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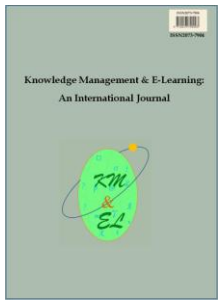

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Challenges of knowledge integration in small and medium enterprises

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Abstract: This study attempts to develop a better understanding of the challenges of knowledge integration (KI) within the innovation process in Small and Medium Enterprises (SMEs). Using several case studies, this study investigates how knowledge integration may be managed within the context of innovation in SMEs. The research places particular focus on identifying the challenges of knowledge integration in SMEs in relation to three aspects of knowledge integration activities, namely knowledge identification, knowledge acquisition, and knowledge sharing. Four distinct tasks emerged in the knowledge integration process, namely team building capability, capturing tacit knowledge, role of knowledge management (KM) systems, and technological systemic integration. The paper suggests that managing knowledge integration in SMEs can be best managed by focusing on these four tasks, which in turn will lead to innovation.

Keywords: Knowledge integration; Knowledge acquisition; SMEs; Knowledge sharing; Knowledge identification

Biographical notes: Kavoos Mohannak is a senior lecturer at the School of Management, QUT Business School at the Queensland University of Technology. Currently he teaches courses on entrepreneurship, technology and innovation management. His research focuses on management of innovation and knowledge in SMEs as well as large enterprises. He also has conducted research on cultural aspects of knowledge management.

1. Introduction

Knowledge integration (KI) is one of the major aspects driving innovation in organizations. Innovative organizations are recognized as having well managed processes for innovation and knowledge integration. Some recent studies have emphasized that internal and external knowledge integration explains performance differences in the pursuit of distinct capabilities (Nassim, 2009; Verona & Ravasi, 2003; Zucker, Darby, Furner, Liu, & Ma, 2007). These studies aim to explain changes in the acquisition and distribution of knowledge over time and the effects of those changes on organization performance, particularly on the innovation activities of the firms. One of the roles that knowledge integration plays in the innovation process is integrating various knowledge activities in the innovation lifecycle, across the phases of creating, gathering, sharing, and leveraging knowledge.

This paper aims to explore the challenges of knowledge integration within the innovation process, focusing on three aspects of knowledge management activities including knowledge identification, acquisitions, and sharing within SMEs. In considering the role of knowledge integration in the process of innovation, several authors (Andreu & Sieber, 2005; Huang & Newell, 2003; Mohannak, 2011) have emphasized different levels of knowledge dissemination, focusing on individuals to groups to the whole organization. In this context, this paper focuses on three stages of knowledge management (KM) processes that are linked to organizational learning and innovation process (Kraaijenbrink, Wijnhoven, & Groen, 2007). The first stage is identifying the knowledge gap where the required specialized knowledge is identified. The second stage is knowledge acquisition where knowledge is sourced from both internal and external sources. The third stage is knowledge sharing and distribution where knowledge is distributed and is used for the benefit of the organization in a process of social interchange. The paper argues that four tasks of knowledge integration, namely team building capability, capturing tacit knowledge, role of KM systems, and technological systemic integration, influence these aspects of knowledge management process which in turn affect the innovation capability.

In what follows, firstly the previous research that shapes the theoretical foundations of this study has been outlined briefly. Secondly, based on the theoretical discussions, the challenges of knowledge integration have been examined by providing evidence from four Australian SMEs. Finally, some lessons have been drawn which may provide useful guidelines for managing and integrating knowledge within innovation process in SMEs.

2. Theoretical framework

Knowledge integration in firms has received considerable attention in recent research (see, for instance, Hung, Kao, & Chu, 2008; Kleinsmann, Buijs, & Valkenburg, 2010; Mitchell, 2006; Ozman, 2006). In particular, the research has highlighted the pivotal role of knowledge integration in creating and sustaining firms' innovative and competitive advantage. From the perspective of the knowledge-based theory of the firm, the main problem lies in assuring the most effective integration of individuals' specialized knowledge at the lowest attainable cost (Grandori, 2001; Grant, 1996). A central claim of the knowledge-based theory of the firm is that organizational capabilities depend not only on specialized knowledge held by individuals, but also on an organization's ability to integrate that specialized knowledge. The knowledge-based theory thus extends existing theory on organizational differentiation and integration to include the differentiation and integration of knowledge. Stemming from the need for differentiation and integration, the theory of knowledge integration emphasizes the economic value of specialization and the effectiveness of integration. In other words, competitiveness depends on the diversity and strategic value of specialized knowledge, as well as an organization's capacity to integrate the knowledge in an effective manner. Grant (1996) describes the integration of individuals' specialized knowledge to create value as a key capability.

Following knowledge-based theory of firm, Alavi and Tiwana (2002) have defined knowledge integration as a synthesis of individuals' specialized knowledge into situation-specific systemic knowledge. This definition is based on the fact that the specialization of individual organizational members turns organizations into distributed knowledge systems in which the range of knowledge that is required for production or innovation is dispersed over all organizational members. As a consequence,

organizational members have to integrate dispersed bits of specialized knowledge held by individuals, i.e., to apply this dispersed knowledge in a coordinated way. In this sense, knowledge integration is essentially a matter of organization, and the ability to create and exploit useful combinations is critical for firms.

