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Environmentally sustainable innovations in offshore shipping: A comparative case study

Oyvin Kyvik*, Age Svein Gjoesaeter

Western Norway University of Applied Sciences
Faculty of Technology, Business, and Maritime Education
*Campus Haugesund, 5528 Haugesund, Norway
oyvin.kyvik@hvl.no, age.gjosaeter@hvl.no

Abstract. Two Norwegian offshore shipping firms facing the challenge of developing more environmentally sustainable services choose divergent strategies. One focuses on managerial innovation and develops a new business model equally dividing fuel-savings achieved through operational optimization between customers and the Norwegian Rainforest Foundation, thus operating climate neutrally. The other firm develops a technology-driven strategy and develops LNG-propulsion for part of its fleet. Following the firms through the innovation processes, the study finds that implementing environmentally sustainable innovations requires managerial capability to provide a holistic and integrative perspective on organizational innovation processes which align technical and managerial actions and activities. The findings indicate that a business model can be used as a boundary-spanning tool that goes beyond the ambidextrous challenges of balancing and integrating exploration and exploitation and provides a complementary view on organizational innovation processes. The comparative case study looks inside the "black box" of sustainable innovation and offers theoretical and practical insights to academics and students. The study also contributes guiding principles for practitioners and policymakers.

Keywords. Innovation, comparative case study, environmental sustainability, offshore shipping, technological and managerial capability, business model.

1 Introduction

Norway has one of the largest and most comprehensive maritime sectors in global terms. Its offshore fleet is the second largest in the world[1], and the industry is characterized by high competence, innovation, and advanced technology. Norwegian maritime clusters comprising leading shipping companies, shipbuilding yards, equipment manufacturers, designers, service providers, universities, research and development centres, and regulatory bodies are among the world's leading suppliers of innovative and environmentally friendly solutions (Benito, Berger, de la Forest, & Shum, 2003; NSA, 2016).

In the global context, sea transport is a cost-effective, reliable, and comparatively environmentally friendly mode of transport, and some 90% of goods are transported by sea. According to the International Maritime Organization (IMO), maritime shipping

[1] The Norwegian maritime industry accounted for approximately 5.5% of Norway's GDP in 2012, and the maritime industry is the country's second largest export industry after the oil and gas sector.

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accounts for 2.2% of global CO_2 emissions (IMO, 2014), and while the general debate continues on just to what extent industrial activities impact the environment and what needs to be done about it (Mendonca & Oppenheim, 2007), the maritime industry, amongst others, has b*een called to action by the Brundtland report's call for an increased focus on sustainability[2] (UN, 1987). Accordingly, and in line with many other industries, more sustainable maritime shipping has during the past 10 to 15 years increasingly become a political, public, and business concern. The issue has also been on top of the agenda for national and international organizations representing ship owners, such as the Norwegian Shipowners' Association (NSA) (Henriksen, 2014) and the International Maritime Organization (IMO, 2013).

This development has also stimulated a growing body of literature on *corporate social responsibility* (CSR) (Bocken, Short, Rana, & Evans, 2014; Porter & Kramer, 2006) and *corporate greening* (Cohen & Winn, 2007), but despite this growing scholarly interest, management research still lacks a varied empirical examination of sustainable business practices and the potential for entrepreneurial rents arising from environmentally friendly innovations. And this is in spite of Porter and Kramer's (2006) reminder 10 years ago with reference to CSR that "companies are called on to address hundreds of social issues, but only a few represent opportunities to make a real difference to society or to confer a competitive advantage" (p. 92).

This study contributes to meeting this challenge by analysing how two *environmentally conscious* (Huang & Kung, 2011; Lynes & Dredge, 2006) Norwegian firms engaged in offshore maritime operations in the oil and gas sector chose different innovation paths in their search for more sustainable operations. The study responds to specific calls from scholars from both the natural and the social sciences to gain more knowledge about firm-based technical and managerial actions and activities involved in the process of going green in the maritime industry (Dalsøren et al., 2009; Gjosaeter & Kyvik, 2017; Helfre & Boot Couto, 2013; Mansouri, Lee, & Aluko, 2015). Based on recent theoretical perspectives on innovation (Giannopolou, Ystrom, & Ollila, 2011), this study specifically has an objective to open up the "black box" (Brown & Duguid, 2000; Sydow, Schreyogg, & Koch, 2009) of innovation and explore two real-life innovation contexts to determine the role played by technical and managerial resources, competencies, and capabilities in innovation processes aimed at more sustainable maritime operations. With its comparative analysis, the study will first and foremost contribute to the body of knowledge by revealing how two Norwegian offshore shipping firms facing the same environmental challenge chose very different strategies to reach the goal of more sustainable shipping services.

The next section describes the study's conceptual foundation. Then the design of the study and the methodological approach are outlined, followed by an elaboration of the cases forming the empirical basis of the research. Subsequently, the findings are explored, before the study concludes with a discussion of the implications, outlining the contributions of this research and indicating avenues for future study.

[2] The Brundtland report defines sustainability as "the ability to meet the needs of the present, without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987).

2 Conceptual foundation

Conceptually the study refers to a combination of several bodies of literature seen as offering explanatory theory relevant for the two empirical cases. However, notably, each body of literature and its disciplinary origin overlap, jointly contribute knowledge, and add theoretical perspectives on the complexity of the firms' strategic choices and the actions and activities forming part of the innovation processes on the path to improved sustainability.

With reference to factors pertaining to *individual- and firm-level entrepreneurial conditioning*, since the two firms are relatively small and specialized in one particular industrial segment, the resource- (Barney, 1996) and capability-based views of the firm (Grant, 1996; Teece, Pisano, & Shuen, 1997) are seen as central in explaining the firms' entrepreneurial urge, active searches for opportunity (Baron & Ensley, 2006), and approaches to strategic choices and strategic fit along their chosen path. Secondly, the firms' common Norwegian cultural setting, maritime business origin, and shared history as entrepreneurial and family-based firms are also seen as explanatory factors, on both the individual and the collective firm levels (Kotey & Meredith, 1997), and as helpful to understand the firms' individual strategic developments. These factors are also seen to explain the motivations behind the two firms' *green* strategies. In addition, they are in line with more recent findings showing that sustainable entrepreneurship has the potential to slow the degradation of and even gradually improve the earth's ecosystems (Cohen & Winn, 2007), and that the maritime industry can offer important contributions (Henriksen, 2014; Mansouri et al., 2015).

