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The front-end of cluster innovation platforms: Is it half the work?

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Abstract

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1) Briefly, describe the existing state-of-the-art:  
   In recent years clusters and business networks have repeatedly proven to be a valuable player in fostering innovation (Eisingerich et al., 2010). Firms in clusters are more likely to innovate compared to firms outside clusters (Baptista and Swann, 1998), and innovation processes are essential for the survival of the clusters. At the same time, the innovation literature has evolved in an awareness of that the early stage of innovation processes in particular often referred to as the fuzzy front-end of innovation (Reinertsen and Smith, 1991) significantly influence the fostering of innovation processes (Markham, 2013).

2) Explain the research gap that you are trying to fill and pose a research question:  
   However, while the emphasis on the importance of fuzzy front-end of innovation processes have been examined from the perspectives of firms, projects, and individuals, fuzzy front-end of innovation processes has however been devoted less attention to the network settings and cluster research (Takey and Carvalho, 2016). In addition, the current literature on fuzzy front-end of innovation neglect in-depth investigations of how to improve the process of fuzzy front-end innovation (Matinheikki et al., 2016) as well as insights into how the fuzzy front-end unfolds in practice (Hoholm and Araujo, 2011). These are serious omission because decisions made in the fuzzy front-end influence both the process, cost and performance outcome. Therefore, the paper aims to investigate: How does the fuzzy front-end of innovation processes unfold in a cluster context?

3) Give your main theoretical arguments  
   Much speaks in favor of that fuzzy front-end innovation processes in clusters differ from more individual firm-driven fuzzy front-end innovation processes. Even though studies show that improvements in the fuzzy front-end of innovation processes are directly reflected in a higher performance rate (Herstatt et al., 2004), few studies have investigated it (Rocca and Snehota, 2014). This paper tries challenging the current fuzzy front-end innovation literature tends to portray the early stage innovation process as the first step of a linear innovation process, thereby the literature disregard the dynamic, chaotic and unstructured nature of the fuzzy front-end (Murphy and Kumar, 1997). Furthermore, this paper tries to contribute to the ongoing debate is if
a best practice of fuzzy front-end exist through a structural or non-structural approach (Pereira et al., 2017), or remain the early-stage to fuzzy (Reinertsen, 1999).

4) Spell out your method (and data, if an empirical paper)
The investigation of the front-end of innovation processes in clusters is rather complicated and requires in-depth analysis of the phenomenon. This paper, therefore, builds on a case study approach exploring three launched fuzzy front-end innovation processes in the Danish offshore cluster, establish to create joint innovation processes among the firms in the cluster. Danish offshore cluster is a well-established cluster in the Danish business community. Utilizing more cases limits the biased for generalization and provide more valid into the achieve results (Eisenhardt, 1989). The empirical data are collected through a combination of interviews, workshops, and observation, to gain a deeper understanding of how the fuzzy front-end of innovation is unfolded in a cluster setting (Miles et al., 2014).

5) Present your results
The findings indicate fuzzy front-end of innovation in cluster separates from our general knowledge about the fuzzy front-end. Its dynamic co-creating character and complexity of a cluster to coordinate and secure a joint alignment among different firms make it impossible to structure after a linear frame. Furthermore, the study implies the power structure between firms has a significant influence on how progress is achieved in the fuzzy front-end.

References:
The front-end of cluster innovation platforms: Is it half the work?
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Abstract
Firms in clusters are more likely to innovate compared to firms outside clusters and innovation processes are essential for the survival of the clusters. Studies shows improvements in the front-end of innovation processes are directly reflected to higher performance. However, while the importance of the front-end of innovation processes has been examined from the perspectives of firms, projects and individuals, it has been less explored in relation to network settings and cluster research. Furthermore an ongoing debate concerning whether the best front-end practice uses a structured or an unstructured approach or remain to fuzzy. Through a process study of two innovation forums, this investigating how the front-end of innovation processes unfolds in a cluster setting. Findings indicates sometimes, obstructing the creativity process in exchange for a beneficial outcome may be preferable.

Keywords: Front-end of innovation, cluster,
JEL classification codes:
- JEL: O31 – Innovation and Invention: Process and Incentives
- JEL: R10 – General
- JEL: R11 – Regional Economic Activity: Growth, Development, and Changes
The front-end of cluster innovation platforms: Is it half the work?

1. Introduction

In recent years, clusters and business networks have repeatedly proven valuable in fostering innovation (Eisingerich et al., 2010). This is particularly true nowadays, with today’s international market creating more customer opportunities and introducing more and stronger competition. Firms are continuously forced to be “on their toes” and to provide some degree of innovation in the form of exploitation (redefining products or services) and/or exploration (creating new product solutions or service setups) (Andriopoulos and Lewis, 2009; O’Reilly and Tushman, 2008; Schumpeter and Schumpeter, 1988; Zakrzewska-Bielawska, 2016). Collaborations and business networks have proven efficient for meeting the constantly changing market demands and market shifts (Ai and Wu, 2016; Medlin and Törnroos, 2015).

Firms in clusters are more likely to innovate compared with firms outside clusters (Baptista and Swann, 1998), and innovation processes are essential for cluster survival (Belussi and Sedita, 2012; Franz and Trippl, 2005; Gracht et al., 2010). At the same time, the innovation literature has evolved an awareness of how early stages of innovation processes, often referred to as the front-end of innovation (Reinertsen and Smith, 1991), significantly influence the fostering of innovation processes (Markham, 2013). The front-end of innovation involves fostering ideas before engaging in creating innovation processes (Koen et al., 2001).

