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Design Driven Innovation in Clusters

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Abstract

Collaborating with experts from other fields of knowledge may be an attractive way for small and medium (SME's) sized companies to gain new knowledge and improve innovativeness. As a consequence, open innovation in different forms have gained increasing popularity the recent years. A gap in current research is the limited focus "how to do" open innovation, as most research focus on the strategic intent in open innovation. Hence, this paper reports from an open innovation cluster to cluster project, which developed a full-scale working prototype of an intelligent energy pylon made from aluminum. The project was based on collaboration between two Norwegian Center of Expertise clusters in Norway. Aiming at understanding better why this project was successful, success factors were identified within the categories innovation networks, knowledge management, managerial challenges and individual motives. The article provides a contribution to how companies better can organize for open innovation, which should be relevant and useful both for professionals and researchers.

Keywords: Clusters, open innovation, design, collaboration

1 Introduction

As organizations more and more find themselves unable to have all relevant competences in-house, they are forced to open up their innovation processes and engage in open innovation (Enkel, Gassmann, & Chesbrough, 2009). Collaboration with peers is increasingly considered an advantageous way for organizations to gain access to knowledge important to innovativeness (Ollila & Elmquist, 2011). Similarly, the design discourse surrounding a company is considered important for radical new design, and typically involves actors like firms in other industries, product designers, education and research, suppliers, artists, events, showrooms, users etc. (Verganti, 2008).

Organizing companies in industrial clusters may be one way of facilitating open innovation between companies. Such clusters have for years been recognized as crucial for innovation and value creation, and their advantages has been studied abundantly (Eisingerich, Bell, & Tracey, 2010): enhanced reputation, easy access to highly skilled labour, increased knowledge creation og transfer between companies. Due to the many positive effects associated with clusters, governments in many countries have developed specialized support systems to enforce such collaboration. Norwegian Centres of Expertise (NCE) are part of Norwegian Innovation Clusters which is such a government supported cluster program. The current paper describes a collaborative research and development (R&D) project, involving several companies and two NCE clusters, the process and its outcome.

The objective of the project was to develop smart, intelligent and sustainable energy pylons in aluminum. It was the first cluster-cluster collaboration project in Norway, comprising 11 small and medium enterprises (SMEs), 5 from Cluster A and 6 from Cluster B. The participating clusters are both world leading in their field of technology, respectively on micro & nano technology (Cluster A) and materials research and productivity (Cluster B). The clusters and its participants did not know each other prior to the project. The R&D project lasted for 2,5 years, through which the companies where not co-located. Physically, they worked within their respective clusters, but met for meetings and design workshops throughout the project. Substantial parts of project communication was through e-mail and telephone. The project manager was located in Cluster B and was responsible for enabling collaboration between the companies involved, and for achieving the project goals. Considering these characteristics, the project should provide an interesting case to learn more about cluster-cluster collaboration through open innovation. To our knowledge, there are no publications on this type of cluster-cluster open innovation project. Hence, this paper empirically explores: how was this project conducted and why was this project successful? The main theoretical contribution is to the field of open innovation practices relevant to SMEs.

2 Success factors for design driven open innovation

2.1 Radical innovation in networks

Verganti has proposed that radical design implies radical innovation of meaning, because radical innovation assumes a different context and user approach than those products already on the market. Hence, radical innovation on new meaning implies moving away from the tradition user-centred approach common in design thinking. In user-centred design, the key is to get as close as possible to the users and to elicit their needs. Instead, radical innovation means taking a step back and investigating trends in the society, economies, culture, arts and technology development. At the same time, future innovation will take place in networks and be formed by the countless and unpredictable interactions between the actors in the network, instead of taking place in a single firm (Verganti, 2008). Chiaroni et al. (2011) suggest establishing long term relationships with universities and research centers, in addition to exploring social networks as one way of establishing innovation networks for open innovation. Important capabilities in radical innovation will be firms' ability to access and share knowledge, and to identify key partners for long-term relationships (Verganti, 2008).