The firms form part of a strong maritime cluster on the southwest coast of Norway (Benito et al., 2003; Reve, 2009), and the positive effects on innovation performance (Zeng, Xie, & Tam, 2010) of *cluster-collaboration, networking, and knowledge-sharing* within a geographic area (Krugman, 1991; Marshall, 1920; Pouder & St. John, 1996) or within a field of competence (Decarolis & Deeds, 1999; Fontes, 2003), and particularly among resource-scarce smaller enterprises (Brunswicker & Vanhaverbeke, 2015), are well recognized both in practice and in the literature. While it is also recognized that the term innovation itself has many different meanings, actions and activities depending on the industry and context "which one must understand and study separately" (Jenssen & Nybakk, 2009 p. 460), scholars nevertheless seem to agree on the positive relationship between knowledge-sharing, absorptive capacity, and how informal industry networks, in line with prior research (Kaish & Gilad, 1991), are "found to be directly related to entrepreneurs' alertness to new opportunities" (Ozgen & Baron, 2007, p. 186).

Firms are social agents (Pitelis, 2009) and form part of the development of society, thus creating a *societal sustainability impetus*. The increasing focus on CSR (Porter & Kramer, 2006), global warming (Mendonca & Oppenheim, 2007) and emissions from ships (IMO, 2014; Skjølsvik, Andersen, Corbett, & Skjelvik, 2000) have undoubtedly led to social pressure on firms' owners and employees to contribute to a more sustainable industry. This trend is clearly reflected in maritime organizations' strategies and propaganda (Henriksen, 2014; IMO, 2014; NSA, 2016), but it is also seen in the increase of attention in the literature to establishing how much the world fleet pollutes through emissions (Dalsøren et al., 2009), and also to other effects of maritime

operations, such as waste (Butt, 2007; Encheva, 2015), emissions while in port (Scott, Gössling, Hall, & Peeters, 2016), and negative externalities of cruise tourism (EU Commission, 2009).

Combined, these developments have greatly influenced and formed the background for developing the *going green innovation process* and the empirical setting of the case studies. In particular, the recent work with a focus on climate-neutral offshore shipping operations (Gjosaeter & Kyvik, 2017) provides perspectives on the balance between operational innovations, customer orientation, and development of a business model supporting the sustainable development, and indicates a crucial link between innovation, entrepreneurial drive, and the user of or market for the innovation. Huang and Kung (2011) study the "greening" of management focus based on a quantitative analysis of Taiwanese firms' environmental consciousness, finding positive relationships between environmental consciousness, green intellectual capital, and competitive advantage, and concluding firmly that "the world is entering a green era" (Huang & Kung, 2011, p. 1420). In a more discourse-based study of the motivations for the airline industry to "go green", the sustainable development debate is presented as a quest for greater integration of the economy and the environment, but with the question of using market-based instruments of environmental policy or the setting of environmental standards by direct legal regulation (Lynes & Dredge, 2006). Their findings "suggest that environmental management practices should be aimed at reducing costs, delaying or avoiding regulatory action, reinforcing a positive image (being a good corporate citizen) and should respond to pressure from corporate customers and client stakeholders" (p. 135). However, the scholars go on to point out that the social sciences do have role to play in developing scientific indicators and behavioural patterns to benchmark what are socially and politically legitimate management decisions. This may also be interpreted to coincide with a call for an increased cross-disciplinary research orientation in response to the need for more relevant research on sustainability within the field of management and organizational science (Skoglund, 2015).

This leads to a final contributing construct of the conceptual framework, which is the search for a *sustainable business model* — a model able to balance the various social- and market-related requirements. In essence, a business model embodies nothing less than the organizational and financial architecture of a business (Chesbrough & Rosenbloom, 2002), and thus articulates the conceptual logic while also providing structure and eventually data (revenue and costs) demonstrating how a business creates and delivers value to customers. Since the relaunching (Trott & Hartmann, 2009) of the business model concept (Chesbrough, 2003), much has been published on business models and increasingly also with a focus on *sustainability* (Sarkis, De Bruin, & Zhu, 2013). With reference to relatively recent literature (Charter, Gray, Clark, & Woolman, 2008; Schaltegger & Wagner, 2011), Boons and Ludeke-Freund (2013) point out that how firms succeed in bringing an invention to the market is still relatively unexplored in the field of sustainable innovation, and they elaborate how business models and sustainable innovations interrelate to form separate, but overlapping, research streams — one with a technological focus, one organizational, and a third centred on social innovation. Their conclusion is that "sustainable business models enable social entrepreneurs to create social value and maximize social profit; of significance is the

business model's ability to act as market device that helps in creating and further developing markets for innovations with a social purpose" (p. 16). *How* this process is managed is however not elaborated by the authors.

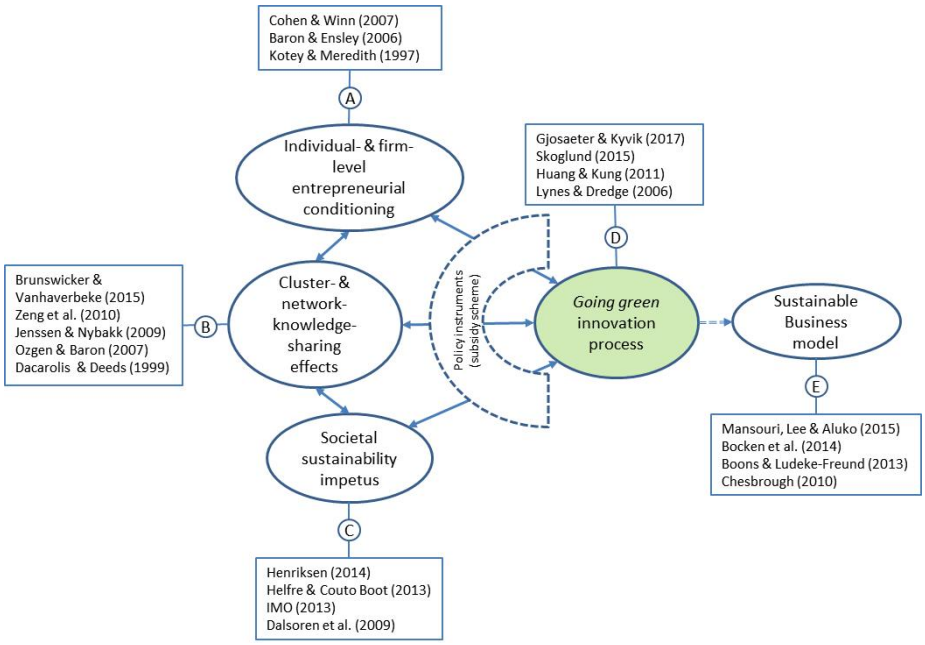

Fig. 1 Conceptual framework

The conceptual framework for this study is illustrated and summarized in Figure 1. It should be noted that the double arrows are meant to indicate interrelationships and a partial overlap between the constructs; however no causal effects or effects between the constructs over time are implied. Using a combined activity- (Johnson, Melin, & Whittington, 2003) and resource-based view of the firm, the study elaborates empirically the role of resources, competencies, and capability in organizational innovation processes within the two case companies aiming to provide a more environmentally sustainable offshore shipping service. These combined perspectives were chosen because of their specific focus on the study of work as a flow of activities (needing resources and capability) while addressing the detailed processes and practices that constitute the day-to-day activities of organisational life and which relate to strategic outcome (Johnson, Melin, & Whittington, 2003). The present study, on the basis of its rich empirical context, contributes valuable additional insights to the understanding of organizational innovation processes and the balance between technology, human competence, and commercialization. Partly based on the literature review and partly based on the empirical context, this study poses the following research questions:

1. How does the firm context (company culture, history) influence the emergence of sustainability-innovation strategy and subsequently the flow of activities and actions forming part of the innovation process?
2. Forming part of the same sector and located in the same geographic area, why

did the firms choose different innovation strategies?

3. Within each firm and in its strategic context, which factors are main drivers and enablers for the innovation process?

In line with the conclusion that "when a well-run business applies its vast resources, expertise, and management talent to problems that it understands and in which it has a stake, it can have a greater impact on social good than any other institution or philanthropic organization" (Porter & Kramer, 2006, p. 92), in addition to addressing the research questions, this study also offers perspectives on how the art and science of management, as an important part of the social sciences, may contribute with examples of practical and innovative solutions on the path to more sustainable offshore shipping.

3 Research design and methodology

A comparative and exploratory case study design was chosen because a lack of in-depth knowledge about the role of resources and competencies in innovating environmentally sustainable and profitable offshore shipping services made it impossible to advance well-grounded a priori hypotheses (George & Bennet, 2005). Further, a qualitative approach (Denzin & Lincoln, 2000; Eisenhardt, 1989; Ghauri & Grønhaug, 2010) was used to gain a more thorough understanding of the organizational innovation processes and the role played by resources and professional competencies within the two case companies than is offered by a quantitative methodology (Graebner, Martin, & Roundy, 2012), which is often conducted as a survey investigating relations between dependent and independent variables established in advance (Edwards & Bagozzi, 2000; Revang & Olaisen, 2014). A cases-in-the-case design (Yin, 2014) with several observational units within each case company was established with the objective of providing primary data in a way that is rather rare within strategic innovation research. The research ambition was thus not only to approach, but also to look inside the black box (Brown & Duguid, 2000) of activities and actions involved in the various phases of the innovation processes and thus provide a richer understanding.

With the firm as the research context, two comparable maritime firms from the same industry sector were selected, and within in each case company four vessels were chosen for data collection. The four vessels selected as observational units within case company A were chosen on the basis of the results of their environmental efforts at the time the study commenced (2009), and in case company B four out of five available ships were chosen on the basis of their propulsion system (LNG[3]). An overview of the research design developed for the study is shown in Figure 2, and it should be noted that the unit of analysis is the *cases of innovation processes* within each of the firms. For both cases, primary and secondary data were collected on various organizational levels both onshore and offshore and in continued dialogues and coordination with the firm's top and middle management.

[3] LNG = Liquefied Natural Gas

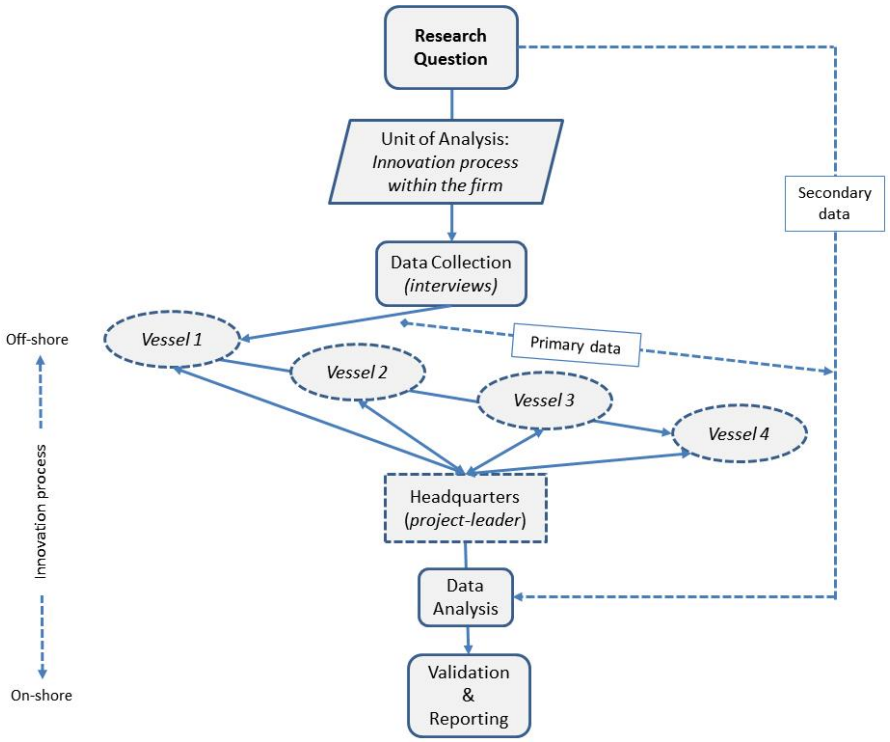

Fig. 2. Research design (adapted based on Gjosaeter & Kyvik, 2017)

An initial meeting with the project leader in company A, who reported directly to the managing director, was arranged to obtain an overview of activities, establish a level of confidence, and secure access to the four vessels. Similarly, an up-front coordination meeting was arranged with the engineering director who was in charge of the project in company B. Based on data from these first meetings and information obtained from secondary data sources, a semi-structured interview guide was developed. Thereafter, interviews were performed with onshore personnel as well as managers and crews on board the vessels, and the data collected was amplified and cross-referenced by secondary data from company records, press coverage, and press releases. The appointments to conduct the interviews on board the selected vessels were arranged in cooperation with the project leader in each firm and scheduled to take place when the vessels were in port. Since some of the vessels did not often approach nearby ports, the first interview on board a vessel was conducted in early 2011 and the last one late in 2012.