However, while the importance of the front-end of innovation processes has been examined from the perspectives of firms, projects and individuals, it has been less explored in relation to network settings and cluster research (Takey and Carvalho, 2016). The current literature contains only a few studies investigating how innovation emerges in business networks (Rocca and Snehota, 2014), suggesting a lack of a deeper understanding of how decisions made at the front-end influence the process, cost and performance outcomes of innovation.

The fact that studies shows improvements in the front-end of innovation processes are directly reflected to higher performance (Herstatt et al., 2004). This relationship highlights the importance of investigating the front-end of innovation in a cluster context. Furthermore, much speaks in favor of front-end innovation processes in clusters are likely to differ from more individual firm-driven front-end innovation processes. Thus, findings from individual firm studies cannot be uncritically transformed into guidelines for cluster collaboration. This is mainly because clusters of firms must address different agendas and purposes for being involved in the business network. Thus, firms face an ongoing dilemma concerning how to overcome this complexity and achieve a shared understanding. In fact, the current literature lacks debate on how organisations coordinate, negotiate and create innovation processes. This paper contributes to the current literature by addressing the current lack of in-depth investigations of how to improve front-end innovation processes in a cluster setting (Matinheikki et al., 2016).

Part of existing literature portray the front-end of innovation by using structured models to achieve effective management (Boeddrich, 2004; Kim et al., 2002). However, this literature disregards the dynamic, chaotic and unstructured nature of the front-end (Murphy and Kumar, 1997). Other streams of existing literature take an unstructured approach to investigate the front-end innovation process (Gupta and Maltz, 2015). This stream acknowledges the complexity and fuzziness inherent in innovation. The above divide has prompted an ongoing debate concerning whether the best front-end practice uses a structured or an unstructured approach (Pereira et al., 2017) or simply remains (Reinertsen, 1999). Here, current literature requires deeper empirical
knowledge and insight into how front-end innovation unfolds in practise to develop unified implications (Hoholm and Araujo, 2011).

The aim of this paper is to investigate and contribute to current fragmented literature research on the front-end of innovation in a cluster context. The research question of this paper is: How does the fuzzy front-end of innovation processes unfold in a cluster context?

This study explores the front-end of innovation in clusters through a process case study in order to outline and identify the early start of two innovation forum within the Danish offshore cluster. The findings indicate that the front-end of innovation in a cluster setting requires some structure or management to deliver beneficial outcomes. Moreover, alignment and a commitment to a shared vision is central to utilising the cluster’s competences at the front-end.

This article contributes to the unclear literature on how the front-end of innovation unfolds in a cluster setting. It further aims to increase the practical understanding of the underlying triggers or drives for fostering the front-end of innovation in collaboration.

The paper summarises and debates the theoretical issues and uncertainty associated with not knowing how the front-end of innovation emerges in inter-organisational collaboration. This is followed by a methodological outline and explanation of the steps involved in the data collection. Hereafter, the empirical context and descriptions of the innovation processes in the two selected cases are presented. This is followed by a discussion of the empirical findings in relation to the literature. The paper ends with a conclusion and suggestions for future research.

2. Clusters as drivers for innovation

There is an ongoing debate concerning the extent to which clusters are potential drivers of innovation. The ways in which clusters drive innovation processes are perceived differently. In this debate, two of the leading cluster schools are: the Porter school and the regional innovation system (RIS) school.

According to Porter, (2000), rivalry and innovators’ (key firms) efforts to take on a leading role to achieve beneficial performance are the main drivers for innovation processes (Albertini, 1999; Forsman and Temel, 2016). Since Porter (2000, 1998) considered a cluster to be a group of interconnected firms and associated institutions geographically bound and linked together by complementarities and commonalities within in a particular industrial context, a cluster’s ability to create innovation processes is limited by its access to resources, knowledge, financial capital and environmental conditions possessed by other firms, universities or institutional organisations within the collaboration or geographical area (Isaksen, 2001; Porter, 1998; Porter and Stern, 2001). Thus, not all clusters possess the same driving power or ability to motivate innovation.

By contrast, the RIS school uses the triple helix approach to consider the main drivers of innovation processes (Asheim and Coenen, 2005; Lengyel and Leydesdorff, 2011; Lengyel and Leydesdorff, 2015). In other words, RIS suggests that policies, initiatives or embedded institutional arrangements provide the capital, resources and knowledge flow necessary to motivate a specific area/network/industry to be more innovative (Ai & Wu, 2016; Purchase, Kum, & Olaru, 2016; Wang et al., 2015). Thus suggests that political agendas could have a major influence on a cluster’s ability to continuously interact and exchange knowledge, resources, and capital flow to create innovation (Cooke, 2004; Tödtling et al., 2005).
The dominant logic sees clusters as positive drivers of innovation due to the way in which knowledge, resources and opportunities expand when organisations and institutions work together (Braun et al., 2012; Westerlund and Rajala, 2010). For instance, the Silicon Valley cluster achieves high innovation outcomes because it is able to develop potential entrepreneurial ideas, support existing innovation and educate the workforce (Engel and Del-Palacio, 2011; Ferrary, 2011). Moreover, firms within a cluster often get free access to information and networks with a common interest in generating profit in the same business area (Gertler, 1995, 2003).

Firms benefit from being in clusters because clusters offer opportunities for interaction and networking. However, existing literature sheds little light on how firms in clusters interact when developing, unfolding and evolving innovation processes (Baptista and Swann, 1998).

