mover advantage,' companies need to focus their innovation efforts on one direction to adapt to the competitive situation (Chassagnon & Haned, 2015). Thus, companies need stronger reconfiguring capabilities for gaining a first mover advantage in response to environmental regulations.

6. Implications, Limitations, and Avenues for Future Research

The results of our empirical study contribute to research and practice in several important ways. First, this study improves our theoretical and managerial understanding of innovation management practices for sustainability. This study draws on the dynamic capabilities approach to provide new insights into firms' innovation for sustainability. The dynamic capabilities approach provides a coherent theoretical framework for innovating towards sustainability. It identifies a set of capabilities that are useful for innovating towards sustainability. It is found that dynamic capabilities, as manifested by sensing, seizing, and reconfiguring capabilities, have a positive effect on innovating towards greater sustainability. Furthermore, this study identifies and confirms the importance of organizational routines which are building blocks of the firms' capabilities for innovating towards sustainability. Our research, therefore, responds to a call made by Dangelico et al. (2013) and Dangelico (2016) to study the development of innovation for sustainability from a dynamic capabilities perspective. Their suggestion is motivated by the fact that the context of sustainability has been characterized by high dynamism and unpredictable outcomes.

Second, this study also contributes to the growing body of the literature on dynamic capabilities. We extend the current literature by investigating how companies should build-up and shape their capabilities for innovating towards sustainability both theoretically and empirically. As measuring dynamic capabilities and their effects are associated with difficulties (Easterby-Smith et al., 2009), studies on dynamic capabilities have been largely theoretical (e.g., Seebode et al., 2012). On the other hand, the empirical studies that have been published often address the evolution of dynamic capabilities or offer case study insights (e.g., Iles & Martin, 2013). Few empirical studies have investigated the association of capabilities with sustainable innovation activities (e.g., Ketata et al., 2015); this study also provides an operationalization of dynamic capabilities for future research on managing innovation for sustainability. Moreover, our study provides a more nuanced understanding of the relative influence of different contexts. We support the emerging consensus that dynamic capabilities for innovation activities exist and go hand in hand with the operating environment (e.g., Helfat et al., 2007; Kim & Pennings, 2009; Priem & Butler, 2001).

This paper also contributes to the literature on sustainable innovation from a methodological perspective. The majority of the quantitative analyses on sustainable innovation so far have focused just on manufacturing sector (e.g., De Marchi, 2012; Ketata et al., 2015). Hence, we investigate organizational routines and capabilities for both manufacturing and service companies to increase the generalizability of our findings. Furthermore, these organizational routines and capabilities have been studied in combination simultaneously; while previous research has investigated these organizational routines separately (e.g., De Marchi, 2012; Ketata et al., 2015). Thereby, this study contributes to a more holistic appreciation of organizational routines and capabilities of the companies for innovating towards sustainability.

From a managerial point of view, the study points to the importance of reconfiguring capabilities in managing innovation for sustainability. Accordingly, companies need to renew the existing routines of their sensing and seizing capabilities for innovating towards sustainability. In particular, the analyses provide new insights into the configuration of organizational routines that enable firms to reconfigure the development process of their innovations for sustainability. The paper supports the assumption that companies need to do things differently to be able to innovate for sustainability. Our study also provides guidance concerning the most appropriate and important organizational routines for innovating towards sustainability. Such insights may translate into the firms' business and innovation strategies to facilitate the development process of sustainable innovation.

The study has some limitations which can provide opportunities for further research. First and the most important, our data is a cross-sectional data; however, capabilities are a dynamic phenomenon, and sustainable innovation is a long-term process. For further research, it should be investigated through longitudinal data. Second and related to the first, cross-sectional data have been used to derive causation, but they are restricted to one point in time. Even though this approach is quite common among academic studies and the majority of the studies of innovation in organizations are cross-sectional (Damanpour et al., 2009). We suggest overcoming this problem by using panel data. Finally, as the analysis is conducted using data from a sample of German companies, the generalizability of the present research may be limited. Future research could, for example, use CIS data from other European countries in a cross-national comparative study. Apart from these limitations, the study provides valuable new insights into firms' sustainable innovation activities and the organizational and managerial capabilities through which they shape performance.

Appendix

Table 3.A1 IPMA results

Capabilities	First-order constructs	Indicators (Routines)	Importance (Total effects)	Performance (Index values)
Sensing (A) Importance: **0.968** Performance: 37.20	**Internal Sources (A1)** Importance: **0.395** Performance: 38.09	1- Sources within the company or enterprise group	0.305	**83.54**
		2- Having procedures in place to regularly identify the company's environmental impacts	**0.695**	**22.63**
	Market sources (A2) Importance: 0.160 Performance: **57.26**	1- Clients or customers	0.334	**78.45**
		2- Suppliers of equipment, materials, components, or software	**0.346**	49.22
		3- Competitors or other enterprises in the sector	0.320	56.59
	Institutional sources (A3) Importance: 0.131 Performance: 27.11	1- Universities or other higher education institutions	0.254	**35.84**
		2- Government research institutes	**0.292**	23.81
		3- Consultants, commercial labs, or private R&D institutes	0.192	26.83
		4- Professional and industry associations	0.262	30.69
	Public sources (A4) Importance: 0.294 Performance: 34.19	1- Conferences, trade fairs, exhibitions	0.224	**51.48**
		2- Scientific journals and trade/technical publications	0.226	48.07
		3- Patent specifications	**0.301**	24.35

Continued

Continued

		4- Standards and standardization boards/documents	0.249	28.49
Seizing (B) Importance: 0.292 Performance:**40.45**	**Internal capabilities (B1)** Importance: **0.351** Performance: **62.23**	1- In-house research and experimental development (internal R&D)	0.440	**71.21**
		2- Professional development measures for innovation projects (Employee Training)	**0.560**	63.08
	Adoption of the best practices (B2) Importance: 0.348 Performance: 48.27	1- Acquisition of machinery, facilities, and software to realize innovation projects	**0.534**	**69.51**
		2- Acquisition of other external knowledge	0.466	31.01
	Market introduction of innovations (B3) Importance: -0.074 Performance: 56.16	1- Market launch of innovations- marketing activities, including market research, directly related to innovation projects	**0.525**	52.97
		2- Preparations for the introduction of product or process innovations, such as design, prototype manufacture	0.475	**66.81**
	Cooperation with market partners (B4) Importance: 0.220 Performance: 11.85	1- Cooperation with other companies within the enterprise group	**0.282**	14.08
		2- Cooperation with clients or customers	0.245	**19.72**
		3- Cooperation with suppliers of equipment, materials, components, or software	0.260	13.39
		4- Cooperation with competitors or other enterprises in the sector	0.213	03.33
	Cooperation with knowledge partners (B5) Importance: 0.155 Performance: 17.60	1- Cooperation with universities or other higher education institutions	0.226	24.74
		2- Cooperation with government research institutes	0.260	11.16
		3- Cooperation with consultants, commercial labs, or private R&D institutes	**0.273**	09.66

Continued

Continued

		4- Awarding of R&D contracts to third parties (R&D outsourcing)	0.240	**32.49**
Reconfiguring (C) Importance: 0.242 Performance: 32.14	**New marketing methods and strategies (C1)** Importance: 0.134 Performance: 29.27	1- New media or techniques for product promotion, introduction of brands	0.328	31.75
		2- New methods for product placement or sales channels (incl. new ways to present products and services)	**0.337**	**35.32**
		3- New methods of pricing goods and services	0.335	25.37
	New management practices (C2) Importance: **0.589** Performance: **36.52**	1- New business practices for organizing procedures (i.e., supply chain management, knowledge management, etc.)	**0.343**	**46.51**
		2- New methods of organizing work responsibilities and decision making (i.e., teamwork, decentralization, etc.)	0.322	40.30
		3- New methods of organizing external relations with other firms or public institutions (i.e., first use of alliances, partnerships, outsourcing, etc.)	0.335	27.44
	New manufacturing-related processes (C3) Importance: 0.286 Performance: 23.45	1- New development or significant improvement of process technology- (scale range: 0–3)	0.250	**42.55**
		2- Source inputs, allocate supplies within the firm, deliver products (supply chain processes)- (dummy)	**0.750**	34.73

Note: All total effects (importance) larger than 0.10 are significant at the $\alpha \leq 0.10$ level. The bold values indicate the highest total effect and highest performance value of the indicators (organizational routines) per upper-level constructs.

Table 3.A2 The results of permutation test for groups of environmental turbulence

Constructs	Original Correlation	Correlation Permutation Mean	5.0%	Permutation p-Values	Compositional invariance?
Internal Sources	0.999	0.992	0.969	0.719	Yes
Market Sources	0.999	0.999	0.996	0.588	Yes
Institutional Sources	1.000	0.999	0.998	0.779	Yes
Public Sources	0.999	0.999	0.998	0.219	Yes
Internal Capabilities	0.998	0.991	0.964	0.692	Yes
Adoption of the Best Practices	1.000	0.998	0.994	0.976	Yes
Market Introduction Activities	1.000	0.980	0.991	0.817	Yes
Cooperation with Market Partners	0.999	0.998	0.995	0.472	Yes
Cooperation with Knowledge Partners	0.995	0.997	0.992	0.138	Yes
New Marketing Method and Strategy	1.000	0.998	0.993	0.952	Yes
New Management Practices	0.998	0.999	0.998	0.054	Yes
New Manufacturing-Related Processes	0.974	0.990	0.960	0.124	Yes
Sensing	0.989	0.985	0.963	0.588	Yes
Seizing	0.939	0.926	0.833	0.535	Yes
Reconfiguring	0.982	0.978	0.941	0.449	Yes
Innovation towards a Greater Degree of Sustainability	1.000	1.000	0.999	0.626	Yes

Table 3.A3 The results of permutation test for groups of firms' strategic sustainability behaviors

Constructs	Original Correlation	Correlation Permutation Mean	5.0%	Permutation p-Values	Compositional invariance?
Internal Sources	0.998	0.976	0.902	0.754	Yes
Market Sources	0.998	0.997	0.990	0.564	Yes
Institutional Sources	1.000	0.999	0.996	0.809	Yes
Public Sources	0.999	0.998	0.995	0.461	Yes
Internal Capabilities	0.928	0.972	0.893	0.101	Yes
Adoption of the Best Practices	0.965	0.990	0.962	0.062	Yes
Market Introduction Activities	0.997	0.861	-0.984	0.404	Yes
Cooperation with Market Partners	0.999	0.970	0.947	0.946	Yes
Cooperation with Knowledge Partners	0.993	0.964	0.932	0.632	Yes
New Marketing Method and Strategy	0.993	0.993	0.976	0.367	Yes
New Management Practices	0.999	0.998	0.995	0.616	Yes
New Manufacturing-Related Processes	0.938	0.976	0.907	0.116	Yes
Sensing	0.969	0.961	0.908	0.505	Yes
Seizing	0.799	0.839	0.634	0.283	Yes
Reconfiguring	0.964	0.952	0.875	0.518	Yes
Innovation towards a Greater Degree of Sustainability	1.000	0.999	0.997	0.998	Yes

Chapter 4
Firms' Capabilities for Sustainable Innovation: The Case of Biofuel for Aviation[3]

Abstract

Innovation is one of the increasingly important means by which companies can contribute to sustainable development. The shift of focus in business from competitiveness alone, to the combination of sustainability and competitiveness impacts firms' capabilities for innovation. This process study aims to investigate what the organizational and managerial capabilities through which companies can innovate for sustainability are, referred to as dynamic capabilities for sustainable innovation. We address this question through a retrospective longitudinal case study of the attempts of the KLM Royal Dutch Airlines (KLM), which uses its influential position in the value chain to stimulate production and use of biofuel for aviation. The study identifies critical organizational and managerial capabilities that are forming the basis of the successful realignment of a firm's dynamic capabilities with its sustainable innovation strategies. We explain how these capabilities are built and strengthened for sustainable innovation and how these capabilities function throughout the development process of sustainable innovation. This study aims to contribute to a further theoretical and practical understanding of how capabilities are deployed by firms to create and implement sustainable innovation.

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[3] This chapter is based on Mousavi, S. and Bossink, B. A. G. (2017) Firms' capabilities for sustainable innovation: The case of biofuel for aviation. ***Journal of Cleaner Production.*** Volume 167, 2017, Pages 1263-1275.

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1. Introduction

Many studies point to company resources and capabilities as key factors influencing sustainable innovation activities of firms (Dangelico, 2016; van Kleef & Roome, 2007). A resource can be defined as an "input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis" (Helfat & Peteraf, 2003: 999). A capability refers to the capacity of an organization to deploy resources for the purpose of achieving a particular end result (Amit & Schoemaker, 1993). Eisenhardt and Martin (2000) argue that in addition to the resources themselves, firms need strategic capabilities to manipulate resources into value-creating strategies. Thus, capabilities refer to strategic "know-how" with the potential for influencing future action. Sustainable innovation usually involves a departure from the present knowledge base and can be seen as "competency-destroying" (Hall & Vredenburg, 2003). This competency-destroying innovation needs capabilities that challenge existing practices to generate new products and processes (Larson, 2000). Put differently, the shift of focus in business from competitiveness alone, to the combination of sustainability and competitiveness impacts firms' capabilities for innovation (van Kleef & Roome, 2007).

Acknowledging that sustainability issues are generally beyond the core activities of most firms, the companies' challenge is how to recreate new managerial and organizational capabilities for innovating towards sustainability. These capabilities help companies to identify, enhance, and exploit key resources and competencies for innovating towards sustainability (Dangelico et al., 2013). This recreation of managerial and organizational capabilities is often referred to as dynamic capabilities for innovation (Eisenhardt & Martin, 2000; Teece et al., 1997). For example, Iles and Martin (2013) argue that companies are most able to bring new technologies and products for sustainability to market effectively when they develop and mobilize their dynamic capabilities around sustainability. They contend that dynamic capabilities of companies should focus not only on achieving competitive advantage but also on driving, and creating accountability for sustainability within and outside of the organizations' boundaries. An understanding of these capabilities is a major step in being able to manage better and enhance the development process of sustainable innovations. Furthermore, extant literature does not sufficiently incorporate different perspectives on the phenomenon to improve our understanding of the innovation management practices toward sustainability. The previous studies have mostly concentrated on capturing the dynamic nature of innovation for sustainability and the specific role of different resources - internal or external - in its development (e.g., De Marchi, 2012; Kammerer, 2009; Ketata et al., 2015; Larson, 2000).

In light of this research gap, this paper adopts the dynamic capabilities approach to provide new insights into firms' sustainable innovation activities. Dynamic capabilities are a set of strategic activities aimed at enabling companies to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape, rapidly changing business environments (Teece et al., 1997). The dynamic capabilities approach explicitly focuses on how firms perform innovation activities and reconfigure their resources/competencies in pursuit of improved effectiveness (Helfat et al., 2007). This perspective can provide a useful theoretical lens for advancing our knowledge of management practices for sustainable innovation. Furthermore, as sustainable innovation represents a high degree of change and uncertainty, Dangelico (2016) argues that a dynamic capabilities approach could be an apropos perspective to study dynamic environments like environments in which sustainability is pursued.

We deploy a process research method (Langley, 1999) to investigate what the organizational and managerial capabilities through which firms can innovate for sustainability are. We address this question through a retrospective longitudinal case study of the attempts of the KLM Royal

Dutch Airlines (KLM), which uses its influential position in the value chain to support the creation of a market for biofuels in the aviation industry. The KLM case illustrates how a company as a "lead firm" can use its "smart power" (cf. Williamson & De Meyer, 2012) to initiate and stimulate a change in the value chain it is part of.

The aimed contributions of this paper are as follows. First, we provide conceptual insights regarding the organizational and managerial capabilities through which firms can innovate for sustainability. As well, we contribute toward emerging theory on dynamic capabilities, focusing on identifying the components of dynamic capabilities relevant to managing innovation for sustainability. Secondly, this study leads us to improve our practical understanding of how resources and competencies are deployed, and sustainability value is created by firms through innovation.

2. Theoretical Background

2.1. The specifics of sustainable innovation

Bossink (2013: 1) defines sustainable innovation as the development of new initiatives at the firm "to sustain, improve and renew the environmental, social and societal quality of its business processes and the products and services these business processes produce". Sustainable innovation is an innovation towards more sustainable technologies and processes, in which processes are systematic, dynamic, non-linear and involving significant uncertainties (Foxon & Pearson, 2008). This is due to the involvement of a heterogeneous set of stakeholders with different preferences, and competition in sustainable innovation that complicates this innovation (Alkemade & Suurs, 2012).

As innovation management scholars have made the distinction between incremental and radical innovation, firms can also develop sustainable innovation through incremental changes or through more radical, disruptive changes (Carrillo-Hermosilla et al., 2010). Incremental changes are regular and continuous competence-enhancing modifications that preserve current production systems and sustain the existing networks to create added value in the current system. In contrast, radical changes refer to competence-destroying, discontinuous changes that seek the replacement of existing components or entire systems to create new networks and added value. Adams et al. (2012) call these different approaches respectively 'operational optimization' and 'system building.' In an operational optimization approach, firm innovation is mostly reactive. Reactive innovation includes responses to external stimuli, for example, environmental regulations. This innovation behavior cannot be expected to be going beyond incremental innovation (Klewitz & Hansen, 2014). In the system building approach, firm innovation is proactive, and the goal of innovation is to transform the market. In this approach, firms catalyze systems changes (Adams et al., 2012; Klewitz & Hansen, 2014).

The traditional distinction between radical and incremental innovation can also be related to sustainability consequences (Carrillo-Hermosilla et al., 2010; Hall, 2002). It is increasingly acknowledged that incremental innovation does not suffice for achieving sustainability goals (Hall, 2002). The innovation required for sustainable development often needs to move beyond incremental adjustments (Hall & Vredenburg, 2003; Hall & Wagner, 2012). Put differently, a focus on radical change or even system-level change is needed for sustainable innovation (Carrillo-Hermosilla et al., 2010). More system-level changes embody higher potential benefits than simple modifications in processes and products (e.g., Carrillo-Hermosilla et al., 2010).

Sustainability is a complex and multi-dimensional concept that cannot be addressed by a single corporate action. A common argument is that sustainable innovation needs coordination and cooperation in the innovation process. Bossink (2013) contends that sustainability must be pursued in a complex system of interrelated elements of business, society, and ecology;

it is important to understand these elements, the interaction between them and the behavior of different elements. Hence, it is increasingly acknowledged that a transformative restructuring of socio-technical systems is needed to achieve sustainability; i.e., system innovation (Geels et al., 2008). System innovation includes not only product and process innovation but also an innovation of user practices, market dynamics, national policies, regulations and cultures, institutional infrastructures, and management of firms. Accordingly, companies have shifted their sustainable innovation strategies towards system innovation, which emphasize the development of radical innovations (Jepsen et al., 2014). While the focus of system innovation is on system-level changes, the issue of how firms can contribute significantly to bringing about these system-level changes, and what the role is of individual firms, has received too little attention (Boons et al., 2013). Accordingly, sustainable innovation can be defined as the discovery and exploitation of economic opportunities that originate from market disequilibria, which initiate the transition of a system towards an increased environmentally and socially sustainable state (cf. Hockerts & Wüstenhagen, 2010). Adopting a corporate perspective, this study investigates what the organizational and managerial capabilities through which a company can innovate for sustainability are.

2.2. Dynamic capabilities

To get a better theoretical and empirical understanding of innovation management practices for sustainability, the present study adopts the dynamic capabilities approach (Teece et al., 1997). It is an extension of the resource-based view (RBV) of the firm, which aims to explain how firms develop and maintain their resources and competencies to adapt to changes in their business environment. Furthermore, dynamic capabilities allow companies to shape the ecosystem around their business and develop new products and processes in response to the threats and opportunities in the marketplace (Teece, 2007). Helfat et al. (2007: 4) define dynamic capabilities as “the capacity of an organization to purposefully create, extend or modify its resource base.” To understand how firms identify or respond to the need or opportunity for change, we aim to explore the managerial and organizational processes that underpin and enable the deployment of dynamic capabilities (Helfat et al., 2007; Teece et al., 1997).

A growing discourse in the literature suggests that innovation is the solution for improving the sustainability performance of firms (e.g., Porter & van der Linde, 1995). Integration of the sustainability concept into the innovation approach has significant implications for a firm’s resources and competencies (Hall & Vredenburg, 2003). Accordingly, firms should fundamentally reconsider their resources and competences to innovate for sustainability. This reconsideration can be conceptualized as a shift from ‘business-as-usual’ to ‘doing things differently’ (Nidumolu et al., 2009). While doing things differently, firms need to review their established routines and practices to ask whether their existing models for handling sustainable innovation are sufficient. Maybe they are forced to abandon existing ones or develop new routines and practices (Seebode et al., 2012). Therefore, firms should reconsider their core activities. One common theme of dynamic capabilities with the nature of innovation is that dynamic capabilities are associated with changes (Eisenhardt & Martin, 2000). This implies that the dynamic capabilities approach can play a key role as a theoretical foundation for understanding what the organizational and managerial capabilities through which firms innovate for sustainability are.

Dynamic capabilities involve the effective orchestration of a cluster of activities directed toward achieving something that is strategically imperative (Feiler & Teece, 2014). Teece (2007) has categorized dynamic capabilities into three clusters of activities and adjustments: (1) sensing: identification and assessment of an opportunity; (2) seizing: mobilization of resources to address an opportunity and to capture value from doing so; and

(3) reconfiguring: continued renewal of resources. For analysis of the empirical data, we adopt the threefold classification of dynamic capabilities proposed by Teece (2007) as a theoretical foundation for our study. It explicitly introduces a bundle of 'microfoundations' for each category of dynamic capabilities. 'Microfoundations' are defined by Teece (2007: 1319) as "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines" that form the organizational basis of dynamic capabilities. The concept of dynamic capabilities is operationalized by microfoundations.

2.2.1. Sensing

Sensing is an inherently entrepreneurial set of dynamic capabilities that involves gathering knowledge about the external and internal environment and making decisions about the firm's strategic direction (Teece, 2007). According to Feiler and Teece (2014), sensing involves gaining knowledge about competitors, exploring technological opportunities, probing markets, listening to customers or suppliers, along with scanning and exploring other elements of the business ecosystem (partners, joint ventures, government regulators, etc.). This capability helps firms to identify the future development paths in the sector (Lieberherr & Truffer, 2014); it requires the organization to observe best practices in the industry (Wilden et al., 2013). Thus, a strong sensing capability helps firms to avoid lock-in effects and competency traps (Helfat et al., 2007). Strong sensing capability also meets the scarcity challenge of internal resources because it facilitates the identification of opportunities for external knowledge acquisition (Katila & Ahuja, 2002).

2.2.2. Seizing

Once opportunities are detected and assessed, the seizing capability helps firms to translate the opportunities into a promising product or process innovation by implementing and investing in new technologies or adopting alternative approaches (Lieberherr & Truffer, 2014). Seizing involves mobilizing and inspiring the organization to develop organizational and ecosystem readiness to capture the knowledge and use it to commercial ends (Feiler & Teece, 2014). As the role of complementary assets and co-specialization has been emphasized in the innovation process, companies need to recognize strategic partners and collaborate with them (Teece, 2007). To seizing capabilities, it is not enough to invest in technology and complementary assets. A business model must also exist that is capable of sustaining and exploiting new opportunities as they present themselves (Chesbrough, 2010; Teece, 2010). Bocken et al. (2014b) argue that business models are important in driving and implementing corporate innovation for sustainability. The business models can help to incorporate sustainability into business purposes and processes and serve as a key enabler of competitive advantage. In sum, developing a business case for the sensed opportunity, communicating it, aligning stakeholders, raising capital, planning to execute the strategy, and doing organizational or business model innovation, are core microfoundations of seizing capabilities (Feiler & Teece, 2014).

2.2.3. Reconfiguring

According to Teece (2010), resources/competencies should be aligned and realigned to match the opportunities and requirements of the business environment; i.e., to achieve strategic fit. Henderson and Clark (1990) argue that innovation for sustainability needs shifting to new architectures, routines, and modification – or even abandonment – of existing ones. Thus, there would be a mandate to completely revamp the organization and create an entirely new break out structure, within which new, different sets of practices and procedures are established (Teece, 2000). Reconfiguring capabilities may involve embracing open innovation routines such as mergers, acquisitions, or joint ventures for appropriation and sharing of capabilities (Teece, 2007). Firms also need a meta-competence for managing integration and coordination of the co-specialized assets between, and amongst firms and other institutions within the business ecosystem; i.e., asset orchestration (Teece, 2007).

3. Research Methods

We conducted a retrospective longitudinal case study as the empirical research strategy of our qualitative approach to developing initial theoretical insights into firms' capabilities for sustainable innovation. A qualitative approach is appropriate for the following reason. Our research question - *what are the organizational and managerial capabilities through which firms can innovate for sustainability?* - is a phenomenon driven research question (Eisenhardt & Graebner, 2007). The use of qualitative procedures helps to explore key events and practices, as well as the logic behind them; i.e., to describe the phenomenon. Thus, our empirical research strategy aims at a detailed understanding of processes, which can be found in qualitative data sources (Langley, 1999). Using the dynamic capabilities approach as a theoretical lens of the study, a process study is performed; i.e., a study of the temporal order and sequence of change events based on a story or narrative (Van de Ven, 2007: 196). Process studies address questions of why and how situations emerge and develop over time; thus, they focus empirically on evolving phenomena to explain and understand it (Langley et al., 2013). As a process study is adopted to answer the research question of our study, it is of particular importance to conduct the study in the context of longitudinal research to unravel the underlying dynamics of the phenomenon. Thus, we employed a single case study as the research strategy of our study. This empirical strategy focuses on deep and thorough understanding the dynamics present within a single setting (Eisenhardt, 1989).

Our case study focused on a sustainable innovation in the context of system building (system innovation): the KLM Biofuel Program. This empirical setting enables an explanation and understanding of why and how a firm can initiate and build a system for sustainable innovation, and how to play an active role in stimulating and shaping the system. Therefore, this case can provide rich empirical data on the phenomenon we are studying (cf. Siggelkow, 2007); i.e., radical and system innovation around a sustainability opportunity. Accordingly, the case company was selected as a critical case. This single case study helps us to elaborate and sharpen an existing theory; i.e., the dynamic capabilities approach, to the context of innovation for sustainability. Table 4.1 provides an overview of strategies that have been used to ensure rigor within this choice and approach.

3.1. KLM vignette

KLM is a leading air transportation company and its core business is the transportation of passengers and cargo and providing aviation maintenance services. Sustainability has been integrated into the core of KLM's business strategy. KLM has set long-term sustainability objectives. With its "Climate Action Plan," the company works on a 20 percent reduction in CO_2 emissions per passenger by 2020. To achieve this target, KLM invests in new and more fuel-efficient aircraft, lightweight materials, onboard flight optimization, and the use of sustainable biofuels. In 2015, Air France-KLM occupied the position as the most sustainable airline in the Dow Jones Sustainability Index for the 11th consecutive time.

Table 4.1 An overview of adopted strategies for ensuring rigor of the study

External validity (research design)	**Reliability (data collection)**	**Construct validity (data collection)**	**Internal validity (data analysis)**
The dynamic capabilities approach is used as a theoretical lens of the case study.	A case study protocol is developed to specify how the entire case study searched for data from interviews and archival sources.	Multiple sources of evidence, including 12 expert interviews and 210 archival sources are used during data collection; i.e., data triangulation.	The research framework of the case study is derived from the literature (Dynamic capabilities theory) to guide data gathering and analysis.
In view of the research question and research design (process research theory), a rich longitudinal case study research approach is used.	A case study database is built, which includes all available archival data and interview transcripts. It is used to develop a chain of evidence.	The case report is reviewed by the key informant of the case and by two senior researchers; i.e., researcher triangulation.	The data analysis procedure (coding procedures and use of coding software) is explained to show how the case study went from the raw data to final case analysis.
A critical case is selected to elaborate the dynamic capabilities approach to the context of innovations for sustainability.			The empirical findings of the case study have been compared with previous studies to provide an insight into the merits and limitations of the research outcomes.
The details of the empirical setting; i.e., the case study context, were recorded in a case study database.			

3.2. Data collection

We relied on both primary and secondary sources of data, including semi-structured interviews and archival data. Before data collection, a case study protocol was developed to specify how the entire case study, would be conducted. The case study protocol consisted of an introduction to the case study, the theoretical framework of the study, the interview process and questions, a strategy for obtaining archival data, and a concept outline of the case study report. The case study protocol was used as a guide in carrying out data collection (Yin, 2009).

Data collection started with interviews with key informants. Our source to identify key informants was the Environmental Manager at KLM, who has a coordinating role in this program, particularly for sustainability issues. The interview questions intended to explore why and how KLM has initiated the innovation project. We wanted to identify a sequence of action/interaction that occurred during the implementation of KLM's sustainable innovation project. Twelve semi-structured interviews lasting 60 minutes on average were conducted with all of the key informants: six employees from KLM, two employees from SkyNRG, two employees from WWF Netherlands (WNF), and one policymaker at the Ministry of Infrastructure and the Environment (Dutch government). SkyNRG is a joint venture co-founded by KLM and other partners and aims to be the global market maker for sustainable jet fuel. WNF is the Dutch part of the international conservation organization WWF (World Wide Fund for Nature). Due to the coordinating role of the Environmental Manager at KLM, he was interviewed twice and consulted on an ad-hoc basis several times during the interview trajectory. All interviews took place from January 2015 up until the end of August 2015. All interviews were fully transcribed in, and coded and analyzed in a case study database, using ATLAS.ti software.

Our sources for archival data included ten annual and CSR reports of the company, five technical publications, two marketing brochures on sustainable biofuel for aviation, 33 public interviews, 156 publicly available news publications about the innovation project, and four reports by the Dutch Sustainable Growth Coalition (in total 210 sources). By means of triangulation of data from multiple sources, and the combination of interview data and archival data, we reach a thorough understanding of the research phenomenon, and mitigate possible retrospective bias in the interviews with the key informants. We used ATLAS.ti software to compile all gathered data into a case study database, and to code and analyze the data (Yin, 2009).

