How to support knowledge exchange in a multi-division manufacturing firm using a prototype platform?

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Abstract. Knowledge management and intellectual capital are essential factors in a company's success. An intrinsic element of knowledge management is knowledge exchange. Obtaining knowledge outside of a firm's boundaries, also known as open innovation, is necessary. Although these topics are well described in the literature, they seem less developed in a manufacturing context. The current economic context is favourable to the firm's merger and acquisition. This paper aims to understand how knowledge exchange can be supported in a multi-division manufacturing SME. During three months, thanks to a prototype platform, part of the knowledge exchanges and collaboration were tracked and evaluated in a Quebec aerospace multi-division manufacturing firm. Through this period, knowledge exchanges' quantity, success and collaboration symmetry were monitored. Semi-structured interviews were conducted at the end of the experimentation with the members to gather the foundations and limitations of the prototype platform. This one proposes a supportive organizational structure and incentives which enhance knowledge exchanges among involved SMEs. This prototype platform approach should provide the foundations of more structured knowledge exchanges.

Keywords: Knowledge exchange, Open Innovation, Collaboration, SME.

1 Introduction

Knowledge is one of a firm's most important intangible assets, which resides in its employees [11, 32]. The company's internal knowledge is a limited resource and obtaining knowledge from outside is necessary to renew the knowledge pool [9]. Innovation cycles are getting shorter and shorter, and managing this knowledge is essential if firms want to remain competitive [27]. Many companies will face a knowledge management problem across potentially new subsidiaries in a merger and acquisition trend.

Knowledge management in subsidiaries belonging to the multinational firm is well documented [26], and there is also literature available in knowledge sharing in SMEs [5, 8, 28, 13]. However, when SMEs are divided into several units, managing the knowledge held by the units might be challenging. Therefore, the question that needs to be asked is: How to support knowledge exchanges in a multi-division manufacturing

firm? This paper aims to present opportunities and barriers to knowledge exchange among a group of SMEs by using a prototype platform.

The paper is structured as follows: Section 2 will present the state of the art on the knowledge exchange inside a multi-division firm and the open innovation in an intra-firm context by using a prototype platform. Next, section 3 will present the context in which this study has been conducted. The methodology will be presented in section 4. The opportunities and the barriers will be covered in the next two sections. The last section will be the conclusion.

2 State Of the Art

2.1 Knowledge exchange inside a multi-division firm

Literature shows that knowledge exchange can be supported by using a prototype platform in a multinational group having subsidiaries. However, there are fewer examples in the literature of how knowledge exchange can be supported in a group of SMEs.

Key benefits have been observed by multinational firms which perform knowledge management and knowledge exchanges across their subsidiaries. The subsidiaries' knowledge management capabilities, such as favouring knowledge exchange across the group, showed a higher innovative performance [12]. This can be explained by selecting and leveraging the new knowledge more effectively across the firm [12]. The subsidiaries' knowledge absorption and diffusion can also positively affect the employees and internal processes [12].

To support knowledge exchange across the subsidiaries, several methods are used by larger firms. Moving employees from the headquarter to the subsidiaries, and vice-versa is one of the most used methods [10]. Multinational firm managers', which allocate resources to subsidiaries, can localize specific knowledge to better exchange knowledge across subsidiaries [22]. Moving resources between subsidiaries have proven to reduce the costs of knowledge exchanges by enhancing the building of networks and promoting knowledge exchanges across subsidiaries [22]. Larger firms can employ around more than 10 workers to ensure knowledge exchange across all subsidiaries [10]. Their knowledge exchange team oversees the dissemination of the best processes and auditing the actual processes to ensure the firm reaches operational excellence [10]. This team is also in charge of employee training and coordinating the annual event to foster knowledge exchanges [10]. Technology and IT tools, such as a prototype platform, also seem to be used by multinational firms to coordinate their operations with their subsidiaries, to describe firm projects or suggest the best practices [10, 16].

Knowledge exchange between subsidiaries at the multinational level can be fraught with barriers. The motivation of the workers performing knowledge exchange and their absorptive capacity can affect the effectiveness of the knowledge exchange [12, 10].

However, studies on knowledge exchange in SMEs suggest that it is more than just a scaled-down model of the literature available on multinational firms [5]. Few kinds of literature are available about knowledge exchange in SMEs, which its subsidiaries also consist of SMEs. On the other hand, literature is available on favouring knowledge exchanges inside a single SME, which can be a starting point.