In general, most literature suggests that clusters are a driving force for innovation processes. However, the relationship between clusters and innovation also includes trapdoors, barriers and challenges that must be taken into consideration. The extant research reveals that homogeneous clusters have the potential to be a negative drivers of innovation, because they increase the risk of experience lock-in, unless external actors provide inputs capable of untangling such obstructions. A cluster’s capability to establish and utilise its environmental settings and combine its different firms’ competences to create innovation depends on its management ability. Thus, there is a need for deeper knowledge of how to successfully manage clusters of firms and orient them towards a single goal firms (Molina-Morales et al., 2002; Porter and Stern, 2001).

3. Clusters’ early stages of innovation

In 1985, Reinertsen introduced the term ‘fuzzy front-end’ to refer to the predevelopment activities of innovation, such as discovering and fostering ideas, scoping and screening market opportunities before investing in a selected idea (Heising, 2012; Reid and De Bretani, 2004). Since then, the fuzzy front-end has had a variety of names: the front-end of innovation, predevelopment innovation, the early stage of innovation and the early phase of innovation (Pereira et al., 2017). The front-end first gained wide research attention through Reinertsen and Smith’s 1991 research. Since then, studies have devoted extra attention and coordination to how the front-end influences and impacts innovation process performance (Markham, 2013; Wagner, 2012). But, what is front-end of innovation?

A majority of the literature considers the front-end of innovation to be the earliest stage of new product development, meaning all the resources, time and activity spent from generating an idea to developing a potential product (Koen et al., 2002; Murphy and Kumar, 1997; Reid and De Bretani, 2004). A small subset of the literature considers the front-end of innovation to be the earliest stage of new process development.

The ability to devise and utilise resources is a critical factor in firms’ ability to survive (Zahra and George, 2002). Logically speaking, a cluster has more resources at its disposal and is capable of identifying more ideas than a single firm. Therefore, it can be assumed that the front-end of innovation has better “living conditions” and supports higher performance outcomes in a cluster than in a single organisation. However, current literature has struggled to address this, since most current studies take the firm, project or individual as the unit of analysis (Takey and Carvalho, 2016).

The fragmented findings indicate that, when firms collaborate, the chaos and uncertainty of the front-end of innovation on the cluster level become less fuzzy (Alam, 2006). Furthermore, firms can utilise cluster collaboration as an opportunity to acquire new skills (Aken and Weggeman, 2000).
and, thus, increase their competitiveness. Furthermore, adopting the front-end of innovation on a cluster level enriches possibilities for diverse creativity and supplies comprising resources, which must positively influence the potential for performance outcomes. Moreover, collaborations enhance firms’ ability to enter new business areas and expand their current business.

The chaotic process of front-end innovation requires some structure; however, structure can also preclude creativity (Brem and Voigt, 2009). Firms’ increasing interaction and coordination may negatively influence the front-end of innovation performance by creating an unmanageable level of complexity. The front-end of innovation is influenced by “[...] the ability to identify, attract and retain collaboration partners [...]”, all of which affect performance (Braun et al., 2012, p. 41). Therefore, identifying the dynamic capabilities of the “right” collaboration partners and gaining access to required resources or expertise are, therefore, crucial (Stevens, 2014). However, when the “right” partners identified, the front-end of innovation is influenced by the degree of the firms’ willingness to participate and cooperation. This is an underlying dilemma, since firms typically have no desire to expose their core competences and, therefore, lack trust in one another (Braun and Mueller, 2009). Even firms that are willing to participate and interact with one another sometimes struggle to utilise and take full advantage of their shared resources, often due to a lack of communication, internal resources, internal capabilities or trust issues (Mason & Mouzas, 2012; Olaru & Purchase, 2015; Purchase, et al., 2016). Therefore, despite good intentions, barriers or challenges may obstruct or negatively influence the front-end of innovation. Furthermore, the lack of a common “language” may increase miscommunication, which, in turn, may increase costs and delays or lead the front-end innovation process to fail (Haarstad and Rusten, 2016).

These different indication enhance the need for a deeper investigation of how to facilitate and overcome the challenges faced by clusters engaging in front-end innovation. However, before these challenges can be overcome, an awareness and deeper understanding of what and how front-end innovation unfolds in a cluster is needed.

4. Research design and methods

The methodology chosen for this study was based on a process case study and was designed to outline and identify the early start of two innovation forums within the Danish offshore cluster in order to investigate how front-end innovation processes unfold in a cluster setting. The selection of a process case study allows the study to explore the front-end of innovation in a real cluster context (Robsen, 2002, p. 145). Due to the dynamic nature of this research and the interest in gaining deeper insight than that afforded by current literature, a process case study is appropriate, since it provides a possibility to explore the dynamics of front-end innovation processes in a cluster setting (Yin, 2003). Utilising two innovation cases enabled the study to collect rich data, limited the potential for generalisation bias and yielded more valid results (Eisenhardt, 1989).

The selection criteria for the two chosen cases are as follows. 1) First, the cases must have a comparable sampling mass (Miles et al., 2014), and the two cases must be centred on the same basis. This leads to: 2) The innovation process object must focus on product development, since current research investigating the front-end of innovation in a cluster setting focuses primarily on product development (Koen et al., 2001). Furthermore, 3) the collaboration needs to have accomplished the front-end process and written down an execution plan, as these criteria will enrich the study and create possibilities to access information and the framework necessary to fully comprehend the front-end of innovation (Crabtree and Miller 1992).
4.1 Data collection

The empirical data are collected from two innovation forums through a combination of semi-structured interviews and documents. This data collection approach facilitates a deep understanding of how the front-end of innovation unfolds in a cluster setting (Miles et al., 2014).