3.3. Data analysis

As the first step in our analysis, a first overview of the case was created by means of constructing a chronological overview of events (Langley, 1999). Table 4.2 provides this chronological sequence of events in the KLM Biofuel Program. Within this chronological structure, we used an inductive approach to the analysis of the data. We progressed from empirical details expressed in the interviews and in the archival sources towards a structure of coded data that could be compared, categorized, discussed and analyzed in terms of the chosen theoretical approach (dynamic capabilities) (Langley, 1999). More specifically, in the coding process, we followed the Gioia methodology (cf. Gioia et al., 2012). As the first-order analysis, we coded the data by in vivo terms or informant terms. The aim was to adhere faithfully to informant concepts. The first-order concepts, presented in Figure 4.1, are labeled by Strauss and Corbin (1990) as open coding.

Table 4.2 Sequence of events in the biofuel program

Time	Event History
1995	KLM developed KLM's group strategy on sustainability.
1996	Environmental Management System was implemented in the company to get a better understanding of environmental issues of the company.
2002-2007	KLM developed "Climate Action Plan" including biofuel program strategy. The environmental manager said that the climate issue is one of the main topics of KLM's sustainability strategy.
2007-2009	KLM engaged with the Worldwide Fund for Nature in the Netherlands (WNF) to develop and maintain its climate strategy and biofuel program strategy.
2008	KLM joined the Sustainable Aviation Fuel Users Group (SAFUG) as a member to focus on accelerating the development and commercialization of sustainable aviation biofuels.
2009	KLM conducted the first demonstration flight ever with passengers on board using a blended mixture of 50 percent biofuel to power one of the airplane's four engines. It shows the technical feasibility of using alternative fuels for jets.
2010	KLM co-founded a joint venture, SkyNRG, to give the production and availability of biofuels a powerful impulse through actively developing a sustainable production chain for sustainable biofuels.
2011	KLM and WNF renewed their strategic partnership for another 4 years. As part of the agreement, KLM aimed to use an average of 1% sustainable biofuels in its fleet by 2015. This was an aspirational target as no commercial market did not exist for the biofuels and prices needed to come down substantially.
2011	KLM closed a so-called Green Deal on biofuels with the Dutch government to further promote the use of sustainable biofuels for the airline industry.
Late 2011	KLM started the first commercial flight; a series of 100 biofuel-powered flights from Amsterdam to Paris. It was followed by a series of another 100 flights in February 2012.
June 2012	KLM conducted the longest biofuel flight ever, to Rio de Janeiro.
June 2012	KLM launched the KLM Corporate Biofuel Program, which enables companies to achieve environmental goals and accelerating the further development of sustainable biofuel supply chain.
2012	SkyNRG joined the ITAKA (Initiative Towards Sustainable Kerosene for Aviation) project as a partner. This project is the first of its kind collaborative project in the EU-funded by the European Commission, which aims to develop a full value-chain in Europe to produce sustainable aviation fuels.
March 2013	SkyNRG' s commitment to the sustainability of biofuels for aviation was rewarded by the Round Table on Sustainable Biomaterials (RSB), making SkyNRG the first jet-fuel operator worldwide to deliver RSB-certified sustainable biofuel into the wing at any airport in the world.
March 2013	KLM conducted the first flight from Amsterdam to New York partly powered on sustainable biofuel supplied by SkyNRG, which recently obtained RSB Certification.
November 2013	SkyNRG and KLM signed a Letter of Intent with the Dutch Government, Neste Oil, Amsterdam Airport Schiphol, and the Port of Rotterdam to scale up production of sustainable biofuels in the Netherlands. These supply-chain partners will work together in the Holland BioPort project.
May 2014	KLM launched a new series of sustainable biofuel-powered flights between Amsterdam and Aruba and Bonaire as part of ITAKA project. This is yet another important step towards demonstrating that more sustainable aviation is possible.
March 2016	KLM operated a new a series of 80 biofuel flights from Oslo to Amsterdam. The biofuel for these series of flights was produced within the ITAKA project and supplied by SkyNRG.

During the second-order analysis, we moved on to axial coding (Strauss & Corbin, 1990), a practice of data reduction into a theoretical level of themes, guided by the theoretical framework. We started seeking for similarities and linkages among the first-order concepts to develop second-order themes, shown in the middle of Figure 4.1. This coding stage is sensitized by the dynamic capabilities concept (cf. Glaser, 2005). During this stage, the analysis becomes more explicitly theory-driven, as it focuses on nascent concepts for discovering the theoretical contribution contained in the empirical results. The next step is the distillation of the second-order themes into aggregate dimensions; i.e., theoretical coding. This step involves assessing the semantic relationships among the second-order themes. Put differently, the second-order themes were coded and aggregated according to whether they support sensing, seizing, or reconfiguring. The data structure in Figure 4.1 demonstrates the outcome of this data structuration process.

Analyzing the Biofuel Program helps to explore a sequence of action/interaction that occurred from the start of the Biofuel Program until April 2016. The study focuses on an analysis at the organization-level, with a particular emphasis on the innovation processes in the project. It tries to provide a complete as possible rendering of the story of the sustainable innovation project with rich qualitative data (Eisenhardt & Graebner, 2007).

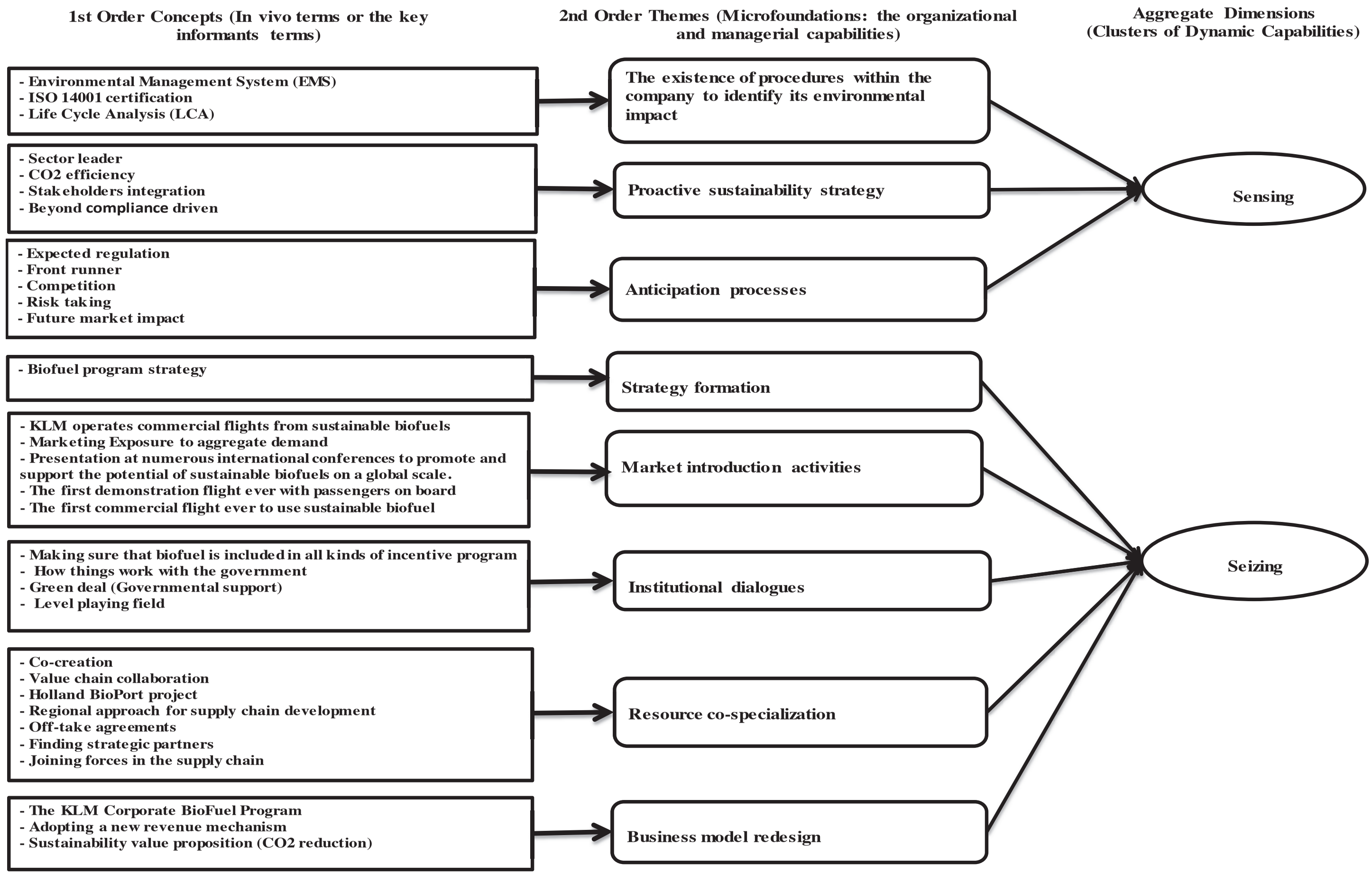

Figure 4.1 Final data structure after third coding round

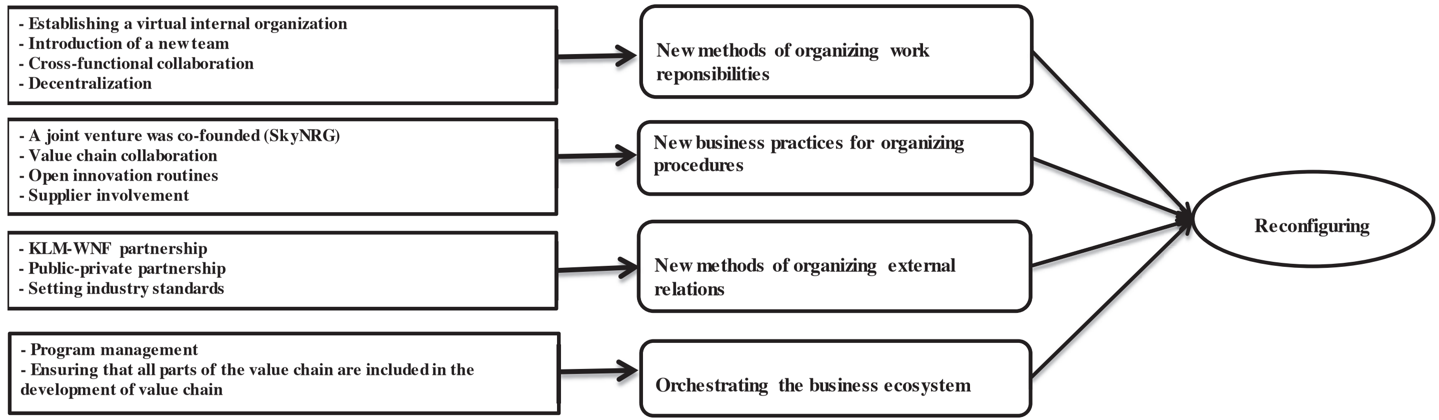

Figure 4.1 Final data structure after third coding round (continued)

Table 4.3 Representative quotes, events, and archival data underlying second-order themes

Sensing: Dimension 1	
The existence of procedures within the company to identify its environmental impact	"The Dutch airline KLM believes itself to have been the first airline to achieve ISO 14001 certification of its environmental management system, leading to measures that have reduced noise, in-flight water consumption, and use of toxic dry cleaning chemicals, led to 40% cabin paper recycling, improved wastewater quality, and saved 1,6 million kilograms of fuel last year." (Archival data)
	"In 1996, the implementation of the environmental management system broadens the focus of the company to include not only compliance with the law but also a proactive improvement of environmental performance." (An employee from KLM)
Proactive sustainability strategy	"Increasing pressure from environmental groups, and the importance of maintaining the support of decision-makers and the public to ensure the growth of the airline industry in the Netherlands convinced the KLM Board that a systematic and pro-active approach was essential." (Archival data)
	"Nowadays, we have an integrated sustainability strategy which gives us the tools and possibilities to be proactive on energy topics and every long-term perspective within this scope. When you are proactive, you can better adapt to changes and things that are getting relevant in coming years. That's what our strategy is based on. It helps us to make the right choices and prepare better than when we are not doing this way and in developing a long-term strategy". (An employee from KLM)
Anticipation processes	"KLM wants to retain its 'best in class' for CO_2 and fuel efficiency. To do this, KLM's ambition is to achieve 20% CO_2 and fuel efficiency for each tone transported/kilometer in 2020 in comparison with 2011." (Archival data)
	"KLM is a frontrunner in the development and use of sustainable biofuel to reduce its CO_2 emissions in the aviation industry." (An employee from WNF)
Seizing: Dimension 2	
Strategy formation	"KLM has developed its strategy for sustainable biofuels around a value chain perspective by simultaneously creating demand and developing supply chains." (Archival data)
	"In 2007, KLM engaged with WNF as a partner. WNF is mainly on the sustainability part. As a part of the partnership on CO_2 reduction, WNF was the supporter of KLM's strategy in the field of sustainable biofuels." (An employee from WNF)
Market introduction activities	"KLM has spoken at numerous international conferences to promote and support the potential of sustainable biofuels on a global scale." (Archival data)
	"The first part of the strategy is to engage the industry, incentivizing the government or make government incentivizing

Continued

Continued

	this new development. Thus, demonstration flight was really the first things that we could do for stimulating the supply chain. (An employee from KLM)
Institutional dialogues	"KLM also supports regulatory incentives stimulating the biofuel market. KLM has been participating in European Commission Biofuel FlightPath 2020. The FlighPath aims to reach an annual production of 2 million tons of sustainably produced biofuel for aviation by 2020." (Archival data)
	"My actions were twofold; making sure that biofuel was included in all kinds of incentive programs. If you are not in the incentive program, you cannot apply. My role was to get biofuels on the incentive program. That's the most important one; making sure that the topic is included in the list of potential projects that can get funding." (An employee from KLM)
Resource co- specialization	"SkyNRG has introduced various measures and established important joint partnerships to guarantee and control the sustainability of the supply chain. By joining forces in the supply chain and by involving all relevant stakeholders, SkyNRG is able to understand and act upon the integrated environmental and socioeconomic consequences associated with the development of the biofuel industry." (Archival data)
	"What we have done is to find strategic partners as much as we could do in order to help us or help the market to increase the supply. Thus, we have joined a lot of European projects and consortiums. Also, we have done a lot of marketing actually around our biofuels ambition." (An employee from KLM)
Business model redesign	"If we truly want to compete with fossil fuel, we need to perform even better to create the market for sustainable biofuel. Cooperation between the different stakeholders and the important commitment of corporate clients has stimulated demand and helped to bring down the price of sustainable biofuel significantly." (Archival data)
	KLM Corporate BioFuel Program helps us to compensate the additional cost of using biofuels in our flights. In this program, we have corporate biofuels partners. They pay money to fly on biofuels and we enable them to do that. Of course, the whole sourcing and the venture of SkyNRG cause a lot of money, and that's our own investment. However, the principle is that the use of biofuels itself should affordable by this customer program. (An employee from KLM)
Reconfiguring: Dimension 3	
New methods of organizing work responsibilities	"We believed that the development of biofuels was important and that we couldn't organize it within the boundaries of KLM. It was beyond the business model of KLM. Therefore we decided to come up with a new venture." (Archival data)

Continued

Continued

	"There are three big pillars where our biofuel strategy is running on. The first pillar is sustainability issues. That's my main focus in the Environment Strategy Department. The other one is supply chain pillar where all the supply engagements and technical feasibilities are taking place in the Innovation Department in collaboration with SkyNRG. The third part is demand; to create a market, we should develop the demand a lot. We also engage a lot with Sales Department and the Marketing Department." (An employee from KLM)
New business practices for organizing procedures	"KLM, in the absence of reliable biofuel suppliers to the aviation industry, has co-founded a joint venture, SkyNRG. SkyNRG, an independent entity, helps create a sustainable future for aviation through actively developing a sustainable production chain for alternative aviation fuels." (Archival data)
	"Looking back to the time that we started the Biofuel Program, we find that we didn't have a lot of external partnerships to drive forward innovations. During the Biofuel Program, KLM has involved in open innovation with external parties. Open innovation is actively used to accelerate innovation efforts and stimulate co-creation with third parties." (An employee from KLM)
New methods of organizing external relations	"WNF and KLM look back on a successful partnership which began in 2007 and ended in 2015. A partnership which at first sight was quite as unique; a conservation organization and an airline committed to working together to improve the climate." (Archival data)
	"The partnership of WNF with KLM is unique within the WWF group, and we had to defend this choice. Most other WWF branches would not want this. Others focus on the absolute reductions of CO_2 emissions; we deviated from that view. Our focus is also on innovation." (An employee from WNF)
Orchestrating the business ecosystem	"SkyNRG's mission is to set up an ecosystem of strategic partners to introduce biofuels as an alternative source of energy. From feedstock-to-flight, the supply chain covers elements such as strict selection of sustainable feedstock, refining contracts, distribution to any airport in the world, quality assurance, plane fuel service, insurance, marketing and project (co) funding with airports and end customers." (Archival data)
	"KLM's strategy is based on a value chain approach; i.e., from feedstock to flight. We should not go for technology or feedstock purely. If we do something, we should have projects covering the entire of the value chain." (An employee from KLM)

4. Findings

The study uses Teece's tripartite framework to explore what the organizational and managerial capabilities are through which KLM has restructured and mobilized its resources and competencies for innovating for sustainability. Accordingly, a number of organizational and managerial capabilities for three clusters of activities and adjustments have been found that facilitate and support innovation for sustainability. These organizational and managerial capabilities will be explained separately for the 'sensing,' 'seizing' and 'reconfiguring' activities of dynamic capabilities. Table 4.3 highlights some key first-order data in support of the second-order themes and dimensions; other essential first-order data is part of the case narrative in the following paragraphs.

4.1. Sensing: Recognizing the sustainability opportunity and making a strategic decision

Sensing refers to the firm's activities for scanning and monitoring the operating environments to identify sustainability opportunities and make a strategic decision about them. The study found three organizational and managerial capabilities that helped KLM to recognize the sustainability opportunity of biofuels for aviation, which will be described in the next three subsections.

4.1.1. The existence of procedures within the company to identify its environmental impact

To innovate for sustainability and reduce its negative impact on the environment, the first step for KLM is to increase the awareness about the company's environmental impact. Accordingly, two decades ago, KLM recognized that its strategy had to be based not only on primary economic issues but also on a longer-term sustainability strategy. Beyond compliance with governmental regulations, KLM took one step beyond that and adopted a proactive strategy.

In 1995, the company developed KLM's group strategy on sustainability. A year after that; an Environmental Management System (EMS) was implemented in the company. According to the Environmental Manager at KLM, the EMS helped to recognize that the climate issue is one of the main topics of KLM's sustainability strategy:

> *"The EMS gave a good feeling of where we stand, what the bigger risks are, what the expectation of stakeholders is, and how we manage regulations. Climate was one of the main topics to be addressed."*

Therefore, the existence of an organizational capability within the company to regularly identify and evaluate the company's environmental impacts is helpful and is seen as a necessary step for innovating towards sustainability.

4.1.2. Proactive sustainability strategy

Adopting a proactive sustainability strategy, KLM started to improve its sustainability performance. During 2002-2007, KLM developed a "Climate Action Plan" to reduce its environmental impact. KLM set long-term sustainability objectives. The company aimed to be the most sustainable airline and formulated a long-term vision and ambition for 2020. To achieve this target, a range of initiatives was driven by KLM's sustainability strategy for lowering carbon emissions and to stay best in class with regard to CO_2 efficiency in the aviation industry. One of the most important ways to reduce CO_2 emissions is using biofuel. The Innovation Manager at KLM confirmed this boldly:

> *"At this moment using biofuel is the only option we have to reduce our footprint. If you look at our footprint, 99% of our CO_2 footprint comes from fuel. We expect, in the long-term, aircraft will be produced that can use different types of fuel. However, for now, we have to work with engines that use liquid fuel. Therefore, the only way to reduce our footprint is by using biofuel."*

Accordingly, KLM adopted an integrated, proactive sustainability strategy that is integrated with its business and innovation strategies.

4.1.3. Anticipation processes

We also found that other considerations played a role in making this strategic decision; i.e., the Biofuel Program. For example, anticipating what issues from the general environment may have an impact on the business activities of the firm soon, allows the company to recognize future opportunities for competitive advantage. Therefore, the company focused on seizing the identified opportunities before issues are institutionalized or regulated. KLM wanted to be a frontrunner in the development and use of sustainable biofuel for reducing its CO_2 emissions in the aviation industry According to the Innovation Manager at KLM, expected regulation is another driver of the Biofuel Program. She said:

> *"We saw some regulations about CO_2 footprints in the aviation industry coming. Targets in this area are already emerging in the European Union. The only way to meet these targets is to move into sustainable biofuel."*

Regarding the effects of existing regulation on the Biofuel Program; currently, these are only partly applicable for aviation in Europe. Although the existing regulations are incentivizing the use of biofuel, these regulations do not secure a level playing field in the sector globally.

Reducing KLM's dependency on finite fossil fuels and securing a supply of renewable energy are the other drivers of the Biofuel Program. Also, from an economic point of view, there are a lot of fluctuations in fuel prices that bring volatility to the market. Biofuel seems to be able to bring more stability to the jet fuel market. By ensuring that there is a market for biofuels, new investments can bring stability and predictability to biofuel prices. This is the starting point for KLM to develop its biofuel program strategy during 2007-2009, and take steps further on.

4.2. Seizing: Mobilizing resources to address sustainability opportunities

To capture value from recognized sustainability opportunities as a result of a proactive sustainability strategy, firms need to develop organizational and managerial capabilities related to seizing activities. At KLM these capabilities are strategy formation, market introduction activities, institutional dialogues, resource co-specialization, and business model redesign.

4.2.1. Strategy formation

The challenges of a sustainable innovation process, i.e., complexity and uncertainty, encourage firms to formulate a strategy for the innovation project. Strategy formation concerns the use of simple rules that enable the firm to adapt to a changing environment and to prevent from falling off the edge of chaos. Identifying the sustainability opportunity of biofuels helping KLM to reduce its CO_2 emissions; the company started to translate this opportunity and option into a project by developing a biofuel program strategy and investing in the program. KLM partnered with WNF in 2007 to develop and maintain its climate strategy and biofuels program strategy. At that time, the market for biofuels for aviation was not developed to any extent. Biofuels were not a feasible option; it was, for example, argued that biofuels would freeze at high heights. But KLM stayed on the path it has chosen and developed a biofuel program strategy that consists of four steps: developing the supply chain, supporting governmental incentives, stimulating an industry push, and collaborating with customers and partners. This strategy of tapping the business ecosystem increases the ability of the company to shape the sustainability opportunity of biofuels and mitigate risks.

4.2.2. Market introduction activities

KLM performed some market introduction activities in the Biofuel Program to commercialize the opportunity of biofuels for aviation. Market introduction activities can be a major determinant of sustainable innovation success; these activities stimulate a greater demand in the market to enhance the supply. For instance, as KLM started to source biofuel, the price of biofuel was 20 times higher than fossil fuel prices. KLM found that sustainable biofuels and suppliers thereof are still very scarce.

The real challenge is more towards availability of sustainable feedstock and creating scale. Renewable feedstock has to meet stringent sustainability criteria. Also, all the fuels that are used in aviation should meet the requirements for ASTM certification (American Society for Testing and Materials), which is a technical certification for jet fuel. The biofuels should be safe for engines of expensive airplanes, and these engines should not be damaged by alternative fuels. Accordingly, every new supply chain of aviation biofuel should meet these criteria and standards. Only few technologies will be able to pass this stage. With this knowledge, KLM recognized that the supply chain actors are not interested in sustainable aviation fuels because they expect big challenges and high-level costs. According to the Innovation Manager at KLM, the scarcity of supply for aviation biofuel is also attributed to the lack of market demand in the sector.

To stimulate a greater demand in the market, to strengthen the supply side, and to reduce aviation biofuel prices, KLM took a proactive approach to developing the supply chain and carrying out concrete projects with flights on sustainable biofuels. KLM launched the first biofuel-powered demonstration flight ever with passengers on board in 2009. Doing this, KLM wanted to make the world aware of the importance of sustainable biofuel for aviation, and prove that sustainable aviation is possible. The demonstration flight helped the company to attract partners and cooperate with them in stimulating the demand, leading to a breakthrough for scalable, affordable and sustainable biofuel.

Aggregating and creating a steady demand in the market was another market introduction activity of KLM. As KLM found that no commercial market currently exists for biofuels, and prices need to go down substantially, KLM co-founded a joint venture, SkyNRG in 2010, to aggregate demand for aviation biofuels. SkyNRG, unique in its kind and acting as an independent entity, helps KLM to develop sustainable fuel supply, from growing feedstock to delivery. The independent entity of SkyNRG could be serving as jet fuel supplier for KLM and other airlines to increase the demands by aviation, which would help markets to grow.

4.2.3. Institutional dialogues

To change the system, KLM engaged in institutional dialogues at the national and European level to "change the rules of the game." According to interviewees, aviation can only operate on a level playing field because biofuels are more expensive than fossil fuels and the margins for passengers are extremely thin and price sensitive. Thus, the aviation needs incentives from the government. The level playing field is created with governmental regulation. An employee from WNF noted that:

> *"The problem for commercializing the biofuels for aviation is that the aviation is not included in the Kyoto Protocol. It is problematic that there is no governmental regulation. Only with governmental regulation, aviation can get the level playing field."*

Accordingly, KLM started a lobby towards the government to recast regulation in more stringent terms to crystallize markets for products or services that meet the newly identified environmental needs of customers. In 2011, KLM closed a so-called Green Deal on biofuels with the Dutch Government. According to this deal, KLM aims to further develop into a sustainable aviation firm, including the increased use of sustainable biofuels. KLM is also committed to increasing the awareness and use of sustainable biofuels by other parties in the aviation industry. In return, the government supports the initiative and invests in adapting its regulation and remove barriers. The company also successfully negotiated with authorities to insert biofuel as a topic into the European agenda for grants and funding. As a result, organizations from the entire value chain can apply for grants and funding.

Furthermore, KLM together with WNF promote the Roundtable on Sustainable Biomaterials (RSB) standard as the highest sustainable standard for the production of biofuels for aviation. For KLM, a biofuel is only an option if it does not have a negative impact on biodiversity, local development, and the local food supply. Accordingly, the main bottleneck of biofuels for aviation is the lack of sufficient sustainable feedstock because RSB certified feedstock is not available in a great/steady quantity.

4.2.4. Resource co-specialization

KLM exploited some resource co-specialization activities in the Biofuel Program. Resource co-specialization refers to the synergistic gains that arise from the interaction of different resources within a business ecosystem. This is a co-creation mechanism through which firms create co-development agreements for long-term collaboration. For that reason, KLM looks to find strategic partners in the value chain and collaborates with them to help the market to increase the supply. KLM uses its power in the value chain to lead the building of the business ecosystem around the sustainability opportunity. With regard to this the Innovation Manager at KLM substantiated:

> *"KLM is a logistical company. Our role in the biofuel supply chain is to be the off-taker, situated at the end of the value chain. Thus, when we are on a project or a cooperative setting with other companies or in consortia, we are and remain in the dominant position of the off-*

taker. In many projects, also in European subsidized projects, you need an off-taker at the end of the chain."

Adopting a regional approach to developing the Biofuel Program is another resource co-specialization activity of KLM. The company strives to choose the most sustainable and cost-effective feedstock and technology for that particular region in the world at that moment in time. The regional approach is mainly based on the fact that biofuels have different feedstock.

4.2.5. Business model redesign

On their journey to sustainability, companies need to develop new business models. Business models provide the conceptual link between sustainable innovation and economic value at a system level. Given that, KLM reframed its business model by adopting a new revenue model to commercialize the sustainability opportunity of biofuels for aviation. Currently, at the end of the case study in 2016, biofuels are still three to four times more expensive than regular fuel; i.e., Kerosene. The Biofuel Program has not reached the point yet of being economically viable. The Innovation Manager at KLM affirmed this:

> *"I do not know when the moment will come that we gain profits. For now, the goal is not to commercialize, but to reduce our footprint, to reduce dependency on fossil fuel; that is a long-term goal. The primary goal is to be more sustainable, and that point still is coming at a certain price. Currently, it is tough to commercialize sustainability."*

Thus, to use the biofuel opportunity, KLM introduced the KLM Corporate Biofuel Program in June 2012, which is based on the co-creation idea. It covers the additional costs of using biofuel for flights. The aggregation of demand through the Program has enabled KLM to develop a demonstration project for biofuels. This program is an elaboration of the so-called Green Deal between KLM and the Dutch government. Participated corporations into the Program struggle to initiate measures that result in a real decline in the carbon emissions caused by traveling of staff. Instead of purchasing carbon credits to offset staff travel, corporations divert the funds to the development of sustainable biomass production, required infrastructure, and key technologies.

4.3. Reconfiguring: Management innovation to renew resources and competencies

In response to sustainability challenges, firms need capabilities to strategically renew and manage the internal and external organizational competencies, routines and resources to innovate out of their current routines. The core capabilities identified with respect to reconfiguring activities are new methods of organizing work responsibilities, new business practices, new methods of organizing external relations, and orchestrating the business ecosystem.

4.3.1. New methods of organizing work responsibilities

New methods of organizing work responsibilities and decision making, such as team-work and decentralization are important factors for providing support to innovation for sustainability. For example, the study found that KLM has established a cross-functional team to collaborate in the Biofuel Program. This team is not a separate business unit; however, it is formed by members from different departments and focuses on decision-making concerning the Biofuel Program. Hence, it can be argued that firms need to collaborate internally and across functions to innovate for sustainability. The Director Innovation, Corporate Venturing & Biofuels at KLM for example said:

> *"We created an internal virtual organization – the Core Biofuel Team - which grows along the way. We saw that we need to create this internal virtual organization. We need to establish an internal organization that has to exist for a long period, not for one year or two years, but maybe for ten years. It is not officially a separate organization within KLM; people come from different departments;*

but, they join forces in this particular project. Therefore, we want to make sure that all those departments allow their resources to be involved in this project."

