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Managing knowledge within networked innovation

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Abstract
The purpose of this paper is to research firms' knowledge management practices within the context of networked innovation between multiple actors. The analysis is based on case research carried out with six companies. Based on earlier literature and the theoretical framework of the paper, two models of networked innovation can be distinguished according to knowledge management needs: networks focusing on the transaction of explicit knowledge and intellectual property, and networks focusing on the co-creation of new knowledge and business opportunities. The paper argues that a strategic approach to knowledge management is a key element of success within networked innovation, both in the theory and in the practices of firms. In that way, firms are able to manage knowledge within networked innovation when they understand their partners' business models and strategic intents, for example their motivation to collaborate.
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Introduction

The success of a firm depends on its strategic collaboration with other organizations that influence the creation and delivery of its products or services. The required knowledge and resources are therefore distributed among several independent but interconnected network actors. This distributed network of actors explores future business opportunities and, through its actions, influences the creation of business solutions. The increasing complexity of new innovative and technology-intensive products and services poses challenges for the decision-making of firms, as economic success is increasingly dependent on the acquisition and application of both internal and external knowledge and related intellectual property (Teece, 2000; Lee, 2009; Bocquet & Mothe, 2010; Paasi *et al*, 2010; Dahlander & Gann, 2010). Such inter-organizational innovation processes form the context of networked innovation.

Intense debate on the most favourable collaboration models and their management is ongoing in research on both networks (Wilkinson & Young, 2002; Andersson *et al*, 2007; Möller & Rajala, 2007; Valkokari, 2009) and alliances (Lazzarini, 2002; Das & Teng, 2002; Grant & Baden-Fuller, 2004; Inkpen & Tsang, 2005). The great diversity of this research has produced important new knowledge, but unfortunately it has also resulted in conceptual confusion over the network phenomenon itself (Dhanaraj & Parkhe, 2006; Möller & Rajala, 2007; Järvensivu & Moller, 2009; Valkokari, 2009). Although the focus of the network literature has shifted from the

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structures and functions of networks to the dynamics and management of networks, few studies focus on knowledge management practices within different network types. Overall, even though researchers agree on the importance of networks as a new type of organizing, little is known about the challenges that the networks place on inter-organizational innovation processes across company borders.

Looking at the knowledge management literature, the scholars disagree on the construct of knowledge itself, and in particular, organizational knowledge has several partly overlapping concepts and definitions (von Krogh, 2009). Thus, in order to transfer or create knowledge, interaction of some kind has to take place between the actors. As these interaction patterns are guided by both formal management and informal social structures, it is not possible to fully separate the knowledge management practices from the other activities that take place within inter-organizational innovation processes. The focus of the research has been on knowledge transfer and the organizational ability to utilize external knowledge, for example on the concepts like the absorptive capacity as described by Cohen & Levinthal (1990), or the dynamic capabilities introduced by Teece *et al* (1997). On the other hand, knowledge co-creation between firms and the knowledge owner's motivation to share knowledge are more narrowly studied subjects (Hagel & Brown, 2006; Valkokari *et al*, 2009). Furthermore, also in the discussions related to the management of intellectual property, some authors have pointed out the need for new models in order to cope with the challenge between dynamic innovation processes and static protection methods of intellectual property (Lee, 2009; Lee *et al*, 2010; Luoma *et al*, 2010).

However, the starting point for the study is that success within networked innovation requires a strategic approach to knowledge management (Sanchez & Mahoney, 1996; Zack, 1999). When considering the business development of firms, the paradigm between efficiency and innovativeness exists at every turn, as March (1991) conceives organizational learning as a balance between the exploration of new alternatives and the exploitation of existing competencies. The purpose of this paper is to broaden the research of companies' knowledge management practices from single supplier–customer relationships (Paasi *et al*, 2010) to networked innovation between multiple actors. The main research question of the study is how firms in practice explore and exploit knowledge within the context of networked innovation. In this context the collaboration models are divided into two main categories and the key characteristics of models are defined by empirical research. This sheds more light on the differences in knowledge management practices between knowledge exploitation and exploration.

The remainder of this paper is structured as follows. First, the paper briefly reviews the existing research on organizational knowledge and its management within business networks and strategic alliances. Based on this discussion, the preliminary framework is presented. The research approach, methods and design are then described. The case findings on knowledge management practices within networked innovation are presented through the preliminary research framework. Finally, the contribution of the study and its practical implications, limitations and needs for further studies are presented.