The interviews were conducted in an open and conversational manner, allowing for topics to emerge during the sessions. Some of the interviews were conducted in the captain's cabin, some on the bridge, and others in the vessel lounges, as was most convenient for a ship in full operation and preparing for the next assignment. The interviews in the captain's cabin were with the captain himself as the only interviewee, while the interviews on the bridge usually were with the whole management team (depending on operational requirements at the time, this team comprised some or all of

the captain, the chief mate, the chief engineer, and the steward). The interviews lasted for one to three hours, followed by guided tours around the vessels that also included brief conversations with other crew members. After the interviews with the management and crews on board the four chosen vessels in each firm, a final interview lasting for a whole day was conducted with onshore management to validate the findings and their significance thus far in the data collection process.

The data collection through interviews took place over a period of almost two years, during which the activities and actions forming part of the innovation processes in the two firms were gradually operationalized at all organizational levels both on and off shore. This is seen to strengthen the validity of the findings, as they emerge as part of a real-life evolutionary process where the vision might be questioned by the practitioners in the beginning before gradually being accepted and adopted through on-the-job dialogues and activities. At the end of the data collection process, the nine interviews with firm A and the ten interviews with firm B, all digitally recorded, were transcribed and subsequently interpreted separately and then jointly by the two interviewers. It should be noted that the interview-based data collection was somewhat constrained by the fact that the interviews were performed while the ships were in full operation, thus time with and access to the offshore CEOs (the captains) were limited. Due to circumstances onboard two ships, for instance, the captain was not available. However, it is still perceived that the data collection resulted in data saturation, as new themes did not occur during the interview sessions towards the end of the data collection process. Based on a comparison of notes between the two interviewers and an open dialogue when perceptions diverged, it was concluded that the empirical data fully represents the strategic and operational logic of the two firms. For further validation, the interview data was triangulated with secondary data covering the entire data collection period and until the end of 2014. In addition, the interpretation of the findings has been supported and amplified by follow-up conversations with the project leaders of the two firms.

4 Empirical context and case studies

The contextual foundation of the comparative case study is summarized in Table 1, indicating both similarities and differences between the two case companies (NSA, 2011). Notably, both firms are engaged in the Norwegian petro/maritime shipping sector, have vessels of a similar class, and offer comparable, but not identical, services. With a historic perspective, company A has grown more rapidly from being a start-up in the 1960s, after altering its strategic focus from deep-sea shipping to the offshore shipping segment. With reference to Table 1, it is also in general terms deemed reasonable to classify company A as more transport and support oriented and company B as relatively more technically advanced and specialized in its operation.

Below follows a presentation of the context of the two innovation-process case studies following Yin's (2014) cases-in-the-case research design.

Table 1. Comparative firm characteristics (2016)

	Case company A	Case company B
Number of vessels	50	25
Type of vessels	Construction service; anchor-handling tug-supply; platform-supply	Platform-supply; subsea; seismic
Type of fuel (M/E[1])	MDO[2]	MDO 79 %/LNG[3] 21 %
Main market	World wide	World wide
Number of employees (approximate)	1800	900
Ownership	Family-controlled publicly listed company	Family-controlled publicly listed company
History	Liner/deep-sea shipping	Fishing ships

Notes: 1 = Main engine
2 = Marine diesel oil
3 = Liquified natural gas

4.1 Case A: Green operations campaign

The innovation process within case company A began as a campaign to reduce the consumption of fuel by offshore service vessels. The campaign, which started in the fourth quarter of 2009, was motivated by a Norwegian governmental incentive scheme allowing for tax deductions for shipping companies' efforts to reduce environmentally damaging emissions. The initial aspiration of the firm was to reduce the fleet's total diesel fuel consumption by some percentage, initially without an exact target. After a while, however, the target was specified as a 10–20% reduction, or up to 20,000 tons (approximately 23,000,000 litres) of diesel a year. The reduction in fuel consumption was to be achieved by carrying out fuel-saving *green operations* on board the vessels. A green operation was defined as a saving of 500 litres (or 0.5 m^3) of diesel fuel in specific operational manoeuvres during a day. By carrying out various forms of fuel-saving operations the company manifested care for the environment while at the same time building a competitive advantage by operating in a cost-effective manner. The company also strategically branded itself as a *green* shipping company in all external (marketing and profiling) communications.

In 2011 the company extended the campaign by introducing a new environmental concept for the fleet. The concept was named Climate Neutral Operations (CNO), and the objective was to compensate for the exhaust emissions from the fleet of vessels by introducing the opportunity for customers to contract *climate-neutral* ships. This was done by splitting the diesel cost savings equally between the customer contracting the vessel and a contribution to the Norwegian Rainforest Foundation (donor to the United Nations Rainforest Foundation).

The environmental efforts of the company have been recognized at the national as well as the international level. The Norwegian Minister for Environment and International Development expressed in an announcement in 2013 that he was impressed by the

company's environmental work, emphasizing the importance of taking the initiative to implement such an important and forward-thinking environmental model as the CNO concept, which is ahead of both the current market and regulatory requirements. In 2014 the company was also listed on the exclusive CDP[4] Climate Performance Leadership Index for 2014 with the highest score. The Climate Performance Leadership Index is based on an assessment of the environmental efforts of major companies worldwide, a rating done both to highlight the environmental performances of companies and to provide investors with the opportunity to assess the environmental profile they choose to invest in. Company A was one of only three Norwegian companies included on the list, and the only shipping company.

The firm was established in the 1960s as a start-up venture and is today a publicly listed company. With reference to Table 1, the firm had at the time of the study approximately 1800 employees (including onshore and offshore personnel), and a total fleet of 50 vessels. A project leader reporting directly to the CEO and working in close collaboration with the top management team and operations staff was hired from outside the company to run the fuel-saving campaign.

During 2010, according to company records fuel savings of about 10% were achieved compared to before the campaign was launched. Since then fuel savings have gradually increased year by year up to and including 2013, when according to company records the savings reached 25–30%. The corresponding reductions in environmental emissions include among others nitrogen and CO_2. The yearly reduction in diesel costs is estimated at NOK 25–30 million, or USD 4–5 million. In addition, maintenance costs have been reduced because less use of the engines of the four vessels results in less wear and tear.

It should be noted that these achievements have been realized without any additional capital investment and thus represent managerial innovation through more efficient use of existing technical equipment and optimization of operational routines carried out by motivated and well-trained management and crews both on board the vessels and on shore.