4.3.2. New business practices for organizing procedures

A starting point for the idea of changing business practices is that firms can and should fundamentally reconsider their routines and practices for introducing sustainable innovation. For example, adopting open innovation routines can help firms to acquire ideas and resources from the external environment. Accordingly, as KLM concluded that creating a market for biofuel is beyond KLM's individual sphere of influence, it integrated partners throughout the value chain in the project to make it happen. The Director Innovation, Corporate Venturing & Biofuels at KLM mentioned that the open innovation idea emerged, and is applied within KLM for the first time in the Biofuel Program. Furthermore, KLM, in the absence of reliable biofuel suppliers to the aviation industry, co-founded a joint venture. KLM realized that the company needs to create a new venture and put it outside company to be able to accelerate the Biofuel Program. KLM's approach was distinctive in that a company, SkyNRG, was specially established and designated to give the production and availability of biofuels a powerful impulse. An employee from WNF explained more about the importance of the establishment of SkyNRG:

"SkyNRG establishment was one of the most innovative things that KLM did because innovations do not usually happen in the big companies. They occur in small companies. KLM realized that it needs a different structure. Forming the process and realizing what needs to be done; i.e., enablers, are critical."

4.3.3. New methods of organizing external relations

Firms on their own have limited impact on sustainability challenges. Therefore, they need to identify new methods of organizing external relations and work with new types of partners to motivate and inspire systemic change. Firms may engage in unique collaborations including collaboration with environmental NGOs and governments to enhance their ability to lobby or to find alternative routes to the market. For example, in 2007, KLM engaged with the WNF to develop and maintain its climate strategy and biofuel program strategy. In 2011, KLM and WNF renewed their partnership for another four years to collaborate in the Biofuel Program. As part of the agreement, KLM took the aspirational target to use an average of 1% sustainable biofuels in its fleet by 2015. WNF gives KLM credibility because of its knowledge and its statue. WNF has been a visible and credible supporter of KLM in the Biofuel Program. Also, KLM only uses sustainable feedstock on the recommendation of the Sustainability Board wherein WNF is participating. KLM hopes in cooperation with its partner, WNF, to serve as a catalyst to create a more sustainable airline industry and to raise awareness among all parties in the value chain. The other goal of the partnership is to set a standard for sustainable biofuels and to develop an international market for sustainable biofuels.

4.3.4. Orchestrating the business ecosystem

One of the main competencies that firms need to innovate for sustainability is the ability to orchestrate the business ecosystem efficiently. As KLM's strategy is to explore the entire value chain, from research to commercialization, the company needs to be sure that the whole value chain is included in the Biofuel Program. Orchestration leads to an increased emphasis on value creation in the broader context of the business ecosystem. For example, as in the Biofuel Program, there are a lot of partners, stakeholders, technologies and feedstock, and different resource co-specialization activities, KLM should orchestrate resources both inside and outside of the company. Therefore, KLM needs a high asset orchestration competency for managing resource co-specialization activities. According to the Innovation Manager at KLM, the innovation department is responsible for this:

> *"The biofuel program is not just one single project; that is the reason we say that the role of the Innovation Department is to organize program management. Many different projects are part of the biofuel program; it needs to be coordinated. One of the things that we do as an innovation team is to find the partners in the value chain; we go outside KLM and look for feedstock partners, technology partners, and governmental partners who can cooperate with KLM to supply sustainable biofuel."*

5. Discussion and Conclusion

In this section, the findings are discussed regarding the organizational and managerial capabilities through which the case company, KLM, initiated and developed the Biofuel Program. Our study shows that a company's innovation for sustainability notably depends on how effectively the company co-opts the complementary resources and competencies around an innovation opportunity, individually and collectively. Doing this, companies need organizational and managerial capabilities that form the basis of three distinct clusters of dynamic capabilities; i.e., sensing, seizing, and reconfiguring. Teece et al. (1997) argue that dynamic capabilities are organizational and managerial capabilities, which enable a firm to innovate outside of its current routines. Our study shows that dynamic capabilities help a company not only to invest in its own development for innovating towards sustainability but also invest in the development of the business ecosystem in which they operate with others in the value chain.

5.1. Sensing capabilities

It is found that the EMS implementation helped KLM significantly to get a better understanding of its environmental impacts. Adopting the EMS, the company explored the opportunities to improve its sustainability performance. The EMS incorporates environmental issues into strategic organizational activities of companies to regularly improve their relationship with the natural environment (Bansal & Hunter, 2003). Porter and van der Linde (1995) argue that identifying profitable innovation opportunities is one of the organizational failure possibilities in environmentally sustainable innovation. The study shows that the implementation of an EMS can help firms to alleviate this failure. Based on this theoretical viewpoint and the empirical research at KLM, the following proposition is suggested:

> ***Proposition 1.*** *Having procedures in place to regularly get a better understanding of firms' environmental impacts helps companies to improve their sensing capabilities for recognizing the innovation opportunities for sustainability.*

KLM is moving from fossil fuel to sustainable biofuel as a fundamental way to reduce its carbon footprint and to achieve sustainability. The KLM Biofuel Program is a sustainability-rooted innovation, and it can give the company a future competitive advantage. Porter and van der Linde (1995) hypothesize that companies achieve a new competitive advantage by viewing environmental issues as core to their business strategies. Firms with a proactive sustainability strategy identify sustainability issues as sources of future competitive advantage and deliberately (and systematically) engage in sustainability performance improvements. It often leads to disruptive and radical sustainable innovation in products and processes (Aragón-Correa et al., 2008). Accordingly, the following proposition is introduced:

> ***Proposition 2.*** *Companies with a proactive sustainability strategy have greater sensing capabilities for recognizing the innovation opportunities for sustainability.*

To recognize future opportunities for competitive advantage, KLM focused on seizing the identified opportunities before issues are institutionalized or regulated. Stalk et al. (1992) argue that in a dynamic business environment, competition is a "war of movement," in which success depends on anticipation of market trends and quick responses to changing needs of the business environment. The anticipation processes also allow KLM to scan information and developments outside and inside the organization to make informed decisions. As a result, the company identifies what the most important environmental or social issues are that impact the business performance of the company. Porter and van der Linde (1995) argue that environmental regulation stimulates innovation. Following the ''Porter hypothesis", we contend that current or expected regulation is input to the companies' anticipation processes. Hence, anticipation processes help companies to understand what initiatives to be selected. This discussion leads us to suggest the following proposition:

> ***Proposition 3.*** *Anticipation processes help companies to make a strategic decision regarding the organization's readiness to capture the value of innovation opportunities for sustainability.*

5.2. Seizing capabilities

The study posits that a firm's business strategy for developing a sustainable innovation may involve reshaping the business ecosystem, rather than by "coping with competition" (Porter & van der Linde, 1995). From this perspective, successful sustainable innovation needs a focus on meta-competence; i.e., resource co-specialization (Teece, 2007). Resource co-specialization allows companies to bring together specialized resources and competences scattered in diverse actors of the value chain around a sustainability opportunity. Accordingly, companies co-evolve their resources and competencies and align their investments to create value and improve efficiency (Williamson & De Meyer, 2012). In this case study, KLM used its "smart power" (cf. Williamson & De Meyer, 2012); i.e., its position in the value chain as the off-taker and the 'brand KLM' to initiate system-level changes to stimulate production and use of biofuels for aviation. The study also indicates that government and policymakers should provide incentives and engage all value chain stakeholders in pushing companies to innovate for sustainability. Accordingly, we introduce the following proposition:

> ***Proposition 4.*** *Greater resource co-specialization competency helps companies to improve their seizing capabilities for implementing and commercializing the innovation opportunities for sustainability.*

Tsvetkova and Gustafsson (2012) argue that businesses that are based on ecosystems thinking, such as biofuel businesses, need to establish new business models for the ecosystem to survive and develop. A business model can be defined as the rationale of how a firm does business and creates, delivers, and captures value (Osterwalder et al., 2005). Accordingly, KLM as a lead firm of the value chain considers the radical nature of the sustainable innovation and the consequences for its business model. The Corporate Biofuel Program allowed KLM to develop a boundary-spanning demonstration project that is capable of integrating a number of corporations into a new innovative value chain. By this, it could support KLM's future attempts to integrate what it has achieved and learned in the project, in its future, more sustainable business model. Boons and Lüdeke-Freund (2013) argue that the business model of a company can be seen as a mediator for innovations that not only links production and consumption but also integrates stakeholders and their expectations into the corporate innovation for sustainability. Changing the core of business model around sustainability value proposition is ideal; however, if it is not possible, restructuring some elements can also be an effective strategy. This leads us to suggest the following proposition:

Proposition 5. *Companies with a business model that is open for sustainability value propositions have greater seizing capabilities for implementing and commercializing the innovation opportunities for sustainability.*

5.3. Reconfiguring capabilities

For managing and bringing together specialized resources in a business ecosystem, leaders and managers of the innovation project need orchestration skills (cf. Williamson & De Meyer, 2012). This competency allows firms to manage internal and external relationships of the ecosystem or build relationships with suppliers, other companies, research centers, universities, regulatory and standardization bodies, financial institutions, and governments. For example, as KLM's strategy explores the entire value chain, the Innovation Department is responsible for finding and coordinating strategic partners in the whole value chain. Furthermore, as the Biofuel Program involves many different projects, the Innovation Department should organize program management. Thus, it is argued that companies need high managerial orchestration activities to search, select, and configure the resources and competencies for innovating towards sustainability. The leads to the following proposition:

Proposition 6. *Companies with high orchestration skills have greater reconfiguring capabilities to sense and seize the innovation opportunities for sustainability.*

We noted how in its seizing attempts, KLM co-founded a joint venture. A venture which is independent of traditional ways of doing business in the parent company can be more flexible in developing new structures necessary to exploit the new opportunity (Birkinshaw & Gibson, 2004). It is found that the company has developed and modified some new business practices and new methods of organizing work responsibilities to facilitate sensing and seizing the innovation opportunities for sustainability. For example, KLM has established a new internal virtual organization – the Core Biofuel Team – to make sure that all those departments allow their resources to be involved in the project. The study indicates that successful innovation for sustainability is not just the result of technological innovation, but is also comprehensively dependent on what has been called 'management innovation.' Management innovation includes changing a firm's organizational structure, practices and processes in a way that is new to the firm and industry to leverage the firm's resources for innovation activities (Volberda et al., 2013). Accordingly, we introduce the following proposition:

> ***Proposition 7.*** *Management innovation helps companies to improve their reconfiguring capabilities to sense and seize the innovation opportunities for sustainability*.

5.4. Implications, limitations, and avenues for future research

Using the dynamic capability approach, the study shows that sustainable innovation is an inherently dynamic and evolutionary process, and its success is dependent on a recreation of managerial and organizational capabilities. Companies need organizational and managerial capabilities to shape and structure the business ecosystem around a sustainability opportunity and capture value in the value chain. We show how companies can sense and seize innovation opportunities for sustainability. The study also indicates that firms' dynamic capabilities for sustainable innovation do not simply emerge; rather they are identified and built through the intentional effort of leaders and managers, who reconfigure and orchestrate clusters of activity to achieve sustainable innovation. Where previous research into dynamic capabilities has been mainly conceptual (Seebode et al., 2012), this study provides empirical evidence of dynamic capabilities in practice, especially in the context of the value chain and eco-system building for sustainable innovation. This perspective has provided us a useful theoretical lens for examining sustainable innovation management practices at the organizational and system level.

The findings of our study also contain practical implications to managers of the studied case and to managers from other organizations. The microfoundations identified and discussed in this study are building blocks of firms’ dynamic capabilities aiming to innovate for sustainability. These microfoundations provide managers insights into the aspects on which to focus in their innovative efforts for sustainability. It is also learned that for innovating towards sustainability, companies often need to stimulate and orchestrate system-level changes in the macro environment in which the innovative companies operate. The study shows how the companies can function as a business system builder to co-evolve resources and competencies around an innovation for sustainability. Furthermore, our study demonstrates that for the successful implementation and commercialization of innovation for sustainability, companies can formulate a viable business model for sustainability in collaboration with other actors of the value chain to build a favorable environment for their innovation. The business model, as a reference point for communication and coordination among the different actors of the value chain, allows the companies to orchestrate the co-specialized opportunities and resources effectively for innovating towards sustainability. Finally, our findings support the assumption that companies need to do things differently to be able to innovate for sustainability. Thus, the companies' managers should think of alternative, sustainably innovative routes to go, and renew their organizational routines in favor of innovating for sustainability. They can adopt radically different approaches for managing innovation for sustainability.

Next to its merits this study also has its limitations. Our study used an in-depth case study approach as a research strategy. It has been known that single case studies do not lend themselves to comparison with other studies (cf. Eisenhardt & Graebner, 2007). Thus, the discussion about to what extent the firms' dynamic capabilities for sustainable innovation in this case are firm-specific or whether there are commonalities, particularly underlying microfoundations, across firms or industries is open for further research. This study's findings have no statistical validity, but the actions taken to assure the rigor of the research design (see Table 4.1) do provide a basis for an analytically valid analysis of the KLM case. Further research is needed to develop insight into the microfoundations of (less) sort-like organizations in (less) sort-like contexts.

5.5. Conclusion

With regard to sensing, seizing and reconfiguring firms have a range of actions that can be implemented to innovate toward sustainability.

Sensing. Our research indicates that companies need three strategic organizational and managerial capabilities, microfoundations, which help them to be more alert to innovation opportunities for sustainability. These microfoundations are a proactive sustainability strategy, having procedures in place to regularly identify and evaluate the company's environmental impacts, and having anticipation processes.

Seizing. To exploit and capture the potential value of sustainable innovation opportunities, firms need to develop some microfoundations for seizing activities. These microfoundations are strategy formation, market introduction activities, institutional dialogues, resource co-specialization activities, and business model redesign.

Reconfiguring. In addition to this, companies need reconfiguring capabilities that help them to innovate out of their current routines. Therefore, firms need to focus on microfoundations of new methods of organizing work responsibilities, new business practices, new methods of organizing external relations, and orchestrating the business ecosystem.

This case study showed that by developing sensing, seizing and reconfiguring capabilities, a firm can develop a sustainable innovation demonstration project that has an effect on the firm's sustainability strategy and organization, as well as the sustainability strategy and organization of the value chain the firm is part of.

Chapter 5
Investigating Firms' Dynamic Capabilities for Innovating towards Sustainability[4]

Abstract

Though innovation for sustainability has received an uprising attention during the last two decades, companies struggle to envision how to manage the innovation effectively. That uncertainty is understandable, given that sustainable innovation often involves a significant shift in a new strategic direction, a new organizational structure, and new skills. To be able to develop innovation for sustainability continuously and comprehend the underlying business logic of sustainability provision, companies have to develop dynamic capabilities that enable them to innovate for sustainability. Adopting the dynamic capabilities approach as a theoretical lens of the study, we aim to provide a relatively new perspective on how to manage innovation for sustainability. The other purpose of this study is to identify the key microfoundations that enable companies to build the dynamic capabilities that can facilitate innovation for sustainability. The study uses a process research approach, investigating the evolution of two sustainable innovation projects in large incumbent companies and two sustainable innovation projects which were started and commercialized by start-up companies. The findings contribute to the literature by shedding light on the actual processes and practices that comprise companies' dynamic capabilities for innovating towards sustainability. The study shows that firms' dynamic capabilities for innovating towards sustainability include not only organizational routines but also individual and managerial entrepreneurial resources and organizational competencies. Thus, companies' dynamic capabilities for innovating towards sustainability have to be developed 'in-house' through a set of activities and cognitive processes focused on the organizations' routines.

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1. Introduction

During the last two decades, innovation for environmental sustainability (hereafter, sustainability) has taken an upsurge of attention in organizations. Sustainability is becoming an integral and explicit element of companies' management agenda for profiting from sustainable business practices in addition to deriving financial benefits from these activities (Kiron et al., 2012). Larson (2000: 305) defines sustainability as "the innovative and potentially transformative corporate activities that generate new products and processes that challenge existing practices." The way companies can incorporate sustainability concerns into their strategies while consolidating their competitive advantage is through sustainable innovation (Hall & Vredenburg, 2003; Paramanathan et al., 2004).

Sustainable innovation is seeking to arrive at 'win-win' situations where economic and sustainability performances are improved in a balanced way (cf. Porter & van der Linde, 1995). Sustainable innovation is an entrepreneurial opportunity for transforming technology, products, and markets into sustainable ones (Senge & Carstedt, 2001). Hall and Vredenburg (2003) argue that the development of sustainable innovation frequently involves a departure from the present knowledge base and is thus competency-destroying. Accordingly, the current approaches for managing innovation are not sufficient for innovating towards sustainability. Notably, competency-enhancing incremental innovation does not suffice to achieve additional demands of environmental sustainability. Instead, a need for radical technological change or even system innovation is often required to innovate for sustainability (Carrillo-Hermosilla et al., 2010; Nill & Kemp, 2009). Likewise, Kiron et al. (2013b) argue that sustainable innovations fall along a rich spectrum- from doing things differently to doing entirely different things. Therefore, companies have to reconsider their core activities to integrate, coordinate, build, and reconfigure their resources and competencies in the case of innovations for sustainability (Dangelico, 2016). This is often referred to as dynamic capabilities for innovation (Helfat & Peteraf, 2003).

Teece (2012) argues that strong dynamic capabilities are critical for innovating firms to pioneer a market or develop a new product. Helfat et al. (2007) define dynamic capabilities as the companies' abilities to purposefully create, extend, and modify their resource bases. On the other hand, as there are many diverse types of dynamic capabilities for performing different tasks, from new product development to post-acquisition integration, Helfat and Peteraf (2009) recommend that dynamic capabilities should be investigated specifically for different tasks. Despite the attention given to sustainable innovation during the last two decades, there is limited understanding of what are the dynamic capabilities of firms for innovating towards sustainability and how these capabilities develop, emerge or evolve within the companies to manage innovation for sustainability.

The existing literature often focuses on the antecedents (e.g., Horbach et al., 2012; Rehfeld et al., 2007; Rennings, 2000) and the outcomes of sustainable innovation (e.g., Leenders & Chandra, 2013; Leonidou et al., 2013; Rennings & Rammer, 2011). The literature also highlights that building new networks of collaborations, establishing cross-functional teams, internal R&D, and employee training are key factors for developing the resources and competencies required to innovate for sustainability (Dangelico et al., 2013; Dangelico & Pujari, 2010; Ketata et al., 2015; Noci & Verganti, 1999). However, it is less clear how this process is managed. Typically, the innovation process involves a series of strategic decision-making processes, which affect the configuration of firms' resources and competencies for the formation/discovery and exploitation of sustainability opportunities (Seebode et al., 2012). Furthermore, extant literature does not sufficiently incorporate different perspectives on the phenomenon to improve our understanding of managing innovation for sustainability. The research suggests that dynamic capabilities are useful for the innovation context (Eisenhardt & Martin, 2000; Winter, 2003). Lee and Kelley (2008) also argue that the dynamic capabilities perspective can provide a useful theoretical lens for examining innovation management practices at the organizational level. The focus on change inherent in the dynamic capabilities concept is a difference in comparison to previous literature and a reason for why dynamic capabilities contribute to our understanding of sustainable innovation in this study (Helfat et al., 2007).

Adopting a 'dynamic capabilities approach' (Teece, 2007), as a theoretical lens, this study intends to identify a set of dynamic capabilities useful to innovate for sustainability. This adoption is also consistent with Dangelico (2016)'s call for studying the development of sustainable innovation under the dynamic capabilities perspective. She argues that dynamic capabilities are more useful in the context of sustainability, which has been characterized by high degrees of environmental dynamism. This brings us to investigate how dynamic capabilities develop, emerge or evolve for innovating towards sustainability.

An empirical process research study is undertaken (Langley, 1999) to investigate the evolution of two sustainable innovation projects in incumbent companies and two sustainable innovation projects which were started and commercialized by start-up companies. We focus our analysis at the organization-level, with a particular emphasis on investigating what the dynamic capabilities of firms for innovating towards sustainability are and how these capabilities develop, emerge or evolve within the companies to manage innovation for sustainability.

We proceed as follows: First, the relevant literature on sustainable innovation development is reviewed. After that, we discuss the dynamic capabilities associated with an innovation for sustainability. Next, we describe the research method and the study context. We then present the findings of the study, followed by a discussion of the findings, implications, limitations, and future research. Finally, conclusions of the study are provided.

2. Theoretical Background

2.1. Sustainable innovation development

Innovation is an important means to contribute to sustainability (Hansen et al., 2009; Schaltegger & Wagner, 2011). Klewitz and Hansen (2014) argue that innovation for sustainability is about relative improvements in either environmental or social performance of firms' innovation activities in comparison to a prior one. However, most innovations focus on environmental sustainability to lessen the impact of companies' activities on the natural environment (Varadarajan, 2017). Sustainable innovation may involve the implementation of a new or significantly improved product (e.g., change in product properties), process (e.g., energy-efficiency), or organizational method (e.g., set-up of an environmental team) in business practices. Seebode et al. (2012) also suggest that much of the sustainable innovation takes place as firms begin to consider the environmental impact of their business activities. Therefore, companies need to understand and integrate sustainability issues in the development process of their innovation and beyond (Dangelico et al., 2013). This reconfiguration requires the development of new processes and products at the incremental level or even abandonment of existing ones.

The integration of economic and environmental aspects makes noticeable sustainable innovations in comparison with conventional innovations. Furthermore, sustainable innovation integrates stakeholder demands into decision making and usually is radical or transformational by nature (Rycroft & Kash, 2000). Therefore, sustainable innovations could be perceived to be more complex and value creating in comparison with conventional innovations (De Marchi, 2012; Hall & Vredenburg, 2003). Using concepts developed by innovation management researchers for assessing the complexity of innovation, it is possible to emphasize that sustainable innovations, often, have higher levels of novelty, uncertainty, and need a variety of resources with respect to the conventional innovation (Cainelli et al., 2015). Furthermore, companies are likely to have a higher need for resources, internally and externally, to be able to address such demands while remaining competitive (Cainelli et al., 2015). Ketata et al. (2015) argue that sustainable innovation requires knowledge inputs from different and heterogeneous sources and competencies which might considerably need to go beyond a firm's core competencies. The core competencies are those competencies that define a firm's fundamental business as central (Teece et al., 1997).

Innovation may be based on already existing resources and competencies of a firm or may require resources and competencies that the firm does not have (Danneels, 2002). Thus, companies need to identify, enhance, and reconfigure their resources and competencies to integrate sustainability issues into the development process of sustainable innovations (Dangelico et al., 2013; Hall & Wagner, 2012). Doing sustainable innovation, firms have to review their routines and practices for sustainable innovation to ask whether their existing models for handling the process are sufficient or they are forced to abandon existing ones. As such, they adopt a new process or may modify the existing routines and practices (Seebode et al., 2012). This implies that dynamic capabilities can play a key role to realize sustainable innovation successfully.

Existing literature shows that a firm's decision to innovate for sustainability is influenced by a variety of factors, including technology push, market pull, and regulatory push/pull factors (e.g., Horbach et al., 2012; Rehfeld et al., 2007). In technology push driven innovations, the stimulus for new products and processes comes from (internal or external) research, and the goal is to make commercial use of new know-how. For market pull innovations, the innovations' source is market and customer needs, which results in new demands for problem-solving. In the traditional theory of innovation, technology push and market pull factors have usually been identified as the primary drivers of innovation (Rehfeld et al., 2007). However, the literature has focused mainly on one specificity of sustainable innovation that differentiates it from other innovations- what Rennings (2000) called the 'double-externality problem.' One side of this problem is that investments in R&D efforts are inhibited when innovations from that investment spill over to competing companies. A second aspect is that investments in sustainable innovations are also inhibited when the private return on R&D in environmental technology is less than its social return. Thus, the double-externality problem reduces incentives for companies to invest in environmentally sustainable innovations, which emphasizes the crucial role of regulatory push/pull factors as drivers of sustainable innovation. Nowadays, it has been accepted that the impulses given by technology are mainly relevant for the initial stages of the life cycle of an innovation and market factors mostly for their further diffusion (Pavitt, 1984). Current and expected regulations are also linked and complementary to technology push and market pull factors in the evolution of new sustainable innovations (Rehfeld et al., 2007).

In line with the Schumpeterian view of innovation dynamics (cf., Schumpeter, 1934), the literature highlights that large incumbent companies have a higher probability of being sustainably innovative than smaller companies (e.g., Chassagnon & Haned, 2015; Rehfeld et al., 2007). These large incumbent companies may have developed a relatively broad resource base over time, which can lead to the realization of further sustainable innovations (cf., Schumpeter, 1934). Bos-Brouwers (2010) also argues that there are significant differences in innovation processes between large companies and small companies. Therefore, innovation practices, theories, and instruments suited for large companies do not necessarily lead to successful innovation for small companies (Bos-Brouwers, 2010). As a result, specification of dynamic capabilities for both large and small companies' sustainable innovations is necessary.

2.2. Dynamic capabilities for innovating towards sustainability

To get a better theoretical and empirical understanding of sustainable innovation development, the present study adopts dynamic capabilities theory, which is an extension of the resource-based view (RBV) of the firm (Barney, 1991). The resource-based view (RBV) argues that resources and competencies which are valuable, rare, inimitable and non-substitutable (VRIN) form the basis of sustainable competitive advantages (Barney, 1991). According to Helfat and Peteraf (2003: 999), a resource can be defined as an "input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis." However, a "capability refers to the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result." Dynamic capabilities extend the RBV by including the evolutionary fitness of firm resources and competencies, in relation to changes in the business environment (Wang & Ahmed, 2007). Researchers argue that dynamic capabilities are crucial for firms in a rapidly changing business environment because they enable companies to renew their resources and competencies (Eisenhardt & Martin, 2000; Teece et al., 1997).

The dynamic capabilities approach is a dominant theory in organizational studies for explaining sustained performance differences across companies. In particular, the dynamic capabilities approach shows that the development of new products and processes arises from new combinations of resources and processes for strategic renewal of firm-specific assets (Teece, 2007; Teece et al., 1997). The focus of the dynamic capabilities approach is on a firm's ability to adapt to and take advantage of the changing environment. Dynamic capabilities not only allow companies to exploit their existing resources and organizational competencies but also help them to renew and develop their resources and competencies to fit the uncertain environment (Teece, 2007; Teece et al., 1997). Teece (2012: 1395) defines dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape, rapidly changing business environments." As such, dynamic capabilities are considered as strategic activities by which firms search for new ideas, choose between them, mobilize resources, modify them, and then create and capture value (Eisenhardt & Martin, 2000).

Teece (2007) classified dynamic capabilities according to whether they support sensing, seizing, or reconfiguring. Sensing refers to a firm's activities for scanning and monitoring the internal and external business environment to identify new business opportunities and make a strategic decision about them. Seizing refer to the mobilization of resources and organizational infrastructure and strategy for addressing an opportunity to capture value from doing so. Reconfiguring refers to the continuous strategic renewal of resources and competencies aimed at maintaining the firm's resource base as markets and technologies change. We use Teece's dynamic capabilities classification (2007) as a theoretical guideline for understanding evolutionary processes of companies' dynamic capabilities for sustainable innovations.

To date, the literature has identified a plethora of particular routines as the microfoundations of capabilities (e.g., Teece, 2007; Winter, 2003). Routines are defined as repetitive patterned activities that evolve through experience and that allow the firm to get things done (Teece, 2012; Zollo & Winter, 2002). Therefore, dynamic capabilities can be described as a set of routines which impact on the evolution of firms' resources configuration. However, dynamic capabilities consist of more than an aggregation of routines. Routines cannot explain necessarily how projects are identified, prioritized, and selected (Teece, 2012). For example, many strategic renewal trajectories require actions that one may never replicate. It means that entrepreneurial actions around sensing, seizing, and reconfiguring are required to sustain dynamic capabilities (Teece, 2012). Therefore, dynamic capabilities may sometimes be rooted in particular change routines (e.g., cross-functional R&D teams). However, they are also commonly rooted in creative managerial and entrepreneurial actions (e.g., creating new markets). In summary, this dichotomous nature of dynamic capabilities can provide a framework for understanding how the dynamic capabilities develop, emerge or evolve for innovating towards sustainability.

Teece et al. (1997) argue that dynamic capabilities are unique to the firm. This implies that for operationalizing dynamic capabilities, they should be measured by their existence. As dynamic capabilities are considered as organizational-level constructs (Eisenhardt & Martin, 2000; Teece et al., 1997), dynamic capabilities are operationalized as 'companies' experience, actions, and performance.' Dynamic capabilities, for example, include patents, acquisitions, alliances or adoption of specific processes, product launch, setting up new distribution channels, acquire new skills and resources entirely. Dynamic capabilities are the ones that create change and affect firm performance (Laaksonen & Peltoniemi, 2016). This operationalization enables us to build a dynamic capabilities profile for each case company that then can be used as a basis for a cross-case analysis, which is elaborated in the next section.

3. Research Method

3.1. Research design

A process research approach was adopted (Langley, 1999) to explore the nature of firms' dynamic capabilities for innovating towards sustainability in practice and assess their similarity across companies. As dynamic capabilities theory is about change over time (Laaksonen & Peltoniemi, 2016), the process research approach is appropriate to uncover the processes of organizational learning and resource building for innovating towards sustainability. This research approach is used to investigate the evolution of sustainable innovation processes in the case companies as “a sequence of events or activities that describe how things change over time” (Van de Ven, 2007: 197).