Theoretical framework

Strategic approach to organizational knowledge

Organization scholars differ in their understanding and application of the construct of 'knowledge' in both theorizing and empirical research (von Krogh, 2009). Nonetheless, von Krogh (2009) argues that a combined view is needed to understand organizational knowing. Organizational knowledge is predominantly a result of social construction, and for knowledge to exist, people have to agree that it exists. As people can debate on the existence of knowledge, fundamental concepts like 'facts' or 'truths', 'information' or even 'data' differ from one perspective to another (Mingers, 2008). However, organizational knowledge is a multidimensional phenomenon and strategic approach to organizational knowledge requires both combined view and simplification of key concepts.

The concept of tacit knowledge refers to knowledge that is difficult to codify and communicate to the rest of the organization. Also the concept of intellectual capital refers to the knowledge and knowing capability of a social collectivity, such as an organization, network or professional community of practice (Nahapiet & Ghoshal, 1998). This tacit component is often connected to knowledge and understanding of the conditions of knowing, which makes it challenging to transfer knowledge from one place to another, that is across the borders of a firm or industry (Qvortrup, 2006). In innovation literature, such accumulated know-how is also referred to as architectural knowledge, that is knowledge developed and enacted in innovation processes by aligning heterogeneous business and technical elements (Henderson & Clark, 1990). Thus, the organizational members' ability to transfer their knowledge or co-create knowledge with other organizations is also tied to the degree to which knowledge is independent or dependent (Hansen, 1999) – in other words, whether knowledge is a standalone component that can be transferred without a strong awareness of the larger system or, conversely, an element of a set of interrelated components. In the latter case, co-creation is required in order to generate new knowledge and business opportunities.

Business development and networked innovation processes are closely connected to the organization's ability to sense the emerging opportunities, to see the coming-into-being of the new. This mystic ability has several overlapping descriptions. Originally, Cohen &

Levinthal (1990) highlight the critical importance of absorptive capacity – the ability of a firm to recognize the value of new external information, assimilate it and apply it to commercial ends – to the innovative capabilities of firms. Furthermore, Teece *et al* (1997) define dynamic capability more broadly as 'the firm's ability to integrate, build and re-configure internal and external competencies to address rapidly changing environments'. In this discussion, this study intents to point out that success within networked innovation requires a strategic approach to knowledge management (Sanchez & Mahoney, 1996; Zack, 1999). As the networked innovation process requires the firms to co-produce the innovation outcome with each other, knowledge management must be based on understanding the strategic meaning of knowledge at the network level in both the present and the future. Thus, the strategic management of organizational knowledge was defined to have two main dimensions, explicit and tacit, within the framework of this study. Typically, in the context of networked innovation explicit and codified knowledge can be managed by formal methods, while management of tacit knowledge is informal and linked with social structures and interaction (Lee, 2009; Lee *et al*, 2010; Paasi *et al*, 2010).

The study utilizes further the distinction between the two dimensions of inter-organizational innovation processes identified by earlier knowledge-based literature (Grant & Baden-Fuller, 2004), while similar conflicting dimensions are also recognized in the business development of firms. First, there are activities that increase an organization's innovativeness and stock of knowledge – what March (1991) refers to as 'exploration' and Spender (1992) calls 'knowledge generation'. Second, there are activities that deploy existing knowledge to efficiently create value – what March (1991) refers to as 'exploitation' and Spender (1992) calls 'knowledge application'. The next section reviews the literature of networks and alliances and summarizes how earlier typologies have described the differences between knowledge exploration and exploitation.

Network approach and dimensions of collaboration models

In both alliance and network research there is intense debate on the most favourable collaboration models. Based on a broad research review, Möller & Rajala (2007) make a distinction between the intentionally created business nets and macro-level networks of organizations. According to them, densely embedded nets with many strong ties are more manageable and beneficial. Furthermore, collaboration within closed and tightly coupled networks is stated to generate trust and cooperation between actors (Ahuja, 2000) and facilitate the exchange of high-quality information (Gulati, 1998) and tacit knowledge (Qvortrup, 2006). On the other hand, more 'open', loosely coupled, networks with many weak ties (Granovetter, 1985) and structural holes (Burt, 1992) have different advantages. In this open network configuration, network actors can build relationships with multiple unconnected actors and explore external knowledge sources (Brusoni *et al*, 2001; Chesbrough, 2003) and brokerage new opportunities (McEvily & Zaheer, 1999).