4.2 Case B: Development of innovative LNG technology

Case company B was pioneering innovation processes aimed at developing LNG-fuelled main engines for offshore service vessels. The initial trigger for the innovations was the sharp rise in oil prices in 1999. One of the consequences of this rise was a corresponding increase in diesel fuel costs, leading to serious concern about how to reduce the cost of fuel. Company B decided to investigate if LNG might be used as marine fuel for its ships, since this type of fuel was cheaper than diesel fuel and had the greatest potential for reduction of emissions to the air, particularly of CO_2. LNG consists mainly of methane (CH_4), and has previously been used in steam boilers, gas turbines, and various types of engines. Furthermore, a ferry using LNG as fuel instead of diesel had recently been put into operation on the west coast of Norway, drawing attention to the possibility that LNG might also be used for fuelling offshore service

[4] CDP = Carbon Disclosure Project, https://www.cdp.net/en-US/Pages/About-Us.aspx, accessed 18.05.2016.

vessels. In collaboration with Innovation Norway[5], a local shipyard and technical consulting companies within the adjacent maritime cluster, the company in 1999 started the pioneering innovation processes aimed at developing the first offshore supply vessel in the world fuelled by LNG. In 2003 the first vessel was delivered ready for operation in the North Sea. Partly subsidized by Norwegian governmental grants, company B invested in four additional LNG-propelled vessels during the next 10 years and now has a total of five vessels operating on LNG instead of diesel fuel.

With reference to Table 1, the history of the firm is similar to that of company A. It was established in the 1960s by two brothers, but began as a fishing company. During the 1970s the company entered the offshore market, and by the end of the 1970s the company operated a fleet of three vessels servicing the offshore petroleum industry. Today the fleet totals 25 vessels made up of platform supply vessels, subsea vessels, and seismic vessels. The total number of employees is about 900 on and off shore. The company is owned by the founder's family. A key characteristic of the company is that it has always been in the forefront regarding environmental sustainability. To our knowledge no other offshore shipping company in the world has been prepared to support technological innovation processes by way of capital investments aimed at realizing environmentally sustainable shipping to the same extent as company B.

The environmental efforts of the company have according to company records resulted in significant reductions in releases of detrimental emissions from the vessels operating on LNG instead of diesel fuel, gradually increasing from 2003 when the first LNG-operated vessel was put into operation up till 2016 with 5 LNG-fuelled vessels in operation, representing a total reduction of 20–25% compared to using diesel fuel. The use of LNG as fuel instead of diesel has resulted in about 80% less nitrogen and about 20% less CO_2 released into the atmosphere. The consequent reduction in fuel costs for the company's fleet of vessels is reportedly about NOK 10–12 million, or about USD 1.5 million, on a yearly basis.

It is emphasized that the innovation processes of company B are very distinct from those of company A in that they are technologically driven and include a significant capital investment in new technology, reflecting a long-term technical commitment to LNG as fuel.

Below are presented the comparative findings of how the two companies implemented their environmentally friendly innovation strategies.

[5] Innovation Norway is the Norwegian government's institution for innovation and development of Norwegian enterprises and industry.

5 Operationalization of the innovation strategies: Empirical findings and analysis

5.1 Case A: Green operation campaign – a managerial invention

The campaign launched by case company A in 2009 to operate the fleet of offshore service vessels in a more environmentally sustainable manner was primarily motivated by governmental grants allowing for tax deductions for initiatives to reduce detrimental emissions to sea and air by maritime shipping. The stated objective to realize environmentally sustainable shipping by carrying out fuel-saving operations on board the vessels resonated well with prevailing societal trends and values. It quickly became a salient issue within the offshore shipping industry, recognized on both the national and international levels. The creation and promotion of a strategic idea for which the time was right was therefore a vital precondition for making the *green operations* campaign an environmental as well as a financial success, as confirmed by one of the interviewees: "The campaign would probably not have become so successful if it had been launched at an earlier stage."

The strategic objective was supported by the development of a goal-oriented and innovative business model that supported acting out fuel-saving green operations. The business model was based on the idea that 50% of the cost savings obtained through carrying out fuel-saving operations were to the benefit of the customer contracting a vessel, and the other 50% of the savings were to be assigned to the Norwegian Rainforest Foundation. In collaboration with its customers the company was to compensate for its environmentally damaging emissions by investing in and supporting projects that were certified for CO_2 cuts in accordance with the United Nations climate quotas. Through this contractual arrangement the customers were made financial benefactors of the green operations campaign. At the same time, the strategic objective to operate the vessels in an environmentally sustainable way was linked to the preservation of rainforests. In addition, the establishment of the CNO concept in 2011 provided for making the customers even more involved in the company's environmental work. The CNO concept was designed to enable climate-neutral shipping to be a commercially profitable measure for the company as well as its customers.

A further key precondition for implementing the strategic idea was concretizing *how* environmentally sustainable offshore shipping services might be realized on board the vessels. To this end, the project leader of the campaign sent an invitation to the vessel captains inviting them to propose ideas for how green operations might be transformed into operative reality. In response to the invitation, about 150 proposals were received. The collected proposals were consolidated into seven main categories of fuel-saving operations, as a cooperative effort between onshore and offshore management. The consequent repertoire of fuel-saving green operations comprised anchoring, drift, reducing transit speed, green dynamic positioning, stopping the main engine, optimizing trim, and reducing electrical consumption. The menu bridged the strategic objective and concrete actions and activities on board the vessels to realize the idea, thus constituting the "aim and fire" of concrete operational actions and activities, as confirmed by a captain: "We also did a lot of this before, but now it was systemized..…

The concretizing processes have bridged the strategic idea and how to operate in an environmentally sustainable way on board the ships."

Implementing environmentally sustainable and profitable offshore shipping presupposed that the captain on board a vessel, in close cooperation with management and crew, had to have his "hands on" all operational activities, conducting green fuel-saving operations whenever an opportunity for suspending the normal way of operating the vessel arose. In addition, the customer contracting a vessel had to agree to initiating a fuel-saving operation. In the beginning the customers were, however, hesitant supporters of the campaign. Promotion of the idea to customers to make them stakeholders in the campaign was, therefore, an important activity, initially focusing mainly on the cost savings to be achieved. Gradually, however, the customers realized that the green operations initiative constituted a win-win project, and little by little became supporters of the campaign. Thus, acting out fuel-saving green operations presupposed close contact with the customers on a daily basis to decide if any fuel-saving operations should be carried out, while at the same time taking into consideration the operational risks involved in carrying out one or more operations. As described by a chief mate: "We discuss with the customer whenever there is an opportunity. There is a continuous dialogue regarding what is going to happen during the day, particularly at the morning meeting, and then we decide if we for example can shut down one engine or more." Thus, executing fuel-saving operations demanded campaigning for the strategic idea as an environmental as well as a financial issue, despite the fact that half of the cost savings obtained through carrying out green operations was of direct financial benefit to the customer.