We chose a multiple-case study as a research strategy to corroborate findings and dissociate emerging patterns from company-specific circumstances (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). Put differently, the study employs replication logic to generate more analytically valid findings across a certain type of cases (Eisenhardt & Graebner, 2007; Yin, 2009). We thus aim to search for findings that are robust and generalizable across most or all cases studied. Accordingly, the cross-case replication of findings contributes to enhancing the external validity of the study (Yin, 2009).

3.2. Sample

Consistent with Eisenhardt’s (1989) recommendation that four to ten cases usually work well for establishing replication, four companies were chosen by means of theoretical sampling. Figure 5.1 provides a typology of sampling. The selected cases had to be similar on several criteria. First, all cases had to be active in manufacturing industries because there are real differences between how manufacturing and service companies approach the innovation process (Ettlie & Rosenthal, 2011). Second, the case companies had to engage in developing new technologies or products for sustainability. Accordingly, we were interested in those companies that provide innovations with economic value as well as environmental value. A third selection criterion was to choose information-rich cases that allow the collection of detailed information on the development process of innovation for sustainability. The innovation process begins with a novel idea and concludes with a market introduction (Freeman & Engel, 2007).

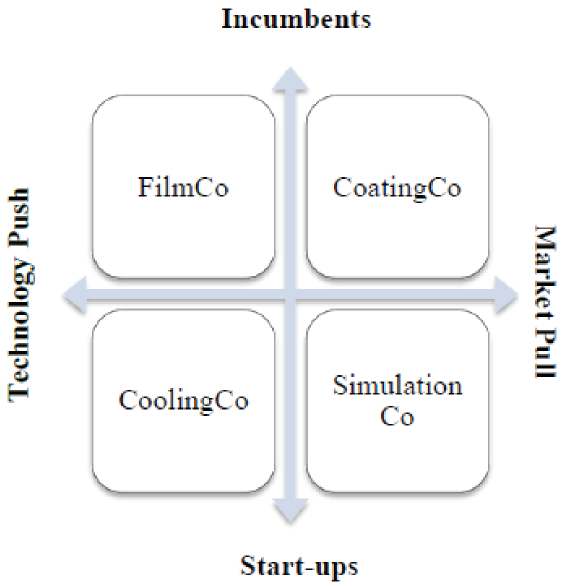

Figure 5.1 A typology of sampling

Within bounds of these three criteria, we employed maximum variation sampling to identify ‘important shared patterns that cut across cases and derive their significance from having emerged out of heterogeneity’ (Patton, 2002: 235). This strategy led to diversity among cases. Accordingly, cases were selected that differed with regard to the two main conditions influencing the innovation processes: company size (incumbents vs. start-ups) and innovation impulses (technology push vs. market pull). Thus, we investigated the evolution of two sustainable innovation projects in large incumbent companies and two sustainable innovation projects which were started and commercialized by start-up companies. Furthermore, for each size of the company, the innovation projects were selected from both innovation impulses to create a picture of the sustainable innovation process in these organizations. Table 5.1 provides innovation projects and companies descriptions, anonymized as FilmCo, CoatingCo, CoolingCo, and SimulationCo.

3.3. Data collection

Data collection took place from March 2015 to September 2016. Prior to data collection, a case study protocol was developed to explain how the entire cases study would be conducted. The case study protocol included an overview of the case study, the theoretical framework for the study, themes to be investigated, data collection procedures, and a concept outline of the case study report. We relied on both primary and secondary sources of data, including semi-structured interviews and archival data. Table 5.2 provides an overview of all data sources for each case company. The companies' innovation projects are explored via semi-structured interviews with key informants including the project leader or innovation manager of large incumbent companies or founder(s)/director of start-up companies. In total, we conducted five interviews for all cases, which lasted 90 minutes on average. Interviews provided a chronology of the innovation trajectories, identifying important events affecting the innovation project from its ideation to its endpoint in the innovation trajectory; i.e., market introduction. We triangulated the interview data with archival sources such as public interviews, annual reports of the companies, secondary data, company presentations, companies' press releases and websites, news about the innovation projects in mass media, and patent specifications. The triangulation of data from multiple sources and the combination of interview data and archival sources enable us to reach an in-depth understanding of the research phenomenon (Denzin & Lincoln, 2007). We used ATLAS.ti software to compile all gathered data and build a case study database for each case company. It is used to establish a chain of evidence from raw data to findings (Yin, 2009).

3.4. Analytical strategy

First, a narrative strategy was used to construct a detailed story from raw data (Langley, 1999). Based on the interviews and archival data, a narrative of each innovation project was made to understand the development process of innovation for sustainability in the case companies. Then, we subjected the narrative of each case company to a thematic analysis to identify the variety of practices including organizational routines and entrepreneurial actions performed by companies during the innovation for sustainability. In the third step, we categorized the previously identified organizational routines and entrepreneurial actions according to whether they support sensing, seizing, or reconfiguring capabilities. Accordingly, the research framework of the study; i.e., the dynamic capabilities theory, was used to guide the analysis and enhance the internal validity of findings (Yin, 2009). Accordingly, based on within-case analysis of each case, we were able to describe the dynamic capabilities of each company for innovating towards sustainability.

The fourth step of the analysis was guided by the cross-case replication logic (Eisenhardt & Graebner, 2007; Yin, 2009) to find general patterns that are replicated across all cases. The aim of this step was to assess the similarity in the composition of dynamic capabilities across the case companies. Finally, in the last step, we looked for semantic relationships among the replicated practices to find the logic behind the development of dynamic capabilities. This step included a distillation of the replicated practices of dynamic capabilities into a theoretical level of themes; i.e., microfoundations, sensitized by the theoretical framework.

Table 5.1 Companies and innovation projects descriptions

Case	Company size	Employees	Short case descriptions	Technology/Product Innovation	Innovation impulses
FilmCo	Incumbent	89000	FilmCo is a diversified technology company which is among the leading manufacturers of products for many of the markets it serves. The Company began operations in 1902 in the United States and then became internationally active. The company has a turnover of about $30 billion.	A Daylight Redirecting Film that moves excess light close to the window and redirects the sun's light deeper into the building to increase the daylighting penetration. The stimulus for this technological innovation came from internal research, and the goal was to make commercial use of existing knowledge. As the innovation process began, there was no proven market demand for it. Thus, we considered this innovation project as a technology-driven innovation.	Technology push
CoatingCo	Incumbent	25000	CoatingCo, headquartered in the Netherlands, is active in health, nutrition, and materials. From the beginning in 1902, the company has a long history of successful transformation from a state-owned coal mining operation to a leading Life Sciences and Materials Sciences company. The company has a turnover of about €10 billion.	A solar anti-reflective coating technology to ensure that more of the sun's energy is captured. This anti-reflective coating technology enables solar panel glass to transmit more light instead of reflecting it. The idea behind the technology came from sources within the company. However, the company carried out primary market research activities and analyses to find the potential applications of the technology. Interaction with customers drove the application of the anti-reflective coating to solar panels; i.e., demand factors. Thus, we characterized this innovation project as a market-driven innovation.	Market pull

CoolingCo	Start-up	9	CoolingCo is a venture-backed company and is one of the global leaders who are active in the development of Gas-Free Magnetic Cooling Technology. The company was founded in 2005 as a spin-off from a university in the UK. CoolingCo has been selected as one of the top 100 private European clean technology companies in 2008.	Gas-Free Magnetic Cooling Technology exploits the properties of advanced metal alloys and magnetic fields to drive a novel cooling cycle. The technology intensely reduces energy consumption, uses no polluting gasses and enables lower-cost and high-efficiency appliances for the consumer. The company spins off the primary researches that have been done at a university. As there was no proven market demand for the technology, the company performed deep market and competitor analyses to know which market could be addressed and position the technology in the market. Hence, we considered this innovation project as a technology-driven innovation.	Technology push
SimulationCo	Start-up	40	SimulationCo is a high-tech company, founded in 2011 as a spin-off from a university in the Netherlands. In 2013, the company won the Cleantech Award in Silicon Valley. In 2015, PV Magazine also placed SimulationCo's technology as the Number 1 among the top 50 PV technologies regarding efficiency, innovation, and profitability.	Solar simulation systems that can simulate sunlight up to 99% of real sunlight. These systems enable customers from various industries to accurately test the performance and reliability of their products. For instance, in the solar PV industry, SimulationCo's solar simulation systems are deployed to measure the power and efficiency of solar panels. SimulationCo's solar simulator technology was born out of necessity and is driven by demand factors in the market. Therefore, we characterized this innovation project as a market-driven innovation.	Market pull

Table 5.2 Data sources for each case company

Case	Data sources
FilmCo	- Interview (2) - Public interview (2) - Annual report& sustainability report (10) - Secondary data (16) - Company presentation (4) - Press release & company website (21) - News about the project in mass media (19) - Patent (5)
CoatingCo	- Interview (1) - Public interview (7) - Annual Report (10) - Secondary data (21) - Company presentation (23) - Press release & company website (50) - News about the project in mass media (73) - Patent (4)
CoolingCo	- Interview (2) - Public interview (2) - Secondary data (8) - Company presentation (5) - Press release & company website (21) - News about the project in mass media (49) - Patent (1)
SimulationCo	- Interview (-) - Public interview (8) - Secondary data (13) - Company presentation (7) - Press release & company website (51) - News about the project in mass media (79)

4. Findings

In this section, we use Teece's tripartite classification for dynamic capabilities to understand how each company has built and mobilized its dynamic capabilities to innovate for sustainability. A narrative of each innovation project evolution is provided to create a dynamic capability profile for each organization. Furthermore, the individual case analyses help to identify shared patterns that are replicated across all cases.

4.1. Sensing

Table 5.3 presents the practices that comprise sensing capabilities of the case companies for innovating towards sustainability.

Table 5.3 Summary of the practices comprising sensing capabilities

Second-order themes	**First-order themes**	
Microfoundations	**Similar practices (replicated across all cases)**	**Company-specific practices**
Sources within the companies	Using existing knowledge and competencies including patents for (new) potential application;	Internal R&D (CoatingCo);
	Following the corporate scientists or founders' insights and preferences- Innovation champions;	Having an incubation program inside the company to recognize and shape the opportunities (FilmCo, CoatingCo); Using the current network of contacts to find new market opportunities and cooperation partners (CoolingCo, SimulationCo).
Anticipation processes	Carrying out primary market research activities and analyses for the concept development and finding potential applications;	Assessing the opportunities based on policy trends, regulations and standards, and the strategy of the company (FilmCo, CoatingCo);
	Carrying out competitor analysis and competitive positioning.	

4.1.1. FilmCo

FilmCo obtained the first patent for sun control window film in 1966. Using its existing knowledge base and competencies of the company for a new potential application, the innovation comes from an individual initiative in 2010. One of the corporate scientists thought that daylighting redirection is a significant opportunity for the future. He became a business and technical champion to convince the leaders of his business that daylighting redirection is a good opportunity. He used the 15% rule; i.e., FilmCo employees are given 15 percent discretionary time to create whatever they want. If an employee believes they have a worthy creation, they can follow their idea and inject it into the firm's "champion" new product development system. The idea receives a fair hearing and possibly also resources. Building on primary market research activities, competitor analysis, and anticipation processes, the company made a strategic decision and assessed the innovation opportunity to be connected to the strategy of the renewable energy division and the company. Anticipation processes were based on policy trends, regulations and standards, and the strategy of the enterprise. The primary market research activities and competitor analysis with potential customers and marketing experts are carried out at the early stage of concept development to learn the market needs. The Business Development Manager at FilmCo explained more about these sensing capabilities of the company:

> *"As the division lab comes up with a new product or concept, the company starts looking for potential applications for that new product or idea through a filter process. We go through a primary research process with potential customers and market experts to decide and prioritize high-value applications for that product or concept, the markets where we play in or where we want to play strategically."*

4.1.2. CoatingCo

The idea behind the technology came from sources within the company (Internal R&D). In 2005, a researcher of CoatingCo Materials cluster developed a coating based on nanotechnology that has a particular structure which reduces the reflection of the glass to almost zero. He made some trails and found that is a great technology, but it did not fit into the product portfolio of that cluster. Hence, the cluster transferred the technology to the CoatingCo Innovation Center to see whether they can do something with the technology. The CoatingCo Innovation Center serves as an enabler and accelerator of innovation within CoatingCo as well as providing support to the clusters. With its Emerging Business Areas (EBAs) and the Business

Incubator, the Innovation Center has a business development role, focusing on areas outside the current scope of the business groups. Accordingly, the idea was entered into the CoatingCo Business Incubator. The aim was to accelerate and to build a real business around it. The incubator's team carried out primary market research activities and analyses to find the potential applications of the company's existing knowledge and competencies (i.e., the technology). As there was no launching customer for the technology and nobody wants to buy the coating, the company decided to build a small facility to coat glass by itself. Accordingly, an anti-reflective glass is produced by the company for using as a picture framing glass. That was the start-up of the anti-reflective coating business. As selling more than one Million Euro turnover was not nice for a company like CoatingCo with 10 Billion Euros turnover, the company started scanning the alternative applications with a possibly higher volume in 2009. A Business Development Manager at the CoatingCo Innovation Center mentioned:

> *"After almost four years in the incubator's program, the company said you have proved the technology. Now go and look for real applications with a high volume. We went back to the market to investigate the coating's alternative applications. We also used some inputs from consultants to get from them some advice about which market is more attractive. We went to trade shows, to exhibitions and conferences, and to the customers to see if there is a market need for it."*

Accordingly, carrying out primary market research activities and competitor analysis enabled the company to find that the technology almost has the perfect properties for the solar market. It is concluded that the technology could improve the output of the panel, and the customers are prepared to pay for it. The customers are looking for improvement of the technology to make the panels more efficient, which also helps them to cut the costs. Furthermore, the solar market was growing quickly. As the company found that solar is the best market for the technology and sustainability was a top priority of CoatingCo's business strategy, CoatingCo decided to promote it towards an Emerging Business Area.

4.1.3. CoolingCo

At the beginning of 2000, a researcher at a university in the UK, currently, the CEO of CoolingCo, found that some researches have been done in the university around the new alloys that could provide a more efficient way to produce cold instead of using gasses compression and expansion. He came across with a former colleague that now he is the Executive Director Business Development of CoolingCo with an opportunity to spin off the primary researches that have been done in a university. After doing some primary market research activities, they found that it could be an interesting idea to be developed. The Executive Director Business Development of the company explained that their insights and personal preferences were also instrumental in their decision-making process:

> *"Thanks to the experience of working in an incubator, I always keep an eye on start-ups, and particularly innovation is my personal interest. It was also clear that we need to look for new ways of reducing our carbon footprint. You can be more efficient by producing more energy in a renewable way. That was a strong personal motivation for me to work on this technology."*

As the company started, some other companies more or less were also starting at the same time. Competitors had focused on air conditioning because the air conditioning was the biggest market. However, after carrying out primary market research activities and competitor analysis, the Executive Director Business Development of CoolingCo suggested to the board of the company to focus on the domestic refrigeration. He explained more about the technology positioning in the market:

> *"It was an internal process that I had to convince my board that this is the right decision. If you look at the competitors, air conditioning*

was a big deal. Although right now; nobody talks about air conditioning. However, ten years ago they talked about air conditioning."

4.1.4. SimulationCo

In late 2010, during a research project at a university in the Netherlands, co-founders of the company were developing a new type of solar panel, a new type that had to be also tested for its performance and reliability. According to co-founders, they were unable to find accurate testing and measurement equipment to test their design and soon realized that such a solution does not exist. Thus, building on their existing knowledge, and available resources and competencies, co-founders developed their testing equipment (a special solar simulator) that quickly became much more interesting than their solar panel. Almost immediately, there was commercial interest in this simulator from a research institute, and the relevant technology was quickly patented by the university. Accordingly; co-founders identified this market need and opportunity, and shortly after decided to start their company.

By joining and competing in many start-up competitions, SimulationCo also carries out competitor analysis and competitive positioning in the market to achieve a more advantageous position compared with rivals. Accordingly, since its foundation, SimulationCo has received some international business and design awards. SimulationCo's co-founder in a public interview has said:

"Winning the award is not only a great acknowledgment, but also it opens the right doors for us. Also, competitions bring out our strengths, but more importantly our weaknesses."

Building on an existing network of contacts, SimulationCo identifies new opportunities and resources. For example, SimulationCo was introduced to a Belgian venture capitalist by one of the co-founders' investment banking friends to raise funds to meet the growing market demand for their solution. SimulationCo also attends and presents its solar based business, particularly its testing and measurement equipment, at solar energy trade fairs and conferences. By these networking activities, the company puts its business and product portfolio into the spotlight of the fast-developing solar energy sector to find new cooperation partners. These events help SimulationCo to connect with professionals in the industry with wholesalers and solar related manufacturers. Furthermore, the events are an opportunity to obtain an update on the research projects and their facilities.

4.2. Seizing

Table 5.4 presents the practices that comprise seizing capabilities of the case companies for innovating towards sustainability.

Table 5.4 Summary of the practices comprising seizing capabilities

Second-order themes	**First-order themes**	
Microfoundations	**Similar practices (replicated across all cases)**	**Company-specific practices**
Developing internal capabilities	Internal technical development; Cross-functional collaboration for the product development and positioning in the market.	
Engaging customers into the innovation process	Engaging with the potential clients from the early stage of development to find their needs;	Using specialized consultants to understand the market needs and the value chain (FilmCo, CoatingCo); Carrying out formal market research activities and analyses (FilmCo, CoatingCo).
Market introduction activities	Exposing (draft) products to clients early on - Prototyping and Demonstration projects.	
Resource allocation and investment	Leveraging external resources whenever and wherever available including funding;	Internal resource allocation (FilmCo, CoatingCo); Founders' own resources (CoolingCo, SimulationCo); Raise capital from market by partnering with a venture capitalist (SimulationCo);

		Get plugged into startup incubators for guidance and resources (SimulationCo).
Co-specialization of resources and competencies	Collaboration with research institutes; Engaging in complementary partnerships.	
Delineating the business model	Defining the business model based on the targeted market segment and the structure of the value chain;	Product differentiation to make the technology commercially more available (FilmCo, SimulationCo); Using infrastructure of local environment for marketing and selling the products (FilmCo, SimulationCo); Acquiring complementary technologies to enrich the product portfolio of the company (CoatingCo, SimulationCo).

4.2.1. FilmCo

As FilmCo identified the innovation opportunity for sustainability, and there was more certainty regarding the concept development of the new product, formal market studies have been done to ensure that there is a definite market for it. Accordingly, a prototype of the technology product was developed by the Renewable Energy Division and Corporate Research Materials Laboratory in collaboration with the Marketing Division of the company. Daylight Redirecting Film was introduced in 2014. There was also a cross-functional collaboration for the product positioning in the market as the Business Development Manager at FilmCo said:

> *"There was a back and forth between the scientists and marketing during the development. Meaning that if the lab was missing a piece of information, the market division would find out how important that piece of information is. With this information, they would get back to the lab, and so on."*

Thus, it is found that from the earliest stages the company has evaluated the technology and adapted means based on market feedback and expectation. Developing an early draft of the technology product, the company started to expose it to potential customers. However, there was no thorough performance assessment available, and the customers wanted a verification of the daylight redirecting film's performance in the real world. FilmCo deployed a variety of techniques to determine the effectiveness of the film. The company was successful to get funded by the US Department of Defense for a demonstration project. The overall objective of the demonstration project was to evaluate daylight redirecting films under a variety of conditions and to better assess the potential for energy savings in different climate zones. Specific objectives were to verify the performance of the technological product, scale up the prototype in a factory setting, quantify the potential for energy savings, and qualitatively assess occupant satisfaction. A professional consulting services company specializing in the field of building energy efficiency was also hired to assist the company in this study and to understand the product and the value chain to get the product to the market. The use of simulation tools was another technique of the company to speed up the time to market and reduce the development cost of the new energy efficient technology. Accordingly, the project team collaborated with researchers in a national lab to accurately assess the technology and explain the energy efficiency and comfort impacts of this innovation with confidence to potential customers.

Currently, the product is still being monitored to make improvements. To make the technology commercially more available, the company has adopted a product differentiation strategy to develop several versions of the product concurrently. FilmCo has also established complementary partnerships with window manufacturers to incorporate its new technology product as an add-on film in new and retrofit applications in commercial and residential buildings.

4.2.2. CoatingCo

In 2010, Incubator's Functional Coatings program was promoted to an Emerging Business Area; i.e., CoatingCo Advanced Surfaces, to develop the market for its coating technology and to build a portfolio of technologies to enable and improve the capture of solar energy. As the company did not have too much knowledge about the solar market and glass technologies, a specialized consultant is used to understand the solar industry and the value chain. CoatingCo had to do more development on the coating to make it suitable for solar panels. Being a big company with a lot of R&D resources, the company managed it quite fast. A cross-functional team including a dedicated research group and business developers within CoatingCo collaborated with each other on technology breakthroughs that improve efficiency while at the same time allowing significant cost reductions in solar systems. Although CoatingCo made use of Dutch legislation that provides tax facilities for companies who perform R&D work, the Business Development Manager at the CoatingCo Innovation Center explained that subsidies were not critical for the company.

Development and commercialization of the technology are undertaken in close cooperation with customers. As the fast-developing solar market was new to CoatingCo, from the early stage of development, the team collaborated with potential clients to test the product and explore technical issues. CoatingCo and key players in the solar market had limited knowledge about the exact requirements because CoatingCo's anti-reflective coating had never been applied on solar panel glass. Throughout the process, CoatingCo worked with leading independent research institutes to evaluate the efficiency and the durability of solar glass coated with its anti-reflective coating- both in the lab and running field tests. As well, the company worked closely together with equipment manufacturers to develop new technologies to apply the coating to the panel glass because a special deposition procedure had to be developed.

To facilitate the commercialization of the technology, CoatingCo defined its business model based on the targeted market segment and the structure of the value chain. As CoatingCo introduced its anti-reflective coating on the solar glass, there was a small scale in the beginning, and CoatingCo had a small production unit to make small batches. When demand was increased, in 2013, CoatingCo decided to increase its production capacity. Therefore, the company opened its newly constructed manufacturing plant for the anti-reflective coating in partnership with a leading solar glass producer. The need for additional coating supply was a direct result of a fast-growing solar panels market. Responding to a growing global demand, CoatingCo decided no longer to coat a glass by itself. Currently, the company only produces the coating liquid; customers and glass manufacturers apply the coating to the solar panels. CoatingCo also provides them a lot of knowledge on how to implement the coating and how to get the best quality.

In September 2014, CoatingCo inaugurated the first Solar Technologies Demonstration Center in Pune, India. The aim of the demonstration center was to showcase CoatingCo's enabling solar technologies to customers and stakeholders around the world. Notably, the demonstration center validates the performance of anti-reflective coating technology. A Business Development Manager at the CoatingCo Innovation Center explicated the purpose of the demonstration centers:

> *"The industry is growing very fast. You can do a lot of lab testing. The lab is always different from real life. In the lab, you can do an accelerated testing, but you have to prove that it works in real life. Customers in the early years were not only asking for lab data, but also for real data. You can get real data from customers; however, the customers do not like always collaborate. Thus, we decided also to set up a couple of test parks ourselves where we installed different technologies; not only* CoatingCo*'s technology but also some competitors' technologies at the same site to compare the*

performance. Now we are testing the technology at least in fifteen locations worldwide."

Over the recent years, CoatingCo has expanded its solar portfolio to build a solar platform and to extend its offering to the solar photovoltaic (PV) market. Doing this, the company has made significant progress in the development of its portfolio, particularly complementary products to its coating technology, through acquisitions and partnerships. For example, in 2013, CoatingCo acquired a Dutch start-up, which has developed an innovative light trapping technology that can significantly increase the efficiency of solar panels. Activities such as demonstration projects and expansion of its solar portfolio allow CoatingCo to position the company compared to competitors strategically.

4.2.3. CoolingCo

To commercialize Gas-Free Magnetic Cooling Technology for refrigerator applications, a Company was founded in 2005. The company has established two main departments; i.e., Business Development Department and Technical Development Department. The company applies cross-functional collaboration for successful implementation and commercialization of the technology. CoolingCo has mostly focused on refining its technology towards lowering costs and production footprint and developing new components to improve the product. This happens mostly internally, in the form of trials. Doing this, the company took the first step and contacted a government agency to learn about their funding options. Initially, funding is raised from a range of early-stage investors and matching grants. CoolingCo also won a research grant from the Carbon Trust, the independent company set up by the UK Government to promote low carbon technologies. Furthermore, CoolingCo enjoys significant collaborative R&D funding from the European Union. Accordingly, CoolingCo has used resources whenever and wherever available to create an engine that is capable of cooling magnetically. These funding programs have also enabled the company to develop a strong industrial ecosystem that is driving the sustainable growth of the magnetic cooling industry. For example the Executive Director Business Development of CoolingCo mentioned:

> *"European Union public funding was very instrumental for us to establish the ecosystem. We have been able to raise ten Million Euros through public grants for the whole of the ecosystem. If we take off, everybody can also take a piece of the pie."*

From the beginning, CoolingCo has engaged in making partnerships to get access to complementary resources and competencies for its innovation project. The most advanced collaboration started in mid-2009 with a white goods manufacturer, to develop a domestic refrigerator based on CoolingCo's technology. To facilitate collaboration with big manufacturers, the company submits applications together with them for public grants. Currently, CoolingCo is working with mainstream domestic manufacturers. These partnerships provide a great opportunity for CoolingCo to connect to end-users of the technology to considerably expand awareness and uptake of its technology into new business areas. The Executive Director Business Development of CoolingCo argued:

> *"Engaging with the industry at the very early stage of development was the key. When you work with a disruptive technology, you cannot go there with a new machine and say: test it. You need to work side by side because they also provide you their needs. You understand better what they need. It is a long-term process, as a matter of fact, to enable the adoption of a disruptive technology."*

Accordingly, the company developed magnetic cooling prototypes in collaboration with the fridge manufacturers to indicate the technical and economic feasibility of the technology in the domestic refrigerator market. CoolingCo also teamed up with the leading research institutes in the UK to make magnetic refrigeration the future solution for high efficient and gas free domestic refrigerators. To capture value from the technology, CoolingCo has defined “licensing” as the business model of the company for commercializing the technology. It means that the company sells to the customers the design and rights associated to this and produces revenue from the related patents.

4.2.4. SimulationCo

Co-founders introduced the simulator into the market in 2011 via a spin-off company from a university, i.e., SimulationCo. During its startup phase, the company was taken under the wing of a startup incubator and Climate-KIC partner. Climate-KIC is a Knowledge and Innovation Community set up by the European Institute of Innovation & Technology (EIT). Its goal is to spark and deliver innovative solutions to climate change via a powerful alliance of European partners drawn from academia, industry and the public sector. It provided them with excellent facilities and offering them the necessary support. In July 2011, SimulationCo moved into the incubator; a leading technology incubator in Europe. The incubator supports new technology start-ups with the aim of allowing them to grow innovative companies. SimulationCo’s CEO commented on what the incubator yielded for the company:

> *“It's a beehive where many parties come. For example venture capitalists. As workers, we also desperately need coaches with experience. Everyone comes here, so, very quickly, you talk with the right people.”*

Joining the incubator allows SimulationCo to meet people from Climate-KIC. Accordingly, SimulationCo applied for and was accepted to Climate-KIC’s Acceleration Program; gaining access to expert coaching, and a welcome €75.000 grant funding that comes with it.

A core value of SimulationCo is customer engagement and support in customer solutions. From the beginning, the company has involved the client in its product development. By thinking actively with its clients, SimulationCo delivers tailored solutions to the requirements of its customers. Accordingly, the company serves customers across the world by focusing on customer needs and creating products that meet those needs.

Until December 2014, no external capital was involved in developing the business of the company. The company was being self-funded by the founders. As well, SimulationCo was receiving funds through the start-up incubators and acceleration programs. Accordingly, the company has used resources whenever and wherever available to develop its business. However, as there was a growing demand for its products, more capital was needed to meet this growing demand. Thus, SimulationCo decided to raise funds from the market by partnering with a venture capitalist to expand its business and meet the growing demand. The company wanted to use the money to attract additional people and had the ambition to expand into Asia.

To support the development of new solar simulator systems, as well as to reduce manufacturing costs, SimulationCo continuously builds relationships with major research institutes and manufacturers. Working closely with research institutes, the company can keep the innovations and the developments in the solar market closely watched. For example, in 2014, the company started a collaboration with partners including some research institutes on the development of a new type of solar simulator.

Initially, SimulationCo started selling solar simulation systems to the solar energy market in the Netherlands; mainly to research institutions, scientific bodies, and technical universities for conducting degradation studies and for long-term accelerated life testing studies on solar panels. Since then, in 2012-2013, the company has been approached by the bioenergy industry, the automotive industry as well as the chemical industry. For example, the chemical industry is interested in measuring the degradation effects of sunlight on paint and furniture. Accordingly, the company looks further into other industries to make the technology commercially more available.

SimulationCo has developed the simulator in different variants. The company continually refines and improves the products that it has, while working to develop entirely new solutions in all areas of solar technology. This product differentiation also helps the company to make the technology more available by meeting the customers' needs.

In early 2016, SimulationCo acquired the solar testing division of an American company in an asset deal funded through a capital injection from SimulationCo's investing partner. Through the acquisition of this complementary technology, SimulationCo takes the next step in its journey to become the international leader in the development and testing of solar panels. The two companies address different markets and together can offer quality control, insight and confidence across the entire supply chain.

SimulationCo has three types of revenue models: selling the simulators, replacing parts and maintaining services; selling the lamps that need to be replaced and recalibrating the system after a certain amount of usage, and providing testing services instead of supplying a system. These various revenue streams allow SimulationCo to capture value from almost the entire solar value chain.

SimulationCo was able to sell internationally quite fast by finding good strategic sales partners. As the company does not have its sales force to do that worldwide, the company markets and sells the products largely through a network of channel partners, which includes distributors, resellers, and equipment suppliers. Accordingly, the company has used the infrastructure of its local environment for marketing and selling the products.