First, semi-structured interviews were conducted with the forum’s three project managers from Offshoreenergy.dk (OEDK), the Danish cluster organisation, who facilitated and help to establish the “cost reduction innovation forum”, CRIF. The aim was to gain a deeper understanding of the early stage of the process and to gain insight into the interactions between the different firms. In order to identify the key persons influencing the front-end of the innovation processes, the project managers were asked about the role of each participating firm. The project managers also provided the physical applications, summaries, photos, etc. used during the project in order to provide better and deeper insights.

Second, the participating firms’ representatives were identified through a snowballing process using the project managers’ interview data (Miles et al., 2014). This second phase contained knowledge from six semi-structured interviews with participants from the two innovation forums, as illustrated in Table 1. Unfortunately, only some firms agreed to participate in the study; however, based on the data, these firm had little or no influence on the front-end of the innovation process.

Since the aim was to understand collaboration dynamics and how the front-end of innovation unfolds in a cluster setting, the interview guide (see appendix 1) focused on Koen et al.’s (2014) classification of the various phases of front-end innovation. These phases are: opportunity identification; opportunity analysis; idea genesis; idea selection; and concept and technology development. Furthermore, the front-end of innovation is influenced by the engine (leadership and culture) and influencing factors (the environment). However, Koen et al.’s (2014) framework reflects the situation of a single firm, whereas a cluster is more complex due to variations in firm agendas and cultural approaches. The interview guide, therefore, also contains some collaboration questions inspired by the cluster literature.

Table 1: Firm information

<table>
<thead>
<tr>
<th>Firm name</th>
<th>Firm specification</th>
<th>Respondent title</th>
<th>Interview</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1</td>
<td>GTS (approved technological service)</td>
<td>Head of Photonics department</td>
<td>20/11 2017</td>
<td></td>
</tr>
<tr>
<td>Firm 2</td>
<td>Engineering company</td>
<td>Structural Engineer</td>
<td>15/11 2016</td>
<td></td>
</tr>
<tr>
<td>Firm 3 (1)</td>
<td>Drone company</td>
<td>CEO</td>
<td>Not possible to get a hold of</td>
<td></td>
</tr>
<tr>
<td>Firm 3 (2)</td>
<td>Drone company</td>
<td>CEO/ partner</td>
<td>15/11 2017</td>
<td></td>
</tr>
<tr>
<td>Firm 4</td>
<td>Ultrasonic Thickness Measurement company</td>
<td>CEO</td>
<td>No time for participating</td>
<td>Application, summary, rapport, photos</td>
</tr>
<tr>
<td>OEDK 1</td>
<td>Cluster association</td>
<td>Director Oil &amp; gas</td>
<td>5/10 2017</td>
<td></td>
</tr>
<tr>
<td>Firm A</td>
<td>Specialized cleaning of technical company</td>
<td>Managing director</td>
<td>26/11 2017</td>
<td></td>
</tr>
<tr>
<td>Firm B</td>
<td>Technology and automation system company</td>
<td>sales director</td>
<td>16/11 2017</td>
<td></td>
</tr>
<tr>
<td>Firm C</td>
<td>GTS (approved technological service)</td>
<td>Director, market and innovation</td>
<td>Not possible to get a hold of</td>
<td></td>
</tr>
<tr>
<td>Firm D</td>
<td>Transportation company</td>
<td>Managing director</td>
<td>No time for participating</td>
<td></td>
</tr>
<tr>
<td>Firm E</td>
<td>Engineering company</td>
<td>Director</td>
<td>1/12 2017</td>
<td></td>
</tr>
</tbody>
</table>
The interviews were conducted from 5 October to 30 November 2017 and were digitally recorded. The recorded interviews underwent a transcription process, which enriched the foundation for the data analysis and allowed reflection on whether there was a need for additional content.

4.2 Data analysis

The data analysis followed a two-step coding procedure. In the first step, open coding was used to identify the different subjects addressed in each interview. Comparing these subjects across the cases supported the identification of patterns and implications for the front-end of innovation in a cluster setting. The second step was coded following a theoretical framework inspired by (Koen et al., 2001; 2002). This framework greatly helped the coding process and the investigation of how the front-end of innovation unfolds in a cluster setting.

5. Empirical setting

The empirical data were collected in the Danish offshore industry, which is among the most well-established clusters in the Danish business community (Oxford Research, 2010). Geographically, the majority of the Danish offshore industry is located in and around the city of Esbjerg on the west coast of Denmark. The cluster contains two different business area: oil and gas and offshore wind. The Danish offshore cluster creates 28,000 jobs across approximately 899 firms (www.PortEsbjerg.dk, 2017). The cluster comprises several small and medium-sized enterprises (SMEs); a few large globally leading oil and gas corporations, such as Maersk Oil, Dong Energy, Semco, Rambøll and Cowi; and a number of offshore wind companies, such as Dong Energy, Vattenfall, Siemens Gamesa, MHI Vestas, Rambøll and Cowi. Since the Danish offshore cluster has a significant influence on the Danish economy, these large enterprises, along with the Danish government, are the main drivers of the cluster.

The Danish offshore cluster has experience a massive pressure to reduce costs and increase competitiveness in relation to other energy sources. So far, the cluster has tackled this by cutting down costs through small incremental improvements in daily operations (i.e. the exploitation approach) (Jennings, 2009; Ortegon et al., 2013). As a consequence, the cluster now faces an “error trap”, in that it is exploiting its selves “to dead” while neglecting radical innovation (Benner and Tushman, 2003; Hannan and Freeman, 1984; He and Wong, 2004; Milliken and Lant, 1991). Furthermore, the cluster is highly influenced by a highly contract-oriented culture in which operators extend the layout of contracts with extra rules: a so-called “cover my behind” contract culture (OCDK, 2010).