Further, maintaining momentum in acting out environmentally sustainable and profitable offshore shipping was facilitated by organizing the green operations campaign as an internal competition among vessels. The green fuel-saving operations carried out were recorded on a daily basis and reported to the project leader. The project leader reported accumulated green operations achieved by each vessel on a quarterly basis. The number one vessel for a quarter was awarded a small amount for its welfare fund. In addition, the crews on board the three best vessels were awarded T-shirts marked with a *green operations* symbol. Furthermore, a vessel that managed to achieve the target of 200 fuel-saving operations during a year received a green flag to be hung from the mast showing that her crew have a strong environmental focus in their day-to-day work. The internal competition encouraged managers and crews to continually look for new ways of operating the vessels in environmentally sustainable ways, as verified by a chief engineer: "Carrying out fuel-saving operations has become an internal competition where one does not want to appear too low on the quarterly reports stating 'green operations' carried out."

Achieving environmentally sustainable and profitable offshore shipping called for leadership of the innovation processes, more or less on a day-to-day basis. First and foremost, realizing the strategic objective demanded leadership in shaping alignment around the twofold objective of environmental sustainability and profitability. In this respect, caring for the external environment was an idea that resonated with prevailing societal trends and values. However, acting out environmentally sustainable and profitable operation of the vessels also called for managerial capabilities to infuse the strategic idea into actual strategy, including the support of a dynamic business model,

presupposing continuous enactment of the organizational innovation processes. This included top management's detached coping acts (Sandberg & Tsoukas, 2011) implying abstract reflection on the firm's strategy, as well as the crews on board the vessels carrying out green operations as practical coping acts as the campaign was operationalized. Realizing environmentally sustainable and profitable offshore shipping presupposed an evolving and dynamic organizational activity system supported by an appropriate business model, and the management team of company A seem to have managed to keep a pragmatic balance between the left brain (rationality) and the right brain (creativity) in their business model development (Osterwalder & Pigneur, 2010) by encouraging participation and creating ownership of the objectives of the campaign. They also kept close contact with customers throughout the campaign.

5.2 Case B: Development of innovative LNG technology – a technological thrust

A key antecedent for company B's technological innovation processes aimed at realizing LNG-fuelled offshore service vessels was its history as an entrepreneurial "down to the trawl" fishing operation dependent on the natural resources provided by the sea, demanding that the company care for the environment in addition to doing business. A statement by the late founder of the company referred to by one of the interviewees confirms that business is "in any case not only financial results". This statement indicates that the founder wanted the company to attain more than pure business goals. Another interviewee expressed that the founder wanted to be a pioneer in realizing environmentally sustainable maritime shipping: "He wanted to bring the shipping industry on a more environment-friendly track. Therefore, we take responsibility for developing and using technology in a new way that saves the earth from unnecessary environmentally detrimental emissions."

The spirit of the founding brother, who died in 2002, has lived on, and the company has been prepared to financially support environmentally friendly technological development campaigned for by the chief technical officer, who worked closely with the founder during the early years of the innovation process. The continued technological drive was above all welcomed by the onshore engineering staff, considering the LNG project as an interesting and challenging technological endeavour, and LNG as the "the bridging fuel" between diesel and future, more environmentally friendly forms of energy. An interviewee characterized the LNG venture as the company's "moon landing project"; a journey he wanted to take part in. The strategic ambition to operate offshore service vessels on LNG constituted a technological challenge that generated extra energy among the engineering staff. Even further, the company's environmental efforts created organizational pride and made it an attractive employer, as stated by one of the interviewees: "Our innovative efforts take the industry a step forward every time." The environmental efforts of the company also resonated with stated organizational values: responsibility, good seamanship, integrity, passion, innovation, sobriety, and commitment. In addition, environmentally sustainable shipping contained an ethical aspect related to caring for the external environment as a moral foundation of the technological innovation drive.

However, innovation of LNG-fuelled vessels also rested on the technical resources within the adjacent maritime cluster comprising among others companies within the consulting industry and the maritime motor industry, as well as competitors within the

offshore shipping industry. Cluster networking facilitated knowledge sharing, complementing the case company's in-house technological knowledge base. The company became a pioneer and first-mover within the offshore shipping industry to operate LNG-fuelled offshore service vessels, which also made it a pathfinder in the development of rules and regulations for LNG-operated offshore service vessels, in collaboration with the Norwegian Maritime Authority. The involvement in this work contributed even further to creating momentum in the technological innovation processes.

An additional promoter of the technical innovation processes aimed at saving fuel was the progressively competitive market situation within the offshore shipping industry. Since other international offshore shipping companies to a larger extent than Norwegian companies benefited from employing offshore crews that were less costly than Norwegian seafarers, company B considered LNG fuel as a cost-saving opportunity. The customers, on the other hand, were primarily interested in getting an offshore service job done as cost-effectively as possible, but in the end caring less about environmentally damaging emissions. Thus, even though the company branded itself as an outstanding environmentally responsible company, the corporate image thus gained did not enable it to earn a market premium for its more environmentally friendly offshore shipping services. Company B reaped the benefits of its LNG investments through fuel savings, but did not succeed in developing a business model to complement its sustainability strategy.

5.3 Analysis of empirical findings

Company A successfully operationalized its green operations strategy empowered by prevailing societal trends and internal values regarding environmental sustainability. Strategic implementation was supported by the construction of an innovative overarching business model which allowed for alignment of financial and environmental objectives while creating a win-win solution for both the firm and its customers.

Concretizing the implementation of the strategy by determining shipboard actions that would enable the objective to be reached while at the same time winning the minds and hearts of managers (offshore and onshore), constituted key elements in transforming the strategic idea into an operative reality. In addition, designing a results-oriented and accountable system for recording fuel-saving operations launched a competitive spirit among the vessels to carry out the most green operations and helped maintain momentum in the innovation processes.

Company B's approach to realizing environmentally sustainable shipping rested on its technological LNG-based innovation drive. The innovative development of LNG-fuelled propulsion constituted an interesting technological challenge, particularly among the onshore engineering staff, who perceived LNG as a bridging fuel between diesel fuel and future energy solutions en route to even more sustainable forms of energy for marine vessels. The in-house technological innovation resources were complemented by technical resources within the adjacent maritime cluster. As a first mover in developing and using LNG-fuelled offshore service vessels, the company gained significant attention and goodwill from customers and other stakeholders, branding itself as an outstanding environmentally responsible shipping company. The

positive corporate social image did not, however, in itself provide for a market premium for the more environmentally friendly shipping services. The customers supported the environmental efforts in words, but were not willing to pay extra for them.

Key drivers and activities during the innovation processes in the case studies are summarized in Table 2.

