Designing Collaborative Manufacturing Solutions for SMEs: A Case Study

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Abstract: In this paper, we investigate how small manufacturing companies can apply open innovation in the context of process innovation. We present a case study, with embedded action research elements, of a particular set of SMEs that implement a collaborative solution for manufacturing processes. We specifically examine how these SMEs collaborate with both competitors and complementors in an innovative automation project. The findings include a decreasing importance of monetary motivation, a direct competitors paradox, and leadership and ownerships issues, on both inter- and intra-company level.

Keywords: open innovation; SME; manufacturing; collaboration; process innovation; case study; action research

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1 Introduction

A decade after the introduction of open innovation as a new innovation management paradigm (Chesbrough 2003; Gassmann 2006), researchers have uncovered several determinants and mechanisms of open innovation, although many aspects are not yet completely understood (West & Bogers 2013; Dahlander & Gann 2010; Huizingh 2011). One of the areas that has received increased interest in recent years is the role of open innovation in Small and Medium Enterprises (SMEs) (Van de Vrande et al., 2009). While this emerging research has identified some of the main trends and mechanisms, a more detailed understanding of the exact conditions under which SMEs can successfully implement an open approach to innovation is still lacking.

The main goal of this paper is to investigate how SMEs can apply open innovation jointly to design, develop and evaluate new adaptive and flexible manufacturing solutions. Researchers involved in this process undertook an attempt to better understand the drivers and challenges of collaboration between a set of SMEs that are trying to improve their manufacturing competences while partnering with competitors and complementors. The specific research question is thus: How can a particular set of SMEs implement a collaborative solution for an innovative manufacturing process?

Due to very scant research related to open innovation practices in SMEs, this paper particularly addresses how SMEs can implement an open innovation approach in the context of process innovation. Specifically, it explores the drivers and challenges for manufacturing SMEs that are embedded in a regional business ecosystem and starts a collaboration to develop a new automation solution for manufacturing processes. Hereby, this paper also contributes to the understanding of the role of openness in manufacturing and process innovation (Bogers & Lhuillery 2011; Reichstein & Salter 2006).

2 Theoretical background

Since the context dependency of open innovation is not yet well understood, more research on open innovation immersed in business ecosystems is required (Chesbrough & Bogers, 2014; Huizingh 2011). This research should provide a better overview of the external stimuli affecting performance of companies. So far, the most prominent findings come from early adopters of the concept, which are widely represented by large multinational corporations like IBM, Lucent or Intel (Chesbrough 2003). But there are relatively few studies focusing on open innovation in business ecosystems (Van Der Borgh et al. 2012) and they generally do not focus on the role of SMEs in this collaboration.

Companies tend to engage in open innovation activities to accelerate internal innovation, which helps them to stay ahead of competition. Opening up the innovation processes for collaboration with external partners is then inevitable for SMEs, arguably even more than for large firms. Moreover, collaboration for innovation, especially in inter-organisational networks and alliances is nothing new (Powell 2003; Tidd 1995; Vanhaverbeke et al. 2002). However, the development, organisation and sustainability of such inter-organisational relationships has not been widely examined - especially in the case of SMEs.

Previous studies of open innovations in SMEs have identified trends, motives and management challenges (Van de Vrande et al. 2009), as well as intermediation and its role in facilitating innovation in SMEs (Lee et al. 2010; Spithoven et al. 2011). Nevertheless, a better understanding of open innovation processes, especially in the group of SMEs, is still necessary in order to enhance the understanding of drivers and challenges for establishing successful partnerships.

Existing literature points out that in order to start collaboration, partners not only have to have a good reason to do so, but must also recognize a potential gain (Dodgson 1993). However individual motives for collaboration vary from avoidance of external threats to attaining legitimacy and sharing the risk (Oliver 1990). it can be seen as achieving collaborative advantage, where individual organisations need to team up in order to achieve goals which are unreachable alone (Huxham 1993). Despite various examples of collaborative New Product Development (NPD) (Ritala et al. 2013; Salge et al. 2013), questions like how, when, and who to invite to the innovation process, as well as how to manage such a collaboration have not yet been answered (Du Chatenier et al. 2009; Wallin & Von Krogh 2010).

One of the process-related issues, which Huizingh (2011) mentioned as worth exploring, is open innovation practices and particularly, how to perform open innovation regarding processes (Reichstein & Salter 2006).

The major knowledge gap identified in the literature, that serves as motivation for this study, is open innovation collaboration in general and especially the managerial implications for SMEs and their general lack of knowledge of the issues. In this paper, we shift to inter-firm relationships and focus more on exploring the management of the process of collaboration as well as the incentives that motivate different partners.