Knowledge exchange was highlighted to be very important and beneficial to SMEs [8]. Study shows that knowledge management, thus knowledge exchange, is directly linked to SMEs manufacturing performance [28]. SMEs employ fewer people than large firms, which can favour knowledge exchange by making them work closely together [13]. Therefore, knowledge in a manufacturing sector regrouping SMEs represents a significant asset and provides a competitive advantage [24].

A study on Malaysian SMEs showed that knowledge exchange could be largely influenced by technology, motivation, and a reward system [8]. The employee's motivation to perform knowledge exchange will directly impact the result [8]. These items need to be stable and in place to foster knowledge exchange across SMEs [8]. Up-to-date technology also plays a vital role in supporting knowledge exchange in SMEs [8]. Utilizing an intranet or networking application was considered beneficial [8]. Another study on SMEs in Italy showed that SMEs prefer using e-mail, videoconference, or an ERP to share knowledge rather than data mining or social media [5]. In Iceland, a study on two SMEs from the financial and food sector showed that SMEs could perform knowledge exchange. Using e-mail, intranet and social media can diffuse new knowledge and possible solutions to encountered problems [13]. The studied SME also planned a twice-a-week meeting to communicate actual issues and find answers [13]. The second firm studied also used social media to share knowledge and planned competitions to develop new products, which is on a voluntary basis. These competitions are linked to a reward program which can be translated into a salary increase [13].

Knowledge exchange in SMEs can seem costly. Therefore, it would be imperative for SMEs to maximize the potential outcomes of knowledge exchanges [8]. However, SMEs often lack financial and human resources, limiting knowledge exchange [8, 29, 5, 13]. Another element that can limit knowledge exchanges is the need for more training on the subject in SMEs [13]. A survey on Indian SMEs revealed several barriers to knowledge exchange: lack of high management commitment, misunderstanding of the knowledge exchange concept, lack of time to share and lack of motivation [1]. A study on Albanian SMEs identified employees' motivation, lack of top management support and recognition as knowledge exchange barriers [29]. A precise knowledge management strategy is essential to standardize the collection, dissemination and use of knowledge and to reduce the risk of losing it [13].

The literature presented above shows that achieving knowledge exchange within an SME is possible. However, it will be interesting to observe whether it is similar when several SMEs perform knowledge exchange together. Knowledge exchange has been shown to be an essential aspect of successful collaborations in SMEs [7].

2.2 Open innovation in the intra-firm context

A parallel can be drawn between knowledge exchange and open innovation. As a definition, open innovation is characterized by two types of knowledge exchanges which are outside-in and inside-out. Opening innovation processes to the external environment inputs defines outside-in flow [6]. Diffusing the knowledge developed internally, which is little or not used, and making it accessible outside the company represents the inside-out flow [6]. From its beginning, the focus of open innovation has been on large

companies. Intra-firm knowledge has been proven to provide a firm with an acceptable quantity of new knowledge [9]. Literature suggests that larger firms using open innovation with their subsidiaries remark that knowledge inflow benefits the subsidiaries [22]. In comparison, knowledge outflow helps the other subsidiaries of the group [22]. Multinational subsidiaries showed a high involvement in the different knowledge flows, from a high outflow and inflow profile to a low outflow and inflow profile [16].

SMEs have proven to be supporting more prominent firms providing products or services [7]. Recent years have shown an increased interest in using open innovation in SMEs. Obtaining knowledge from outside the company is a trend that has grown in popularity recently [9]. The frame on which SMEs are based makes them more open to external sources of knowledge [19]. Literature has shown that SMEs can benefit from open innovation, such as access to new knowledge or minimizing their new product time to market [19]. Study shows that in contrast to larger firms, SMEs practice open innovation more on the commercialization of new product [30]. A study realized on Italian SMEs shows that technology, globalization, and organizational culture are among the characteristics that favour open innovation in smaller firms [30]. On the other hand, SMEs can encounter some challenges using open innovation. Lack of financial resources, internal resistance and human resources are among them [30, 7]. A study on Belgian firms reveals that technology-intensive subsidiaries are less open to external knowledge [9]. To be effective, knowledge flows need to be supported by personal interactions [22]. Again, the literature shows that it is possible for a single SME to use open innovation. It would be interesting to observe the utilization of open innovation in a group of SMEs.