Table 2. Key drivers and activities during the innovation processes

	Case A: Green operations campaign	***Case B: Development of LNG-technology***
	Strategic objective of implementing "*green operations*" to save fuel	Founder's spirit (*"business is more than profit"* & "*the sea is a renewable resource*")
	New project leader as champion/agent supported by CEO	Technology-*champions* (technical director – chief engineer - supportive CEO) and large technological staff
	Development of new creative business model aligning financial and environmental objectives	Key stakeholder engagement both on intra- and inter firm level (maritime cluster)
	Hands-on/minds-on collaborative effort (on-shore/off-shore) to enact the strategic innovation	High technological compentence and strong *technology-optimism*
	Design of reporting- and incentive system (green flag competition)	A strong collective belief in gaining competitive advantages through technological innovations
	Value-based leadership involvement	Environmental sustainabilty perceived as ethical (*"minds & heart"*) motivator and right thing to do based on technological achievements
Notes:	CEO (2nd generation leader of the firm) has *nautical education and prior experience as sea-captain*	CEO has a MBA and *maritime business-experience*

With reference to the CEOs' education and professional training as per the notes in Table 2, the observations made are only cursory, as no specific data indicate a relationship between the CEOs' professional background and the firms' innovation processes. However, drawing on earlier research (Gavetti & Rivkin, 2007; Lyles & Schwenk, 1992), one might nevertheless hypothesize whether a CEO with a nautical/navigational background might be more inclined to focus on innovation related to *ship operations*, and, similarly, knowing the technological focus of maritime operations, whether a CEO with an economics/business background might be relatively more easily influenced by a detail-oriented and well-motivated engineering staff to follow a *technological* path.

With the benefit of retrospect, in comparison to company A, the management team of company B seems to have had a technological bias and to have been relatively more influenced by the left brain (rationality) than the right brain (creativity) in choosing their strategic path.

6 Discussion and implications

The empirical findings indicate that Company A's success in achieving the strategic objective of an environmentally sustainable and climate-neutral offshore service rests on practical managerial and leadership skills resulting in optimization of the operation of the fleet. The firm was already in the forefront in caring for the external environment, albeit in a more or less unsystematic way, when the employment of a new project manager for the green operations campaign brought fresh ideas to the company's environmental endeavours. Notably, the project manager respected and took advantage of the existing maritime competence within the company and established through team collaboration a new business model establishing new rules, routines, and procedures to guide how work got done (Raisch & Birkenshaw, 2008), allowing 50% of the cost savings obtained by carrying out fuel-saving operations on board the vessels to be paid to customers and 50% to the Norwegian Rainforest Foundation. The contractual arrangement at the same time acted as a canvas for sharpening business ideas to achieve environmentally sustainable as well as profitable shipping services. The innovative business model provided target customers with offshore service that was both cost effective and environmentally sustainable. The value proposition created a win-win situation for both the customers and the external environment, and the firm successfully managed to establish team-based interdisciplinary practices and processes which encouraged innovative thinking. Also, because the organizational innovation processes rested on unique, idiographic, and *sticky* (von Hippel, 1994) organizational resources and capabilities, the innovation processes and the operational implementation were not easily copied by competitors within the offshore shipping industry. This was a solely managerial innovation requiring no additional technological investment.

Company B, on the other hand, did not manage to obtain a market premium on the basis of its LNG innovations, and the customers were not actively involved and encouraged to pay more for service provided by LNG-fuelled offshore vessels. Even though the company possessed excellent in-house technical resources and competence, and also cooperated extensively with technical partners within the adjacent maritime cluster, the company only to a limited extent took advantage of non-technical in-house or external managerial competences like marketing or finance which might have stimulated a dialogue around the possibility of supporting the technical innovations by altering the business model. Even though the company gained an image as an outstanding environmentally responsible company, the LNG technology solely led to fuel-cost savings based on the price difference between LNG and diesel fuel. Beyond the direct fuel-cost savings, no premium for more environmentally sustainable operations materialized even after 10 years. Thus, it appears that although the firm's strategy went a long way to improve environmental sustainability, it lacked the ability to entice customers to pay for this benefit.

From an organization perspective, the innovation drive was strongly technologically dominated, and was referred to as a "moon landing" venture among the participants. The chosen rhetoric indicates complexity and underlines the firm's goal of becoming a pioneer and first-mover in LNG-fuelled offshore service vessels (Gilbert, 2005).

There are several cognitive propositions for how firm B might give the impression to have implicitly downplayed if not ignored the necessity of being paid a premium for its

innovations. One is that the technical success of the project and continued exploitation of the LNG technology might be seen to have led the company into a cognitive *success paradox* (Audia, Locke, & Smith, 2000; Kyvik & Gjosaeter, 2015; March, 1991), blocking it from a more rigorous exploration of opportunities. Moreover, taking into account the size of the firm and available managerial resources, the technological success may thus have diverted attention away from also focusing on a strategy to connect the technological innovation with a customer need. This reasoning corresponds with the fact that company B got a lot of positive press attention as it developed the LNG innovation project, which was also supported by Innovation Norway, and it is possible that the combination of the above factors may have created somewhat of a "success bias" (Lovallo & Kahneman, 2003) and implicitly put a damper on the firm's entrepreneurial drive. This argument is also in line with recent views on how a business model perspective combining different disciplines and functions, both within the firm and externally, may positively contribute to a sustainable innovation agenda by opening up new approaches to overcoming internal and external barriers (Boons & Ludeke-Freund, 2013). Another cognitive trap is that the strong technological focus over several years may have created an organizational path dependence (Nelson & Winter, 1982) and a dominant technological logic (Prahalad, 2004), making it challenging for the firm to develop unique firm-based selling points requiring disciplinary competence from other knowledge areas. This situation is well illustrated by the technical director's off-the-cuff comment during the data-collection process that *the innovations in company A are not real innovations since they are not of a technological nature*.

Also worth noting is that the LNG technological advances for offshore service vessels were partly the result of a more or less open innovation (Bocken et al., 2014; Lee, Park, Yoon, & Park, 2010) process within the regional maritime *cluster* (Brunswicker & Vanhaverbeke, 2015; Brännback, 2004; Ernst & Kim, 2002), which at the time of the data collection was in an LNG-based sustainability mode. However, the entire innovation process was strongly technology driven and dominated by codified knowledge (Grant, 1996; Teece, 1998), and with technology-based interactions relatively easily copied by competitors. The openness of the innovation process and the continued close interactions with governmental authorities and commitment by regulatory bodies turned the LNG project into both a regional and national maritime prestige venture. And it is believed that the cluster-based technological networking further cognitively reinforced the path dependence (Sydow et al., 2009).