3 Research design

We conducted a case study of a consortium of 4 companies, which can be seen as 'an extreme or unique case' (Yin 2009). The case study method with embedded action research elements (Coughlan & Coghlan 2008) was chosen due to the increasing importance of a field-based, practice-oriented research contribution in theory building (DeHoratius & Rabinovich 2011). This research design (Romme 2003) enables getting in-depth understanding of actual companies' practices as well as in designing and developing the most suitable solutions for the participating SMEs - from the whole southern Danish region. As embedded action research elements we understand a tight link between the researchers and the research participants as well as deliberate involvement in actions of the research participants. The motivation for implementation of those elements, as well as its positive implications, was to increase understanding of the context of actions, performed activities, and the reasoning behind them (Huxham & Vangen 2013). We are also aware of the risks of potential negative effects of such an involvement, which could include biased data collection and analysis. Nevertheless, the higher contextual understanding, as well as gained trust and legitimacy among the research participants, helped to collect more reliable data both during interviews and observations.

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Company selection

First, companies were selected that were willing to take the risk of joining a collaborative innovation project, as expressed both by their openness for external sources of knowledge and their willingness to collaborate both with competitors and complementors. A second important criterion was that participants' competencies could be melded together to a suitable common goal. Our main goal was to create a situation where all companies would have the potential to achieve collaborative advantages (Huxham 1993). As a result, there were 4 companies invited to the second stage which exhibited a complementary set of skills: two companies are mechanical solutions providers, and two companies deliver software and hardware solutions. We included two representatives of each set of competences in order to test for competitive behaviours. Last, companies were selected with the power balance in mind, which is also why all of them are small SMEs (with up to 60 employees) chosen with the spatial proximity (the distance between Sønderborg the central city in the region and company should be less than 25 km) in mind (Sternberg 1999; Freel 2003).

Data collection

Data was collected during two stages over a period of one year. In the first stage, empirical data was gathered through 23 exploratory, face-to-face semi-structured interviews conducted with 12 Danish manufacturing companies. Their size varied from micro companies to large global players. Findings from the first stage were used to design the second stage of the research, as well as to establish the setup for study to be presented in this paper.

During the next 8 months, empirical data was collected during 11 internal (strategy and planning) and 21 external (consulting a 3^{rd} party) project meetings as well as 8 individual evaluation interviews conducted with all partner representatives involved in the project. The data consisted of: recorded and transcribed interviews, e-mails, as well as documentation of both internal and external meetings with partners.

Error! Reference source not found. presents the overall structure of the project. The core team comprises representatives from the 4 industrial partners, the local University, the Local Development Council and a Vocational training centre. SMEs from outside the core team are also beneficiaries of the project (those that seek improvements in their manufacturing facilities).

Data analysis

The data analysis from the first stage of the research is not presented in full here to give a place for second stage analysis. During the second stage, the researchers encouraged all research participants to actively contribute in suggesting potential improvements (Coughlan & Coghlan 2008). In order to achieve data triangulation, analyses were based on six months of observations, collaboration (as project support team members), and documentation of the entire project core activities as well as interviews. The data analysis process was aligned with weekly project checkpoint meetings as well as milestone evaluations every two months. After 6 months, 8 semi-structured interviews were conducted with all industrial project participants that were actively involved in the project. Those interviews were a part of a circular process of matching the theory and reality (Van de Ven & Poole 2002) and were analysed through an inductive framework.



Figure 1 the overall project structure

4 Findings

The main motivation for companies to join the project was to get some new customers, make partnerships, increase brand recognition and to expand their network of contacts. After six months of the collaboration most of the companies either are in the process of making specific offers for potential customers or already got some new orders. Additionally, the collaboration between consortium members got much closer than before the project. All of them claimed that they knew about each other before entering into collaboration, However, closer collaboration helped them in involving each other in more projects and orders. So far the biggest challenges encountered in this collaboration are not related to the consortium itself and the fact that competitors and complementors are working together. Most of the potential improvements center on collaboration with SMEs outside the consortium, where the biggest challenge is to

"Get in touch with the right people" **Partner A**

or equally difficult is the follow up process to:

"(...) convince the end user to the new product, new way of thinking. They are not always prepared to it. We are coming with simple things for us, but for them it is breaking news." **Partner B**

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The second focus point is more related to internal issues like the amount of time partners need to dedicate to the project as well as how to balance time and resources, that is why for some partners it is difficult to

"(...) find time and resources for the project" **Partner D**

or

"(...) it was hard for us to find the time. If I had known (...), suddenly it was going very fast and I was not prepared for it" **Partner C**

The role of monetary motivation

During the first stage of the research the sample of interviewed companies stated that due to a relatively high risk and scarce resources, it would be difficult for SMEs to get committed to a project or an initiative which would require purely internal funding. Additionally, high uncertainty was not the biggest stimulus to join the consortium. That is why researchers acquired external funding for SMEs in order to start up this project.