Another definition is given by Huang and Newell (2003, p. 167). Their definition of knowledge integration is "an ongoing collective process of constructing, articulating and redefining shared beliefs through the social interaction of organizational members". In fact, the emphasis on the need for communication and shared knowledge which is to be found in much product development literature is reflected in this definition. This is to say that new product development team members must be able to communicate in a manner that is meaningful. Moreover, they must be able to create new knowledge. In this way, the outcome of knowledge integration consists of "both the shared knowledge of individuals and the combined knowledge that emerges from their interaction" (Okhuysen & Eisenhardt, 2002, p. 371).

However, as emphasized by Huang and Newell (2003), it is crucial to recognize that cross-functional knowledge integration within the context of a project team is not limited to a focus on the dynamics occurring within the team boundary. It is equally vital to understand the dynamics of knowledge integration beyond the team boundary, in particular in relation to knowledge integration within or outside the firm and with all stakeholder groups. In this view, knowledge creation, sharing, and transfer constitute important components of knowledge integration. Kraaijenbrink, Wijnhoven, and Groen (2007) also look at the knowledge integration in high-tech manufacturing SMEs, and defined knowledge integration as the process of identification, acquisition, and utilization of knowledge from external sources for the new product development process within an SME, which is potentially supported by and interacting with information systems.

It is, therefore, through the internal development or external acquisition that an organization is able to get both the range and the quality of expertise, which is required for complex production and innovation processes (Cantner, Joel, & Schmidt, 2011). Project teams, for example, generate knowledge internally and often seek knowledge from external sources. Team members must combine their complementary yet separately held knowledge into a new knowledge set. In order for a project team to be productive, they must have a deep knowledge of their own disciplines and an appreciation for the relevance and importance of their teammates' knowledge (Yang, 2005). All this external and internal knowledge must be integrated into team responses. New product development and innovation require the use of a multitude of skills and expertise, as well as the accumulated knowledge of the organization in order to maximize the performance of the new product. The integration of all this accumulated knowledge into the business processes used by these skilled and experienced employees has great potential to improve the new products themselves. It has been suggested that it is the degree of integration of dispersed and distributed knowledge that helps explain differences in the product development performance of different firms, and that it is the effectiveness of a firm's knowledge integration that distinguishes it from its competitors (Yang, 2005).

Hence, building on the existing literature, in this paper three main aspects of knowledge integration activities, namely knowledge identification, knowledge acquisition, and knowledge sharing, have been investigated, and knowledge integration is defined as all activities by which an organization identifies and utilizes internal and external knowledge, including creating, transferring, sharing, and maintaining information and knowledge.

3. Challenges of knowledge integration

For the purpose of this study, a multiple case study method was employed, since it would allow the authors to document in some depth the challenges of the knowledge integration experiences of the small and medium sized firms. Four SMEs from IT, biotechnology, nanotechnology, and biochemistry industry were selected to represent different sectors of knowledge activity. All the cases were knowledge intensive SMEs where their specialized knowledge plays a critical role in their competitiveness and innovation process (See Table 1). Semi-structured interviews with managers and company published data were used to collect case data, with an interview guide to ensure uniform coverage of the research themes. The questions were framed to gather data around knowledge management activity within the business, focusing on the identification, acquisition, and utilization of knowledge, but collecting a range of information about the subjects as well. The focus of the case studies was on the use of external and internal knowledge to support their knowledge intensive products and services.

Table 1
Context of study and summary of cases

Firm A: This firm is an IT firm engaged in research and development in information systems and automation engineering, with a mission that emphasizes the commercial application of technology, innovative engineering, and design. The firm in its present form was formed in 2003 with around 30 staff, although the parent company originally started in 1993. The firm has consistently expanded production and financial goals over the last couple of years, winning a number of innovation awards.
Firm B: This is a nano-technology firm that started about ten years ago and currently has about 30 employees. The firm has invested nearly $150 million on research but as yet has no commercial product in the market. The strategic goal of the firm is to get a commercial deal in place as quickly as possible. The unique knowledge of the firm is the production process used to produce nano-scale complex metal oxides for various diverse applications. The firm holds a portfolio of patents including a worldwide patent for its unique production process.
Firm C: This firm is a commercial biotech laboratory that offers a range of chemical and microbiological testing across food, agricultural, and environmental sectors utilizing leading edge technology. The firm commenced in 1997 and currently has 65 employees. The firm also provides specialized training services and sells knowledge. The company's goal is to maintain a growth rate of 20% per annum, with an ongoing R&D program as part of their overall provision of their services, and has developed sophisticated databases.
Firm D: This firm provides health-care solutions and products based on the science of cell biochemistry. The firm began in 2006 and presently has five employees. The firm is planning to position themselves not only as a supplier of unique ingredients, but also to develop formulations for new products, applying their very specialized knowledge in the area of nutritional biochemistry. As a true small technopreneurial firm, only a couple of people drive all business processes within the firm.