4.3. Reconfiguring

Table 5.5 presents the practices that comprise Reconfiguring capabilities of the case companies for innovating towards sustainability.

Table 5.5 Summary of the practices comprising reconfiguring capabilities

Second-order themes	First-order themes	
Microfoundations	**Similar practices (replicated across all cases)**	**Company-specific practices**
Sustainability is a key driver of companies' innovation strategy	Defining and pursuing innovation projects aimed at new product and applications with significant sustainability advantages.	
Marketing in conjunction with technology development	Marketing in conjunction with technology development;	Calibrating the technology for the market needs (FilmCo, CoolingCo).
Managing the technology development expectations and ambitions	Managing the technology development expectations and ambitions;	Recalibrating the strategic focus towards a new market opportunity (CoatingCo); Establishing a company (CoolingCo, SimulationCo); Defining and satisfying organizational needs (hiring new personnel, building new organizational structure and a new team) based on the strategic approach of the company towards the technology (CoatingCo, SimulationCo).
Pursue open innovation practices	Partnership and collaboration with other organizations;	Acquiring a company (CoatingCo, SimulationCo).
Orchestrating the business ecosystem	Actions to build the value chain's stakeholder collaborations to pursue opportunities.	

4.3.1. FilmCo

According to a strategic decision of the company about the sustainability opportunities, the aim of the company is to create sustainable solutions and product platforms to help its customers manage their environmental footprint. Daylight Redirecting Film helps the customers to ease energy consumption by providing natural lighting deeper inside a building and reducing the use of electric lighting in the building. It is also found that the company has done marketing in conjunction with innovation development. It means that the development of the product was dependent on both the requirements that are found by the marketing division and the capabilities of the scientists. However, the learning processes around the daylight redirecting film shifted from learning the market needs to a more technical learning process during the development process. As the Business Development Manager at FilmCo said:

> *"The early stage gates were more market focused on making sure we are developing something that makes sense, given what we know about the market. And the later stages were much more about the ability to manufacture the product."*

As the prototype film was developed and the demonstration project was implemented, it became clear that a diffusing film must be positioned in front of the redirecting film to reduce or eliminate glare. Furthermore, the project team learned that the redirecting film should be integrated with the diffusing film. Accordingly, the company has gathered and incorporated the feedback of demonstration project into the technology development, i.e., demonstration project learnings, leading to calibrating the product for the market needs. Establishing sales channels and initiation of partnerships with window manufacturers have helped the company to build the value chain's stakeholder collaborations to pursue the innovation opportunity.

4.3.2. CoatingCo

Sustainability is an important business driver in addition to being a core value and responsibility for CoatingCo. As a result, sustainability plays a central role in innovation, new product and business development, operations and strategic decisions of the company. CoatingCo's technology enhances the yield of solar panels that make solar energy more viable and affordable. Put differently, although initially, the company focused on solar as the best market for its technology, sustainability was certainly a driver for CoatingCo to bring it to the next level.

CoatingCo has launched an engaging marketing strategy to support its coating technology. It means that the company has conducted marketing among the different players in the value chain to engage them in the technology development. Marketing in conjunction with technology development enables the company to develop and modify the technology according to the requirements of the customers to increase the value it captures from the technology. This marketing strategy plays a decisive role in understanding the customer needs and market dynamics.

To manage growth expectations and ambitions related to solar enabling technologies, particularly, the coating technology, CoatingCo has defined and changed its organizational structure based on its strategic approach towards the technology. For example, as CoatingCo decided to upgrade or promote the Incubator's Functional Coatings program to an Emerging Business Area, it built a new team. In the beginning, the company had only a small team, two to three people. But it quickly started hiring a lot of industry experts; also some people from China to locally develop and sell to the solar industry in China. Accordingly, CoatingCo built R&D teams and technical service teams to accelerate growth.

To better be able to develop the coating technology and to discover the solutions and new opportunities in the solar market, CoatingCo uses a so-called open innovation approach, to continuously look at the outside world. For example, the company has bought one start-up company with an interesting technology for complementing its coating technology. In June 2014, CoatingCo entered into a three-year research program alliance that focuses on developing new solutions for solar modules efficiencies. An employee of CoatingCo said:

> *"This collaboration is an excellent example of our strategy for open innovation, bringing together the best technologies from both industry and academics to create new record-breaking technologies in the solar energy field."*

Good cooperation and shared interests were crucial for the development and commercialization of CoatingCo's coating technology. That is why the company has engaged all players in the value chain to collaborate in the technology development and commercialization process. The players are not only the direct customers, producers of the cover glass of solar panels to which the coating is applied - but also the manufacturers of the panels. The company also has some strategic partnerships in the value chain. For example, in October 2014, CoatingCo partnered with a Finnish supplier of production and research equipment to develop and commercialize jointly a completely new and superior aerosol deposition technology for solar glass applications.

4.3.3. CoolingCo

To lead the technology to its greatest competitive advantage, CoolingCo has defined a strategic focus for its technology development. Its technology seeks to deliver a 100% improvement in energy efficiency while maintaining a competitive cost compared to traditional vapor compression technology. The company aims to become a worldwide leader in energy-efficient and gas-free refrigeration technology. For managing the technology development expectations and ambitions, the release of the technology has been postponed two times; a first plan was 2014, then 2016, but now 2020; the solution is still not cost effective enough compared to vapor compression technology. During this time, the company has calibrated the technology for the market needs. The focus of the company has been mostly on developing and improving the technology towards better performance and cost-effectiveness.

During the last ten years, the company has built an ecosystem. It is comprised of end users, domestic fridge manufacturers, the alloys suppliers, research centers, and universities. Currently, CoolingCo is looking for strategic partners to expand the business ecosystem around the innovation opportunity. Open innovation logic has inspired both a public grant funded framework for establishing a consortium and several bilateral cooperation agreements. The Executive Director Business Development of CoolingCo explained how the company started orchestrating an ecosystem:

> *"As we started, there were only a few research papers on these new alloys. There was nothing. The challenge was huge. First of all; you need to build up a sort of ecosystem. Doing so, we needed to put in place very disciplined processes to approach big companies where they are still in charge of producing these alloys in bulk. On the other hand, you need to engage since the beginning with end users. As we experience, we are confronted with a technology, traditional vapor compression technology, which has been developed and redefined in an incremental way since seventy years ago. Even the language of the people we were talking to was different. Their first reaction was that they are not interested. We have already a well-known and established technology. It took a while to build the right relationship with them. Currently, the industry is going under very strict regulation as far as domestic refrigerators' efficiency is concerned."*

4.3.4. SimulationCo

SimulationCo focuses on lean product development and fast customer development. Marketing in conjunction with the technology development allows the company to be flexible and provide customers with equipment that suits their needs. The first delivery was scheduled four months later from the first prototype development. Meanwhile, the solar simulator gets excellent evaluations from the international community of solar simulation. As pilot customers already paid their second and third prototypes, the company managed to reach market fit very quickly and bootstrapped its business. Also, requests came from other parties or industries including coatings, automotive dashboards, and components. Accordingly, SimulationCo found customers all over the world within 1.5 years after its foundation. The CEO of SimulationCo has explained two reasons behind this success; i.e., a combination of having an early prototype and having a remedy to their customer's pains.

SimulationCo grew from two employees in 2011 to fourty employees in 2017. The company has hired new staff, established new teams, and acquired one of the largest suppliers of equipment for solar panels to be able to manage the technology development better and meet the growing demand for its equipment. In early 2016, SimulationCo took over an American rival company and established SimulationCo Group. Following this acquisition, the company can also serve the manufacturers of solar panels. In addition to this complementary technology, SimulationCo benefits from the brand, market access and talent pool of the acquired company's employees related to the simulator business.

The company continuously strengthens the partners' network by building up new partnerships to develop its products. Mainly, SimulationCo is looking for strategic partners that have an excellent knowledge of the solar market, the market the company operates, and about selling high-tech systems. The company also keeps the innovations closely watched. The CEO of SimulationCo mentioned that:

> *"We still see ourselves as a start-up; hungry for innovation and improvement. SimulationCo witnesses the developments closely."*

Accordingly, the company pursues open innovation routines to bring new products to the market in cooperation with partners. For example, SimulationCo joined a Dutch consortium to develop a new hybrid system, a combination of a climate chamber with a sunlight simulator, to gain insight into the behavior of all types of solar cells and mini-modules that were previously unattainable.

5. Discussion

The purpose of this study was to explore the development and heterogeneity of firms' dynamic capabilities for innovating towards sustainability. Based on within-case analysis of each case company, we found practices that comprise dynamic capabilities for each case company. Then, we performed a cross-case analysis of all cases to find similar practices that are replicated across all cases. Within this replication logic, we also had an eye for differences in the companies' practices in detail. Finally, sensitized by Teece's (2007) tripartite form of dynamic capabilities, we managed to distill the replicated practices of dynamic capabilities into a theoretical level of themes; i.e., microfoundations. This step enabled us to find the essence and logic of the development of dynamic capabilities for innovating towards sustainability.

5.1. Sensing: Opportunity formation process

Our study finds that companies mainly rely on sources within companies for recognizing innovation opportunities for sustainability. As the innovation opportunities for sustainability are recognized, the companies start shaping the opportunities. In other words, the recognition of opportunities is followed by underlying processes of 'strategic selection.' Strategic selection involves organizational activities through which companies identify a preferred alternative for organizational change, such as the evaluation of potential alternatives for their current knowledge and competencies (Zott, 2003). The organizations in our cases use strategic selection to assess the opportunities for making strategic decisions about them.

Sources within companies. This study finds that companies' dynamic capabilities for recognizing innovation opportunities for sustainability are initiated from 'individual entrepreneurial resources' and are grounded on organizational routines of research and development activities. Put differently, the companies' dynamic capabilities for sensing innovation opportunities for sustainability are initiated and championed by corporate scientists or start-up founders. For example, in the case of FilmCo, a corporate scientist used existing knowledge and competencies, particularly existing patents of the company, for new potential applications. In the case of CoolingCo, the innovation opportunity for sustainability was recognized by one of the founders due to his alertness to the newest research findings in a university in the UK. Thus, corporate scientists or start-up founders discovered the innovation opportunities based on their cognitive orientation, insights, and their alertness to the patent specifications; i.e., "recognition of opportunities" (Alvarez et al., 2013). Narayanan et al. (2009) argue that cognitive orientation not only involves the belief in the efficacy of a new opportunity but also the understanding that there is a need for a new initiative for using the opportunity. Alertness also reflects differential knowledge and information that individuals have about an opportunity (Kirzner, 1978). According to Kirzner (1978), "alertness" is the main difference between entrepreneurs and non-entrepreneurs. Mosakowski (1998) also propose that the creativity, foresight, intuition, and alertness possessed by an individual can be defined as "individual entrepreneurial resources." Therefore, it is revealed that companies' sensing capabilities for identifying innovation opportunities for sustainability rely on sources within companies; i.e., individual entrepreneurial resources, existing knowledge and competencies, and internal R&D activities within companies.

Anticipation processes. In this stage as a cognitive process, incumbent companies evaluate multiple alternatives concurrently to calculate the fitness of alternatives to the business and sustainability strategies of the companies. Our incumbent case studies used organizational practices including primary market research activities and competitor analyses for developing a concept or finding the potential applications for the recognized opportunities. The study shows that the incumbent companies have an enabling structure, incubator programs, for assessing and shaping innovation opportunities for sustainability. For example, in the case of FilmCo, the 15 percent rule as an individual initiative, unique to FilmCo, allows employees to work on ideas that are not related to the business they are working in. For the case of CoatingCo, as the recognized innovation opportunity did not fit to the product portfolio of the researcher's business cluster, the technology was transferred to a Business Incubator at the CoatingCo Innovation Center to find potential applications and opportunities for it. It is concluded that the incumbents have a structured process in place and commit appropriate resources for assessing and shaping innovation opportunities for sustainability that are widely accepted at several hierarchical levels of the companies. It is also found that start-ups carried out primary market research activities and competitor analyses for shaping the recognized opportunities. These practices help founders to know which market could be addressed best. Furthermore, they help the start-ups to achieve a more advantageous position compared with rivals. We find that building on an existing network of contacts; the start-up companies recognize new market opportunities for their technologies and find new resources and partners to develop their businesses. These findings show that studied start-ups did not have dedicated resources and formalized enabling structures for sensing opportunities.

5.2. Seizing: Implementation and commercialization of innovation

Once an innovation opportunity for sustainability is recognized and shaped, companies need to allocate and mobilize resources/competencies for seizing the sensed opportunity. Put differently, the sensing of potential innovation opportunities for sustainability is only the first step toward implementation and commercialization of innovation opportunities for sustainability. As the opportunities are sensed, companies engage in organizational routines and entrepreneurial activities to exploit these opportunities.

Developing internal capabilities. Our study indicates that innovations for sustainability are mainly developed internally within the organizations. Accordingly, developing internal capabilities is a key enabler of companies to innovate for sustainability which often needs a high degree of novelty. Although large companies have higher resources and capabilities for internal technical development, the studied start-ups also develop innovations internally due to the degree of novelty or newness of given technologies. It is also found that during the innovation development for sustainability there is a cross-functional collaboration inside the companies for products development and positioning in the market. Cross-functional collaboration refers to the degree of cooperation and the extent of representation of marketing, research and development (R&D), and other functional units in the product innovation process (Luca & Atuahene-Gima, 2007: 95). Cross-functional collaboration leads to communication and sharing of information across functions to integrate internal and external expertise. The literature argues that cross-functional integration and coordination is one of the important factors for providing support to innovate for sustainability in organizations (Dangelico, 2016; Pujari, 2006). The cross-functional collaboration combines technological, financial, and market data and leads to evidence-based decision making for the innovation development (Kester et al., 2011).

Engaging customers into the innovation process. The study shows that understanding customer needs is a key part of any innovation process for sustainability. It is found that incumbent companies rely on both systematic formal market research and market probing routines to elicit customer preferences and estimate potential revenues. For example, both incumbent companies used specialized consultants to understand the market needs and the industry value chain. For market probing, early drafts of the technology products, i.e., prototypes are exposed to potential customers to find and meet their needs. This is consistent with the literature on conventional innovation which rests principally on large, established companies research (Berends et al., 2014). In line with the argument of Adams et al. (1998), market research helps innovators overcome the barrier of avoiding ambiguity and uncertainty of market acceptance of innovative products and technologies for sustainability. Probing the market with prototypes is a method for engaging customers into the innovation process (cf. Schaarschmidt & Kilian, 2014). However, in our incumbent cases, it was not a customer co-creation approach. The customers were viewed more as passive responders to new technologies or products rather than as active co-creators. Regarding the start-up companies, we find that start-ups also engaged with the potential clients from the early stage of development to find and meet their needs. The start-up companies relied on feedback from customers by probing the market with prototypes. Accordingly, from the beginning, the start-up companies have actively involved the customer in their product development. Although formal market research is seen as a best practice in incumbent companies' innovation for sustainability, we find that, unlike large companies, start-ups did not engage in any systematic formal market research activities. Accordingly, in both organizational contexts, i.e., incumbents and start-ups, companies react to their market environment by engaging with the potential clients/customers from the early stage of technology or product development to find and meet their needs. Accordingly, their approach towards the business environment, particular customers, is an adaptive feedback-seeking and feedback-incorporation process. However, start-ups have a stronger involvement of customers and cooperation partners in their innovations for sustainability. It is a co-creation approach; however, incumbents get feedback to meet the customers' needs.

Market introduction activities. We find that market introduction activities such as prototyping and demonstration project play a significant role in the successful development and market acceptance of innovative technologies or products for sustainability. For example, after developing earlier prototypes of technologies, the studied incumbent companies performed demonstration projects to improve their technologies technically, and also prove the performance of given technologies in the market. It is argued that the demonstration project is an effective organizational routine to transform a clean technology prototype into a marketable product (Bossink, 2015; Bossink, 2017). For the case of start-ups, they did not have formal demonstration projects. However, prototyping was an important practice for them to inform potential customers about the advantages and benefits of their innovative products or technologies. Prototyping also helped them to adjust further, improve, and adapt the products or technologies to market needs.

Resource allocation and investment. Our study finds that companies' resource allocation processes play a critical role in innovation for sustainability. It is highlighted that resource allocation, and investment allows companies to develop and acquire required capabilities for innovation. Resource allocation and investment have long-term and far-reaching effects on the way in which they shape the sets of resources and competencies used to innovate for sustainability. Agarwal and Helfat (2009) argue that resource allocation and investment in new technologies as a strategic renewal process is critical to enterprise performance. Resource allocation and investment not only involve investment in research activity and the probing market needs; but also involve understanding and gaining technological capabilities through acquisitions. Commercialization activities such as prototyping and demonstration projects also require investment and financial resources. Comparing the studied companies, it is highlighted that incumbent companies rely on internal resources for their new investments to innovations for sustainability. Although they also leverage external resources whenever and wherever they are available, these resources are not critical for large companies. Concerning start-ups, we find that start-ups use external resources whenever and wherever they become available to the companies and focus on working towards possible effects that can be created with these resources. The start-ups often join start-up incubators for guidance and resources. As well, the start-up companies acquire resources through market transactions or contract-based agreements with stakeholders of the value chain. These companies rely heavily on founders' resources and external financial resources.

Co-specialization of resources and competencies. Although both incumbent and start-up companies have patented the products or technologies to protect their knowledge and competencies from outsiders, the companies interact and involve other partners in their innovation activities for sustainability. Our empirical evidence suggests that companies engage in complementary partnerships in their innovative efforts for sustainability. They select the partners based on complementary resources and competencies that they need to innovate for sustainability. It is found that cooperation and partnership with outsiders allow companies to tap external knowledge and competencies, and thus profit from their cooperation partners' expertise by complementing their internal knowledge and competencies. De Marchi (2012) argues that the development of innovation for sustainability is often more challenging for companies than the development of conventional innovations. It is because sustainable innovations represent a technological frontier where companies are still inexperienced and often require knowledge and competencies from beyond what is available internally. Our study finds that for innovating towards sustainability, companies cooperate mostly with customers and research institutes. It is also found that in the context of start-up organizations, the partnerships with outsiders are more contingent on the involvement of them as committed partners. It means that start-ups search for partners that commit to provide resources to co-innovate for sustainability.

Delineating the business model. Our study illustrates that flexible business models help companies to adapt to changing customer needs and the value chain of given industry. It is found that an adaptable business model to the targeted market segment and the structure of the value chain has a key role in the successful commercialization of innovations for sustainability. A business model demonstrates how a company creates and delivers value to customers (Teece, 2010). Baden-Fuller and Haefliger (2013) conceptualize the business model as a system that solves the problem of identifying who are the customers, engaging with their needs, delivering value, and outlines the architecture of revenues and profits associated with delivering that value. For example, CoatingCo used alternative business models depending on the targeted market segment and the structure of the value chain to facilitate the commercialization of the technology. SimulationCo has three types of revenue model: selling the simulators, replacing parts and maintaining services, and testing services. We also find that the studied companies adopt organizational routines such as industry differentiation, product differentiation, and the acquisition of complementary technologies to make their technologies commercially more available. These routines help the companies to make their business model more effective and create value for distinct market segments with clearly differentiated needs.

5.3. Reconfiguring: Strategic renewal of companies' resources and competencies

Case analyses illustrate that companies capabilities for sensing and seizing innovation opportunities for sustainability rely heavily on the companies' capabilities for strategic renewal of resources and competencies. Companies should have in place organizational routines and competencies that allow them to align and orchestrate internal and external resources and competencies for innovating towards sustainability. Thus, to innovate for sustainability companies need to keep pace with the internal and external dynamism such as changing markets, technology capabilities, and customer demands, and continuously achieve strategic fit.

Sustainability is a key driver of companies' innovation strategy. This study finds that one of the key microfoundations associated with the firms' reconfiguring capabilities is to define and pursue innovation projects aimed at new products and applications with sustainability advantages. In the studied incumbent companies, sustainability was a driver for companies to assess, select, and bring it to the next level, i.e., seizing. Accordingly, there is a sustainability-oriented mental model within the companies. In that regard, individual entrepreneurial resources and managerial cognition play the crucial role of messenger and ambassador, proposing and leading change while championing innovation opportunities for sustainability. Although, start-up companies did not have a formal innovation strategy; sustainability was the created value proposition of their business model around the innovation opportunities. Pisano (2015) argues that an innovation strategy enables companies to make trade-off decisions and choose all the elements of the innovation system. Thus, sustainability as the driver of companies' innovation strategy plays as a guiding policy and cohering element in sensing and seizing the innovation opportunities.

Marketing in conjunction with technology development. This study illustrates that studied companies have conducted marketing in conjunction with the innovation development. This enables the companies to develop and calibrate the technology according to the requirements of the customers and market needs. Put differently, doing this enhances the adaptability of new products and technologies to market needs. As there is a high market uncertainty for sustainability-oriented innovations (Karakaya et al., 2014), this approach involves customers into the development process of innovations. Thus, it minimizes market uncertainty and adequately stimulates demand for sustainable innovations. Boström et al. (2015) argue that pathways towards coping with market uncertainty and complexity of sustainable innovations go through learning the market needs. The implication of this predictive process is that the end product fits the selected market.

***Managing the technology development expectations and ambitions*.** Findings of the study show that the studied companies took an iterative, stepwise approach to innovation for sustainability. The companies did not use strict and detailed planning for managing the technology or innovation development. They worked in steps toward tangible outcomes, such as the concept development, market positioning, prototyping, or subsequent variants of the same product. These steps enable the companies to reexamine the innovation projects in the market and to move them forward, with the latest information, options, and possibilities. This microfoundation enables companies to renew their resources/competencies and manage to reach market fit gradually over time. Helfat et al. (2007) argue that the extent of evolutionary fitness depends on how well the dynamic capabilities of a company match the environment in which the company operates. For example, CoolingCo has postponed the release of its technology two times because the solution was not cost effective enough compared to current technology. Accordingly, to compete with the current technology and create a market demand, the company has calibrated the technology for the market needs. It means that for innovating towards sustainability, firms' dynamic capabilities should provide and increase the evolutionary fitness of the innovative products and technologies for prospering them in the marketplace.

Pursue open innovation practices. Our study shows that for innovating towards sustainability, companies need to adopt open innovation practices to achieve higher innovation results. In the case companies, innovation for sustainability frequently demanded the inclusion of external partners such as customers, suppliers, research institutes, and other companies throughout the innovation development process. The study, particularly, asserted the importance of collaborating with customers in the development process of innovation to achieve marketable products. Acknowledging that sustainability issues are not generally core competencies for most companies, this imperative requires companies to enhance their competencies by collaborating with other organizations outside their boundaries. This finding is in line with the existing empirical literature (e.g., Cainelli et al., 2015; De Marchi, 2012; Klewitz et al., 2012) which argues that companies need to collaborate with parties outside their organizational boundaries for innovating towards sustainability. Our study also shows that partnership and collaboration with other organizations, particularly, with research institutes, help companies to gain more credibility and legitimacy in the market.

Orchestrating the business ecosystem. We find that orchestrating the business ecosystem is one of the most important microfoundations of firms' dynamic capabilities for innovating towards sustainability. Alvarez et al. (2013) argue that opportunities are being exploited if they are socially constructed and coevolved. This needs co-evolutionary processes that enable entrepreneurs to co-enact with other actors of the value chain to shape and exploit the opportunities. Orchestration involves organizational routines and entrepreneurial actions such as enhanced interaction and strengthening the partners' network for building the value chain's stakeholder collaborations to pursue and exploit innovation opportunities for sustainability. Accordingly, companies need to convince the value chain's stakeholders or even their people of the value of sustainable innovation. Put differently, the companies are not only responsible for the direct management of the innovation project for sustainability but also for adopting organizational routines and entrepreneurial actions that support the systematic development of the value chain for innovation.

5.4. Implications, limitations, and future research

Our findings contribute to the literature of innovation development for sustainability especially by investigating dynamic capabilities in different organizational contexts. First, the study indicates that innovation for sustainability is an inherently dynamic process, which its success is dependent on how well dynamic capabilities enable a company to create, extend, or modify its resources and competencies; i.e., evolutionary fitness. Accordingly, the findings demonstrate that dynamic capabilities significantly help companies to leverage entrepreneurial resources for innovating towards sustainability. Second, our study contributes to the literature on innovation for sustainability and dynamic capabilities by shedding light on the actual processes and practices that comprise firms' dynamic capabilities for innovating towards sustainability. The study shows that firm's dynamic capabilities for innovating towards sustainability do not simply emerge; rather they are identified and built through the intentional effort of entrepreneurs and managers, who configure and orchestrate clusters of activity to achieve sustainable innovation. Third, the study confirms that although firms' dynamic capabilities for sustainable innovation are idiosyncratic in their details and path dependent in their emergence. However, they have noteworthy commonalities across firms, particularly per different organizational contexts: incumbents and start-ups. Eisenhardt and Martin (2000) term these commonalities as "best practices." Commonalities imply the efficacy of particular dynamic capabilities across a range of companies. Although some commonalities are identified in the case companies, the goal, sequence, and extent to which they are implemented and activated vary across companies due to the firms' idiosyncrasies and to the stimuli of innovation projects. Therefore, microfoundations should be considered more as propositions than as essential requirements.

Findings of the study also have managerial implications. Understanding how dynamic capabilities are built, maintained, extended, leveraged, adapted, and phased out in terms of their constituent microfoundations has general managerial relevance. First, this study improves the understanding of how resources and competencies are deployed and sustainability value is created by firms through sustainable innovations. In other words, how sustainable innovation can be managed in different organizational contexts: incumbents and start-ups. Focusing on microfoundations of firms' dynamic capabilities for innovating towards sustainability enables managers to drill down to a level of detail that would not otherwise be possible and thereby devise strategies for the implementation and commercialization of innovation opportunities for sustainability. Second, the identified microfoundations provide managers insights into the aspects through which companies can focus on their innovative efforts for sustainability to enhance sustainable innovation activities. As the microfoundations and compromising dynamic capabilities have path-dependency and are related to the idiosyncrasies of the particular company, managers should consider their company's specific situation and the environment in which they are operating for choosing and developing situation-specific microfoundations. Finally, the study highlights the role of individual entrepreneurial resources and managerial cognition in directing the capability-development path. It is noted although there are commonalities across the cases' dynamic capabilities for innovating towards sustainability. The logic and mechanism behind these commonalities are strongly dependent on the requirements of the business environment and the organizational context of companies. Therefore, practitioners should be aware of how their managerial cognition and entrepreneurial actions potentially affect the development of dynamic capabilities for innovating towards sustainability.

The study's limitations invite further research. The main limitation of this study is its reliance on retrospective data which could impact the completeness and accuracy of the gathered data. We adopted some measures to limit this retrospective bias, such as using both archival data and interviews. However, future research would benefit from gathering and analyzing the dynamics of sustainable innovation development in a real-time longitudinal study. We also see opportunities to adopt theories of entrepreneurship for investigating the development process of companies' dynamic capabilities. It is found that entrepreneurial resources and actions play a critical role in the development process of innovation for sustainability. Future research could adopt, for example, effectuation theory (Sarasvathy, 2001) to investigate the logic behind the development of firms' dynamic capabilities for innovating towards sustainability. Put differently, effectuation theory, which emerged in entrepreneurship studies (Sarasvathy, 2001), enables us to advance our theoretical understanding of how sustainable innovation unfolds in companies.

6. Conclusions

In sum, our findings show that all of the different categories of dynamic capabilities; i.e., sensing, seizing, and reconfiguring capabilities, are essential for managing and developing innovation for sustainability. We find that companies sensing capabilities to identify and shape the innovation opportunities for sustainability are grounded on sources and anticipation processes within companies. Particularly, the study emphasizes the role of individual entrepreneurial resources in identifying and shaping the innovation opportunities for sustainability.

Having sensed innovation opportunities for sustainability, companies have to adapt their business model to the targeted market segment and the structure of the value chain to commercialize the opportunities. It is found that companies' capabilities to seize the innovation opportunities for sustainability rely on both internal and external resources and competencies. Thus, for innovating towards sustainability, companies need to develop their internal capabilities including in-house R&D activities and cross-functional collaborations. Furthermore, the companies have to strategize to engage customers into the innovation process, to introduce the innovation to the market, to approach investment and leverage external resources to the innovation project, and to co-specialize complementary resources and competencies.

Our findings show that for innovating towards sustainability, companies use an iterative and stepwise approach to continuously renew their resources and competencies as sustainability criteria, technologies, market needs, and the value chain continue to evolve. Reconfiguring capabilities enable the companies to deal with the potential challenges of the recognized opportunities and maintain the competitiveness of their innovation in the marketplace. Thus, companies need to consider sustainability as a key driver of companies' innovation strategy. Furthermore, the companies have to focus on microfoundations of marketing in conjunction with technology development, managing the technology development expectations and ambitions, adopting open innovation practices, and orchestrating the business ecosystem.

Our study also investigates the logic and mechanism behind the development of dynamic capabilities in different organizational contexts. It is found that companies do not follow and do not deploy routinized practices for building the dynamic capabilities to manage innovation for sustainability. As well, commonalities across the case companies, particularly in start-ups, result from entrepreneurial actions of the companies. They have evolved over time in the case companies independently and endogenously. Therefore, we suggest that firms' dynamic capabilities for sustainable innovation include not only organizational routines but also individual and managerial entrepreneurial resources and organizational competencies. Thus, companies' dynamic capabilities for innovating towards sustainability have to be developed 'in-house' through a set of activities and cognitive processes focused on the organizations' routines.