However, the cluster is now slowly realising the need to shift its conservative culture and establish a more collaborative exploration mindset (Audon, 2015). In connection with this, Offshoreenergy.dk (OEDK), the Danish cluster organisation, created a “cost reduction innovation forum” referred to as the CRIF. The OEDK is a non-profit cluster organisation that was chosen as the innovation network for the Danish offshore cluster. The organisation comprises than 240 member firms, has approximately 280 million Danish crowns at its disposal and currently facilitates approximately 30 projects (www.offshoreenergy.dk, 2017)
The “cost reduction innovation forum”, or CRIF, seeks to connect the supply chain and foster discussions concerning new solutions and different ideas to decrease costs. All CRIF projects are driven by demand, meaning that they must contain committed buyer (problem owner) outcomes (www.Offshoreenergy.dk/crif, 2017). The OEDK acts as the coordinator, linking different organisations and providing a ‘neutral ground’ for presenting potential ideas and solutions that may benefit the industry. Furthermore, the OEDK helps to identify potential problems and problem owners and to assemble firms for collaboration within each CRIF.

5.1 Case 1: Drone project
Case 1 started on February 2016, and the first meeting with all the partners was held November 2016. This CRIF comprised four firms and the OEDK. Firm 3 was replaced during the process. The case is part of a large funding application containing five different CRIFs, and the application was submitted in August 2016. The four firms had no previously links or overlaps in terms of business area. As illustrated in table 2, the firms contributed different competences and operated in different business areas. Their overarching purpose was to contribute game-changing equipment to measure corrosion damage and improve inspection management. Presently, they still lack some testing; however, the partners have just entered the product communalisation phase. The project started with problem owner A that, but they withdraw. After a period of time OEDK pitch the solution to problem owner B, which now is the new problem owner.

<table>
<thead>
<tr>
<th>Firm name</th>
<th>Competences</th>
<th>Found</th>
<th>Size</th>
<th>Revenue (TKr)</th>
<th>Entered CRIF</th>
<th>Operation field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1</td>
<td>Research in new knowledge, measurement techniques and standards</td>
<td>1985</td>
<td>29</td>
<td>31.6 million</td>
<td>February 2016</td>
<td>Operate outside offshore</td>
</tr>
<tr>
<td>Firm 2</td>
<td>Engineering</td>
<td>1986</td>
<td>60</td>
<td>43.119</td>
<td>July 2016</td>
<td>Operate in offshore</td>
</tr>
<tr>
<td>Firm 3 (1)</td>
<td>Inspection by drone technology</td>
<td>2009</td>
<td>1</td>
<td>Non available</td>
<td>July 2016</td>
<td>Operate in and outside offshore</td>
</tr>
<tr>
<td>Firm 3 (2)</td>
<td>Inspection by drone technology</td>
<td>2016</td>
<td>4</td>
<td>Non available</td>
<td>September 2016</td>
<td>Operate in and outside offshore</td>
</tr>
<tr>
<td>Firm 4</td>
<td>specialized in Ultrasonic Thickness Measurement</td>
<td>2012</td>
<td>1</td>
<td>Non available</td>
<td>July 2016</td>
<td>Operate in offshore</td>
</tr>
</tbody>
</table>

The idea for this product was fortuitously generated through a conversation between the OEDK and firm 1 at a workshop conducted on January 2016. After that, the OEDK and firm 1 engaged in regular contact through meetings and emails to develop the idea into a business case. The idea was to shrink and transform firm 1’s current equipment, which was as big as a closet, by measuring and altering the equipment materials into a box small enough to fit on a drone. During these meetings, OEDK and firm 1 outlined the basic business case and, more importantly, the resources required to implement the idea in practice. The OEDK used the outline to screen and select three firms that possessed these resources. Each of these firms was ask to join the project under the condition that they accepted the overall foundation and idea. Between June 2016 and August 2016, the OEDK created the application primarily by using firm 1’s outlines and inputs, supplementing them with e-mails from the other firms contributing their competences to the project. Thus, the distribution of roles and technical inputs had already been established when the firms entered the first meeting on August 2016.

In the first meeting, the OEDK opened by letting representatives from each firm introduce themselves, their area of competence and their expectations for the collaboration. Thereafter, they fine-tuned the business case and distributed working tasks for the next meeting. However, after the first meeting, firm 3 chose to withdraw due to a lack of financial compensation and long-term...
prospects (if any) of profit, which firm 3 judge the risk concerning the return on investment too high. The OEDK was, therefore, forced to screen another firm with the same competences and a willingness to participate despite the low financial compensation. The recruitment of a new firm 3 resulted in small changes to how the drone technology operated. Figure 1 illustrates this cases process for the front-end of innovation.

Figure 1: The process for the front-end of innovation in case 1
The discussion was dominated by firm 1, since much of the project relied on firm 1’s ability to transform the measurement equipment. Thus, though each firm contributed input and expertise, the dialogue went primarily through firm 1. All firms expressed that the collaborating process involved mutual respect.

5.2 Case 2: New solution for an SLIC platform

In August 2015, the OEDK organised a workshop of 15 different firms from the offshore cluster. The workshop started with a large firm presenting that it had too many problems with its unmanned platforms. The large firm then asked the 15 firms for potential solutions and inputs to solve the problem. After the presentation, the OEDK organised a brainstorm discussion, and all potential inputs were written on a board. The inputs were thereafter categorised into four groups, and all participants were ask to join the group for which they felt most inspired. According to the presenting firm, group two had the most potential. This group became the foundation for case 2: a new solution for an SLIC platform.