3.1. Identifying the knowledge gap

Knowledge identification and technology selection are the steps by which the knowledge gap is identified and recognized for the benefit of solving problems in the new product

development process. The knowledge gap created by facing new challenges in the creation of something new requires radically new solutions and the acquisition of new knowledge. It may be necessary for firms to explore knowledge from different sources. SMEs are likely to source the knowledge from internal or external sources. For example, after identifying the knowledge gap, various knowledge sources will be identified and subsequently the information will be evaluated. If the knowledge is found to be critical, it will be acquired either from external sources or will be developed internally. Knowledge that is being created from inside the firm is more likely to be transferred easily within the firm compared with knowledge which is sourced externally. In studying the issues associated with identifying the knowledge gap, the research focused on a few specific questions. For example, questions were asked such as, "Do you determine what knowledge the firm has internally?" "How do you identify the knowledge gap in your company?"

A strong participative style of company interaction was found to be important in the process. All case companies took a very informal approach to identifying the knowledge gap. However, they took a very proactive approach to evaluating the required knowledge through more established routines or systems. Identifying knowledge gap and what knowledge the firm has internally is the first step in managing knowledge process. Several indirect processes have also been used to identify the knowledge gap within the firm such as performance appraisals, brainstorming, et cetera. As expressed by one of the interviewees, firms exercise a number of these indirect methods:

> *Performance appraisals, we do every six months, a. because it is good practice and b. because we have a pretty tight quality control and quality management system which means we have to. Performance meetings, we have quite a few of, our project teams all meet every Tuesday, Management meets on Mondays, Sales meets on Wednesday and we do that consistently and we take notes on those. The visiting exhibitions are something that we do quite regularly, although it is something that we could more at an engineering level I suppose. Brainstorm sessions, we certainly do that on a project basis, we could do that more on a broader basis if you like, on a whole level of staff basis. We have spoken about ways of getting brainstorm type information from our team, because you know they see and encounter much more in the field than any of us ever will, but that is something we could work harder at.*

It is found that even if employees had access to required technical and market information, there was still a need to have strong support systems in place. When these systems fail, information is lost along the innovation process and the integration of knowledge into product development process stalls. As expressed by one of the interviewees, the systems and tools are important components of the knowledge management process:

> *In terms of running a company there are a lot of things you have to do, especially in a small technology based company, my experience is, this is probably my eighth start up technology company with no exception, you always get caught out in terms of traceability and change control, so there are a lot of systems put in place that I have put in place, to ensure that you don't get caught out in those two areas, so that knowledge if you like is captured and controlled in a way, to ensure that mistakes don't happen, so it is not all just floating around in people's heads, there are systems and procedures as well in the important areas.*

Overall, the specific nature and context of specialized knowledge appears to be different, depending on the stage of the innovation process. During the early stages, for example, there seems to be emphasis on tacit and technological knowledge. However, in the later commercialization stages, the emphasis will be put on market and explicit knowledge that is more formal and administrative in nature. One of the interviewees commented on how his firm identifies what knowledge gap they have in various stages of product development:

> *... just by identifying that we don't have either, a. the resources, or b. the skills to complete what is happening, so it will generally come from a meeting where we discuss that we have these things coming up, how are we going to achieve them. That is where we start trying to identify gaps and holes.*

As discussed, the first activity involved in the KM process is that organizations should identify the knowledge they own themselves, namely the core knowledge of competitive advantage and knowledge gaps. It seems that although these small firms exercise indirect methods such as performance appraisal, brainstorming, management meetings, or other similar processes, they are not using more systematic and technical KM tools such as knowledge audit, knowledge maps, knowledge topographies, knowledge assets, geographical information systems, knowledge source maps, knowledge matrices, and intranet, which can all facilitate knowledge identification (Probst, Raub, & Romhardt, 2000). It was found that none of these methods were used in the case companies, and mostly the firms relied on ad hoc and informal methods. Informal processes included working collaboratively to share and build knowledge. This was emphasized by one of the interviewees:

> *Probably that is done more ad hoc if you like, we are not a particularly big team, we know who is well skilled in what. We do have, and again it is informal, but we do have practices in place where we will try to have you know, he should work with him because he is really skilled in this area, but we need to have more people skilled in this area.*

As these firms relied on their technical staff for identifying knowledge gap, the main system for managing this was through management meetings. The senior management in all case study firms had a significant role in identifying potential new areas for innovation and the decision to respond to these. All directors interviewed relied heavily on their personal networks to assess market trends, to confirm or test the results of formal market surveys or other sources of market data, and to find people to deliver services when these were not available inside the firm.