To sum up the discussion on networks and alliances, the literature review compares how the different – partly interdependent and overlapping – typologies correspond to the discussion on organizational knowledge and its management. On the basis of the above descriptions from the extant literature, two main types can be distinguished: (1) more open and informally organizing networks of knowledge creation and (2) more closed and formally managed networks of knowledge exploitation. This division also has similarities with loosely and tightly coupled organization structures (Orton & Weick, 1990; Sanchez & Mahoney, 1996; Brusoni *et al*, 2001). Table 1 presents a chronological summary and comparison of different approaches.

A key feature of knowledge-based explanations of networked innovation is the imprecision of the concepts of knowledge creation and transfer (Grant & Baden-Fuller, 2004; Paasi *et al*, 2010). Earlier typologies describe how knowledge exploration and thereby its creation occur within joint bindings, R&D consortia, implicit alliance constellations, knowledge accessing alliances, industrial districts, practice networks, macro-level networks of organizations and creativity networks. On the other hand, product bundlings, horizontal keiretsu, explicit alliance constellations, knowledge acquisition alliances, strategic alliances, process networks, intentionally created business nets and transformation networks focus on the exploitation and transfer of existing knowledge between the known actors of a closed network. Although these earlier typologies shed important light on the cooperation types, they do not properly describe how knowledge in practice can be managed within different network types.

Research framework: management of knowledge exploitation and exploration within networked innovation

Knowledge management in inter-organizational innovation relationships is challenging and not very well understood. Within academic discussions one of the main reason for this is the conceptual confusion about open or networked innovation (Järvensivu & Möller, 2009; Valkokari *et al*, 2009; Groen & Linton, 2010; von Hippel, 2010). Thus, in company practices the dynamics of networked innovation processes increases the vagueness of this phenomenon. The dynamics of networked innovation occur when interdependent but independent network actors co-produce the innovation outcome. These innovation operations can therefore be expected to be nested and interacting; consequently, innovation may also require the reshaping of the network. Also the role of network actors may change according to the innovation phase, and this may

Table 1 Different network and alliance approaches related to networked innovation

Source	*Types of network or alliances*	*Key characteristics*	*Focus related to networked innovation*
Harryson *et al* (2008)	• creativity networks • transformation networks • process networks	The network types are phased creativity networks for the creation of new knowledge, transformation networks for the transfer and integration of relevant knowledge and process networks for the implementation of the results.	Creation networks are related to knowledge exploration (eg creation), and transformation networks to knowledge exploitation (transfer), while process networks can focus on either exploitation or exploration.
Möller & Rajala (2007)	• intentionally created business nets • macro-level networks of organizations	The closed intentional business nets are further divided into three generic net types: current business nets, business renewal nets and emerging new business nets.	Current business nets do not belong to the scope of this study. Business renewal nets focus on exploitation of present knowledge, and emerging business nets focus on knowledge creation.
Hagel & Brown (2006)	• practice networks • process networks	A practice network relies on looser forms of co-ordination, and a process network requires more active forms of co-ordination.	Process networks operate with exploitation of knowledge for joint problem solving, while practice networks give greater priority to knowledge sharing and creation.
Inkpen & Tsang (2005)	• intra-corporate networks • strategic alliances • industrial districts	An intra-corporate network consists of a group of organizations operating under a unified corporate identity. A strategic alliance is a group of interdependent firms entering into voluntary arrangements. An industrial district is a network comprising independent firms operating in the same or related market segment and a shared geographic locality.	Intra-corporate networks are not in the focus of our approach related to inter-organizational innovation. Strategic alliances typically involve exchange, sharing or co-development of products, technologies or services based mostly on explicit knowledge. Loosely coupled industrial districts focus on knowledge exploration.
Grant & Baden-Fuller (2004)	• knowledge acquisition alliances • knowledge accessing alliances	The alliances-as-learning thesis predicts that the knowledge bases of alliance partners will tend to converge as each partner learns from the other. The alliances-as-knowledge-accessing thesis predicts that alliance partners will maintain and possibly increase their knowledge specialization.	Within knowledge acquisition alliances each member firm uses the alliance to transfer and absorb the partner's existing knowledge base, while in knowledge accessing alliances it is also possible that new knowledge will be created.
Lazzarini (2002)	• explicit alliance constellations • implicit alliance constellations	The explicit constellations involve formal, publicly known agreements in a multilateral fashion. The implicit constellations, by contrast, are informal groupings 'implied' from the structure of bilateral agreements between firms.	Explicit constellations operate mostly on knowledge exploitation based on formal agreements, while the focus of implicit constellations is on knowledge exploration.
Das & Teng (2002)	• Product bundling • joint binding • horizontal keiretsu • R&D consortia	Product bundling is the joint marketing of products or services. Joint bidding is a type of constellation in which member firms jointly bid for a big project, with each member responsible for a portion of it. A horizontal keiretsu is a cluster of interlinked Japanese firms and the specific ties that bind them. In R&D consortia, a number of firms create a new legal entity that conducts joint research activities.	Product bundling and horizontal keiretsu typically focus on knowledge exploitation to improve existing products. Joint binding and R&D consortia focus on knowledge exploration via joint research projects.

influence their ability or willingness to collaborate. Concurrently, a network actor is a subject that makes its own decisions and thereby causes emergent changes to its business environment and innovation networks.

