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Firms' capabilities for sustainable innovation: The case of biofuel for aviation

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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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1. Introduction

Many studies point to company resources and capabilities as key factors influencing sustainable innovation activities of firms (e.g., Dangelico, 2016; van Kleef and 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 and 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 and Paul, 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 and 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 and 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 competences 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 and 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

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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/competences 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/competences 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 and 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 competences 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 and 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 and 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 and 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 and 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 and Vredenburg, 2003; Hall and 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 inter-related 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 and 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 competences 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 and van der Linde, 1995). Integration of the sustainability concept into the innovation approach has significant implications for a firm’s resources and competences (Hall and 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 and 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 and 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 and 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 and 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 and 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 and 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. (2014) 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 and Teece, 2014).

2.2.3. Reconfiguring

According to Teece (2010), resources/competences 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 and Graebner, 2007). The use of qualitative procedures helps to explore key events and practices, as well as the logics 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 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 CO₂ 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.

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 min 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 policy maker 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 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 Fig. 1, are labeled by Strauss and Corbin (1990) as open coding.

During the second-order analysis, we moved on to axial coding (Strauss and 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 Fig. 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 Fig. 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 and Graebner, 2007).

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 competences 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

Table 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.			

will be explained separately for the “sensing,” “seizing” and “reconfiguring” activities of dynamic capabilities. Table 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 CO₂ efficiency in the aviation industry. One of the most important ways to reduce CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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

Table 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 is 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 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.

ensuring that there is a market for biofuels, new investments can bring stability and predictability for 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 with 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 enables 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 CO₂ 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