3.2. Knowledge acquisition and development

Knowledge acquisition and development are the processes by which knowledge from different sources is transferred and developed within the firm. The firm should make conscious efforts to sense, search, and define relevant knowledge and its sources. Because not all knowledge is relevant, identifying and acquiring relevant knowledge is a critical step. The firm may have to develop special protocols, processes, and systems to acquire knowledge. Acquisition can take several forms, ranging from a document transfer to interactive cooperation. Based on the knowledge carrier, Kraaijenbrink (2006) has distinguished different types of knowledge acquisition including knowledge that can reside in actors, activities, information technology, and non-information technology, and in combinations of these. This recognition of the types of knowledge suggests that some

knowledge can be acquired by moving one or more of these carriers across organizational borders. In terms of the methods of the acquisition, one of the interviewees expressed:

> *Well it could be in a number of different ways, it could well be that we decide somebody needs training … it could be as I said that we hire an external resource. It could be a contractor/specialist in that area, it could well be that we use documentation … look up documentation of previous procedures, it could be a combination of those things and it may well be that we gain access to an external resource, get them to document what we need and then use that as a tool as well.*

Compared to knowledge identification, knowledge acquisition activities differ in a number of ways. The main difference is the degree to which knowledge acquisition is considered an interactive process between sources and recipient. For example, in the case of hiring new staff, knowledge is transferred by moving the carrier to the recipient without much interactivity. On the other hand, in the case of knowledge acquisition by cooperation, knowledge is acquired by much interaction between parties. The cases indicated that they use both interactive and non-interactive methods for acquisition:

> *We do collaborate with different universities, mainly in terms of ongoing research and development and in optimizing the product, so yes from that perspective if you look at the external we are actually, collaboration is the wrong word, but we are interacting very closely with several global companies in the US, China, and Japan and Korea.*

However, in most cases, knowledge acquisition occurred through hiring a new staff with required expertise or in-house training:

> *In some instances when you bring something on new you employ someone who has got expertise in that area, or alternatively you might make a decision that your existing staff can be trained to utilize that, it depends how quickly you want to get to the end result I suppose.*

During interviews, it also became obvious that companies were outsourcing services for different reasons.

We use a range of organizations and consultants to outsource … Specific knowledge that we need, we just outsource to get it.

Interviewees indicated that the reasons for outsourcing services varied and included the need to access particular skills not available in-house on a one-off basis, or the need to access complementary skills on a longer term basis. Overall, it seems that the main reasons that these technology firms outsourced services was lack of internal capacity and a complementary need to obtain particular skills for their ongoing operations and innovation. Also, in most cases, the firms retained the knowledge imparted by the service provider in the form of a design or a report. Where it was important for staff to absorb the learning external service providers provided notes or trained staff directly. Most firms said that they would prefer to employ staff but they could not justify the expenditure in a small firm when the need for the service fluctuated, and they wanted to obtain people who had knowledge of the wider industry and best practice.

It is also observed from case studies that the amount of external knowledge a technology firm will obtain depends on a number of factors. These factors include aspects of social capital in the relationship and level of social interaction between the firms, particularly the quality of the relationship in terms of goodwill trust and reciprocity, and the level of network ties created through the relationship. The importance of the

networking and social interaction and the quality of their relationships with customers was emphasized by several interviewees. For example, one interviewee commented that:

> *We are continually on the outlook working with our clients to say what more do they require, and then we will feed that into the lab for them to then go about deciding how they are going to deliver on those methods required by the tests.*

On the whole, these SMEs indicated that external knowledge sources are crucial to their innovation process. Even organizations that are in totally different industries can be fruitful sources of ideas and catalysts for innovation. Technology firms obtain knowledge on the external knowledge market, for example, external experts, other firms, stakeholders, and knowledge products. From the perspective of individual knowledge, companies have used recruiting employees on long-term commitments, or hired external experts and used their expertise for a short time.

From the case studies, it has become evident that the acquisition of knowledge and its embodiment in the organization may have a positive impact on the innovation process and new product/service development process. More specifically, the effective management and acquisition of knowledge linked to the innovation process may result in a point of differentiation and uniqueness which may lead to sustainable competitive advantage to the firm. It was found that all the firms studied were actively modifying and growing their products and services to meet changing customer demand, and to take advantage of new ideas and technologies which would enable them to deliver a more consistent service or to do so at a lower cost.

3.3. Knowledge utilization and sharing

Regarding knowledge utilization, organizations need confirmation that knowledge is used efficiently and effectively, and is not misused or abused. Psychological impediments to using new knowledge result from overconfidence or fear of losing one's specialist position (Probst, Raub, & Romhardt, 2000). Organizations should thus establish a culture of encouraging knowledge by employees. User-friendly information systems are necessary for knowledge utilization. A user-friendly system requires simplicity, good timing, and compatibility (Probst, Raub, & Romhardt, 2000). Numerous firms have developed valuable intellectual capital, yet they have not accurately valued them and thus fail to exploit them; meanwhile, such firms always waste resources on developing intellectual capital, which they already own (Davenport, Thomas, & Desouza, 2003; Torres, 1999). Consequently, commercializing or reusing intellectual capital is an important component of KM. In terms of the importance placed on IT systems for this purpose, the interviewees reinforced this strongly:

> *It is all through our, you know we maintain a central server, we have two full time IT employees, two and a half, I would say, personnel that are dedicated to maintaining our system. Wherever we can we try to get things electronically, we still can't get away without paper, but virtually all of our employees have access to, there is password protection at various levels to what they can access in terms of information on our server, and that then becomes their daily tool that they use.*

It is clear that the utilization of knowledge is also a knowledge activity that rests largely on the company culture. The utilization of knowledge should chiefly be stimulated and motivated by the management. A crucial aspect within knowledge

utilization is sharing the available knowledge between employees mutually, between employees and managers, between departments, et cetera. It is important that the correct knowledge gets to the right person at the right time. Knowledge sharing is primarily a knowledge stream that is dependent on the culture of the organization. One can share knowledge by making project or fact sheets, job rotation, internal secondment, and lunchtime meetings. The importance of both formal and informal communication links is well documented in the literature. For example, Nonaka (1994) describes innovation as an information creation process that arises out of social interaction. Our study shows that the informal system is very important for these firms. As one manager commented:

> *We are quite keen to encourage activities outside of the workplace as well, I mean we have quite a few social evenings where we encourage the guys to do things together at lunchtime and we have our little lunch learning meetings, they are less formal environments, but they still allow the guys to talk about and share ideas.*

It was evident from the responses of our interviewees that most firms realized the strategic value of smooth and effective distribution of knowledge between all the relevant employees. However, they were not taking steps to alleviate the potential disruptive effects of dysfunctional communication systems. However, one of the managers came up with a new initiative to ensure smooth and effective transfer of knowledge:

> *I've already started taking some initial steps to ensure that we do communicate properly, we have communication type meetings with all staff, we also regularly do research and development type meetings with all staff, so it is quite interesting in how you grow companies, you do it through these steps at different times, you've got goals where different types of approach are necessary and you will find that different types of people are necessary for different stages in the growth.*

Hence the findings indicated that effective sharing of knowledge has a large impact on the efficacy of commercialization process. Another aspect of the commercialization and management of specialized knowledge that was emphasized by the managers was the effective management of intellectual property and protection of new knowledge. One of the participants point to the importance of the electronic management of IP assets:

> *In terms of the information that we have, we obviously have a significant amount of IP that we have developed over the years which is contained within our in-house methods and that is all maintained electronically.*

In fact, managing intellectual capital and intangible assets is one of the key activities in managing specialized knowledge in technology firms. There seemed to be a fine balance between the provision of a relatively flexible system to encourage the acquisition of knowledge to initiate creative thinking in the initial stages and a more rigid, defined, and controlled group structure in the later stages where tacit knowledge was converted to more explicit knowledge which constitutes valuable intellectual property for the firm. The mismanagement of intellectual property is often the main hurdle for the successful implementation and exploitation of specialized knowledge. It appears that in some cases, project leaders had overlooked the importance of the management of intellectual property and management of knowledge transfer that often needs protection. It seems that management of intellectual property is a deficiency, especially at the early stages of the projects when there is a lack of understanding of what might be necessary to protect the value of knowledge.

In short, the findings with regard to knowledge identification, knowledge acquisition, and knowledge sharing show that the knowledge integration process in these SMEs is mainly project specific and based on ad hoc and informal processes. Conceivably, these firms fail to understand the importance of knowledge management support systems and tools that facilitate the knowledge process. The common thread is the effective management of creating new knowledge or combining the existing knowledge into their innovation process. However, the managers appreciate that the innovation process can be complex, and addressing the transformation and integration of knowledge associated with the innovation process can facilitate the new product or service development process.

4. Managing knowledge integration in SMEs

As emphasized before, integration capability plays an important role in acquiring and exploiting the knowledge from internal and external sources. This paper argues that knowledge integration can be characterized as having a multi-layered structure with an external (i.e., outside the firm) or internal (i.e., within the firm) orientation. Furthermore, this study emphasizes that in SMEs, the extent of the individual specialized knowledge, team-building capability, social networks, and internal/external organizational climate affect capability, which in turn will affect the creation of new products and services.

Therefore, this paper suggests that the process of integrating knowledge in SMEs is comprised of various activities that are involved in the identification, selection, acquisition, development, exploitation, and protection of technologies. These activities are needed to maintain a stream of products and services to the market. In fact, SMEs deal with all aspects of integrating technological issues into business decision-making and innovation processes. Furthermore, it should be emphasized that knowledge integration is a multifunctional field, requiring inputs from both commercial and technical functions in the firm. Therefore, effective knowledge integration requires establishing connections and appropriate knowledge flows between core business processes and between commercial and technological requirements in the firm.

Hence, this study suggests that organizational mechanisms for effective knowledge integration should address four tasks: 1) team-building capability; 2) integration of individual specialized knowledge that are sources of technical and commercial information; 3) knowledge integration through communication networks within and outside the organization; and 4) technology/knowledge systemic integration (see Fig. 1). These tasks are elaborated below.