2.2 Knowledge management in open innovation

Open innovation as about leveraging and exploiting knowledge generated inside and outside a firm, in order to develop innovation opportunities. Consequently, open innovation requires knowledge management to support the diffusion, sharing and transferring of knowledge between a firm and its environment (Chiaroni, Chiesa, & Frattini, 2010). Hong et al. (2011) have proposed a framework derived from knowledge management literature review, based on organizational and individual barriers. Main organizational barrier includes language, conflict avoidance, bureaucracy and distance. Language barriers concerns that certain languages (technical terms, trade terms) are only used in some organizations or departments and unintelligible for others. Conflict avoidance concerns effort to avoid change and risk taking. Bureaucracy at a high level will hinder knowledge sharing. Distance concerns geographical separation, which may cause cultural differences and reduce face-to-face communication, which is considered most efficient in innovation (Hong, Suh, & Koo, 2011). R&D cooperation can further be classified according to how close actors co-operate, from distant or arm's lengths co-operation, to close collaboration where representatives from both parties actually develop a joint solution (Wynstra & ten Pierick, 2000). Transdisciplinary research can be described similarly; whether the researchers are merely working on the same topic and meet to present their results organizing common seminars, or if the researchers are actually creating solutions and knowledge (publications) together (Sørensen, 2002).

2.3 Managerial challenges in open innovation

Open and closed innovation requires different cultures, in which open innovation requires a risk taking culture, managers who support cultural change, new thinking and provides clear mandate to access external innovation (Slowinsky, Hummel, Gupta, & Gilmont, 2009). Managerial challenges in an open innovation project is also discussed in a Swedish case study (Ollila & Elmquist, 2011). It addresses competition and potential conflicts between the open innovation project and the home organization related to exploitation of knowledge and solutions, and resource priorities. Other issues highlighted are: lack of acknowledgement of open innovation project work, poor anchoring of ideas, conflicting goals with the home organization, time-consuming decision processes in the home organizations. Further unclear role and the mandate of the open innovation project itself are also found to be hampering. In addition to these managerial challenges, the study strongly suggests that the motives, expectations and incentives for participating in such collaboration are important to address. Previously, Chesbrough and Crowther have identified the importance of having champions to lead open innovation projects, but also to have rewarding and incentive systems (goals, metrics) for open innovation (Chesbrough & Crowther, 2006). Chiaroni et al. (2010) also highlight to the importance of innovation champions and gate keepers, as well as innovation performance measures for long term open innovation.

2.4 Individual motives in open innovation

According to Hong et al. (2011) and Ollila and Elmquist (2011) individual motives and barriers toward information and knowledge sharing are crucial for project success. Chatenier et al. (2010) have investigated which individual competencies that are important for working in open innovation project teams in particular. Main competences found to be important were: committment and motivation for the work, self-governance, to be able to build trust (to be honest), to have social astuteness, to have interpersonal relationships, to be a social person and to be friendly. For the manager, personal skills found to be important were: to be inventive, to control and coordinate and to cope with chaos and un-certainties. Lee et al. (2011) have gone even deeper and researched individual motives for information sharing and providing in organisations. Information is defined as resources that involve any advice, opinion, instructions etc., which may or may not contribute to individual knowledge. Lee et al. (2011) found that indeed, personal traits have a significant impact on willingness of employees to engage in helping with information sharing. Such personal characteristics have not been given much attention in open innovation literature, but should be of highest importance as open innovation is based on information sharing, and thereafter knowledge building based on the shared information.

3 Research design

3.1 Case description

This paper is based on case study following an R&D project involving 11 SMEs from Norway, where two of these were R&D institutions with substantial experience. Two of the companies were recent start-ups, whereas the remaining companies are well-established actors within their field. In addition, a technical university participated to some extent. A total of 23 people were involved, whereas 15 followed the project from start to end. In addition, experts from three different power companies were involved in workshops, meetings, or on-site inspections. All project participants worked part-time on the project, including the project manager. The project's overall objective was to "*dramatically increase customer value through knowledge-based development of advanced, intelligent, and sustainable pylons, strongly rooted in two world class industry clusters*".

3.2 Data collection, validity and limitations

This longitudinal field study was carried out over 2,5 years, allowing in-depth study of the project in its natural environment. In the project, the role the researchers were active participant observation (Robson, 2003), meaning that the researchers participated in daily project activities as project managers as well as being researchers. Reflective notes were taken during the course of the project (meetings, workshops, and other relevant events), and process facilitation was regularly discussed for planning activities and for reflection. Additional information was collected about the companies, and photos were taken during workshops to support the data collection. The presented results are based on the reflective notes, the actions taken during the project, as well as their outcome.