Clearly limiting company B's opportunity to benefit from its technological innovations was the lack of national and international rules and regulations demanding environmentally sustainable shipping by legislation (Huang & Kung, 2011; Sjaafjell, 2015). The reasoning here is simply that if international legislation required reduced emissions, this would more or less immediately reflect itself in the freight rates (the market price for transportation) due to a reduction in the supply of qualified ships.

The development in firm B compares quite sharply to company A's firm-based, more closed and intensely interdisciplinary and human-interaction-based (Barney & Wright, 1998; Gustavsen, Finne, & Oscarsson, 2001; Schaltegger & Wagner, 2011) process resting on idiographic and sticky tacit managerial and hands-on operational skills. In effect, the actions and activities within firm A may be seen as examples of practical ambidexterity (Birkenshaw & Gibson, 2004; Junni, Taras, Tarba, & Sarala, 2013),

where the land-based staff, in collaboration with the captains and crews, together explore operational manoeuvres to better exploit the vessels.

The research findings reveal that capturing profit from technological innovations presupposes a value proposition that responds to perceived customer needs and invites (through incentives) customers to take responsibility for negative externalities caused by the commercial services they are using. Transforming environmentally friendly technological innovations into commercial success constitutes a technical as well as a managerial challenge (Lindegaard, 2010; Sarkis et al., 2013; Tidd, Bessant, & Pavitt, 1997) demanding managerial capabilities to align strategy with an appropriate business model defining the *go to market* tactics (Teece, 2010). The business model must address the actual business issues at stake, reflecting an activity-system perspective that encourages systemic and dynamic thinking in business model design, instead of concentrating solely on technological choices (Teece, 2014), also keeping in mind that "a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model" (Chesbrough, 2010, p. 354).

The research illustrates that both managerial and technological innovations supporting strategizing of environmentally sustainable and profitable shipping is a dynamic leadership challenge (Jansen, Tempelaar, Bosch van den, & Volberda, 2009) and an emerging process based on experimentation (Khanagha, Volberda, & Oshri, 2014; Mansouri et al., 2015). Particularly in case A, the findings support the growing innovation literature's stress on the importance of a dynamic, multilevel, and multifunctional focus on innovation processes in organizational contexts (Jansen, Dusya, & Crossan, 2009; Kaplan, 2012; Teece, 2010) and emphasize the role played by managerial capability in managing innovation processes.

7 Contributions, limitations and further research

This comparative case study contributes important empirical insights into the challenges related to operationalizing environmentally sustainable innovations in offshore shipping. The research points to the importance of aligning the innovation drive with firm strategy and seeks to tie the process to the development of a key value proposition (Chesbrough, 2007). The results of the study emphasize that this goes beyond technology. As a mediating vehicle between a financial and a non-financial strategic configuration (Chesbrough & Rosenbloom, 2002), the development of a sustainable business model (Bocken et al., 2014) serves as a boundary-spanning instrument that goes beyond the more limited ambidextrous challenges related to balancing and integrating exploration and exploitation (March, 1991), providing for a complementary perspective on organizational innovation processes.

With reference to the research questions, the findings from the comparative case study analysis confirm the following:

- The firm-context (company culture, history, entrepreneurial origin) greatly matters and influences the *emergence* of the different sustainable innovation tracks. Also, timing of actions and activities, personalities of key personnel, knowledge-type and knowledge integration, and geographic positioning vis-à-

vis key members of the maritime cluster influence the innovation process.

- The flow of activities and actions is strongly firm and project leadership dependent. Consciously managed *interdisciplinary* knowledge-sharing processes seem to have a positive impact on innovation and tend to relate the process to commercialization and a potentially revised or new business model.
- The companies chose different sustainable innovation tracks partly based on historic track records (areas of expertise and leader's dominant logic), but also based on the hiring of external *sustainability champions* with highly different competencies. The hiring of enthusiastic champions supported by the CEOs created a self-enforcing sustainability process which developed and supported the different innovation paths (both project leaders were educated engineers, but with different orientations — one commercial and the other towards engineering).
- The main drivers and enablers for the innovation process in each of the firms are:
    - High level of nautical/technical and maritime operations knowledge as a starting point
    - High motivation to respond to a societal call for more sustainable maritime operations
    - Sustainability considered as ethical "right thing to do"
    - CEO/top-level support during the innovation process
    - Required resources and capabilities (in-house or external) made available when required
    - Active in-house champion as innovation project leader
    - Conviction that the innovation process would lead to competitive advantage
    - Inter-/cross-disciplinary approach to innovation
    - Both intra- and inter-firm (on regional- and cluster-level) positive image-building and incentives supporting the innovation process
    - Active networking during the innovation processes
    - Active key stakeholder engagement, including for external knowledge-sourcing, marketing, and image building

This study contributes to theory by applying varied management- and innovation-related theories to a still under-researched context, namely sustainability in the offshore maritime industry. The research context and findings of the comparative case study are useful for current management at both the top and medium levels and are seen as relevant for the teaching of engineering as well as management students. Though this was not an objective of this study, the outcome may also be seen as instructive for cluster management and industrial and regional network management, and as generally informative for policymakers.

The fact that the empirical observations in the study are limited to two firms within the same industry and limited to a Norwegian regional context may be seen as a weakness according to standard academic criteria. Though the cases provide details and understanding by its "thick description" (Geertz, 1973) of the innovation processes, the findings are still based on single-and exploratory case studies which might rise doubt about external validity. While the study has rigorously followed a protocol and a pre-

established research design conscientiously triangulating first- and secondary data over an extensive time-period, it is evident that it is hard to generalize the findings. It is, however, reasonable to believe that the findings of the study, due to the similarities between organizations and maritime operational environments across continents, also may be relevant for other offshore shipping firms being challenged to develop sustainable innovation strategies.

The outcome and learning from the study indicate several areas for further research. One is to further explore ambidextrous challenges (Giannopolou et al., 2011; O'Reilly & Tushman, 2004) in transforming sustainable innovations into reality, and to look closer at the role business models might play in bridging exploration and exploitation issues from a practical vantage point. Another is to investigate the role of governing rules and regulations promoting and constraining innovation of environmentally sustainable shipping projects. Finally, another avenue for follow-up research is to study the challenges related to collaboration among functional areas and disciplines within a firm and/or with external actors, with the objective of developing environmentally sustainable innovations as part of collective business model(s) in line with ideas from Salojarvi, Tarkianen, Ritala, and Sainio (2015). The proposed studies might contribute to the growing body of research within the innovation field focusing on how it is possible to profit from environmentally sustainable innovations (Amit & Zott, 2012; Boons & Ludeke-Freund, 2013; Droganova & Eyquem-Renault, 2008).

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