Chapter 6
Business-NGO Collaboration for Innovating toward Sustainability: KLM and WNF Creating a New Market for Sustainable Biofuels for Aviation[5]

Abstract

Although cross-sector collaboration between businesses and NGOs for sustainability has received much attention in recent years, existing literature does not sufficiently explain how companies' partnerships with NGOs influence organizational change and innovation towards sustainability. Adopting a dynamic capabilities approach, a process research method is employed to understand how such a partnership arises and evolves, and to observe in what way these dynamics influence the innovation process, with a particular emphasis on which contingencies contribute to its viability. The dynamic capabilities enable us to explicate the nature and essence of cross-sector partnership for innovating towards sustainability. Data was collected from and about an ongoing business-NGO partnership, working together to promote the market for sustainable biofuels for aviation. Our primary data collection method is the semi-structured interview. This study offers four strategic imperatives about managing innovation for sustainability in companies' collaboration with NGOs. First, before entering any partnership for sustainability, management should evaluate the strategic fit between cross-sector partners' strategic visions and long-term objectives towards sustainability. Second, the study demonstrates that developing an integrated mission as the partnership's outcome is needed to achieve a better collaboration for innovating towards sustainability. Third, sustainability has economic aspects; business also must work. Partners need to discuss and agree on specific evaluation criteria for sustainability early in the process of partnership formation. Finally, the study highlights that Business-NGO partnerships should contribute to formulating a novel and viable business model for sustainability or even support adjustments to companies' business models.

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[5] A version of this chapter was presented at the International Conference on Innovation and Sustainability Transitions (IST) 2017, Gothenburg, Sweden.

1. Introduction

Hall and Vredenburg (2003) argue that innovation is one of the primary means by which companies can reach sustainable growth; i.e., sustainable innovation. Research of sustainability transitions has shown that innovative firms are the key players in the creation, adoption, and diffusion of sustainable innovations as well as the most prominent actors responsible for sustainability challenges (Nidumolu et al., 2009). On the other hand, moving toward sustainability needs a socio-technical transition which not only entails new technologies but also changes in markets and governing institutions (Loorbach et al., 2010). Therefore, sustainability is a complex and multi-dimensional concept that cannot be addressed by any single corporate action (e.g., van den Bergh et al., 2011). Sectors' leaders agree that sustainability challenges require unparalleled cooperation to be addressed. In other words, no single organization or sector has the knowledge or resources to 'go it alone' (Gray & Stites, 2013). Recent studies have emphasized the growing role of cooperative arrangements in developing innovation for sustainability (e.g., De Marchi, 2012; Hartman et al., 1999; Horbach, 2008). Bos-Brouwers (2010) also shows that cooperation gives firms ability to compensate for the lack of resources. As a result, companies actively seek to collaborate with different actors/sectors for innovating towards sustainability (Nidumolu et al., 2009). Thus, partnership-based arrangements have become increasingly popular in recent decade to be able to manage complex social, economic and environmental problems (Harman et al., 2015).

A partnership can be described as a '*cross-sectoral collaboration*' or a '*coalition of interests*' (Harman et al., 2015) between at least two partners in the following sectors: business, non-governmental organizations (NGOs), government or communities. Partnerships help partners to leverage expertise and to share risks (Harman et al., 2015). Accordingly, the collaboration between NGOs and businesses is growing and becoming more strategically important in practice in the literature (Austin, 2000). Although cross-sector collaboration between businesses and NGOs for sustainability has received much attention in recent years, existing literature does not sufficiently explain how companies' partnerships with NGOs contribute to innovation for sustainability. Much of the previous studies looking at the partnerships for sustainability as a way for businesses to access and further develop various and complementary resources, and to manage legitimacy with clients/customers as a source of competitive advantage. These studies emanate from the perspectives of the Resource-Based View (RBV) (e.g., Hond et al., 2015; Lin, 2012), Resource Dependence Theory (e.g., Hond et al., 2015; Lambell et al., 2008), Stakeholder perspective (Holmes & Smart, 2009), Agency Theory and Transaction Cost Economics (e.g., Guay et al., 2004). Put differently, in cross-sector collaborations, the partners bring in various resources and competencies which promise to be complementary in the design and implementation of innovative solutions to sustainability challenges (Holmes & Smart, 2009).

Realizing innovative solutions for complex problems needs the creation and integration of practices across boundaries (Carlile, 2002). Thus, the involved partners need to go beyond their logic, organizational routines, and practices; particularly, for dynamic collaboration in evolving ecosystems (Carlile, 2002; Dougherty & Dunne, 2011). Accordingly, it is required to open further the black box of managing innovation for sustainability in cross-sector partnerships and investigate how cross-sector partnerships can be achieved and maintained.

Building upon a dynamic capabilities approach (Teece et al., 1997), the aim of this study is to answer the question of how companies' collaborations with NGOs influence organizational change and innovation towards sustainability. This study focuses on the nature of a business-NGO partnership to promote cross-sector resources and competencies for innovating towards sustainability, and the contingencies required for its success. The concept of dynamic capabilities as a coordinative management process opens the door to the potential for inter-organizational learning (Teece et al., 1997). Dynamic capabilities are the firm's ability to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape a changing business environment (Teece et al., 1997). Of note, the concept of dynamic capabilities is also apropos to explain organizational change processes in particular dimensions including innovation, entrepreneurial behavior, or organizational transformation (Ambrosini & Bowman, 2009; Helfat & Martin, 2015). The dynamic capabilities approach holds that the organizing process must extend beyond the company's boundaries as necessary resources/competencies are often found outside the company- embedded in inter-organizational resources and routines (Helfat et al., 2007). Thus, the dynamic capabilities approach is well suited to explain the formation of an effective business-NGO partnership for innovation towards sustainability and to explore the contingencies required for its success.

A process research approach is adopted to investigate the phenomena (Langley et al., 2013), as it is particularly appropriate for investigating the dynamics of collaboration between organizations. To address our research question, a research setting involving a long-running, ongoing business–NGO partnership is selected, working together on an innovation project for sustainability. In this project, KLM Royal Dutch Airlines (KLM) has focused on the potential of biofuels in the aviation sector for the climate change mitigation. As a partner of KLM with regard to this, World Wide Fund for Nature- the Netherlands (WNF), as an NGO, believes that the only way to prevent the planet from unacceptable climate change is to generate all energy from renewable sources. However, the biofuels market for aviation is in the early stages of development, production is not yet consistent, and the prices are higher than regular fuel; i.e., Kerosene.

Accordingly; KLM and WNF work together since 2011 to promote the market for sustainable biofuels for aviation.

The paper proceeds as follows. First, we provide an overview of the literature on the strategic collaborations between Businesses and NGOs. We also develop a conceptual foundation for the study by leveraging the dynamic capabilities approach to the phenomenon of business–NGO collaboration for innovating towards sustainability. Then, we explain our research methods. The fourth section presents the dynamics of partnership and its role in developing the innovation project. Next, we discuss the implications of the findings, describe the limitations of this study, and suggest possible future research. Finally, our conclusions will be presented.

2. Theoretical Background

2.1. Strategic collaborations between businesses and NGOs

The use of more collaborative and interactive organizational arrangements particularly collaboration with NGOs as an open innovation approach is driven by the need to address issues other than those of a purely economic nature (Holmes & Smart, 2009). These collaborations broaden a firm's search activities and deliver innovations in exchange for enhanced social legitimacy– acting innovation capital for future enterprising activities and market advantage (Holmes & Smart, 2009). NGOs are ‘‘social, cultural, legal, and environmental advocacy and/or operational groups that have goals that are primarily non-commercial" (Kourula & Laasonen, 2009: 36). Businesses and NGOs collaborate to utilize the complementary resources and competencies of each other; these alliances help them to address issues that actors would not be able to deal with individually (Austin, 2000; Bitzer & Glasbergen, 2015). NGOs can be an external source of specialized skills and knowledge, particularly when the internal development of such expertise is costly, inefficient, and time-consuming (Peloza & Falkenberg, 2009). NGOs can bring to such partnerships, the competencies and resources including market knowledge, legitimacy with clients/customers, civil society players and governments, and access to local expertise and sourcing and distribution systems (Dahan et al., 2010). There is an extensive literature on Businesses and NGOs partnership, and the variety of partnerships arrangements has also changed, from adversarial to cooperative or a combination of the two (Van Huijstee & Glasbergen, 2010).

Business–NGO partnerships can take many forms. Austin (2000) has categorized the types of Business-NGO relationships based on the collaboration continuum; i.e., what kind of collaboration do they have, and how might it evolve over time? He defines three types or stages: philanthropic, transactional, and integrative collaboration. The level of responsibility and complexity that partners face during the partnership increases as they move from partnerships in the lower stages to the upper stages of the collaboration continuum (Gray & Stites, 2013). Partnerships may evolve from one type to another one, or maybe they can begin their collaboration from a specific stage (Austin, 2000). However, firms and NGOs could enter into partnerships anywhere along the continuum. Partnerships often evolve through a 'reactive-to-proactive' strategy, where pressures from NGOs, government and other stakeholders lead the business to go from resistance and mere compliance to strategic actions (Gray & Stites, 2013).

2.1.1. Philanthropic collaboration

Philanthropy is the simplest form of partnership in which the relationship is largely that of charitable donor and recipient; the contribution could include joint marketing (Austin, 2000; Gray & Stites, 2013). Partnerships in this type of collaboration mostly will be established in response to threat-induced, compliance, or charity-driven goals. Usually, this kind of partnership involves a single business and a single NGO. A business might also refer to NGOs for short-term problem-solving on a single sustainability issue (Gray & Stites, 2013).

2.1.2. Transactional collaboration

In the transactional type, there is a reciprocal exchange of more valuable resources on specific activities such as event sponsorships, cause-related marketing, and personnel engagements (Austin, 2000; Austin & Seitanidi, 2012). According to Austin (2000), the cornerstone of this type of richer collaboration is the identification of an overlapping of missions and a compatibility of values. In transactional sustainability partnerships, the primary motivation of business is to improve profit or market share. Accordingly, businesses develop a more sustained dyadic partnership with one NGO. Both short-term problem solving and a sustained dyadic partnership might generate changes in the firm's supply chain (Gray & Stites, 2013).

2.1.3. Integrative collaboration

In the integrative type, the partners reached to a level of collaboration in which the partners' missions, strategies, values, and activities merge into more collective action and organizational integration (Austin, 2000). In this stage, the partners see the collaboration as an integral to the strategic success of each organization and partners use more of their critical assets and core competencies in comparison to transactional collaborations (Austin, 2000; Austin & Seitanidi, 2012). In this stage, businesses move further than bottom-line considerations to reflect how to balance those considerations with social and ecological concerns. Thus, industries and NGOs discuss with the government to recommend legislation or regulations. Also, similar discussions among industries and NGOs lead to developing industry sustainability standards (Gray & Stites, 2013).

2.2. A dynamic capabilities approach to cross-sector partnerships for innovating towards sustainability

We argue that the concept of dynamic capabilities (Teece, 2007; Teece et al., 1997) can be leveraged to explicate the nature and essence of cross-sector partnerships for innovating towards sustainability. Building upon a resource-based view (RBV) (Barney, 1991), organizations enter into cross-sector partnerships to access and co-create new resources and competencies (Ahuja, 2000; Austin, 2000; Austin & Seitanidi, 2012). Resources are assets, organizational processes, technical know-how, management skills, human capital, and reputation, which enable organizations to conceive of and implement their strategies (Barney, 1991). The value of partnership resources is dynamic and depends on how partners can develop and orchestrate them to be valuable in facilitating the exploitation of an opportunity in the business environment (Helfat & Peteraf, 2003). Therefore, beyond these resources, organizations need capabilities that enable them to adapt, integrate, and reconfigure internal and external organizational skills, resources, and functional competencies; i.e., dynamic capabilities (Teece, 2007; Teece et al., 1997). The role of dynamic capabilities is to renew resources and competencies to better match with the changing business environment (Eisenhardt & Martin, 2000; Teece et al., 1997). Thus, organizations are motivated to collaborate for developing and gaining access to new external resources and competencies. Partnerships need dynamic capabilities that allow them to acquire and synthesize resources to generate innovative responses to rapidly evolving environments (Helfat et al., 2007). Applied to cross-sector partnerships for sustainability, dynamic capabilities are defined as the partnership's ability to integrate and reconfigure existing resources and competencies to shape an environment (Teece, 2012). In other words, dynamic capabilities are the company's processes that use resources to match and even create market changes, organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, or die.

Dynamic capabilities include cognitive skills and organizational processes which enable the companies to identify, address, and importantly create new markets and technologies (Pitelis & Teece, 2010). Many new technologies or products for sustainability challenges often fail because of their market implementation (Caniëls & Romijn, 2008). Van De Ven (2005) argues that one of the primary conditions for the wide adoption of new technologies or products is that there should be a market for them. Schumpeter has recognized the opening up of new markets as a particular category of innovation alongside other categories of innovation (Schumpeter, 1934). By creating a new market, the market-creating innovation changes the existing market structure of an industry or even develop a new one from scratch (Jaworski et al., 2000). According to Schumpeterian tradition, most new market creations are pushed up from the supply side (Schumpeter, 1934). Thus, companies need to possess high market sensing and opportunity recognition capabilities to uncover and promote the latent demand to increase the supply (Day, 1994).

Because of the complexity of sustainability issues, companies need partners who can provide complementary resources and competencies. Partnerships provide opportunities for learning about appropriate sustainability solutions, disruptive innovations and market opportunities (Adams et al., 2012). Pitelis and Teece (2010) also argue that a significant cognitive and strategic skill in the context of innovation is to understand the role of complements and complementary resources to companies' success. The growing literature on strategic partnership shows that the success of a partnership depends on the effective coordination of tasks and resources (Helfat & Peteraf, 2003). Researchers also argue that collaborations and partnerships- as dynamic capabilities- can be a means of new organizational learning, helping companies to recognize complementary resources and competencies (Teece et al., 1997). Thus, dynamic capabilities reflect the partnership's ability to mobilize and integrate resources for implementing and commercializing the innovation opportunity. Dahan et al. (2010) argue that in cross-sector partnerships, partners contribute complementary resources along the value chain to develop products or services that neither of them could produce alone. Complementary resources can be referred to as co-specialized resources as the value of one partner's resources is a function of using resources in conjunction with other partner's resources (Pitelis & Teece, 2010). Therefore, the partnership can create value by combining the complementary and co-specialized resources.

Planko et al. (2016) argue that market creation for innovative sustainability technologies or products often involves extensive changes to the macro environment in which the innovating companies operate. Sarasvathy and Dew (2005) also demonstrate that new market creation requires an effectual network of stakeholders that collaborate in the network or industry cluster to shape a favorable environment for their technology. Foxon and Pearson (2008) argue that for market creation, push and pull factors have to be considered. This includes promoting interactions between the demand and supply sides of the market, and the institutions that connect the demand and supply sides of markets in a co-evolutionary approach (Sarasvathy & Dew, 2005). Thus, the strategic management literature describes the need of innovative actors to collaborate strategically is necessary to shape the environment and create a market (Planko et al., 2016; van den Bergh et al., 2011). The innovative actors need the process of continued renewal of resources and competencies that enable the partnership to better adapt to the changing environment; i.e., reconfiguration (Teece et al., 1997). The reconfiguration process is the outcome of dynamic capabilities; i.e., the achievement of favorable configurations of resources and competencies that match the environment. Particularly, the reconfiguration process is relevant in cross-sector partnerships where innovative responses of the partnership to rapidly changing environments are creative adaptations of resources and commences (Ettlie & Pavlou, 2006). Loorbach et al. (2010) argue that companies on their own have limited impact on sustainability challenges, which require systems solutions. Through innovative collaborations (e.g., with environmental NGOs), companies can extend their non-technological competencies to change the ‘rules of the game’ (e.g., the ability to lobby or to find alternative routes to market). Accordingly, the partnership also includes activities to calibrate uncertainty and continuously effectuates the co-alignment and efficient governance of co-specialized resources internally and externally (Pitelis & Teece, 2010). To capture the benefits of co-specialization, partnerships need a great orchestration capacity to successfully build and orchestrate resources within the ecosystem (Teece, 2014). Put differently, the orchestration of resources is core to enhancing the effectiveness and exploitation of the partnership.

3. Research Methods

3.1. Research design

A retrospective longitudinal case study, as the empirical research strategy of our qualitative approach, was conducted to elaborate theory on the dynamics of partnership for innovating towards sustainability (cf. Eisenhardt & Graebner, 2007). The aim of the study was to investigate the dynamics of the partnership and their contribution to the market creation for sustainability. Hence, a detailed processual approach was required which can be found in qualitative data sources (Langley, 1999). Qualitative research approach also enabled us to use multiple complementary data sources to generate a comprehensive understanding of the phenomenon (Yin, 2009).

Adopting the dynamic capabilities approach as a theoretical framework of our research, a process study was performed to provide a narrative of the partnership dynamics (cf. Van de Ven, 2007). Process studies focus empirically on evolving phenomena to explain and understand it (Langley et al., 2013). As a process study was conducted to answer our research question, it is of particular importance to perform the study in the context of a longitudinal research design to explore the underlying dynamics of the partnership. Hence, a single case study was adopted as the research strategy of our empirical study. This research strategy provides a profound and detailed understanding of the dynamics present within a single setting (Eisenhardt, 1989).

Our case study focused on a long-running, ongoing business–NGO partnership working together on a market-creating innovation for sustainability as a research setting of this study. KLM Royal Dutch Airlines (KLM), as a business, and World Wide Fund for Nature- the Netherlands (WNF), as an NGO, work together since 2011 to create a market for sustainable biofuels for aviation. This setting allows us to observe how the partnership has raised and evolved, and to find in what way these dynamics influenced the innovation processes for sustainability. Accordingly, the selected partnership, as a critical case, enabled us to elaborate and sharpen an existing theory; i.e., the dynamic capabilities approach, to the context of a cross-sector partnership for innovating towards sustainability (cf. Yin, 2009).

KLM, as part of Air France-KLM group since the merger in 2004, is a leading airline company in the aviation industry and its core business is the transportation of passengers and cargo and providing aircraft maintenance services. During the recent years, Air France-KLM group has been in the top position as the best airline on the Dow Jones Sustainability Index (DJSI) for consecutive years. With its “Climate Action Plan,” KLM has set specific targets to minimize its environmental impact in the fields of CO_2 emissions. Particularly, climate impact is one of the main topics of its sustainability strategy.

WNF is a part of the international conservation organization WWF (World Wide Fund for Nature). Reducing the human footprint and promoting sustainable production of goods, and lessen the threat of climate change and promoting solutions are its primary goals. Doing this, WNF seeks to cooperate with other parties such as governments and businesses, and sector leaders.

3.2. Data collection

We gathered and compiled a broad range of primary and secondary sources of evidence, including semi-structured interviews and archival data into a case study database to maintain the chain of evidence, using Atlas.ti software (cf. Yin, 2009). Data collection started with interviews with key informants of the partnership. Our source to identify key informants was our contact person, the Environmental Manager at KLM, who has a coordinating role in the partnership. Our primary data collection method was the semi-structured interview. The interview questions intended to explore why and how the partnership aroused and evolved. We wanted to identify the dynamics of the partnership. Totally, fourteen semi-structured interviews lasting from 45 minutes to 1.5 hours are conducted. A list of interviewees is provided in Table 6.1.

We interviewed eight informants who played a role directly in the partnership. Two employees from WNF; four employees from KLM, and two employees from SkyNRG. SkyNRG is the global market leader in the emerging fuel market segment of next-generation biofuels for aviation. SkyNRG was co-founded in 2010 by KLM and other founding partners to help create and accelerate development of a market for sustainable biofuels for aviation. It should be noted that due to the coordinating role of the Environmental Manager at KLM for the partnership, we interviewed him two times. For a better understanding of biofuels market for aviation, we also interviewed two respondents from two other major European Airlines who have had flights powered by biofuels. Furthermore, we interviewed one policymaker at Ministry of Infrastructure and the Environment (Dutch government), and one respondent from the Roundtable on Sustainable Biomaterials (RSB). RSB is an independent and global multi-stakeholder coalition which works to promote the sustainability of biomaterials. RSB's certification system verifies that biomaterials are ethical, sustainable, and credibly-sourced.

Table 6.1 List of interviewees

Interviewee	Organization
Director CSR & Environmental Strategy	KLM
Environmental Manager	KLM
Director Innovation, Corporate Venturing & Biofuels	KLM
Innovation Manager	KLM
Program Manager at Public Affairs	KLM
Senior Advisor Biomass	WNF
Chief Footprint and Markets	WNF
Chief Executive Officer (CEO)	SkyNRG
Marketing & Sales Manager	SkyNRG
Senior Manager Aviation Biofuels	A European Airline
Head of New Energies	A European Airline
Executive Secretary	RSB
Senior Policy Maker	The Dutch Government

To mitigate retrospective biases of our study (Golden, 1992; Miller et al., 1997), we collected data from respondents representing at least seven organizations, tapping into potential differences in their perspectives towards the biofuels market for aviation. We also triangulated interview data with our archival data to reach a thorough understanding of the research phenomenon (Denzin & Lincoln, 2007). Our sources for archival data consisted of ten annual reports of KLM, three WWF Corporate Partnerships Reports, one WWF Energy Vision, two marketing brochures on sustainable biofuel for aviation, 13 public interviews about the partnership, 123 publicly available news publications and press releases of the partners about the partnership, and 14 secondary data published by other scholars about the biofuel market for aviation (in total 166 sources). After doing a semi-structured interview with key informants, a focus-group discussion was also conducted to get a better understanding of the partnership. The focus group method is a research technique that collects data through group interaction on a particular topic which is determined by the researcher; the discussion is facilitated and coordinated by a moderator (Morgan, 1997). A group of key informants including two persons from WNF, three persons from KLM, and one person from SkyNRG participated in this group discussion as well as researchers as the moderator. Focus groups can be used for clarifying, extending, qualifying or challenging data collected through other methods (Bloor et al., 2001). Accordingly, at the beginning of the workshop, the initial findings of researchers based on the interviews are presented. Then, participants are asked to share information and their views on the partnership, elaborate the developments of biofuels program, and seek a way forward to increase supply and demand of sustainable biofuels in the aviation sector. Furthermore, the case description was sent to our contact person, the Environmental Manager at KLM, to further ensure that our interpretation is a right understanding of the partnership. His comments resulted in several minor modifications of the case description.

3.3. Data analysis

In the first step of our analysis, we created a narrative of the partnership (cf. Langley, 1999). Accordingly, a chronological overview of the partnership events and its dynamics was provided including the partnership formation drivers, motivations to build the partnership, the partners' positions towards sustainability, outcomes, and challenges of the partnership. Table 6.2 summarizes a sequence of events in the partnership for promoting the creation of a viable market for sustainable biofuels.

Within the provided narrative, an inductive approach was used to analyze the data. We employed the Gioia methodology in the coding process (cf. Gioia et al., 2012). In the first-order analysis, the data are coded based on in-vivo or informant terms. Our aim was to follow the informants' concepts. This first-order coding is labeled by Strauss and Corbin (1990) as open coding. Figure 6.1 presents the first-order concepts.

Using the dynamic capabilities theory as a sensitizing concept, the second step in the analysis was to seek for similarities and linkages among the first-order concepts to develop the second-order themes, shown in the middle of Figure 6.1. Strauss and Corbin (1990) label this coding stage as axial coding. For our third analytical step, we distilled the emergent second-order themes into aggregate dimensions; i.e., theoretical coding. In this step, guided by the dynamic capabilities approach, we assessed the semantic relationships among the second-order themes and aggregated them into theoretically saturated dimensions. The data structure in Figure 6.1 shows the outcome of our data structuration process.

Table 6.2 Sequence of events in the partnership for promoting the creation of a viable market for sustainable biofuels

Year	Action/Interaction
2007-2009	KLM engaged with WNF as a partner in 2007 to develop and maintain their climate strategy and biofuels program strategy. The partnership has formulated an integrated strategy for KLM on supply and demand biofuels for aviation.
2008	KLM joined the Sustainable Aviation Fuel Users Group (SAFUG) as a member to focus on accelerating the development and commercialization of sustainable aviation biofuels.
2009	The launch of the first demonstration flight ever with passengers on board. WNF was part of the process.
2010	SkyNRG was launched following the KLM biofuels test flight in November 2009. Founding partners are KLM, Argos Energies and Spring Associates. WNF advises SkyNRG on sustainability aspects.
2011	KLM and WNF renewed their partnership for a further 4 years.
2011	KLM closed a Green Deal on biofuels with Ministry of Economic Affairs, Agriculture and Innovation, Ministry of Infrastructure & Environment. KLM is also committed to using biofuel certified by the Roundtable for Sustainable Biofuels.
2011	KLM launched the first commercial flight ever to use sustainable biofuels, soon followed by a 6-month program of sustainable biofuels flights between Amsterdam and Paris.
June 2012	KLM launched the KLM Corporate Biofuels Program.
March 2013	SkyNRG's commitment to the sustainability of biofuels for aviation was rewarded by the Roundtable on Sustainable Biomaterials (RSB), making SkyNRG the first jet-fuel operator worldwide to deliver RSB certified sustainable biofuels into the wing at any airport in the world.
2013	KLM launched a new series of flights using sustainable biofuels. This is yet another important step towards proving that more sustainable aviation is possible.
August 2015	KLM and WNF finalized their current partnership and continued collaborating between KLM and WNF on a neutral, not funded basis.

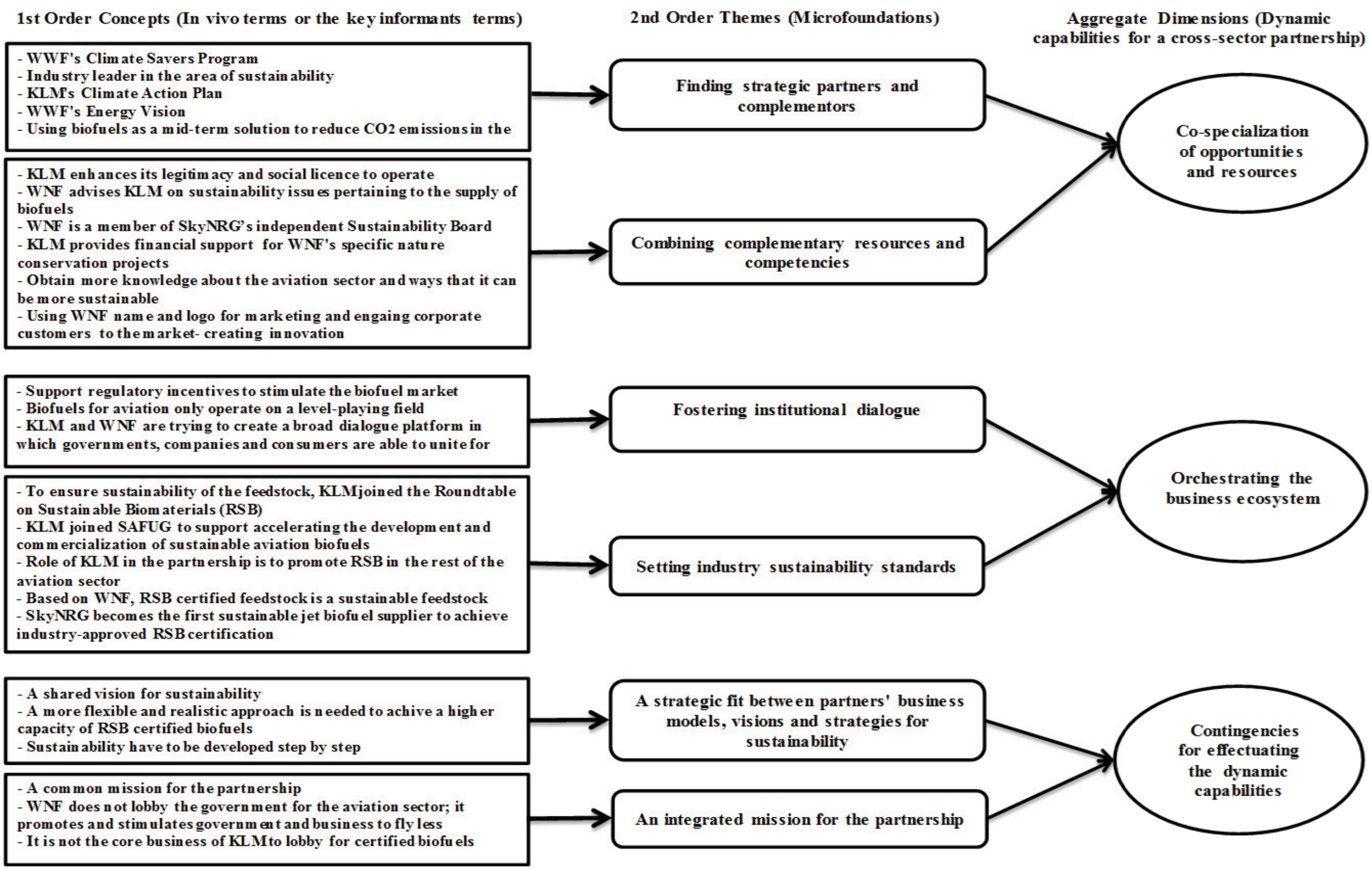

Figure 6.1 Overview of the data structure

4. Findings

4.1. Case description

Implementing Environmental Management System (EMS) in the company in 1996, KLM recognized that the climate issue is one of the main topics of its sustainability strategy. It was vital for KLM to take responsibility for lowering carbon emissions to stay best in class in the aviation industry. KLM wanted to take steps to put standards in this area. In developing its 'Climate Action Plan,' KLM found that it needs some enablers for lowering carbon emissions. Accordingly, KLM has focused on fleet renewal, improving operational efficiency, use of sustainable biofuels and offsetting as enablers of reducing its carbon emissions. However, using biofuels is one of the most important ways to reduce CO_2 emissions because 99% of the CO_2 footprint of an airline comes from fuel, and an airline has no other option as an alternative fuel in mid-term. The Environmental Manager at KLM confirmed this issue:

> *"Currently, using biofuel is the only option we have to reduce our carbon emissions. Developing our Climate Action Plan, we found that we need enablers. In our partnership with WNF, it was also highlighted that to reduce carbon emissions in the short-term, we cannot do much. On the mid-term, using biofuels, not existing when the Climate Action Plan was developed, was the only solution."*

This is the starting point for KLM to develop its biofuels program strategy during 2007-2009 and take steps that they have been taking until now. KLM engaged with WNF as a partner in 2007 to develop and maintain its climate strategy and biofuels program strategy. The partnership formulated an integrated strategy for sustainable biofuels around a value chain perspective by simultaneously creating demand and developing supply chains. The outstanding feature is that a market for biofuels for aviation was not developed at all, and it was something entirely new for aviation until that time. Hence, in 2010, KLM co-found a joint venture, SkyNRG, following the KLM biofuels demonstration flight in November 2009. WNF was part of the demonstration flight process and advises SkyNRG on sustainability aspects. SkyNRG does not own bio jet production capacity but acts as a service provider, like a spider in the web, in building the supply chain between airlines and bio jet producers. Regarding the goal of SkyNRG, the Innovation Manager of KLM said:

> *"As we started thinking about biofuels, it was hardly available and tough to find in the market; because there was hardly any demand. When you want to have more supply, there has to be more demand. That's why we also co-found SkyNRG and placed it outside of KLM because it also could be serving as jet fuel supplier for KLM and other airlines to increase the demands by aviation, which would help the markets to grow."*

In 2011, KLM and WNF renewed their partnership for a further four years. As part of the agreement, KLM took in 2011 the aspirational target to use an average of 1% sustainable biofuels in its fleet by 2015. They have expressed the ambition to develop an international market for sustainable biofuels within a four-year period.