"I did not know what to expect, when we joined the project, but now I think that it is very good. [even without external money] Then I think I would have said no, but now when I know the system I would say yes." **Partner A**

If another collaborative project should take place, without additional financial support, then the biggest and the smallest company would drop out from the consortium, because external funding

"(...) is very important. We would not join the project without external funding" Partner C

Alternative opinion is that

"It is important to have some expenses covered, without money we would just do it alone [without the project]" **Partner D**

However some interesting points are that

"The money takes away the pressure" **Partner B**

Last, but not least, consortium partners get back to the problem of balancing between internal and external activities

"We get our expenses covered, but the funding is not so high that it could be a big motivation. It is ok. Normally you get nothing for doing the sales. It is not the biggest issue; it [the biggest issue] is to get new customers" **Partner A**

The direct competitors paradox

All four companies evaluated their partners and the collaboration with them in a very positive way. The only improvement that was suggested was to expand the consortium by inviting some new 'unknown' partners.

"Maybe we could have some companies from far away, some new firms that we do not know". **Partner B**

It is an interesting suggestion for future projects. However, it should be considered if there would occur any perception and performance difference in the consortium if an 'unknown' company would join as well as when it should happen in order to improve the project performance.

This setup with two couples of competitors does not appear to have triggered any competitive behaviours. Even if one company gets more involved and starts contacting more potential customers to visit within the scope of the project, it does not motivate their competitor to act. The only answer to that is lack of time

"Lucky for them, that they had the time to do that. That time we were very busy. For me it is ok and if [Company B] gets something out of it, it is ok. I did not have the time to do it so no [no additional motivation due to competitors' behaviour] It would be better if xxx had nothing to do, and I could just say go and take that. If we do it [engage in the project] is because we want a new customer, otherwise, we work for a current customer and that's the way we do it"

Partner A

Leadership and ownership on both inter- and intra-company level

After 6 months of collaboration all companies think that the goals set by the project are very good, some even mention that

"It is the same direction and way we do it today in our company" **Partner B**

This confirms some alignment between project and company goals. Clear goals and leadership were mentioned as prerequisites for this project during the first stage of the research.

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"There are goals and leadership and it has really been working good" **Partner C**

During the project CEOs started to step out from the operational level and moved to the strategic one in the Steering Committee. This happen gradually and from the project team perspective improved project efficiency very much. The main reason why CEOs started to delegate their responsibilities was

"because of the time, I have other things to do and xxx can do the same thing as I can do" Partner A

5 Discussion

SMEs would like to be suppliers to big companies, but they prefer to partner with companies of a similar size. That is why they realize open innovation through strong collaboration with various stakeholders – customers, suppliers, but also competitors (Lee et al. 2010; Kogut et al. 1992). This is probably due to having similar scale challenges as well as potential alignment of their business models. That is why the empirical setup was built on the assumption that SMEs solely should be able to form more symmetrical (in terms of a power balance) partnerships than an SME and a large company (Nieto & Santamaria 2010; Blomqvist et al. 2005).

In order to obtain collaboration, those partnerships should be mutually beneficial. Despite monetary benefits, a big stimulus for collaboration is shared business objectives in terms of target market, or the need to acquire various competencies (Rothwell & Dodgson 1991; Granstrand et al. 1997). Other important prerequisites for conducting successful research on collaboration would be a certain propensity to collaborate as well as a degree of openness represented by the industrial partners invited to join the project.

The analysis of the empirical data gathered in the second stage of the research provided several relevant findings, where the most surprising ones were those related to the role of monetary motivation, the direct competitors paradox, and leadership and ownerships issues, on both inter- and intra-company level.

The role of monetary motivation

Extant research often underlines that financial instability is the reason why SMEs encounter limitations in expanding their scope of activities (Van de Vrande et al. 2009). Nevertheless, our empirical evidence shows that extrinsic motivation crowds out intrinsic motivation in regards to pecuniary benefits.

Data from the first stage of the project indicated the importance of financial resources to lower the risk of failure in the proposed collaborative project. That is why project funding assured the money for industrial partners. Each of them is refunded up to 70% of the cost of hours which their employees spend on the project. Those hours can be spent on: contacting local manufacturing SMEs, project introduction meetings, providing consultancy on potential improvements in the manufacturing areas as well as developing

solutions which could help other manufacturing SMEs in getting more competitive in the area of automation etc.