To support or dismiss indicative conclusions, an evaluation survey was conducted with 85 statements derived from reflections and therory. The on-line survey was developed to overcome potential bias in the participatory observation, as the survey triangulate some of the findings from the observations (Creswell, 2003). All variables were measured using a 5-point Likert rating scale. The survey was sent to 23 persons (project participants and affiliated partners). Only the core team (12 respondents) answered the survey. Co-workers that only attended company in-house activities did not answer the survey and account for the low response rate. Finally, as this research reports from a single case study, the specific results are difficult to generalize and should be regarded as indicative only.

4 Results and discussion

Overall, the project was a huge success. The project financed R&D activities strategically important for the partners, and created a new arena for collaboration. A full-scale prototype of the worlds' first intelligent energy pylon made from aluminum is on duty in the power grid, and three more designs were developed by the project. The project organized 8 workshops with representatives from both clusters. In addition, both clusters organized several internal meetings. Workshops contributed to critical examination as well as new perspectives and solutions from other fields of expertise. The results from the R&D project are currently being commercialized in a new company working for the energy sector.

4.1 Radical innovation in networks

To access necessary knowledge required to complete the projects objectives, the innovation network partners evolved organically throughout the project. Starting out, two research centres were part of the project in addition to the companies involved. These research centres acted as knowledge brokers in the project by passing on and sharing knowledge within their field of competence. Later on, whenever a competence was in need, a new partner was introduced to the project, formally or informally. This way of "hand picking" innovation partners ensured that the project at all times had the knowledge required to solve the problem at hand. In general, the evaluation survey also confirms that right actors and competences were involved in the project. These results illustrate the importance of including a great variety of sources for knowledge and inspiration, as recommended (Verganti, 2008). Figure 1 below demonstrate the innovation network in the project.