In June 2012, KLM in cooperation with SkyNRG and WNF launched the KLM Corporate Biofuel Program to aggregate the demand to make biofuels available in suitable quantities, at a competitive price, without compromising on sustainability in any way. The Program enables KLM to cover the additional costs of using biofuel for flights. Partners in this program commit to flying some of their journeys on aircraft powered by biofuels, thereby contributing to reductions in CO_2 emissions. Instead of purchasing carbon credits to offset staff travel, corporations divert the funds to the development of sustainable biomass production, required infrastructure, and key technologies. The Marketing and Sales Manager at SkyNRG explained the idea behind KLM Corporate Biofuel Program as follows:

"The KLM Corporate Biofuel Program was installed to bring the production up to scale. I think the idea came because it's a whole supply chain if you look from feedstock into flights. You need all players in the entire supply chain, but it only works if you involve the end customers. Accordingly, we started with the demand to bring the production up to scale."

From the first commercial flight in 2011 until now KLM conducted flights demonstrating that it is possible to organize and coordinate a complex supply chain and fly regularly scheduled flights on aviation biofuels blends. In late August 2015, KLM and WNF finalized their current partnership and continued collaborating on a neutral, not funded basis.

Analyzing the partnership narrative, the study recognized two dynamic capabilities for the partnership that are instrumental in explicating the nature and essence of business-NGO partnerships for innovating towards sustainability. The dynamic capabilities are "co-specialization of opportunities and resources" and "orchestrating the business ecosystem." We also found that partners should achieve two contingencies to effectuate the cross-sector partnership's dynamic capabilities for innovating towards sustainability. The contingencies are "a strategic fit between partners' visions and strategies for sustainability" and "an integrated mission for the partnership." These dynamic capabilities and the contingencies for effectuating them will be explained in the following subsections.

4.2. Co-specialization of opportunities and resources

Co-specialization of opportunities and resources refers to the synergistic gains from the interaction of different resources and competencies within a business ecosystem. This is a co-creation mechanism through which partners collaborate in a coordinated way to co-evolve their resources and competencies in pursuit of shared ambitions or opportunities for sustainability. Accordingly, we found two underlying mechanisms; i.e., microfoundations, that help the partners in capturing value from their partnership.

4.2.1. Finding strategic partners and complementors

There are two partnership periods between KLM and WNF: 2007-2011 and 2011-2015. The first leads to the second; the partnership has evolved from CO_2 compensation to sustainable (RSB certified) biofuels. At the first period, the collaboration between KLM and WNF started with a focus on CO_2 efficiency and CO_2 compensation. A senior advisor of biomass at WNF described the first period of partnership as follows:

> *"Absolute reductions for aviation or the airlines did not seem to be a realistic target. At that time, biofuels were not a feasible option; it was said that biofuels would freeze at high heights. As a result, the focus of collaboration was the compensation of CO2 growth."*

WNF was looking for sector leaders to engage them in its 'Climate Savers Program.' The goal of the Climate Savers Program is to inspire a change in thinking about climate solutions in companies. It leads to developing low, zero or even carbon positive business models and proves that greenhouse gas emissions reduction can go hand-in-hand with economic growth. On the other hand, KLM wanted to be "best in class" in CO_2 efficiency based on its Climate Action Plan. Therefore, WNF recognized that KLM as an airline could be interested in taking part of this Climate Savers Program. However, they found that an absolute reduction for aviation or the airlines is almost impossible. Therefore, they deviated from the program and agreed to work on stabilizing the carbon emission. According to the Environmental Manager at KLM, this unique partnership was because of KLM's business model; as he said:

> *"As an airline, we do not have flexible business models. Our main purpose is taking passengers around the world. We can't ground our aircraft or use green electricity for reducing our carbon emission. Hence, we solved that with our Climate Action Plan, the first step*

was stabilization together with a carbon compensation program. It was not meeting the international Climate Savers Program principle; however, it was as far as a 'best in class' that an airline could go."

The first part of partnership closed on far-reaching reduction and compensation of the CO_2 emissions, and KLM was investigating alternative fuels. KLM, based on the first part of the partnership and its Climate Action Plan, recognized that in the mid-term, using biofuels not existing in those days is the only solution. Again the Climate Action targets and enablers were the main point; however, there was a transition, and still moving from climate change towards resources. As KLM had recognized biofuels as an enabler in the mid-term and started a research project on alternative fuels, WWF International was developing its energy vision meanwhile. Things were running in parallel. According to 'WWF the Energy Vision,' it is possible for the world in 2050 to be fully supplied with renewable energy. Thus, biofuels become an essential element of energy supply particularly for those activities and sectors that have no alternative for liquid fuels; i.e., aviation, marine, and heavy trucking. Hence, KLM and WNF renewed their partnership from this energy vision and the ambitions that KLM showed in the reduction of CO_2 emissions. The second part of the partnership was also unique because they are working on innovation; i.e., creating a market for sustainable biofuels for aviation.

4.2.2. Combining complementary resources and competencies

KLM and WNF have different motivations to collaborate. KLM's motivation for partnering is mostly legitimacy-oriented. KLM is very proactive in sustainability, and see this partnership as a social license to operate. For instance, the Environmental Manager at KLM said:

"I think what WNF added; of course was credibility. If we say about ourselves that we are excellent and best in class, nobody would believe us or at least to a certain extent. It's better for someone else to tell it. That's the biggest gain of this partnership. We could show

them where we are, where we stand, and they could help us in recognizing the benefits of all these actions. They are a reference and supporter."

The provided legitimacy also helps KLM to have access to critical resources such as financing and social capital through WNF network connections. For example, KLM and SkyNRG are using WNF's name and logo in the KLM Corporate Biofuels Program to engage the corporate customers in the Program to aggregate demand in the market. Accordingly, WNF supports KLM to generate a new revenue mechanism to commercialize sustainability.

The partnership also allows KLM to gain access to the expertise of WNF in sustainability issues. WNF has gathered a lot of knowledge how to develop and maintain the climate strategy including biofuels strategy. WNF is a member of SkyNRG's independent Sustainability Board and advises KLM and SkyNRG on sustainability issues about the supply of biofuels.

KLM via its biofuels program can complement WWF's efforts for the realization of its Energy Vision. KLM helps WWF to start with taking steps to achieve the 2050 vision; i.e., no longer fossils. The other motivation of WNF for partnering with KLM is to get also more knowledge about the sector and ways that it can be more sustainable because WNF is a solution based NGO. They are searching for solutions, and they can share it with other airlines in line with their goal, reducing the threat of climate change and promote solutions. Financial benefits are another motivation of WNF for partnering with KLM. KLM provides financial support for WNF's particular nature conservation projects.

4.3. Orchestrating the business ecosystem

Orchestration of the business ecosystem reflects the business-NGO partnership's ability to synchronize resources and tasks for achieving the superior configuration of resources to co-create a market for sustainability and shape the business ecosystem. The study found two underlying mechanisms; i.e., microfoundations, that enable the partners to stimulate and orchestrate the value chain for innovating towards sustainability.

4.3.1. Fostering institutional dialogue

KLM and WNF, together, have been trying to create a broad dialogue platform in which engage governments, suppliers, and consumers to create demand and develop the supply capacity. In line with this goal, the partnership has supported regulatory incentives to stimulate the biofuel market for aviation. KLM successfully negotiated with authorities to insert biofuel as a topic into the European agenda for grants and funding. Accordingly, companies in the whole value chain can apply for grants and funding. The Program Manager of Public Affairs at KLM noted:

> *"My actions were twofold; making sure that biofuel was included in all kinds of incentive programs. If you are not in the incentive program, you cannot apply. My role was to get biofuels in the incentive program. That's the most important one; making sure that the topic is included in the list of potential projects that can get funding. At the same time, you need to include the entire value chain; in this new business, you have many stakeholders. That's the second part. Ensuring that the whole value chain is included in the discussion when we talk about biofuels."*

In 2011, KLM closed a 'Green Deal' on biofuels with the Dutch Government. The Green Deal underlines the willingness of the Dutch government to strengthen the position of bio jet fuel in the Netherlands. Government action should try to create a synergy between KLM actions in the field of bio-jet fuels and the other initiatives that link directly or indirectly to bio-jet fuels. For example, the Environmental Manager at KLM added:

> *"The government promised us that they would incentivize bio jet fuels as a part of the Renewable Energy Directive (RED). That's one of the European measures for stimulating renewable energy. Currently, it's*

only counting for road transport in Europe, but in the Netherlands, it was an exception; that is also aviation could be part of it. Consequently, the price difference between biofuels and fossil fuels is leveled by credits."

According to this deal, KLM performed demonstration flights to increase the awareness and use of sustainable biofuels by other parties in the aviation industry. Furthermore, KLM committed to the development of sustainability standards along with the Roundtable on Sustainable Biomaterials (RSB). The KLM Corporate Biofuel Program, launched in 2012, was also an elaboration of the Green Deal between KLM and the Dutch government.

4.3.2. Setting industry sustainability standards

During the partnership, KLM joined the Roundtable on Sustainable Biomaterials (RSB), in collaboration with WNF, to ensure sustainability of the feedstock. The standard of the RSB is recognized by WNF as best in class. Commitment to sustainability in the entire supply chain is the main strategy of WNF as an NGO, with sustainability as its core business to protect nature. The role of KLM in the partnership is promoting the RSB in the rest of the aviation sector and other initiatives/collaborations for the bio-jet fuels. Accordingly, the partnership is setting industry sustainability standards to govern the behavior of businesses, governments and other stakeholders of the value chain. The CEO of SkyNRG explained the role of RSB in promoting the biofuel market:

"For us, a biofuel is only an option if it does not have a negative impact on biodiversity, local development, and the local food supply. We don't want backlash things; the biofuel is stimulated for sustainability. If the market grows, we need the RSB for guaranteeing the sustainability; we cannot check everything ourselves."

4.4. Contingencies for effectuating the partnership's dynamic capabilities

The partnership has achieved multiple successes; for instance, the amount of used biofuels almost tripled, CO_2 emissions of KLM have been reduced by its biofuel program, and the RSB standard has been stimulated as the highest sustainability standards for biofuel production. In spite of these achievements, there are some challenges in the partnership that directly and indirectly influence the outcomes of the partnership. The study found that the effectuation of business-NGO partnership's dynamic capabilities for innovating towards sustainability is co-determined and linked to two contingencies which will be explained as follows.

4.4.1. A strategic fit between partners' business models, visions, and strategies for sustainability

We found although there is an overlap between KLM Climate Action Plan and WWF the Energy Vision, there is no strategic fit between partners' business models, visions, and strategies for sustainability. WNF has engaged in collaboration with KLM; however, WNF still plays as an adversary. WNF is working on a program to help organizations cut their flights or fly less. A senior advisor of biomass at WNF explained:

> *"In our roadmap, the reduction of emissions is a key point. Therefore, looking at the roadmap for sustainable aviation, which includes demand reduction, flying less is a part of our vision to get emission reduction, and using sustainable biofuels is another important part of it. As you see, our roadmap is larger than only using biofuels."*

According to most of the interviewees, the fundamental challenge of using biofuels for aviation is the unavailability of sufficient sustainable feedstock. Based on WNF, RSB certified feedstock is a sustainable feedstock. For example, a senior policymaker at Dutch Government said:

"I think the main challenge is more towards availability of sustainable feedstock and creating scale there. When you look at RSB certified feedstock– this is not available in large/steady quantities."

KLM believes RSB is valuable; however, some innovative programs are needed particularly to have more space for experimentation because there is not enough RSB-certified biofuels production capacity on the ground. Thus, a transition period is required for developing a large capacity of 100% RSB certificated biofuels. WNF, on the other hand, argues that one solution should not lead to another problem; it is better for KLM not going in that direction because some risks coming out. WNF focuses on quality instead of quantity. In its view, a focus on quantity is the blame for the current unsustainable situation in road transport.

4.4.2. An integrated mission for the partnership

KLM and WNF have different expectations from the partnership and lack an integrated mission for the partnership. The Chief Footprint and Markets at WNF confirmed this point as she said:

"Both parties, KLM and WNF, have a picture of what we want and why we do it. But we are not twins; do not have a common mission."

For instance, they have a different time frame expectation regarding reduction of emissions. KLM is following the industry position from the International Air Transport Association (IATA) based on the stability of emissions in 2020, and then reduction. However, WNF aims reduction for 2020. KLM believes that the call for the reduction in 2020 is not getting broad acceptance by the industry, government and even customers.

According to the Environmental Manager at KLM, aviation can only operate on a level playing field because the margins for passengers are fragile and price sensitive. Biofuels are more expensive than fossil fuels. They need to give very creative incentives from the government. The level playing field is created with government regulation; however, WNF does not lobby the government for the aviation sector. This is line with its plan to encourage organizations to fly less.

Although WNF has highlighted the RSB certification scheme in collaboration with KLM to ensure the sustainability of feedstock, KLM argues that it is not its core business to lobby for certified biofuels. The director of CSR & Environmental Strategy at KLM mentioned:

> *"We understand the concern of WNF, but that is mostly a concern for NGOs. They should also help the business realization. If they cannot, then what? This requires focus, attention, and a lobby network. This area is also new for us."*

5. Discussion and Conclusion

This research provides a unique study of an ongoing business-NGO partnership, working together to promote the market for sustainable biofuel for aviation. Using the dynamic capabilities approach (Teece, 2007; Teece et al., 1997) as a lens for the study, our analysis reveals how companies' collaboration with NGOs influences organizational change and innovation towards sustainability. Accordingly, we leveraged the concept of dynamic capabilities to a cross-sector partnership to explicate those dynamic capabilities that allow partners to adapt their resources and competencies and shape the environment for innovating towards sustainability. The study identifies two core processes; i.e., co-specialization of opportunities and resources and orchestrating the business ecosystem, that are instrumental to explicating the nature and essence of business-NGO partnerships' dynamic capabilities for sustainability.

5.1. Co-specialization of opportunities and resources

The partnership's ability to identify, develop and leverage co-specialized opportunities and resources is a core dynamic capability for innovating towards sustainability. This study highlights the resources and competencies that NGOs can bring to the partnerships for creating a market. These resources and competencies include sustainability expertise, lobby abilities, and legitimacy with the whole value chain, in particular for clients/customers and governments. Lubik et al. (2013) argue that partnership with NGOs provides reputational resources by improving credibility for business in sustainability. Findings of the study highlight that provided credibility by NGO increases sensing capabilities of the company to find new strategic partners in the value chain. Therefore, collaborating with NGOs possessing sustainability expertise can allow companies to develop a value chain offering that is better adapted to sustainability criteria. It is also found that NGOs can contribute to marketing activities of the company. Dahan et al. (2010) argue that as NGOs usually have recognized expertise in sustainability issues and the legitimacy to address it, the impact of companies' marketing activities is significantly enhanced by endorsements from NGOs. Accordingly, the partnership can raise awareness of the product's existence and convince customers and other actors of the value chain that using this sustainable product is beneficial for sustainability and economically viable. Collaboration with industry leaders allows NGO partners to get access to high potential innovations that can be used to strengthen their offering in core markets or to branch into new companies. Accordingly, the partnership can create and stimulate demand as a necessary prerequisite to market creation for sustainable products.

Beyond contributing to the co-specialization of opportunities and resources, companies and NGOs can offer missing capabilities to complete each other's business models, or even co-create a new innovative business model for their partnership. Our study shows that business-NGO partnerships should create and deliver both sustainability and economic values, which can be mutually reinforcing. In our case, the NGO contributes to adjusting the revenue model of the company's business model. Provided credibility to the company's marketing activities for the KLM Biofuel Program help the company to involve corporate customers in the Program for aggregating demand in the market. Therefore, we show a distinct mechanism whereby businesses and NGOs can collaborate in improving their business models. Although, the case company could not change the core of its business model; however, the company in collaboration with NGO jointly generate and deliver economic value differently. Accordingly, both sustainability and economic benefits can be achieved concurrently in the partnership and can be mutually reinforcing. The generation of new business models for the partnership is required to allow the market actors come into play and support the implementation of the innovation for sustainability to be economically viable. Accordingly, the market should be shaped in such a way that economic incentives are provided to actors of the business ecosystem.

5.2. Orchestrating the business ecosystem

The study also indicates that co-specialization of opportunities and resources enables the partnership to orchestrate the business ecosystem for sustainability. Put differently, leveraging the dynamic capabilities approach to the business-NGO partnership demonstrates that the ability of the partnership is to socially construct and co-evolve the ecosystem around a sustainability opportunity. We find that a business-NGO partnership can promote the creation of the market for sustainability by enhanced interactions; i.e., fostering institutional dialogue and setting industry standards. These microfoundations enable the partnership to support and govern the systematic development of the ecosystem for innovating towards sustainability. This finding is consistent with Day and Schoemaker (2016) who argue that renegotiating the environment and shaping a company's ecosystem is an important dynamic capability for a fast change of the market the company operates in. Accordingly, capabilities such as joint lobbying and creating new industry standards are instrumental in shaping the ecosystem and creating a market for sustainability.

Thus, for creating a market for sustainability, partners have evolved their partnership from reactive and transactional collaboration towards an integrative collaboration. In their integrative collaboration, they have co-specialized their opportunities and resources to focus on fostering institutional dialogue and setting industry sustainability standards. Doing this, they have been trying to engage the value chain's stakeholders such as governments, competitors, and corporate customers in their ambition to create demand and develop the supply capacity. However, they are faced with some challenges in this type of collaboration. Due to these difficulties, their integrative collaboration for establishing a platform for institutional dialogue on a broader scale and setting industry sustainability standards has not been very successful. For example, the NGO did not engage in diplomacy or policy dialogue, either unilaterally or collaboratively. Furthermore, to assure that biofuels are indeed sustainably produced, the partnership is promoting an industry sustainability standard for the biofuel market for aviation. However, the business company argues that the RSB certification system is very tough, and a more flexible and realistic approach is needed for a transition period to achieve a higher capacity of RSB certified biofuels. The company believes that sustainability should be considered as an ongoing process; a learning approach should be adopted to be able to cope with the complexity of biofuel market creation. Therefore, a lot of promotion could not be managed jointly. Hence, the partners terminated the second period of the partnership and started a relatively unique collaboration type, engagement without funds, which is based on expertise exchange and mutual learning between the company and NGO. This collaboration type appears to be appropriate for conflict settings in which the partners have divergent interests and goals for the sustainability partnership. This kind of collaboration provides the opportunity for business and NGOs to interact with and support each other while following their strategy and goals in sustainability challenges.

5.3. Contingencies for effectuating the partnership’s dynamic capabilities

Our study shows that to achieve the effective value of partnership's dynamic capabilities for sustainability, a set of enabling processes; i.e., contingencies must be undertaken. First, there should be a strategic fit between partners' business models, visions, and strategies for sustainability. Second, businesses and NGOs should develop an integrated mission for their partnership for innovating towards sustainability. This is in line with Day and Schoemaker (2016) who argue that when a strategic vision guides the dynamic capabilities, they enable companies to keep adapting to fluid and uncertain conditions of the business environment.

Strategic fit is considered a political aspect of a partnership to synchronize the partners’ resources and competencies and relates to the congruence of strategies and objectives between partners (Douma et al., 2000; Swoboda et al., 2011). Suurs and Hekkert (2009) also argue that the creation of a shared vision and the definition of a common goal are both essential for the coordination of system-building activities to create a market. The business ecosystem as a whole benefits most if the resources are combined and aligned. If business and NGO each has its agenda and its strategic plan for the sustainability partnership, partners' efforts may prove unsuccessful without coordination. In our case, lack of a shared vision for sustainability towards which the partnership should move, and an integrated mission for the partnership hinder the partnership to effectively orchestrate the business ecosystem for creating a biofuel market for aviation. For example, in the second partnership period, partners came from a problem-solving approach to a solution-focused approach. However, the partners could not promote the type of their collaboration as fully as possible because they did not have an integrated mission for the partnership. In this period, their mission and values have still overlap in comparison with the first partnership; however, partners could not foster institutional dialogue or set the industry sustainability standards effectively.

Currently, there is a lack of a conclusive business case for using sustainable biofuels in aviation. To deliver a competitive end product to the end user markets, a robust, reliable and sustainable biofuels supply chain is essential. In the institutional dialogues partnership, partners involve stakeholders in discussions with the government to recommend legislation or regulations. This legislation or regulations can provide a level playing field for the aviation sector and biofuels supply chain for the sector. It was found that the NGO does not lobby the government for the aviation sector due to its vision; it promotes and stimulates businesses and governments to fly less. This goal of the NGO is not in line with the interest and business model of the company as an airline. The literature argues that regulations and policies are one of the most important factors of market formation for innovation towards sustainability in comparison with regular innovation (e.g., Beise & Rennings, 2005; Hekkert et al., 2007; Schot & Geels, 2008). Accordingly, the partnership needs to lobby effectively for convincing governmental actors to put the support of the new market creation on the political agenda. The partnership also needs to adopt a more flexible sustainability target. Strategic management literature argues that standard setting, i.e., standardization, is a critical enabler to the co-creation of a market (e.g., Pitelis, 2012; Ritala & Hurmelinna-Laukkanen, 2009). Therefore, an integrated approach is necessary for which stakeholders of the partnership agree on a shared standard for sustainability. This discussion implies that congruencies between the partners regarding their strategic visions or long-term goals towards sustainability will positively influence the probability of partnership success. Hence, developing a shared vision for sustainability and integrated mission for the partnership are a prerequisite for any collaboration between businesses and NGOs. Austin and Seitanidi (2012) argue that for a successful integrative collaboration, the organizational strategic fit between partners finds a fundamental role to co-create value. The linked interests and synergistic value creation provide an incentive for partners ever more closely to collaborate.

5.4. Implications, limitations, and avenues for future research

The contributions of this study are as follows. First, this study applies the dynamic capabilities concept to Businesses and NGOs collaborations to explicate why and how it is often helpful to bring together Business and NGOs in creating or shaping a market and ecosystem for sustainability. Accordingly, we find that the nature and the essence of cross-sector partnerships for sustainability are co-determined and linked to the partnerships' dynamic capabilities. Thus, the study helps us better appreciate the nature, essence, and impact of Businesses and NGOs partnerships for sustainability. Second, this study further contributes to the dynamic capabilities theory (Teece, 2007; Teece et al., 1997). The dynamic capabilities theory traditionally has been used to explain the transformation of intra-firm or inter-firm existing resources into new functional competencies that better match the environment (e.g., Ettlie & Pavlou, 2006; Pitelis & Teece, 2010). This study extends the dynamic capability theory to cross-sector partnerships for sustainability and shows that the value of partnership resources evolves over time and changes due to partners' strategies towards sustainability. Furthermore, our study highlights the contingent nature of cross-sector partnerships' dynamic capabilities for sustainability. It is found that the value and effectiveness of the partnerships' dynamic capabilities depend on the contingencies internally relating to the partners' vision and strategies for sustainability.

Findings of the study also contain practical implications for managers. This study indicates the importance of four strategic imperatives for the success of Business-NGO partnership in innovating for sustainability, particularly in market-creating innovation. First, the strategic fit between cross-sector partners' strategic visions and long-term objectives. Before entering any partnership to co-develop an innovation for sustainability, management should evaluate the strategic fit of the partnership with the organizations' objectives and the synergy among the partners. Second, the study demonstrates that developing an integrated mission as the partnership's outcome is needed to achieve a better collaboration for innovating towards sustainability. This shortage leads the partners to pursue the development of the innovation project from their perspective. Thus, they cannot manage the partnership effectively. Third, sustainability has economic aspects; business also must work. Partners need to discuss and agree on explicit evaluation criteria for sustainability early in the process of partnership formation. The study shows that stringent sustainability goals may hinder economic performance and result in a hampering improved sustainability performance. Sustainability is not a fixed ideal; putting tough and inflexible standards for sustainability negatively influence the outcome of the partnership. Companies and NGOs need to pursue an evolutionary process. Therefore, innovation partners for sustainability should adopt an attainable target of sustainability for their partnership. Finally, the study highlights that Business-NGO partnerships should contribute to formulating a novel and viable business model for sustainability or even support adjustments to companies' business models. This market device, as a reference point for communication and coordination among the different actors of the business ecosystem, allows partners to orchestrate the co-specialized opportunities and resources effectively for sustainability.

Although this study helps to provide some new insights into the contribution of business–NGO partnership for innovating towards sustainability, there are a number of limitations to this study. First, the findings are based on a single case in a specific context, which limits the generalizability of findings. Further research is necessary, not only in other settings of innovation for sustainability but also in the number of partnership cases. In this study, only one partnership is considered. The key point is about the partners' characteristics which influence the partnership. It is found that partners' attributes play a significant role in explaining the partnership contribution. Second, we have performed a retrospective study, which limits the completeness of the data. Although we have adopted some measures to mitigate the retrospective bias of the study, a real-time longitudinal study could reveal additional insights into the nature and essence of business-NGO partnerships for innovating towards sustainability.

Future research could be designed to investigate the business-NGO partnerships from an "institutional entrepreneurship" perspective (Maguire et al., 2004). Institutional entrepreneurship is useful to conceptualize the activities of partners who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones to cope with environmental uncertainties (cf. Maguire et al., 2004). Recognizing that the nature and the essence of cross-sector partnerships for sustainability are related to the partnerships' entrepreneurial actions to shape the ecosystem, institutional entrepreneurship is a useful approach to govern the restructuring of the environment.

5.5. Conclusion

We leveraged the concept of dynamic capabilities to a sustainability partnership for innovating towards sustainability. Our analysis explains the contribution of a business-NGO partnership on the proactive entrepreneurial shaping of a market for sustainability, with a particular emphasis on which factors contribute to its viability. This study focuses on the nature and essence of Business-NGO partnerships for innovating towards sustainability. It shows how a Business-NGO partnership promotes inter-organizational capabilities to co-create a market for sustainability. It is also found that partnerships are embedded within and evolve with partners' strategies towards sustainability. Over time, changes in organizations' strategies towards sustainability challenges may alter how partnership resources are related to the partner organizations, changing the value and outcome of partnership resources.

Moreover, the study further opens the black box of managing innovation for sustainability in cross-sector partnerships and explores the contingencies required for the success of cross-sector partnerships for sustainability. The study provides an overview of strategic imperatives that partners can undertake to make a successful partnership for sustainability. The most direct implication is that corporations interested in collaborating with NGOs should choose NGO partners that are more likely to have a 'strategic fit' with their business and sustainability strategies. Furthermore, we find that the partnership can create the market for sustainability successfully when partners co-specialize their business models effectively.

Chapter 7
General Conclusions

1. Reflecting on the Topic and Approach

The overall aim of this study has been to provide deeper insights into the management of innovation for sustainability. Adopting a dynamic capabilities approach, this study has been done to understand how companies develop and deploy the required resources and competencies for innovating towards sustainability. Particularly, this study provides a dynamic perspective on how managerial and organizational capabilities act as antecedents to effectuate companies' resources and competencies for innovating towards sustainability. In an effort to address the aim of this study, both quantitative and qualitative research approaches have been used. The combination of these two approaches has enabled us to provide quantitative evidence for testing the dynamic capabilities theory and to gain in-depth insight concerning companies' managerial and organizational capabilities for effectuating companies' resources and competencies. First, prior research has been reviewed to make sense of companies' resources and competencies for innovating towards sustainability. Furthermore, it has helped us to identify relevant theories and develop a conceptual model of companies' organizational routines and capabilities for innovating towards sustainability. Then, the conceptual model of companies' organizational routines and capabilities for innovating towards sustainability has been tested by means of a quantitative approach. Accordingly, the first empirical study provides a more complete and holistic picture of important organizational routines for innovating towards sustainability. Second, we have used case studies as a research strategy for the next three empirical studies to focus on how companies' managerial and organizational capabilities are built and strengthened for innovating towards sustainability. These empirical studies have also enabled us to explain how these capabilities function throughout the development process of sustainable innovation. Furthermore, the qualitative approach has provided in-depth insights into the processes, practices, and entrepreneurial actions that comprise companies' dynamic capabilities for innovating towards sustainability; i.e., microfoundations. Accordingly, this approach has been useful in elaborating the nascent theory of dynamic capabilities in the field of innovation for sustainability.

In the next sections, we review the main findings and provide an overall answer to the research question. Then, we discuss the theoretical and practical implications of this study. Finally, we mention some limitations of this research and offer suggestions for further research.