Case 2 comprised four firms, one of which was replaced during the working process. These firms were previously linked to one another, and their representatives had personal relationships. As illustrated in table 3, the firms contributed different competences, and all operated in the same area of business. Their primary purpose was to contribute an improved solution for cleansing the pipes running from a manned platform to an unmanned platforms. The group used the following keywords as the foundation for their idea: remote, standard solution, service/optimising (logistic, manpower, team), lifeboat service, pigging, drain line, visualisation of data. As of the writing of this paper, the product has been tested, and the results look promising. The initial problem owner, owner 1, was the presentation firm; however, during the working process, this firm withdrew. Thus, firm A and the OEDK found a new problem owner 2, which tested the product. Recently, problem owner 1 has been considering returning to the project, meaning the project may have two problem owners.

Table 3: The firms of case 2.

<table>
<thead>
<tr>
<th>Firm name</th>
<th>Competences</th>
<th>Found</th>
<th>size</th>
<th>Revenue (Tk)</th>
<th>Entered CRIF</th>
<th>Operation field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm A</td>
<td>Specialized cleaning of technical fluid carrying systems</td>
<td>1993</td>
<td>35</td>
<td>22.253</td>
<td>August 2015</td>
<td>Operate in offshore</td>
</tr>
<tr>
<td>Firm B</td>
<td>Control technology and automation - System development and design</td>
<td>1988</td>
<td>29</td>
<td>18.522</td>
<td>August 2015</td>
<td>Operate in and outside offshore</td>
</tr>
<tr>
<td>Firm C</td>
<td>Technological consultancy -facilities and laboratories for testing, demonstration, and documentation of new technologies and products.</td>
<td>1941</td>
<td>1461</td>
<td>775.698</td>
<td>August 2015</td>
<td>Operate in and outside offshore</td>
</tr>
<tr>
<td>Firm D</td>
<td>Offshore transportation, maintenance and training</td>
<td>1994</td>
<td>75</td>
<td>101.529</td>
<td>August 2015</td>
<td>Operate in offshore</td>
</tr>
<tr>
<td>Firm E</td>
<td>Consulting technology engineering solution</td>
<td>1997</td>
<td>400</td>
<td>196.068</td>
<td>October 2016</td>
<td>Operate in and outside offshore</td>
</tr>
</tbody>
</table>

The workshop for this case consisted of firms A, B, C and D. They started with a presentation round, following which firm A took the lead. Firm A began by introducing a new cleaning method for the pipes that the group had just had developed that could be used for the platforms. During the
presentation, everyone had agreed that this new method for cleaning pipes could be conducted from the manned platform and, thus, save visits to the unmanned platform.

Firm A sketched the idea on the board, adjusting its inputs based on information from the other firms. However, though firm A has a strong understanding of the overall idea, it struggled to develop its scope due to a lack of calculation and risk assessment expertise. Thus, with small inputs from firms B and D, firm A drew up a report with the overall framework and idea outline. Interestingly, Firm C participated mainly in the first meeting and been largely absent since.

The report was given to problem owner 1, which ranked its different elements. Overall, problem owner 1 saw the relevance of the project and indicated that it wanted to become a buyer. However, shortly afterwards, as previously mentioned, problem owner 1 withdrew, resulting in a significant slowdown in the project during 2016.

However, the OEDK convinced firm A that the project was still important for the industry, and together, they started looking for a new problem owner. Luckily, they quickly found another problem owner 2 from another country that wanted to test the idea. Adopting a new problem owner required minor adjustments to the existing idea. The group was, therefore, reconnected in October 2016; however, firm A asked firm E to join the collaboration due to both a lack of commitment from the other firms and a need for their expertise. Firm E influenced the process by conducting risk assessment and identifying necessary adjustments.

Around the same time, problem owner 1 reached out to firm D about an idea in the report for easier and cheaper visit transportation. However, since implementing this idea required only firm D’s expertise, firm D, which felt that the larger project lacked relevance to its daily operations, left to start its own project. Ultimately, problem owner 2 successfully tested the final system, and the positive results attracted problem owner 1 back to the project. Figure 2 illustrates this cases process for the front-end of innovation.
Figure 2: The process for the front-end of innovation in case 2
5. Discussion

This investigation of how front-end innovation unfolds in a cluster setting reveals different patterns. The following discusses the findings of cases 1 and 2, closing with a comparison of the two cases.

5.1 Creative outline—Case 1

Case 1 involved a search for a solution opportunity, driven mainly by the prospect of creating a new opportunity that, according to firm 3, would “be a game changer, for sure” for the offshore cluster (Firm 3, CEO).

Firm 1 and the OEDK regulated the creativity at the front-end of the innovation, as illustrated in figure 1. The creative outline and description of the idea frame, which moved from opportunity identification to idea scope to a potential concept and technology development, were developed by only two firms. Thus, the front-end process was closed, structured and clearly defined: characteristics that may go against the dynamic nature of front-end innovation (Murphy and Kumar, 1997). On one hand, this finding indicates that the front-end of this case lacked the advantages of utilising the cluster to enrich idea generation through a variety of inputs and resources (Koen et al., 2002). Obstructing front-end creativity could lead to an undesirable decrease in performance due to delays, a lack of qualified inputs or a lack of development. However, on the other hand, case 1 avoided confusion concerning competences by clearly establishing which firms should contribute which competences and how the finish product should be developed (Kim et al., 2002). Because “the technological roles was established in advance [...] what we could contribute with was almost fix in the application” (Firm 1, Head of Photonics department). Thus, securing the front-end of the innovation process may have helped result in a useable final product. Finally, though the cluster had to recruit missing competences to finish the concept and technology development, this took place last or almost after the front-end of the innovation process.