3 Context

3.1 Knowledge Capitalization Problematic

Few manufacturing companies perform knowledge management instinctively. This does not mean that there is no knowledge within the firm. Knowledge examples in manufacturing firms are multiple, manufacturing processes, and daily production notes are among them [31]. It will not be easy to diffuse knowledge if it is not integrated into the firm's processes [31]. Knowledge can refer to as intellectual capital for firms, representing an essential aspect of a firm's creativity and innovation and directly impacts its success [1]. Knowledge management also positively impacts the firm performance [1]. The knowledge of a firm depends on the people inside it [8]. Nowadays, human resources are highly volatile, which can complicate intellectual capitalization by the firm. The knowledge capitalization problem remains as long as the company does not control the knowledge held by its employees [22].

3.2 Studied Group

The studied group is a Tier 2 firm from the Quebec aerospace cluster. The group has five divisions, all located in the Quebec region. The divisions are mainly Tier 3 firms, with between 50 and 300 employees. In addition to the head office, which provides

common services such as finance and human resources, each division has its own manufacturing expertise. In the current context, the studied group has an active merger and acquisition strategy. This strategy will highlight the need for more knowledge exchanges, open innovation and collaboration between divisions. Applying these concepts would continue to add value to current and future acquisitions.

4 Methodology

Most studies have used surveys of targeted companies to collect data [8, 2, 29]. The Design Research methodology was used in this study. Acquiring knowledge through the act of experimentation is the aim of this methodology [18]. Its application consists of five distinct steps [18, 4], which are described below.

The first step is awareness of the problem, which is described as choosing a problem to solve. As shown above, knowledge capitalization is a problem in aerospace SMEs. Supporting knowledge exchange is essential to help SMEs capitalize on their knowledge. Therefore, the chosen problem is how to support knowledge exchange in a multi-division SME.

Suggesting the key elements needed to solve the problem is the second step. It was necessary to choose a technological tool to evaluate the exchange of knowledge between the group's SMEs. The use of quantitative, qualitative data and regular follow-up also seems important in drawing conclusions.

The third step, based on the available knowledge and the specific element identified in the suggestion step, is to develop a potential solution. The prototype platform was using some functionalities of Microsoft Teams. The planner feature allows the use of tiles which are called cards. These cards are used to keep track of the different knowledge exchange topics. Two criteria - role and knowledge - were used to select the participating members of each division. A meeting was held every two weeks to monitor the knowledge exchange. The agenda included the update of the collaboration criteria, the review of the cards and the blocking point to knowledge exchange.

Evaluation of the developed solution according to certain criteria is the fourth step. This step may involve iteration between the development and evaluation steps to converge on a solution. Only one kind of prototype platform was tested for this study. Data was collected over a period of three months. Quantitative data such as the number of cards, the rate of knowledge exchange and the symmetry of the collaboration were collected to evaluate the knowledge exchanges [25]. It was then collected through Microsoft Excel and analyzed with graphs and descriptive statistics. A total of 19 collaboration topics were placed on the platform by the different divisions. Of these, approximately 52% had knowledge exchange. Opportunities and barriers were the focus of the qualitative data collection. Meeting notes were gathered in Microsoft OneNote. A semi-structured interview was conducted at the end of the experiment to gather the opportunities, barriers, and managerial implications. Content analysis was used to understand data from the meeting's notes and the semi-structured interview. The interview consisted of 13 questions. The questions were grouped by topic: three questions on barriers to knowledge exchange, three questions on the impact of culture, six questions on the

impact of management and one question on the impact of technology. This study covered the knowledge exchange of a manufacturing firm and its divisions. The sample used for this study is a non-probability sample, which means that it is not representative of all populations of manufacturing multi-division firms.

The last of the five steps is the conclusion which is selecting the solution to be implemented following the development and evaluation phase. Although the chosen solution is the use of a prototype platform to promote knowledge sharing within the company, the opportunities and barriers associated with the experiment are presented below.

5 Opportunities

According to Razmerita and Nielsen [26], there are three categories to present barriers, which are individual, organizational, and technological. These categories can also be used to classify the opportunities. These opportunities are the basis for knowledge exchanges between SMEs in the same group.