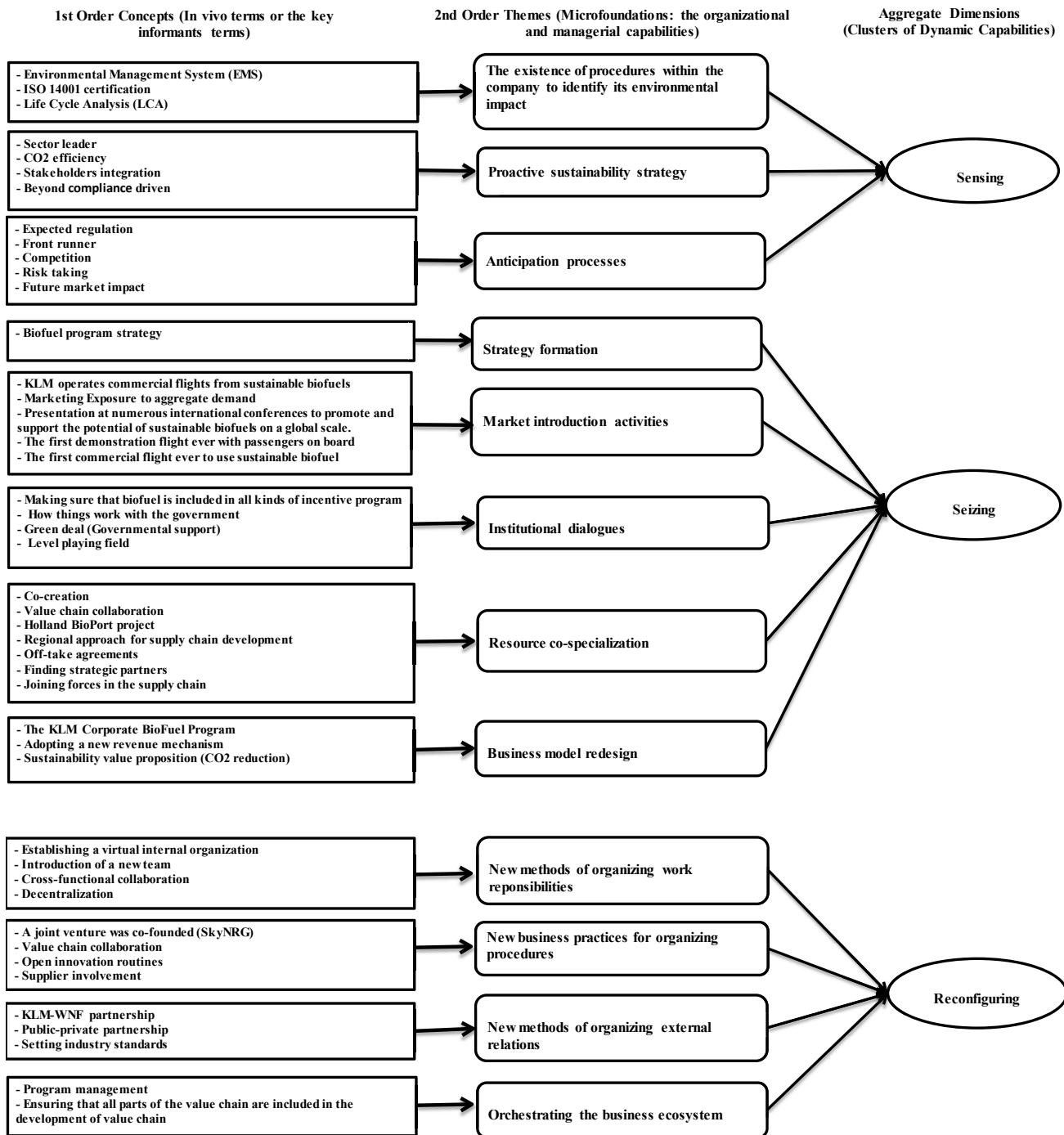


Fig. 1. Final data structure after third coding round.

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.”

Table 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	<p>“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)</p> <p>“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)</p>
Proactive sustainability strategy	<p>“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)</p> <p>“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)</p>
Anticipation processes	<p>“KLM wants to retain its ‘best in class’ for CO₂ and fuel efficiency. To do this, KLM’s ambition is to achieve 20% CO₂ and fuel efficiency for each tone transported/kilometer in 2020 in comparison with 2011.” (Archival data)</p> <p>“KLM is a frontrunner in the development and use of sustainable biofuel to reduce its CO₂ emissions in the aviation industry.” (An employee from WNF)</p>
Seizing: Dimension 2 Strategy formation	<p>“KLM has developed its strategy for sustainable biofuels around a value chain perspective by simultaneously creating demand and developing supply chains.” (Archival data)</p> <p>“In 2007, KLM engaged with WNF as a partner. WNF is mainly on the sustainability part. As a part of the partnership on CO₂ reduction, WNF was the supporter of KLM’s strategy in the field of sustainable biofuels.” (An employee from WNF)</p>
Market introduction activities	<p>“KLM has spoken at numerous international conferences to promote and support the potential of sustainable biofuels on a global scale.” (Archival data)</p> <p>“The first part of the strategy is to engage the industry, incentivizing the government or make government incentivizing this new development. Thus, demonstration flight was really the first things that we could do for stimulating the supply chain. (An employee from KLM)</p>
Institutional dialogues	<p>“KLM also supports regulatory incentives stimulating the biofuel market. KLM has been participating in European Commission Biofuel FlightPath 2020. The FlightPath aims to reach an annual production of 2 million tons of sustainably produced biofuel for aviation by 2020.” (Archival data)</p> <p>“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)</p>
Resource co-specialization	<p>“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)</p> <p>“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)</p>
Business model redesign	<p>“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)</p> <p>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 be affordable by this customer program. (An employee from KLM)</p>
Reconfiguring: Dimension 3 New methods of organizing work responsibilities	<p>“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)</p> <p>“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)</p>
New business practices for organizing procedures	<p>“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)</p> <p>“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)</p>
New methods of organizing external relations	<p>“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)</p> <p>“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 CO₂ emissions, we deviated from that view. Our focus is also on innovation.” (An employee from WNF)</p>
Orchestrating the business ecosystem	

Table 3 (continued)

“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)

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 to 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 in 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 in 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 competences

In response to sustainability challenges, firms need capabilities to strategically renew and manage the internal and external organizational competences, 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 stature. 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 competences 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 competences 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. The empirical findings allow us to introduce the following proposition:

Proposition 1. *Firms with greater dynamic capabilities have a higher propensity to innovate for sustainability.*

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 and 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 2. *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 3. *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 4. *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 and 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 competences and align their investments to create value and improve efficiency (Williamson and De Meyer, 2012). In this case study, KLM used its “smart power” (cf. Williamson and 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 policy makers should provide incentives and engage all value chain stakeholders for pushing companies to innovate for sustainability. Accordingly, we introduce the following proposition:

Proposition 5. *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 6. *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 and 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 competences for innovating towards sustainability. The leads to the following proposition:

Proposition 7. *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 and 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 8. *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 competences 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 and 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 micro-foundations, 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 1) do provide a basis for an analytically valid analysis of the KLM case. Further research is needed to develop insight into the micro-foundations 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, micro-foundations, 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 micro-foundations 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.

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