2. Main Findings

In order to gain more insight into how companies manage and develop innovation for sustainability, this study has focused on the main research question of how companies develop and deploy the required resources and competencies for innovating towards sustainability. By combining the findings of all the research covered in the preceding chapters, we can answer our main research question and discuss our contribution to the existing literature in this field of research. This study has shown that companies need three distinct strategic capabilities to develop and deploy their resources and competencies for innovating towards sustainability. Particularly, this research has proposed and confirmed that companies' organizational and managerial capabilities form the basis of these three distinct capabilities; i.e., sensing, seizing, and reconfiguring. These dynamic capabilities enable a firm not only to invest in its own development for innovating towards sustainability but also invest in the development of the business ecosystem in which the company operates. Hence, it is concluded that companies with greater dynamic capabilities; i.e., sensing, seizing, and reconfiguring, are prone to innovate more towards sustainability.

Furthermore, this research has identified the most important and necessary organizational routines that underlie companies' dynamic capabilities for innovating towards sustainability. It has also shown that a firm's dynamic capabilities for innovating towards sustainability include not only organizational routines but also individual and managerial entrepreneurial actions to leverage the required resources and competencies.

Sensing. This study highlights that innovation for sustainability similar to conventional innovation is an opportunity-driven innovation. Sensing capabilities enable companies to scan and monitor the business environment for identifying innovation opportunities for sustainability. In particular; the study indicates that companies need certain organizational routines to gain knowledge about the external and internal business environment for recognizing innovation opportunities for sustainability. These organizational routines enable companies to overcome incomplete information about environmental issues and to explore novel solutions for them. The companies not only must be able to create knowledge within their boundaries but also need to look elsewhere for new ideas and expertise to prevent knowledge base rigidity and to encourage restructuring their competencies. Accordingly, it is found that four types of information sources are the main sources of companies for scanning the business environment; i.e., sources within companies, market sources, institutional sources, and public sources. This research indicates that companies mainly rely on sources within companies to recognize innovation opportunities for sustainability. In this sense, it is shown that having procedures to regularly get a better understanding of firms' environmental impacts helps companies to improve their sensing capabilities for recognizing the innovation opportunities for sustainability. In particular, the existence of procedure such as EMSs and environmental audits in companies help them to identify the environmental impacts and overcome incomplete information about their business activities. It is also found that companies' sensing capabilities for recognizing innovation opportunities for sustainability are initiated from 'individual entrepreneurial resources' and are grounded on organizational routines of research and development activities. Put differently, the companies' dynamic capabilities for sensing innovation opportunities for sustainability are initiated and championed by corporate scientists or start-up founders. The corporate scientists or start-up founders discover the innovation opportunities based on their cognitive orientation, insights, and their alertness to the business environment.

It is supported that companies with a proactive sustainability strategy have greater sensing capabilities for recognizing the innovation opportunities for sustainability. This finding is in line with Porter and van der Linde (1995) who argue that companies achieve a new competitive advantage by viewing environmental issues as core to their business strategies. Accordingly, proactive companies towards sustainability are more likely to identify and pursue innovation projects with sustainability advantages. In these companies, sustainability is a driver to assess, select, and bring the innovation opportunity to the next level, i.e., seizing. Accordingly, the recognition of innovation opportunities for sustainability is followed by underlying processes of 'strategic selection.' Strategic selection involves anticipation processes through which companies assess the opportunities for making informed strategic decisions about them. In this stage as a cognitive process, companies evaluate multiple alternatives concurrently to calculate the fitness of alternatives to the business and sustainability strategies of the companies. These anticipation processes include primary market research activities and competitor analyses for developing a concept or finding the potential applications for the recognized opportunities.

Seizing. For innovating towards sustainability, it is not enough to find out about technological developments or business trends; firms also need organizational and managerial capabilities to exploit and profit from the recognized innovation opportunities for sustainability. Seizing capabilities help companies to build and improve competencies and deploy resources from internal and external sources to achieve marketplace acceptance. Accordingly, the seizing capabilities deal more with the implementation and commercialization of innovation opportunities for sustainability. This study indicates that innovations for sustainability are mainly developed internally within companies. Hence, developing internal capabilities is a key enabler of companies to innovate for sustainability, which often needs a high degree of novelty. Particularly, the study finds that internal R&D activities and employee training have the greatest importance for innovating towards sustainability. It is found that cross-functional collaboration is also one of the important factors for providing support to the innovation development for sustainability and positioning new products or services in the market. Beyond internal capabilities, adoption of the best practices and new technologies in the sectors is another important organizational routine of the companies for innovating towards sustainability. In that sense, the study supports that acquisition of machinery and equipment from external suppliers is more important and more efficient than the acquisition of external knowledge (e.g., patents).

This study reveals that cooperation with different types of actors enables companies to compensate for the lack of resources or lack of expertise externally and to enhance legitimacy and social license to operate. The study shows that market partners the firms co-innovate with are more important than knowledge partners. In particular, it has been found that suppliers are more valuable partners to co-innovate for sustainability. Concerning cooperation with knowledge partners, cooperation with consultants, commercial labs, or private R&D institutes has the highest importance for innovating towards sustainability. According to this study, engaging customers in the innovation process for sustainability helps innovators to overcome the barrier of avoiding ambiguity and uncertainty of market acceptance of innovative products and technologies for sustainability. It has been found that companies rely on both systematic formal market research and market probing routines to elicit customer preferences and needs.

Our research indicates that companies often need to bring together specialized resources and competencies scattered in diverse actors of the value chain around an innovation opportunity for sustainability; i.e., resource co-specialization. Thus, the companies engage in complementary partnerships in their innovative efforts for sustainability. Particularly, the partnerships with outsiders should be contingent on the involvement of them as committed partners. It means that partners commit to providing complementary resources and competencies to co-innovate for sustainability. Accordingly, partners' ability to identify, develop and leverage co-specialized opportunities and resources is a core dynamic capability for innovating towards sustainability. It can be concluded that the resource co-specialization helps companies to co-evolve their resources and competencies and align their investments to create value and improve efficiency for innovating towards sustainability.

This study illustrates that companies with a business model which is open for sustainability value propositions have greater seizing capabilities for implementing and commercializing the innovation opportunities for sustainability. A business model demonstrates how a company creates and delivers value to customers. The flexible business models help companies to adapt to changing customer needs, the targeted market segment, and the structure of the value chain in a given industry. This research has also shown that partners can complete each other's business models, or even co-create a new innovative business model for their partnership to innovate for sustainability. It has been found that establishing a new business model for a sustainability partnership is often required to allow the market actors come into play and support the implementation of the innovation for sustainability.

The study also finds that market introduction activities such as prototyping and demonstration projects play a significant role in the successful development and market acceptance of innovative technologies or products for sustainability. Prototyping and demonstration projects enable companies to inform potential customers about the advantages and benefits of their innovative products or technologies. Thus, the market introduction activities can be a major determinant of sustainable innovation success as they stimulate a greater demand in the market to enhance the supply. The market introduction activities also help companies to adjust further, improve, and adapt the products or technologies to market needs.

Reconfiguring. This study indicates that sustainable innovation often requires companies to have both learning and unlearning activities around their existing routines and practices in order to contribute to the strategic renewal of organizational knowledge and resources. Reconfiguring capabilities involve organizational routines and entrepreneurial actions for adjusting and changing the patterns of previously utilized innovation processes to enhance the development of innovation for sustainability. These organizational routines and competencies enable companies to align and orchestrate internal and external resources and competencies for innovating towards sustainability. It is also found that companies' capabilities for sensing and seizing innovation opportunities for sustainability rely heavily on the companies' reconfiguring capabilities. Put differently, reconfiguring capabilities enhance sensing capabilities of the firms for discovering the innovation opportunities for sustainability; as well as seizing capabilities for implementing and commercializing the opportunities for innovating towards sustainability. It is indicated that reconfiguring capabilities of companies for sustainable innovation include three strategic renewals of organizational processes; i.e., new marketing methods and strategies, new manufacturing-related processes, and new management practices.

Companies need new marketing approaches emphasizing the sustainability focus of their innovation activities to expand markets for environmentally sustainable goods or services. Accordingly, companies should conduct marketing in conjunction with the innovation development for sustainability. This enables the companies to develop and calibrate the technology according to the requirements of the customers and market needs. As there is a high market uncertainty for sustainability-oriented innovations, this approach also engages customers in the development process of innovations. Thus, it minimizes market uncertainty and adequately stimulates demand for sustainable innovations.

New manufacturing-related processes involve new supply chain processes and new development or significant improvement of process technologies. This finding is in agreement with Porter and van der Linde (1995) who argue that firms need to develop and qualify their production systems and new product development processes for sustainable innovation. Our study also shows that companies should take an iterative, stepwise approach for innovating towards sustainability. Companies should not use strict and detailed planning for managing the technology or innovation development. They need to work in steps toward tangible outcomes, such as the concept development, market positioning, prototyping, or subsequent variants of the same product. These steps enable the companies to reexamine the innovation projects in the market and to move them forward, with the latest information, options, and possibilities.

New management practices include new business practices, new methods of organizing work responsibilities and decision making, and new external relations with other firms or public institutions. It is found that new management practices are the most important and effective strategic renewal of organizational processes, which enable companies to innovate for sustainability. These new management practices facilitate companies to sense and seize the innovation opportunities for sustainability. We find that companies should adopt open innovation practices to achieve higher innovation results for innovating towards sustainability. It is also found that orchestrating a business ecosystem around an innovation opportunity is one of the most important microfoundations of firms' dynamic capabilities for innovating towards sustainability. For managing and bringing together specialized resources and competencies in the business ecosystem, leaders and managers of the innovation project need orchestration skills. Orchestration involves organizational routines and entrepreneurial actions such as enhanced interaction and strengthening the partners' network for building the value chain's stakeholder collaborations to pursue and exploit innovation opportunities for sustainability. Accordingly, institutional dialogue activities and setting industry standards in collaboration with other actors of the value chain enable companies to support and govern the systematic development of the business ecosystem for innovating towards sustainability.

3. Theoretical Contributions and Practical Implications

As mentioned at the outset of this research, the aim of the study has been to advance the understanding of how companies manage and develop innovation for sustainability. Our analysis has been focused on the organizational and managerial capabilities that allow companies to innovate for sustainability. Adopting a dynamic capabilities approach, this research enables us to develop a systematic understanding of how companies build, renew, and deploy internal and external resources and competencies for innovating towards sustainability. Broadly speaking, this research makes several theoretical contributions. First and foremost, this study extends the literature on innovation for sustainability by providing new insights into the configuration of organizational capabilities that enable firms to reconfigure their resources and competencies for innovating towards sustainability. Doing this, the study scrutinizes the concept of the dynamic capabilities in the specific context of innovation for sustainability. This theoretical framework holds promise for advancing our knowledge of innovation for sustainability. Accordingly, the study provides empirical evidence that clarifies and increases our understanding of nature, essence, processes, and sources of companies' capabilities for innovating towards sustainability. Another contribution of this research has been to understand how capabilities are combined in the different stages of the innovation process for sustainability. Accordingly, the study has indicated that companies need to learn how to deploy capabilities for innovating towards sustainability. This research has also used empirical data to gain and provide further insight on the managerial challenges involved in developing the capabilities for innovating towards sustainability. Furthermore, the study provides concurrent consideration to cognition, routines and entrepreneurial actions of companies for innovating towards sustainability. In other words, the study has been done to understand the microfoundations of companies' capabilities for innovating towards sustainability. We also develop a contribution to the emerging literature of managing innovation for sustainability by combining qualitative and quantitative studies. As such, studies presented in this research address the antecedents, processes, and consequences of companies' organizational and managerial capabilities for managing innovation towards sustainability.

This research also has important practical implications. As the research has been built on empirical studies, it provides directions for managers with regards to the choice of capabilities that should be employed for innovating towards sustainability. This study enables managers to understand the function and effectiveness of the companies' capabilities in managing innovation for sustainability. Our findings directly translate into management recommendations on how to strengthen or develop companies' dynamic capabilities for innovating towards sustainability. Accordingly, the study highlights how companies' resources and competencies should be, become and/or develop in order to integrate and enhance sustainability in their innovation activities. A better understanding of the sustainable innovation development identified in this research enables companies to integrate environmental sustainability issues effectively into the companies' innovation processes for sustainability. This research has shown what organizational routines and entrepreneurial actions should be adopted and implemented by the companies to effectuate the required resources and competencies for innovating towards sustainability. One of the implications of these findings is that companies involved in innovating towards sustainability need to rely more on internal resources such as individual entrepreneurial resources and internal R&D activities to recognize innovation opportunities for sustainability. In keeping with this recommendation, companies need to invest in the training of employees in order to enhance not only the ability of employees to collect impulses but also to set priorities and choose the crucial innovation opportunities for sustainability. The findings of this research have indicated that companies cannot often alone innovate for sustainability internally, but they have to collaborate and establish links externally to gain know-how and acquire new knowledge. In particular, it is recommended for companies to follow an open approach for innovating towards sustainability that allows exposure to a diversity of external knowledge and competencies. Various stakeholders may feed companies with new ideas and suggestions for the development of sustainable innovation. This approach helps companies to be proactive and to prevent them from missing important innovation opportunities for sustainability in their business environment. Companies should seek to establish closer ties with customers, suppliers, and research institutes as these actors are the key information sources for the companies to innovate towards sustainability. Our findings have also indicated that innovation for sustainability requires a systemic approach. In particular, new management practices must be in place to enable the companies to co-evolve and orchestrate internal and external resources and competencies in the value chain around an innovation opportunity for sustainability.

4. Limitations and Suggestions for Future Research Directions

While our analysis provides insights for managers on how to develop and deploy their resources and competencies for innovating towards sustainability, it is nevertheless constrained by several limitations that suggest potential avenues for further research. First, the sample used in the quantitative study (Chapter 3) is limited to German companies. The sample has a country bias and a bias towards innovative companies. In future studies, more countries could be included in the study to increase the generalizability of findings and validate them for different empirical contexts. Companies could also have been asked questions about how sustainable innovation projects differ from conventional innovation projects to better compare the organizational routines of the companies for innovating towards sustainability with ones for conventional innovation. Since our empirical analysis in the quantitative research is based on cross-sectional data, the results do not provide ultimate answers about the direction of causation. Hence, future research could make use of panel data to examine the influence of changes in organizational routines of the companies to control for unobserved firm-specific effects. The panel analysis enables us to illuminate which causal relationships are in place while measuring the differential role of organizational routines for sustainable innovation compared to conventional innovation. Furthermore, another important limitation of the quantitative study is that it does not account for different types of sustainable innovation; for example, product vs. process innovation. It would be important to understand if the impacts of organizational routines considered in the present analysis vary across different types of sustainable innovation. In addition, further research should be devoted to analyzing the organizational routines of companies for innovating towards sustainability in large versus small companies, and between sustainable innovations with different degrees of radicalness.

Regarding the case studies, a common so-called limitation in qualitative research approach is that the findings from a case study research are difficult to generalize in the same way a quantitative research is supposed to do. The case studies in this research are conducted with a limited sample of participating companies in complex and therefore unique organizational contexts and whether or not learning derived from the findings is directly applicable in other contexts can be questionable. However, the case studies in this research have provided in-depth insights into the phenomena; i.e., how to innovate for sustainability. The case studies have contributed to existing theoretical concepts empirically by investigating how companies develop and deploy resources and competencies for sustainable innovation. For further studies, scholars should employ comparative studies in different industries to gain a better understanding of sustainable innovation. A second limitation can be found in the retrospective bias of the case studies. A real-time longitudinal study could reveal additional insights into the dynamics of the innovation process for sustainability.

Besides addressing these limitations, further research could be devoted to expanding the research scope on innovating towards sustainability. This research has focused mainly on technological innovation for sustainability. To our knowledge, the literature on organizational innovation and business model innovation for sustainability is emerging, thin and not yet consolidated. Understanding companies' capabilities for these types of innovation for sustainability represents fruitful avenues for future research. In addition, concerning the line of theorizing that has been adopted in this research, there are many other important theoretical perspectives- such as innovation network theory (e.g., Baptista & Swann, 1998), public-private partnerships (e.g., Etzkowitz, 2003), and effectuation theory (e.g., Sarasvathy, 2001)- that can be used as lenses to investigate how companies develop and deploy their resources and competencies for innovating towards sustainability. These theoretical lenses provide a view of the network of resources and competencies surrounding the company and the function and effects of cooperation for innovating towards sustainability. The effectuation theory enables us to develop an understanding of strategic decision-making dynamics in the management of sustainable innovation. Typically, the innovation process involves a series of strategic decision-making dynamics, which affect the configuration of firms' resources and competencies for the formation/discovery and exploitation of innovation opportunities for sustainability.

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Summary

Managing innovation for sustainability- A dynamic capabilities approach

The overall aim of this research has been to provide deeper insights into how companies manage and develop innovation for sustainability. To better understand how companies manage and develop innovation for sustainability, insight should be created into how companies develop and deploy the required resources and competencies for innovating towards sustainability. Adopting a dynamic capabilities approach, this research provides a dynamic perspective on how organizational and managerial capabilities act as antecedents to effectuate companies' resources and competencies for innovating towards sustainability. Dynamic capabilities are a set of strategic activities aimed at enabling companies to integrate, build, and reconfigure internal and external resources/competencies to address, and possibly shape, rapidly changing business environments. In an effort to addressing the aim of this research, both quantitative and qualitative research approaches have been used. The research consists of five studies that provide further insight into how companies manage and develop innovation for sustainability.

The first study (Chapter 2) reviews the findings of previous studies to make sense of companies' resources and competencies for innovating towards sustainability. Furthermore, the review analyses, discusses and synthesizes theoretical foundations of previous empirical studies to investigate and explicate the contribution of companies' resources and competencies for innovating towards sustainability. It also consolidates the companies' resources and competencies for innovating towards sustainability into three theoretically distinct capabilities; i.e., sensing, seizing, and reconfiguring, to describe the function and effectiveness of the companies' resources and competencies in managing innovation for sustainability.

In the second study (Chapter 3), the conceptual model of companies' organizational routines and capabilities for innovating towards sustainability has been tested by means of a quantitative approach. This study adopts the dynamic capabilities approach to argue theoretically and to investigate empirically what the specific organizational routines and capabilities are

that increase the degree of sustainability within firms' innovation activities. It is confirmed that companies with greater dynamic capabilities; i.e., sensing, seizing, and reconfiguring, are prone to innovate more towards a greater degree of sustainability. It is also found that companies' capabilities for sensing and seizing innovation opportunities for sustainability rely on the companies' reconfiguring capabilities. Put differently, reconfiguring capabilities enhance sensing capabilities of the firms for discovering the innovation opportunities for sustainability; as well as seizing capabilities for implementing and commercializing the opportunities for innovating towards sustainability. This study moves beyond the findings of the first study to explain which of the previously organizational routines seem to be the most important ones, based on empirical data from a representative survey on the innovation activities of German enterprises. This empirical study provides a more complete and holistic picture of important underlying routines of firms' capabilities for innovating towards sustainability.

The third study (Chapter 4), adopting a corporate perspective, investigates the organizational and managerial capabilities through which a company can coevolve resources and competencies around an innovation opportunity for sustainability. This study aims to contribute to a further theoretical and practical understanding of how capabilities are deployed by firms to create and implement system-level changes for innovating towards sustainability. According to this study, a firm's dynamic capabilities for sustainable innovation enable the company not only to invest in its own development for innovating towards sustainability but also invest in the development of the business ecosystem in which the company operates with others in the value chain. This study finds that proactive companies towards sustainability are more likely to identify and pursue innovation projects with sustainability advantages. It is also shown that having procedures to regularly get a better understanding of firms' environmental impacts helps companies to improve their sensing capabilities for recognizing the innovation opportunities for sustainability. The study indicates that companies need to bring together specialized resources and competencies scattered in diverse actors of the value chain around an innovation opportunity for sustainability; i.e., resource co-specialization. Thus, the companies engage in complementary partnerships in their innovative efforts for sustainability.

The fourth study (Chapter 5) argues that organizational routines cannot explain necessarily how innovations for sustainability are identified, prioritized, and selected. Accordingly, having a mere understanding of the organizational routines is not enough for a successful management of innovation for sustainability. Therefore, this study intends to investigate how these capabilities develop, emerge or evolve within the companies to manage innovation for sustainability. This study shows that firms' dynamic capabilities for innovating towards sustainability include not only organizational routines but also individual and managerial entrepreneurial actions to leverage the required resources and competencies. The study finds that companies' dynamic capabilities for innovating towards sustainability have to be developed 'in-house' through a set of activities and cognitive processes focused on the organizations' routines.

The last study (Chapter 6) argues that innovation toward sustainability needs a socio-technical transition which not only entails new technologies but also changes in markets and governing institutions. Therefore, firms may engage in unique collaborations including collaboration with environmental NGOs as potential innovation partners for sustainability. This study explores how such a partnership arises and evolves, and observes in what way these dynamics influence the innovation process, with a particular emphasis on which contingencies contribute to its viability. The study shows that institutional dialogue activities and setting industry standards in collaboration with other actors of the value chain enable companies to support and govern the systematic development of the business ecosystem for innovating towards sustainability.

This research extends the literature on innovation for sustainability by focusing on how companies' managerial and organizational capabilities are built and strengthened for innovating towards sustainability. This research enables us to explain how these capabilities function throughout the development process of innovation for sustainability. Accordingly, this research has been useful in elaborating the nascent theory of dynamic capabilities in the field of innovation for sustainability. The research also provides insights for managers on how companies' resources and competencies should be, become and/or develop in order to integrate and enhance sustainability in their innovation activities. It also enables managers to understand the function and effectiveness of the companies' capabilities in managing innovation for sustainability.

Nederlandse Samenvatting (Dutch Summary)

Innoveren in Duurzaamheid - Een 'dynamic capabilities' benadering

Het algemene doel van dit onderzoek is om meer inzicht te verkrijgen in de wijze waarop bedrijven innovatie in duurzaamheid beheersen en ontwikkelen. Om beter te begrijpen hoe bedrijven innovatie in duurzaamheid beheersen en ontwikkelen, kan inzicht worden ontwikkeld in de wijze waarop bedrijven de daartoe vereiste middelen en competenties ontwikkelen en inzetten. Door gebruik te maken van een 'dynamic capabilities' (dynamische bekwaamheden) benadering, biedt dit onderzoek een dynamisch perspectief op de manier waarop organisatorische- en managementcapaciteiten het mogelijk maken voor bedrijven om te innoveren in duurzaamheid. Dynamische bekwaamheden zijn een reeks strategische activiteiten die erop gericht zijn bedrijven in staat te stellen interne en externe middelen/competenties te integreren, te ontwikkelen en aan te wenden om in te spelen op, en vorm te geven aan snel veranderende zakelijke omgevingen. In dit onderzoek, zijn zowel kwantitatieve als kwalitatieve onderzoekbenaderingen gebruikt. Het onderzoek bestaat uit vijf studie die meer inzicht verschaffen in de wijze waarop bedrijven innovatie in duurzaamheid beheersen en ontwikkelen.

De eerste studie (hoofdstuk 2) geeft een overzicht van de bevindingen van eerdere wetenschappelijke studies naar de middelen en competenties die bedrijven inzetten om te innoveren in duurzaamheid. Verder analyseert, bespreekt en synthetiseert dit hoofdstuk de theoretische onderbouwingen die deze studies hanteren. Het presenteert ook een onderscheid in drie theoretisch verschillende dynamische bekwaamheden die bedrijven nodig hebben om te kunnen innoveren in duurzaamheid; dit zijn: detectie, aanwending en herconfiguratie van middelen en competenties van en door bedrijven ten behoeve van innovatie in duurzaamheid.

In de tweede studie (hoofdstuk 3) wordt het conceptuele model dat ten grondslag ligt aan de studies in dit proefschrift getest door middel van een kwantitatieve onderzoekbenadering. Deze studie hanteert de dynamische bekwaamheden benadering, en het beredeneert theoretisch en onderzoekt empirisch wat de specifieke organisatorische routines en bekwaamheden zijn die de mate van duurzaamheid van de innovatie-activiteiten van bedrijven verhogen. De studie bevestigt dat bedrijven met meer dynamische bekwaamheden; d.w.z. meer mogelijkheden hebben tot detectie, aanwending en herconfiguratie van middelen en competenties ten behoeve van innovatie in duurzaamheid, daadwerkelijk meer en in hogere mate innoveren in duurzaamheid. Ook vindt de studie dat de mate waarin bedrijven innovatiemogelijkheden voor duurzaamheid detecteren en aanwenden, afhankelijk zijn van de herconfiguratiemogelijkheden die deze bedrijven bezitten. Anders gezegd, herconfigurerende capaciteiten verbeteren de detectiecapaciteiten van de bedrijven voor het ontdekken van de innovatiekansen voor duurzaamheid; ook verbeteren zij de capaciteiten van bedrijven om deze kansen daadwerkelijk aan te wenden. De bevindingen van de tweede studie reiken verder dan de bevindingen van de eerste studie. De tweede studie gaat in op de vraag welke organisatorische routines belangrijk zijn, en baseert antwoorden op deze vraag op empirische gegevens van een representatieve enquête over de innovatieactiviteiten van Duitse ondernemingen. Deze empirische studie biedt een completer en holistisch beeld van belangrijke onderliggende routines die het bedrijven mogelijk maken om te innoveren in duurzaamheid.

De derde studie (hoofdstuk 4) hanteert een bedrijfsperspectief. Het onderzoekt de organisatorische- en managementcapaciteiten waarmee een bedrijf middelen en competenties kan laten evolueren rond een innovatiekans in duurzaamheid. Deze studie heeft tot doel een bijdrage te leveren aan een verder theoretisch en praktisch begrip van de manier waarop capaciteiten door bedrijven worden ingezet om veranderingen op systeemniveau te creëren en te implementeren voor duurzame innovatie. Volgens deze studie stellen de dynamische bekwaamheden van een bedrijf het bedrijf niet alleen in staat om te investeren in zijn eigen ontwikkeling om te innoveren in duurzaamheid, maar ook om te investeren in de ontwikkeling van het bedrijfsecosysteem waarin het bedrijf samenwerkt met anderen in de duurzaam innovatieve waardeketen. Uit de derde studie blijkt dat proactieve bedrijven die gericht zijn op duurzaamheid, eerder innovatieprojecten met duurzaamheidsvoordelen identificeren en nastreven. Ook toont de studie dat het bezit van procedures door bedrijven om een regelmatig en beter inzicht te krijgen in de milieueffecten hun activiteiten, deze bedrijven helpt hun detectievermogens te verbeteren voor het herkennen van de innovatiekansen in duurzaamheid. De studie laat zien dat bedrijven gespecialiseerde middelen en competenties bij verschillende actoren in de waardeketen moeten samenbrengen rond een innovatiekans in duurzaamheid; d.w.z. 'co-specialisatie van middelen'. De bedrijven gaan dus complementaire partnerschappen aan voor hun innovatieve inspanningen op het gebied van duurzaamheid.

De vierde studie (hoofdstuk 5) stelt dat organisatieroutines niet per se kunnen verklaren hoe innovaties in duurzaamheid worden geïdentificeerd, geprioriteerd en geselecteerd. Het louter begrijpen van de organisatorische routines is daarom niet genoeg voor een succesvol management van innovatie in duurzaamheid. Daarom onderzoekt deze studie de wijze waarop deze vermogens zich ontwikkelen, ontstaan en/of evolueren binnen de bedrijven die innoveren in duurzaamheid. Deze studie laat zien dat de dynamische bekwaamheden van bedrijven om te innoveren op het gebied van duurzaamheid niet alleen organisatorische routines omvatten, maar ook individuele- en managementondernemers-acties om de vereiste middelen en competenties te benutten. De studie concludeert dat de dynamische bekwaamheden van bedrijven om te innoveren op het gebied van duurzaamheid intern moeten worden ontwikkeld door middel van een reeks activiteiten en cognitieve processen gericht op de routines van de organisatie.

De laatste studie (hoofdstuk 6) stelt dat innovatie ten aanzien van duurzaamheid een sociaal-technische overgang vereist die niet alleen nieuwe technologieën, maar ook veranderingen in markten en overheidsinstellingen omvat. Daarom kunnen bedrijven unieke samenwerkingsverbanden aangaan, waaronder samenwerking met milieu-NGO's als potentiële innovatiepartners voor duurzaamheid. Deze laatste studie onderzoekt hoe een dergelijk partnerschap ontstaat en evolueert, en observeert op welke manier dit ontstaan en evolueren het innovatieproces beïnvloeden, met een bijzondere nadruk op het gegeven dat ook onvoorziene omstandigheden bij kunnen dragen aan de levensvatbaarheid ervan. Het onderzoek laat zien dat institutionele dialogische activiteiten en het vaststellen van industriële standaarden in samenwerking met andere actoren in de waardeketen, bedrijven in staat stellen om de systematische ontwikkeling van het bedrijfsecosysteem te ondersteunen en te regelen ten behoeve van het innoveren in duurzaamheid.

Dit onderzoek vormt een aanvulling op de literatuur over innovatie in duurzaamheid door te focussen op de wijze waarop de bestuurlijke en organisatorische capaciteiten van bedrijven worden ontwikkeld en versterkt om te innoveren in duurzaamheid. Dit onderzoek stelt ons in staat te analyseren hoe deze bedrijven functioneren gedurende het ontwikkelingsproces in de richting van innovatie in duurzaamheid. Dienovereenkomstig is dit onderzoek nuttig bij het uitwerken van de ontluikende theorie van dynamische bekwaamheden op het gebied van innovatie voor duurzaamheid. Het onderzoek biedt ook inzichten voor managers over de wijze waarop de middelen en competenties van bedrijven worden, moeten worden en/of kunnen worden ontwikkeld om duurzaamheid in hun innovatie-activiteiten te integreren en te verbeteren. Het biedt managers inzicht in de functie en effectiviteit van de mogelijkheden van bedrijven om te innoveren in duurzaamheid.

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