Our empirical research shows that despite the fact that the availability of money could be a decisive factor in regards to joining a collaborative project, it does not play an important role in motivating SMEs to be more active in the project. Availability of project funding can play an important role for SMEs in lowering the risk of joining a collaboration of uncertain future benefit as well as in convincing the firm of the significance of the initiative. However, what SMEs expect of most of activities that they commit to are not only short-term benefits (like reimbursement), but mainly long term profits, which could be assured only by acquiring new customers. One of the possible explanation could be mentioned by one of the partners the amount that the companies get for participation, which may be perceived as too small.

The direct competitors paradox

Coopetition, in spite of its potential risks and disadvantages, could be also an effective way of creating innovation (Ritala & Hurmelinna-Laukkanen 2009). In relationships where competitors both compete and cooperate simultaneously, the closeness to the buyer would trigger competitive behaviours (Bengtsson & Kock 2000). However, our empirical findings point out that decreasing distance between one of the partners (from competitive relationship) and the buyer does not increase any competitive behaviour (neither positive nor negative).

An explanation of this behaviour may be related to the biggest challenge that 4 chosen SMEs are experiencing in such a collaborative project, which is to find a balance between involvement in the core and side activities. The economic logic for cooperation suggests that despite extending the firms' networks, as well as a huge potential in finding new customers (which is one of the goals of the project), the awaiting order is not something that can be neglected. Moreover, even in the situation when a direct competitor would be involved the current customers and their orders would be still a first priority. The perception of the competitors will be influenced by the fact that the consortium partners knew each other before entering into the project.

Leadership and ownerships on both inter- and intra-company level

In the First Project Stage, strong leadership, as well as clear goals, were pointed out by future partners as prerequisites for good collaboration in any joint projects. During the Second Stage of the research, leadership and ownership issues on inter- and intra-firm level were addressed by keeping both collaboration levels in balance, so CEOs should delegate non-core activities to other employees. Due to this, their firms will not only eliminate situations where their leader with his tacit knowledge will be available both for the company and (to some extent) for the collaborative activity, but commitment to internal activities will also increase.

6 Conclusion

Existing studies suggest that companies fail to capture potential benefits from open innovation due to performing more inbound than outbound innovation activities (Van de

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Vrande et al. 2009; Chesbrough 2003). That is why our research investigates the case where both organisations use and provide sources of knowledge. What is more, this exploratory study has shed some light on the complex issue of cooperation between competitive SMEs, along the way investigating and developing total solutions for other SMEs in need of increasing competitiveness by adapting new automation. As we can see from the empirical findings, cooperation (and competition) may encounter many different challenges.

Limitations and further research

In this paper, we intended to identify drivers and challenges when small manufacturing firms implement an open innovation approach to collaboration in the context of process innovation. Due to the fact that the chosen sample of small manufacturing companies work in the field of mechatronics it would be hard to generalize the case to the overall population of manufacturing SMEs. Therefore, further research could focus on SMEs from different industries as well as consortia from different regions. However, the managerial implications drawn from this work may still be generally relevant for companies representing lower end of high tech (in terms of R&D spending amount, like machinery and equipment sector).

A second limitation relates to the application of action research elements. There is a risk that the researchers' participation in the project changed some of the drivers or challenges that would normally appear, removing our awareness of their influence on the partners as well as the entire project set up. That is why future research should look at more cases of SMEs' open innovation collaboration with embedded action research elements, in order to verify presented findings as well as contribute to further development of the understanding of collaborative innovation processes.

Further studies are also needed to better understand this area of research and try to develop sustainable business models for this kind of relationship. As a step on this way, these research results offer a good basis for establishing a research framework that is necessary to develop a business model for SME collaboration in an open innovation environment, which then also includes an explicit consideration of the wider value chain (Chesbrough & Rosenbloom 2002).

Practical implications

We believe that the empirical findings are an important contribution for both academics and practitioners. From the theoretical point of view, the research adds both to the open innovation works with a special focus on SMEs and to the literature stream related to regional collaboration and business ecosystem development. Besides, the context of openness in manufacturing and process technology emphasizes the importance of broadening the typical scope of R&D and product technologies within open innovation research.

From a practical point of view, we believe that the empirical findings may serve as guidelines for SMEs, which either are involved in different types of open innovation based collaboration, or wish to do so. What is more, not only content-wise, but also method-wise, this paper's findings may also be very helpful for researchers that wish to establish successful projects with the industry. It could not only help in increasing our understanding of the drivers of inter-SME collaboration, but also prepare scholars for

dealing with various challenges in project and process management, especially while adopting an action research design.

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