In terms of individual opportunities, the introduction of a reward system seems to be a good opportunity, according to some studies [15, 8, 21, 14]. Although there was no reward system in this experiment, this addition could motivate people to share knowledge. This system could work by accumulating points or a salary increase for a certain number of knowledge exchanges. However, it is important to note that not every employee can be motivated by a reward system; in this experiment, most of the people involved simply enjoyed helping others.

As for the organizational aspect, several opportunities have emerged as a result of the experiment. Including knowledge exchange in the group processes, such as project management or inter-division project postmortem, represents some opportunities [28]. Building on the studies carried out by Demeter and Losonci and Meyer, Li and Schotter [10, 22], exchanging resources between divisions is a good opportunity. Instead, unlike multinationals, where the exchange period is mostly in years [10], the period should be adapted to SMEs and perhaps reduced to a few months. The introduction of a knowledge exchange program is another opportunity. This program could include periodic meetings between the division to exchange knowledge and resource to spread best practices among the group [10]. This experiment demonstrated the value of appointing one person to foster knowledge exchanges across the divisions [21]. This leader will need specific soft and hard skills, such as being a good communicator and having a good ability to synthesize. Finally, this person will need to act as a bridge between the divisions to favour knowledge exchanges and open innovation across the group. Having an adequate corporate structure also seems to be an opportunity. This corporate structure would favour knowledge exchanges among divisions, as this task could also be included in the job descriptions of certain employees. These opportunities could improve knowledge exchanges, communication between divisions and innovation.

Creating communities seems to be a starting point for technological opportunities. Setting up a community around a specific topic can favour knowledge exchanges between the divisions [23]. Once again, appointing a community leader seems unavoidable. Several studies suggest implementing adequate IT tools to favour knowledge exchange [31, 13, 10, 3]. An IT tool such as a prototype platform seems appropriate to foster knowledge exchange across the divisions. A prototype platform where ideas and topics are documented and then easily accessible would benefit SMEs in exchanging knowledge.

The number of collaboration topics placed on the prototype platform per week during the experiment is shown in Figure **Fig. *1***. The trending line shows an increasing number of collaboration topics every two weeks, and this corresponds with the timing of the meetings. Most of the knowledge exchange and use of the prototype platform took place during these meetings. The project leader organized these meetings, highlighting the importance of appointing a knowledge management leader or community manager to facilitate more knowledge exchanges. As mentioned in section 4, for the 19 collaborative topics placed on the prototype platform, the knowledge exchange rate during this experiment was 52%. While the current outcome may not seem very impressive, it's worth considering that as individuals continue to interact and meet more frequently, there will likely be a greater exchange of knowledge.

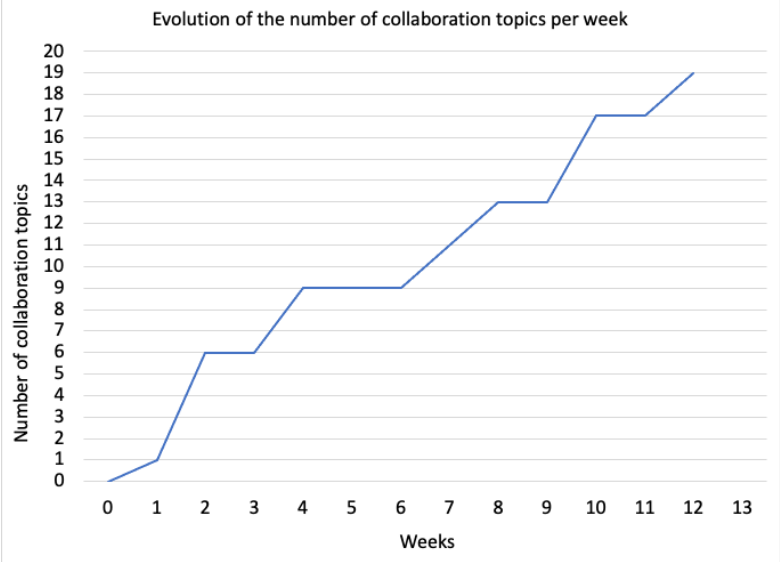

Fig. 1. Evolution of the number of collaboration topics per week

After the experiment, and based on the work of Sokoh and al, a roadmap to support knowledge exchange in a group of SMEs can be suggested [27].

1. Executive management decides to prioritize knowledge management.
2. Appoint a knowledge management leader to develop a knowledge exchange strategy, including the critical knowledge which needs to be shared.
3. Create a knowledge committee with members from each division.
4. Set up appropriate IT tools, such as an intranet and social media.
5. Create a reward and knowledge exchange program.
6. Monitor knowledge exchanges and calculate the benefits.