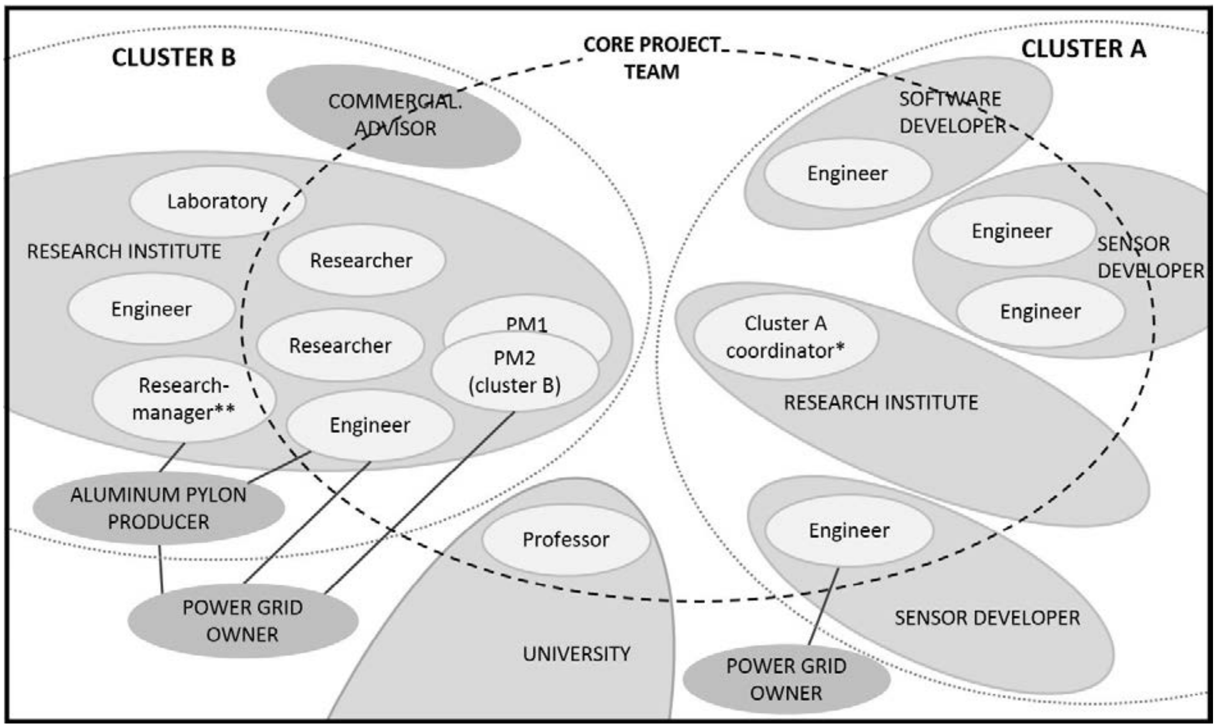

Figure 1. Project innovation and networks partners

Users (senior operators from the power company) of the new solutions participated in the first workshops. They were initially negative as they were familiarized with the radical idea of intelligent (smart) power pylons, Their reasoning was that adding intelligence was unnecessary as they could easily do a field trip to gather the same information. They were also were sceptical towards introducing aluminum as a construction material as they argued that someone must have tried this before and failed. These reactions were not unexpected, as these operators gave meaning to intelligent pylons within their existing social-cultural regime. Radical innovation assumes a different context and user approach than those products already on the market (Verganti, 2008). Hence, asking users' opinions on radical innovation concept can be more discouraging than useful. Bearing this in mind, the project moved forward without user involvement. When involving these operators later in the project, their mind set had shifted towards viewing the advantageous possibilities of intelligent aluminum pylons.

4.2 Knowledge management in open innovation

Knowledge management is vital to cluster-cluster collaboration projects. Hence, there was a clear strategy to facilitate workshops and meetings to foster diffusion, sharing and transferring of knowledge face to face. All workshops had a clear goal and agenda. Some were facilitated simply to exchange information and knowledge, whereas others had clear co-creation goals. That is, to use the collective knowledge in the group to develop common solutions as recommended in literature (Wynstra & ten Pierick, 2000). Both ideas and concepts for solutions were developed during workshops. Then, detailed solutions were evolved in each cluster and then presented collectively and discussed during the next workshop. Example; cluster A participated in pylon design workshops in cluster B; whereas cluster B participated in developing sensor concepts in cluster A. An important insight from the workshops was the usefulness of discussing solutions in details with experts from other competencies. For instance, the relationship between corrosive attacks and what the sensors should measure. Moreover, when a partner from one cluster presented ideas and concepts for participants from the other cluster, "what if"-questions were useful to increase understanding and to build knowledge. The other cluster's experts provided information from their own experiences and competences and functioned as expert evaluators. Premises for good dialogues were enough time and presentations that were at the right level of details. Evaluating the results from the workshops, as well as the work process, these workshops were essential to project progress and success. Figure 2 is from a photo and shape elicitation work shop.

These observations and reflections correspond well with survey results. Face to face interactions were preferred over e-mail, telephone and videoconferences. Videoconferences gained popularity throughout the project, still, working together was considered more useful. The participants also preferred working together to working alone. Such an attitude is vital to open innovation projects.

Figure 2: Pylon design workshop

Language barriers concerning for instance technical terms was not observed to be a problem, although in the survey, language barriers were to some degree reported to be a problem. This result might indicate a need of rich information and depth in the network (Laursen & Salter, 2006). However, these participants were all used to working with people outside their main field of competence, and hence adjusted their language (technical terms) in the workshops. Lack of willingness to take risks may also hamper knowledge sharing (Hong et al.), but was neither observed or reported in the survey to be a problem. To minimize any negative effects from geographical separation, workshops were held every other time in each cluster as there was 3,5 hours travel by car between the clusters. The participants experienced this way of doing it as fair, hence the core team was present in all workshops.

4.3 Managerial challenges in open innovation

Managing open innovation projects requires a variety of personal skills, resources and engagement. Perhaps most importantly, it requires support and recognition from the companies involved. Starting out, the project experienced lack of resources (people) and had little progress the first half year. The experts boarded the project had not been involved in the pre-project. Consequently, they did not feel ownership to the objectives and concept. There was also scepticism towards collaboration with unknown partners. Within each cluster, there was trust and goodwill, but only to a limited extent between the clusters. After discussing these initial problems with the experts and managers in both clusters, a common platform for project collaboration was developed.

In open innovation projects, competition between the project goals and the core business in participating companies may occur (Ollila & Elmquist, 2011). The participants did not experience such competition in this project. In our case, project success would not threaten any of the companies involved, but would instead increase core business for all partners. The project did however, experience competition concerning intelectual property rights (IPR) in cluster B. In this cluster, the innovation climate is very open; engineers and business leaders know each other well and discuss solutions freely across company boundaries. Cluster B may be labeled opportunistic, applying available resources to solve short and long term issues. Consequently, some design activities were carried out without formal contract. In retrospect, it became unclear who had the right to commercialize results. The project also experienced challenges in understanding which ideas and technological solutions that could be shared or not, and to what degree, due to participants from different disciplines, different company culture and different cluster openness. Addressing IPR issues before starting a project like this one is therefore strongly recommended. However, finding the right level of openness is challenging, as too much focus on IPR is likely to hamper information flows and project progress.