4.1. Innovation process and teambuilding capability

From the case studies, it became clear that knowledge integration was not organized as a separate or formalized process at these firms, but that the firms perform it as part of the innovation process without explicitly developing a strategy for it. Innovation process is a dynamic and continuous process of adaptation to changes in the environment. The key elements of this effort are development teams, facing challenges collectively, and a commitment to continuous learning. In these small and medium-sized firms, project teams are assigned to pursue strategic products or process development goals. These teams are perhaps the most important mechanism for knowledge integration. As emphasized in the literature (Enberg, Lindkvist, & Tell, 2006; Okhuysen & Eisenhardt, 2002) and demonstrated by the case studies, teams provide a viable mechanism for the

integration of knowledge for complex, and especially for non-routine organizational, tasks, especially when task uncertainty, novelty, and complexity preclude the use of existing routines or directives.

Through a team structure, diverse knowledge and the expertise of individuals at various locations can be assembled, integrated, and applied to the task at hand. Rich communication, collaboration, and creative solution characterize knowledge integration in teams. Small technology firms rely on distributed organizational knowledge using team structures that facilitate innovation. By encompassing diverse sources of specialized knowledge, teams enhance their ability to innovate. In situations where much tacit knowledge is used for innovation, collaboration between team members is essential. Such interactions produce the routines that create new knowledge and solutions. However, the

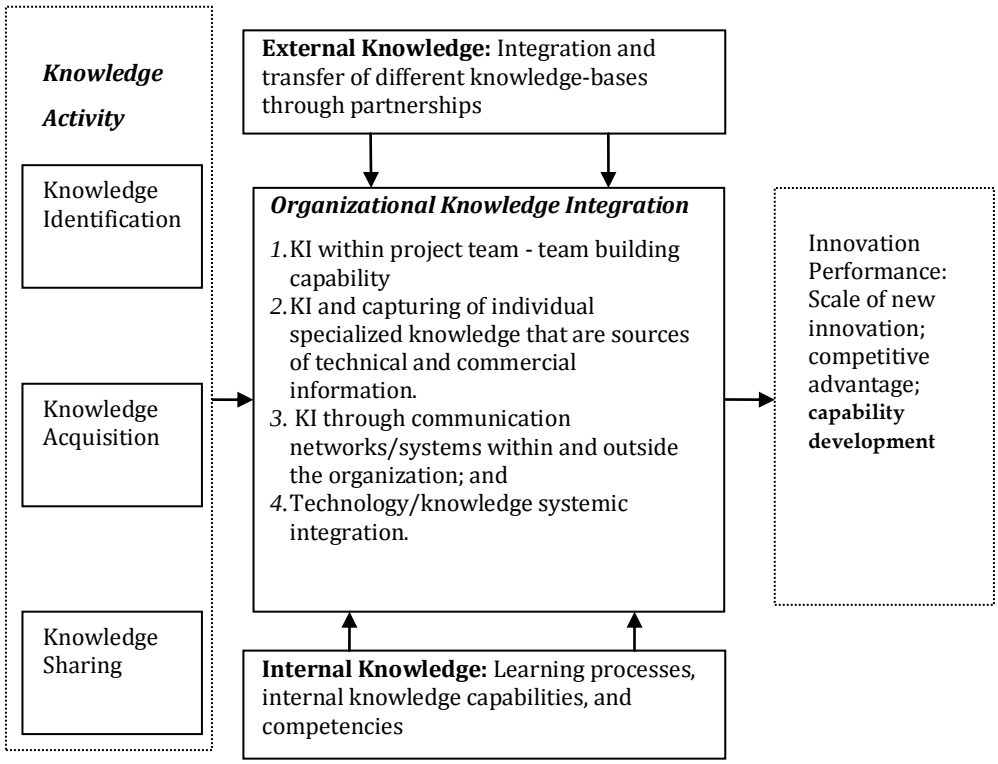

Fig. 1. The relationship between knowledge activity and integration.

new knowledge is not necessarily codified, but often stays within the innovation and operational teams' routines and skills. Knowledge integration can assist in the accessibility of such tacit knowledge and the codification thereof.

Generally, a new product or process development team may consist of fixed members who usually are assigned by management and given the task of creating

something new and innovating. The success of the team is related to the level of R&D and marketing integration as well (sharing of information, working together on specific new product development tasks, organizational structure, attitudes). In SMEs, as with large organizations, methods of organizing team activity are influenced by culture, which accomplishes the necessary factors. In the successful projects, knowledge integration is based on shared commitment and the ability to work well with fellow project members, and is reinforced through participative decision making and effective relationships between marketing and R&D activity.

At small firms, employee participation in new product or service development should be high, as is expected in a participative decision-making. R&D and marketing aspects should also be involved and integrated in the process. Innovation process is one of the most knowledge intensive processes in business and is itself constantly creating new knowledge (Jensen, Johnson, Lorenz, & Lundvall, 2007). Technology and knowledge should be transferred to other team members or subsequent projects and become institutionalized over time. Personnel can be rotated as well. Successful projects should be studied and copied by others in the company. At small firms, innovation relies heavily on collaboration within teams: the question of how such knowledge, which to a large extent is tacit, should best be captured, managed, and disseminated is crucial. This will be further elaborated in the following section.