5.2 Collaboration—Case 1

The collaborating exceeded all expectations, perhaps due to the fact that “the roles, to some extent, are divided in advance” and “because we [the participating firms] have different skills” (Firm 3, CEO). There was no internal competition or hesitation to contribute with their competences because there was no risk of the firms exposing their core competences. This produced an open and dynamic atmosphere of collaboration involving a positive flow of the knowledge and resources necessary to successfully enable the front-end of the innovation (Matinheikki et al., 2016). Another important aspect was the group’s readiness to take risks. As the firms noted, “[...] our director is rather willing to take risks when it comes to development projects” (Firm 2, Structural Engineer) and “we know innovation takes a long time, but we consent to that when we entered the collaboration” (firm 3, CEO). This indicates that, despite this structure (or perhaps because of it), the firms’ interactions positively influenced and supported the front-end of the innovation process (Bertels et al., 2011).

Even though the front-end innovation process was going smoothly, timing played a role. Because firm 1’s commitment was rooted in recent political initiatives, firm 1 was focused more on drone technology. Moreover, firm 1 had already participated in two projects exploring drone technologies; therefore, they entered this case project to foster a synergy effect. This indicates that a political agenda (i.e. the triple helix concept) helped to create innovation opportunities and foster a flow of knowledge that helped to realise the front-end of the innovation (Asheim and Coenen, 2005; Lengyel and Leydesdorff, 2011).
Because firm 1 and the OEDK structured and generated the front-end of the innovation process, they become irreplaceable. This was particularly true for firm 1, since the success or failure of the projected depended on this firm’s ability to shrink the equipment down to fit on a drone. By contrast, the other firms were easily replaced, as was illustrated in the case of firm 3. However, letting one firm dominate the front-end of the innovation process causes several challenges. For instance, sometimes, the process stagnated when this firm had to “[...] wait for that our solution can uses” (Firm 1, Head of Photonics department). Moreover, the other firms wished to participate more in the front-end and felt that they had a “[...] very limited involved in [...]” the process (firm 2, Structural Engineer). These findings suggest that matching expectations is important for front-end innovation in a cluster setting.

One of the advantages of participating in front-end innovation in a cluster is the opportunity to expand networks and build relationships. In this case, due to the relationships they established in this project, firm 3 and firm 1 have since collaborated on other projects.

5.3 Role of the cluster organisation—Case 1

The identification of an opportunity and the search for potential ideas during the front-end of the innovation process were handled by the OEDK and firm 1. The OEDK managed the application and screening process of external firms with the competences necessary for the front-end of the innovation. Thus, the OEDK influenced the front-end of the innovation by undertaking the crucial task of finding and selecting the “right” partners (Stevens, 2014). It is unclear whether the OEDK truly had the qualifications or ability to identify and select firms with the resources and expertise needed to complete the project; however, the OEDK nevertheless influenced the front-end of the innovation by implementing a structural approach and involving limited selected firms.

5.4 Creative outline—Case 2

The main driver for case 2 was a problem opportunity presented by problem owner 1. This creativity process involved more steps relating to cluster collaboration. First, a creative brainstorming session was held to identify opportunities. Then, the inputs were categorised into four groups. Last, the four groups worked independently to develop a solution, as illustrated in figure 2.

The front-end of innovation in this case was, therefore, an open process that sought to foster a dynamic environment with room for chaotic creativity and new opportunities through interchanges among the firms. In case 2, all firms participated to some extent in scoping the idea from an identified opportunity into a potential concept and technology development. By being open-minded and setting aside prejudices relating to how to solve the problem, the firms worked together on the front-end idea on a blackboard, “[...] and suddenly, it just was there” (firm B, Sales director). However, the group had trouble finishing the front-end of the innovation process due to a lack of commitment. This may have resulted from the group’s openness and their unstructured process. However, after agreeing on an idea—a new way to clean pipes—for the front-end of the innovation process and sketching the overall framework, some of the members “[...] didn’t reply, which one has to take as if they do not want to join the group” (firm A, Managing director). This resulted in delays, misunderstandings and a lack of clarity or commitment concerning who should deliver which competences. The group needed to regroup in order to finish the front-end of innovation process and get back on track. Without the OEDK’s persistent interest, the project would have failed. This indicates that the front-end sometimes requires structure to navigate through the fuzziness.
5.5 Collaboration—Case 2

The front-end of the innovation process in case 2 suffered from a lack of common communication and a shared vision, which almost led the process to fail (Haarstad and Rusten, 2016). Although the atmosphere and lack of internal competition induced knowledge flow, and though firm A took on the role of innovator, the firms exhibited limited commitment to drive the innovation. It is possible that the lack of drive was due to a lack of rivalry among the firms (Forsman and Temel, 2016). Moreover, the group failed to reduce the fuzziness of the front-end, which caused uncertainty during the process of developing the front-end into a manageable project Moenart et al. (1995).

Firms’ perceptions of how to plan the front-end of innovation differ significantly, which may inhibit the creativity process around the front-end of innovation. The withdrawal of firm D and problem owner 1 and firm C’s failure to participate due to differences in commitment levels and goals for the project led to an actual halt in the collaboration at one point. This implies a need for management to align participating firms under a shared vision (Hwang et al., 2014).

However, firm A and the OEDK kept the front-end of the innovation process going by finding a new problem owner 2 and adding a committed firm E. A redefining of the front-end was then needed, small adjustments and finishing touches were added to complete the project plan. This suggests that the front-end of innovation can be recreated and redefined by utilising other competences in the cluster.