Applying the categorization of Sørensens model of transdisciplinary project (Sørensen, 2002) the two clusters were working on separate physical solutions in a joint project. This was strategy was chosen intentionally to minimize risk between two unfamiliar cluster partners. The new sensors developed may be applied to any type of energy pylon. Correspondingly, the aluminium energy pylon may be erected without sensors. Interestingly, the survey indicates that most participants experienced that a common solution was developed in the project where everybody took responsibility.

The project developed four shape princicles for energy pylons that satisfied strength requirements. Three shapes were a result from the design workshop – driven by industrial design perpective, and one shape was a result from a strenght analyses of an aluminium pole. The more radical design approach, experimenting with biomemicry and iconic shapes stagnated when the industrial designer left for maturnity leave. Hence, the interest in the innovation network shifted (Verganti, 2009). An experience is that differences between industrial- and structural design might be reinforced by the strong disciplinary focus present among experts. Before starting such a project, one should clarify to what degree a new design in a R&D project is allowed to be experimental, and how to best to communicate critical aspects of chosen concepts in autonomous research teams.

4.4 Individual motives in open innovation

Personal traits impact willingness to engage in information sharing (Lee, Lee, & Sanford, 2011), and this information sharing is again vital to open innovation. Throughout the project, the participants were experienced to be positive, eager and self-motivated. They participated in all workshops, even when geographical distance could have been discouraging. They also freely shared information and discussed solutions, and were encouraged to do so, even when this was in conflict with IPR-handling.

These findings correspond well with survey results, which indicate that project participation was not driven by economic motives or the wish for increased job security. Information sharing was dominantly based on altruistic traits, and the wish for future reciprocity and to learn from other experts. This result indicates that open innovation projects should focus on recruiting experts with the right motivational approach. One may wonder whether such personal traits are unique to this kind of projects, i.e., people with such traits are drawn to open innovation projects. Another explanation may be that these are common traits for any employee in a knowledge driven company. The general lack of trust and motivation experienced in the start of the project, may also indicate that the project itself contributed to an self motivating arena for experts. Table 1 summarizes our indicative findings from the project.

Table 1 Indicative findings from the project

Category	Recommended success factors for open innovation
Radical Innovation in networks	• Research centres actively involved in passing on knowledge • Organically expand knowledge network throughout the project as needed • Abandon user-centered design when working with radical new solutions
Knowledge management	• Organize workshop regularly for knowledge exchange and co-creation • Forming multi-disciplinary teams to learn from other experts and be each other's expert evaluators • Develop clear set goals for each workshop. Meet well prepared. • E-mails, telephone, social media platforms, videoconferences may support knowledge exchange but not replace workshops • Share travel time equally between partners in projects with geographical distance • Spend time to "translate" technical terms and languages to each other
Managerial challanges	• Project members should take part in developing project goals • Invest time to build trust and understanding between new and unfamiliar partners • Seek alignment between company goals and project goals • Find the appropriate level of IPR-handling • Clarify to which degree new design is allowed to be experimental
Individual motives	• Recruit self-motivated experts with altruistic traits to the project

5 Conclusion

In the presented project, the world's first full-scale working prototype of an intelligent energy pylon made from aluminum was developed and is now on duty in the power grid. The project was based on an open innovation cluster-cluster collaboration project between to Norwegian Center of Expertise clusters. Through workshops, the project provided an arena for experts in different clusters to develop knowledge and a common solution with minimal risk.

This study indicate that certain network, organizational and individual factors have influenced the project in a positive way, thus contributing to its overall success. A wide range of carefully selected innovation network partners were recruited to the project, and as the project proceeded, new knowledge partners were added as required. Although the current research cannot be generalized as it builds on a single case, the results indicate that experts from a scientific field reviewing expert solutions from another field influenced project performance in a positive way. Likewise, face to face communication in workshops was found to be more productive for sharing information and knowledge than other means of cooperation. Project goals should be aligned to company goals, and not be in competition with company core business. Involving users at an early stage when developing radical new solutions is unproductive. Moreover, we learned that in open innovation, a company may also be too open when it comes to sharing ideas and solutions. Consequently, IPR should be carefully managed in such collaboration projects to avoid conflicts at later stages. The willingness to share information and knowledge without receiving personal benefits was also considered positive for the project success.

The identified indicative success factors may be useful to future cluster-cluster collaboration projects within the Nordic context. To enhance the results, more research within in this area is needed to better understand actors and how they interact in open innovation projects.

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