4.2. Capturing and utilizing tacit knowledge

One of the major roles of knowledge integration in innovation is enabling the sharing and codification of tacit knowledge. Capturing and sharing tacit knowledge is critical for organizations' innovation capability. As emphasized in the literature and demonstrated by case studies, a prerequisite for effective knowledge integration is knowing who has the required knowledge and expertise, where the knowledge and expertise are located, and where they are needed (Lang, 2004). Furthermore, as mentioned before, effective teamwork (in both virtual and face-to-face settings) requires an emergent process of rich exchanges and joint problem-solving to integrate and apply knowledge and expertise to the task at hand in a coordinated manner. Thus integration of individual knowledge and knowledge sharing has become an important strategy for capturing technical and commercial experience.

A number of ethnographic workplace studies show that the intelligence employed in everyday work practice is crucial to accomplish work. However, it is difficult to share such intangible, invisible, and situated knowledge of workers as organizational knowledge. In SMEs, in addition to common codification and KM systems, organizational learning methods and "personalization" methods that extract organizational knowledge from individual workers' experiences should be put into practice. This method enables the conversion of tacit knowledge to explicit knowledge. It also enables the transfer of the knowledge generated by individual workers' experiences to members who have not experienced the event.

As argued previously, transformation of tacit knowledge to explicit knowledge is through a process of acquisition, embodiment, and transfer. The creation of broad- based explicit knowledge may then have innovative attributes which are difficult to imitate by other companies, and therefore provide a competitive advantage for the firm. If an organization wants to benefit from the fruits of explicit knowledge, more effective and efficient acquisition, distribution, retention, and transfer of tacit knowledge would be required. There is convincing evidence that the acquisition of tacit knowledge and its

embodiment in the organization may have a positive impact on the innovation process and new product/service development process. From the perspective of acquisition of individual knowledge and its transformation to explicit knowledge, this is more challenging when SMEs recruit new employees, or hire external experts and use their expertise for a short time.

This study shows that the informal system is very important for SMEs to capture individual knowledge, transfer it, and ultimately transform it into explicit knowledge. This process should be supported by KM support systems.

4.3. KM support systems

It seems that in the case of SMEs in general, and technology firms in particular, we must look at more practical considerations in managing and integrating specialized knowledge. In these firms, intellectual capital can be too diverse, too complex and too heavily dependent on individuals and communities who may not behave rationally. Moreover, technological know-how constitutes the competitive advantage of the technology firms. Most firms wish to maintain control over how their know-how is used, and in this regard, firms should efficiently control and manage their technology via an excellent KM system in which both internal and external sources of knowledge are managed effectively.

In this relation, technology-based firms need to promote efficient on-site activities to improve communication and information sharing among innovation activities during a new product or service development project. Larger companies have been promoting in-house use of communication networks and knowledge management support systems and have developed several tools for their in-house use (Mohannak, 2011). By applying similar tools, SMEs would also be able to promote the use of KM systems throughout their entire innovation process. In this way, they should be able to accumulate, integrate, and utilize various types of expertise and know-how generated during innovation activities.

Hence, by applying knowledge management concepts to innovation activities, SMEs would be able to foster the practice of real-time management by visualization and knowledge integration. Daily communication between managers and project members is an important activity in many large or medium-scale projects. In effective KM support systems, this communication is supported through communication-based project management tools in which daily reports from members can be captured and used to create information for status management and quality management and to share these reports among each member. For example, in innovation projects involving multiple contractors, all reports related to quality management can be issued within the system, and by analyzing the project progress and taking measures within each development phase, critical problems may be prevented. In short-term projects, KM systems also can be used for communication among members, where the members mutually check the deliverables stored on the system every day. As a result, there would be little need for rework in the project.

Knowledge integration via knowledge management platforms, tools, and processes must therefore facilitate reflection and dialogue to allow personal and organizational learning and innovation. This requires the ability to link, as well as the adaptability and dynamic representation of business information and knowledge. Without effective information and knowledge management tools that drive knowledge integration, that in turn underpins innovation, organizations could be underutilizing knowledge as an innovation resource.

4.4. Technology and systemic integration

In technology firms, knowledge integration should not be viewed only at individual, team, or organizational levels. More importantly, at the technological level, managers should identify the knowledge gap within the firm and absorb technological and scientific knowledge from external or internal sources. To fulfill this need, SMEs may absorb technology from other firms through collaboration with external partners, or rely on in-house innovation teams in order to mobilize heterogeneous elements of technological knowledge distributed within their firms.