Based on the above literature review, two main dimensions of collaboration models are distinguished in the preliminary research framework (Figure 1). The dimensions are: closed and formal networks of

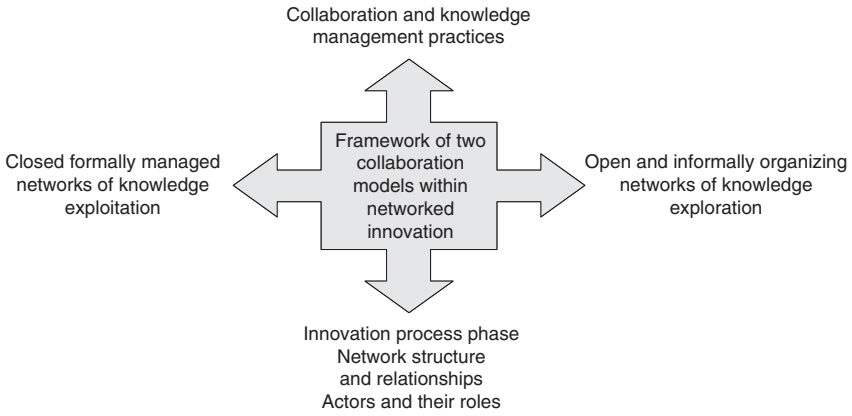

Figure 1 Framework of collaboration models within networked innovation.

Table 2 Two models of knowledge management in networked innovation

	Transaction networks	*Co-creation networks*
Nature of knowledge	Explicit knowledge, IPR managed by formal methods (patents, etc.)	Tacit knowledge, possible explicit background IPR
Innovation process phases	Development & exploitation of present knowledge	Fuzzy front-end & design: co-creation of new knowledge
Network structure and relationships	Simple relationships with limited actors	Nested and interconnected relationships
Network types	Product bundlings, horizontal keiretsu, explicit alliance constellations, knowledge acquisition alliances, strategic alliances, process networks, intentionally created business nets and transformation networks	Joint bindings, R&D consortia, implicit alliance constellations, knowledge accessing alliances, industrial districts, practice networks, macro-level networks of organizations and creativity networks

knowledge exploitation and open and informally organizing networks of knowledge exploration. The network perspective assumes that actors are embedded in networks of interconnected relationships that provide opportunities for and constraints on their actions (Wilkinson & Young, 2002; Brass *et al*, 2004; Andersson *et al*, 2007). However, network research tends to focus on structures, relations and outcomes, and thereby ignores the need to systematically examine the interconnections (Dhanaraj & Parkhe, 2006). The aim is to go beyond the network structure and consider knowledge management practices of network actors.

The notion that there are different types of innovation that call for different organizational forms was already highlighted by Henderson & Clark (1990). In the preliminary research framework (Figure 1), knowledge management practices in networked innovation are divided into two categories, which were termed transaction and co-creation networks. The differences between the two models were further summarized by bridging the literature of networks (summary presented in Table 1) and organizational knowledge. This summary is presented in Table 2. In spite of the multidimensionality of knowledge, organizational knowledge was defined to have two main dimensions: explicit and tacit. This division coincides with firms' practices and is utilized, while the focus is on the strategic management of organizational knowledge.

This framework of knowledge management practices within networked innovation describes how network structure and relationship types differ in terms of the innovation process phase. Within closed transaction networks, explicit knowledge such as intellectual property rights (IPR) is simply transferred from one actor to others, while within co-creation networks there are always nested relationships between the actors. Owing to the interaction and connections between actors, the results of co-creation networks are not known beforehand, and that makes the formal management of knowledge unclear (Lee, 2009; Lee *et al*, 2010). As theoretical frameworks, these two models are simplifications derived from the practices of firms, and therefore the actors in the networked innovation process may, for example, be in different phases.