5.6 Role of the cluster organisation—Case 2

The OEDK influenced the front-end of the innovation process by inviting 15 firms to participate in developing a solution for problem owner 1 and, thus, limiting the idea generation to the expertise and competences of these 15 firms. The OEDK also supported process continuation throughout the process, particularly when problem owner 1 withdrew and the group struggled to utilize its shared resources due to lack of commitment. Without the OEDK’s involvement, this front-end innovation process in a cluster setting would have ended in failure.

5.7 Comparison of the creativity outlines of case 1 and case 2

Although both cases utilized the cluster for creativity in the front-end, their approaches differed significantly. Case 1 involved a solution opportunity; therefore, the group exploited the cluster in order to develop and create a solution. By contrast, case 2 involved a problem opportunity; therefore, the group explored the cluster’s opportunities in order to solve a concrete problem. Case 2 was more open to creativity than the closed case 1. However, though their front-end differed significantly both cases required the extra resources and knowledge offered by the cluster.

These findings contribute to the ongoing discussion on whether a structural or a non-structural approach is best for the front-end of innovation (Pereira et al., 2017). Specifically, they suggest that too much structure may limit creativity. However, sometimes, obstructing the creativity process in exchange for a beneficial outcome may be preferable.

5.8 Comparison of the collaboration approaches of case 1 and case 2

The two cases illustrate two completely different levels of willingness to participate. Case 1 involved a high willingness to participate, which positively influenced the front-end’s utilisation of shared resources. By contrast, case 2 suffered a lack of commitment and shared resources, which almost killed the front-end of the innovation process. This indicates that a willingness to participate and a shared vision and commitment are crucial for front-end innovation processes in a cluster setting.
The findings also suggest that having dominant or leading innovators who are committed to the idea can positively influence the front-end of innovation. Though both cases experienced challenges, the dominant firm kept the process going. Furthermore, the findings suggest that having a common “language” for the front-end of innovation in a cluster setting can positively influence the process (Haarstad and Rusten, 2016).

This study contributes to the ongoing dilemma regarding structured versus unstructured innovation by showing that some degree of structure or management at the front-end of innovation in a cluster setting is necessary, even if such structure limits creativity (Brem and Voigt, 2009).

5.9 Comparison of the roles of the cluster organisations in case 1 and case 2

The findings indicate that no matter how open or flexible the front end of innovation is in a cluster setting, it is always important to find a balance between too little and too much management. As this study indicated, too open of a creativity process could result in failure due to a lack of structure and alignment, as was the case in case 2. By contrast, a closed process that successfully creates a limited front-end of innovation may never reach its exploration potential (Aken and Weggeman, 2000).

Furthermore, the findings show that the front-end of innovation is somewhat limited by the OEDK’s ability to identify and attract collaborating partners. This influence can be either positive or negative (Braun et al., 2012). It is possible that the OEDK could have utilised the cluster more efficiently, instead of managing and limiting the involved firms. For example, the OEDK could have implemented an idea competition or other criteria for attracting and identifying the “right” partners for each front-end innovation process.

6. Conclusion

In recent years, innovation through relationships has received increasing attention. Studies show that improving the front-end of innovation positively influences the performance outcome. However, despite these findings and the growing focus on this area of study, little research has investigated the front-end of innovation in a cluster setting. This study contributes to the fragmented literature on this topic by researching how the front-end of innovation unfolds in a cluster setting. The study was conducted in two innovation forums in an offshore Danish cluster that has recently experienced pressure to create innovation through collaboration. The study findings suggest that the front-end of innovation unfolds differently in a cluster setting, depending on the underlying basis or purpose of the group.

7. Future research

Future research could investigate whether specific mechanisms of front-end innovation in a cluster setting require more or less structure (Brem and Voigt, 2009). It would also be interesting to investigate which qualifications or abilities a cluster organisation should contain or foster in order to assemble the “right” partners for a front-end innovation process.
References:


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Appendix 1: Interview guideline

Introduction questions:
1. What CRIF are you company participating in?
   - Why have the company chosen you?
2. When did your company enter this CRIF?
3. Why did you company enter this CRIF?
   - Is it central for the company culture, vision or mission?
4. Did you know any of the other firm before starting working in the CRIF-project?
   - If yes, who? From what? How well?
5. Did your company point out other firms that could be beneficial to include in this CRIF-project?
   - If yes, who? Why?

General question:
6. How have you experience the process in this CRIF so far?
   - Any disagreements?
     - If yes, which? How was they solved?
     - If no, why not? Did you all just agree all the time?
7. Has there been any other firm like customer, supplier or other consideration there has influence on why your company chose to participate in this CRIF-project?
8. How do you experience Offshoreenergy.dk in this process?

Question to front-end of innovation:
9. How did the process start?
   - When?
   - Who started it?
   - How did you discuss the different idea?
10. How was the process where you as group validated if this ide was relevant?
    - Who was leading
    - How did you make this validation?
11. How did you in the group made the step or plan for what the ide should contain and how it should be realise
12. Who manage or was leading this process?
    - Who did they lead this process?
    - How did this affect the process?
13. How did you agree on the chosen idea?
    - Which criteria did you have
    - Who was leading the process?
14. Did you agree on any success criteria and or milestones for the project?
    - If yes, which, why these?
    - If no, why not?

Question to collaboration
15. Which competences or resource contributes each firm with?
    - When?
16. What has been the other firms strength and weaknesses in this process?
    - Has this obstructed Or strength the process?
17. Has some one been more dominated than others?
    - If yes, who, why, has this influence anything?
    - If no, have you agreed on every think?
18. How did you create trust to one another?