Technology-based SMEs may embody different knowledge and technologies in different organization processes or products, and furthermore these firms must integrate this knowledge and technology into innovation activities to specialize their innovation efforts. Generic technologies, most obviously IT, have also led to a fusion of technological disciplines and knowledge areas, thus triggering new demands to integrate knowledge across a wide variety of knowledge areas and disciplines that used to be separate. Consequently, intentionally managing and integrating both internal and external knowledge is critical to achieving competitive advantage for SMEs.

Knowledge identification and technology selection are the first steps by which the knowledge gap is identified and recognized for the benefit of solving problems in the innovation process. The knowledge gap created by facing new challenges in the creation of something new requires radically new solutions and the acquisition of new knowledge. It might be necessary for firms to explore knowledge from different sources. As discussed before, the technology firms are likely to source the knowledge from internal and external sources. In particular, the cases in our study indicated that external knowledge sources are crucial to their innovation process.

5. Managerial implications

The research provides information that may be useful to many firms in integrating and managing the knowledge more effectively in the innovation process. Knowledge management activities provide an overview of what is available in the organization as well as where knowledge is lacking, and where to systematically build the knowledge base in these areas. SMEs need to be more proactive in identifying their knowledge gaps in strategic areas, and to extend the informal operational business processes by using other knowledge management processes to increase effectiveness (Hutchinson & Quintas, 2008). Considering the findings, the following points are highlighted with regard to managing and integrating knowledge more efficiently within the innovation process:

- SMEs must be strategic and have clear intentions to capture and share their knowledge in all aspects of their business. Taking a proactive approach to systematically identify knowledge gaps in strategic business areas improves the formal and informal operational business processes, while using KM processes increases effectiveness. Embedding KI throughout all business processes establishes them in the firm's routines. For example, linking strategic commercial knowledge and market needs with the firm's knowledge base is a crucial component of knowledge integration processes for innovation.
- Management should demonstrate leadership in motivating and stimulating knowledge integration activities internally at the firm and organizational level, and externally with suppliers, customers, and distributers, to generate positive outcomes.

Leaders also shape a positive company culture where the role of knowledge, KM, innovation, and creative thinking is encouraged and valued. Managers' encouragement of staff members to engage in continuous learning can increase the skills and formal and informal knowledge across functional boundaries, ensuring that a wider knowledge base than that used in day-to-day activities is available to employees.

- Sharing tacit knowledge and integrating this knowledge into the innovation process is extremely important for firms. Tacit knowledge developed through practice and experimentation is enhanced by formal and informal links for capturing internal and external knowledge. Sharing and effectively distributing tacit knowledge and communicating new information from a wide base of knowledge stimulate engagement across disciplines in firms. These knowledge sharing practices can align employees in creative thinking and problem solving, not only in technical aspects of products, but also in the commercial aspects such as finance and marketing. A positive culture and participative innovation activities also encourage knowledge sharing and the integration of employees' specialized knowledge in new product or service development processes.

- Good practice in team knowledge integration is characterized by rich communication, collaboration, and creative solutions, with regular communication between managers and project members in many large or medium-scale projects within firms. Development teams are the key agents of knowledge integration, and their commitment to continuous learning is critical to innovation. In small firms, team knowledge integration based on shared commitment and the ability to work well with fellow project members is critical for innovation projects. Effective relationships and teamwork between marketing and R&D activities will also result in successful projects.

- Formal and informal communication networks that exchange and manage information and knowledge are essential for SMEs to capture individual knowledge, transfer it, and ultimately transform it into explicit knowledge. Social relationships and social capital increase the knowledge available for firms through internal and external networks of relationships. Communities of practice were found to be effective mechanisms for sharing and transferring formal and informal knowledge during innovation projects. Integrating knowledge inside and outside the firm through communication networks can be challenging. KM initiatives need to be designed and implemented for specific contexts.

- Technology and information processing techniques to manage knowledge are critical to improving the general effectiveness of systems in supporting the management of knowledge beyond simple use through databases. For example, to manage R&D and project information, effective information systems must be able to synthesize data by taking and interrogating it, thereby generating useful information and knowledge. Previous research has identified that effective KM systems provide platforms, tools, and processes to ensure the integration of an organization's knowledge base. While SMEs are only beginning to use this technology, they appear to investigate more formal systems of KM as the firm size increases.

6. Conclusion

This paper argues that effective integration of knowledge requires a thorough understanding of the organizational knowledge processes. Knowledge integration capability contributes to the successful innovation and commercialization of new products, and may be a key dynamic capability of firms, requiring an ongoing process of combination and exchange leading to new knowledge. SMEs that attempt to keep aligned with their dynamic environments must focus on how they manage their specialized knowledge.

As this study demonstrates, knowledge integration takes place across multiple organizational levels, namely individual level, team level, and systemic level. The study highlights that knowledge integration occurs in the innovation process as a result of knowledge search and capture, its distribution and embodiment, and finally its transfer, leading to innovation capability and competitive advantage for the firm. When staff members have an integrated view of what knowledge is available, where it can be accessed, and also what the gaps in the knowledge base are, they can ensure that knowledge as resource is utilized to its maximum in the innovation process.

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