The knowledge exchange efficiency will depend on how well the knowledge management leader is supported by other departments, such as IT, human resource management and executive management. Management will have to allow time for their employees to perform knowledge exchange, and on their side, employees will have to be motivated and enjoy performing knowledge exchanges [15]. They also need to be trained to ensure an effective knowledge exchange.

6 Barriers

As described above, according to Razmerita and Nielsen [26], it is possible to classify barriers into three categories which are individual, organizational, and technological. These categories will be used here to develop the barriers that are encountered in the monitoring of the knowledge exchange between a group of SMEs.

Starting with the individual aspect, the first barrier to be revealed by this study was the different vocabulary used by the divisions, which was also identified by Meyer and al. [22]. Although the employees have been working for the same firm for several years and spoke the same language, this project found differences at the technical level such as manufacturing methods, specific tool names or process equipments. This project also revealed differences in administrative and technological vocabulary. In the long term, it might be good to standardize the vocabulary used to describe a concept or an object. By introducing a standardized vocabulary, communication between employees will be enhanced, and therefore knowledge exchange will be more valuable. Several studies have shown that the lack of time allocated to the resources for knowledge exchanges is a significant barrier [20, 12, 26, 27]. One of the five divisions was unable to attend most of the meetings, limiting its knowledge exchange benefits. One person from each division was appointed to the project team for this project. However, knowledge exchange and open innovation are not a single-person job. Knowledge exchange is limited by the absorptive capacity of the people involved [20, 12, 22]. In order to be efficient and add value to the group of SMEs, knowledge exchanges and open innovation have to be performed by every employee level, from the shop floor to the executive management. Sometimes, workers don't know what exactly knowledge exchange and open innovation are. On certain occasions, they do it without being aware of it. Providing training on these two concepts to every new hire employee could be an excellent solution to

train employees and promote a knowledge exchange culture across the divisions. Emphasizing on employees performing knowledge exchanges to continuously create and apply new knowledge is key [11].

The corporate structure does not favour knowledge exchange and open innovation and represents an organizational barrier. This project shows that the opportunities for knowledge exchanges among the divisions are many and varied. As mentioned earlier, appointing a leader to promote and monitor knowledge exchange across the division is essential. Compared to multinational companies where a team of up to 30 employees is dedicated to knowledge management [10], this number needs to be reduced to be effective for SMEs. Selecting one leader and creating a committee of employees would appear more appropriate to begin with. The group culture needs to change to promote more knowledge exchange among people. All levels of management need to be involved in the knowledge exchange process, allocate time and resources to knowledge exchange and communicate a clear vision of knowledge management [1, 21, 17]. Holding conferences within SMEs on a specific topic, such as manufacturing methods or inspection processes, also seems to be a solution to the corporate structure [10].

In a digital era, the project team felt the technological tools available were sufficient to promote knowledge exchanges. A planner in Microsoft Teams was used for this project which seemed to be an inhibitor of knowledge exchange. There is probably a better tool to perform knowledge exchange and open innovation. However, the barrier remains in deploying the available tools to favour knowledge exchange. In addition, there is often a lack of training on the tools used, which limits the knowledge exchange across the divisions.

7 Conclusion

This paper aimed to identify opportunities and barriers to support knowledge exchange in a multi-division firm by using a prototype platform. Data was gathered from a group of five SMEs, all from the Quebec aerospace cluster. The opportunities reside in making knowledge exchange a priority for the firm and appointing a knowledge management leader. Allowing time for employees to perform knowledge exchange and using adequate technological tools are also opportunities. The main barriers are the vocabulary used by employees and the lack of training in knowledge management.

Regarding the limitations, the size of the group studied and its sector can reduce the generality of opportunities and barriers. The external environment, such as the group's region, might also limit the findings. Conducting this study in Europe or Asia, for example, might have led to possible different conclusions. The research approach used also limits the findings, using a survey to collect data on SMEs would probably have revealed different opportunities and barriers.

In terms of future perspectives, developing a model to evaluate the benefits of implementing a knowledge management system in SMEs seems appropriate. Observing how it is possible to support collaboration in another industrial sector that is clustering SMEs or using another platform to support knowledge exchange are other future perspectives.

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