For inter-organizational innovation, this study uses the definition that Swan & Scarbrough (2005) have

proposed for *networked innovation*: 'Networked innovation occurs through relationships that are negotiated in an ongoing communicative process, and which relies on neither market nor hierarchical mechanisms of control'. The concept of networked innovation was defined to have the following characteristics: (1) although multiple actors are involved in the innovation, the collaboration is seldom open to everyone, (2) there is always a specific purpose for collaboration and (3) the collaboration models cover both the knowledge transfer and co-creation activity between actors. Networked innovation is then a hybrid form of organization, having elements from both hierarchies and markets. In other words, its coordination is based on both control-governance and self-organization (Valkokari *et al*, 2009).

The results of networked innovation can be more than the sum of their parts only if new knowledge can be generated on the basis of the knowledge of network actors. Informal management mechanisms – like shared interests, common languages, similar cognitive structures and trust between partners – are defined to be key success factors for knowledge co-creation (Ahuja, 2000; Soekijad & Andriessen, 2003). On the other hand, the same factors can lead to knowledge bases that are too closely aligned and thereby limit the possibility to create new knowledge and innovation. Thus, more 'open' networks with many weak ties and structural holes might be more advantageous to knowledge exploration (Brusoni *et al*, 2001; Valkokari *et al*, 2009). Still, such open networks involve higher uncertainty and are harder to manage (Möller & Rajala, 2007). The aim of the study is therefore to describe how actors, their roles and collaboration models influence knowledge exploitation and exploration between network members within the context of networked innovation.

Research methodology and design

The research design is abductive. The existing theoretical understanding of knowledge management within networked innovation was combined in the preliminary research framework. During the research project the framework was complemented with case studies of actual knowledge management practices at several organizations. In addition to interviews, theme discussions were utilized to test the matching between empirical findings, preliminary research results and the research framework of knowledge management practices within networked innovation. The theory-building process then involved recursive cycling of the case data of the interviews and theme discussions, emerging theory and extant literature. Similarly to 'grounded theory', the research process of an abductive approach aims to generate new concepts and develop theoretical models, rather than confirm existing theory (Dubois & Gadde, 2002).

A case study strategy is appropriate when the research problem is of the 'how' or 'why' type (Eisenhardt, 1989; Yin, 2003). As the study aims to understand the phenomenon from the inside rather than the outside, the research problem of the study also represents a 'how' form. The main question of this study is exploring *how firms manage knowledge in the context of networked innovation*, for example collaboration and joint innovation involving multiple actors. According to the preliminary research framework, the main research question is further implemented through research sub-questions *distinguishing the collaboration and knowledge management practices of firms in the knowledge exploitation and exploration dimensions*:

- Who are typically involved in the collaboration and innovation processes in knowledge exploration or exploitation? What kinds of roles and relationships do the firms have within a networked innovation?
- What kinds of collaboration practices do the firms have in knowledge exploitation or exploration?

Therefore, the study also reflects the firm's interpretations and practices with regards to the concept of networked innovation.

The choice of multiple case studies over a single case was made in order to compare the practices between knowledge exploration and exploitation at several firms in different network roles and industries. Nowadays, the challenge of firms is to cross both the firm and industry borders while looking for new knowledge and business opportunities. Therefore, the aim of the study was to offer new approaches, support learning between case firms and increase the understanding of the different industrial paradigms of inter-organizational innovation. The case companies represent different fields of industry, bringing diversity to the empirical material and maximizing learning and variety in the data. The interviews and theme discussions were successful as the representatives were motivated and openly discussed their experiences, challenges and practices with respect to the researched phenomenon.

The data on networked innovation were collected during the years 2008–2010 with over 10 in-depth interviews and two theme discussions. Altogether, representatives from six companies took part in the interviews and discussions. The case firms are all B-to-B firms, but the size of the firms varies from a small software company with 20 employees to a large technology company with over 2000 employees (see Table 3 for details). The semi-structured interviews included questions related to the targets of networked innovation, typical partners, collaboration models and practices. The duration of a typical interview was 1–1.5 h and each of them was conducted by at least two interviewers. The positions and perspectives of the participants also varied, ranging from entrepreneurs and chief executive officers to lawyers and patent engineers. They each had several years of business experience. The case material was supplemented by product and company presentations and agreement templates from some of the companies.

The scope of the analysis was the knowledge management practices of networked innovation and, in particular,

Table 3 Case companies

Organization	*Industry*	*Typical network role*	*Collaboration partners and practices*	*Staff (2008)*
Arcusys	IT services	Supplier	Co-creation and transaction networks with open source communities, customers, research institutions	12
Blancco	Software, ICT	Supplier, product company	Transaction networks with open source communities, customers, co-creation with research institutions	37
Medisize	Manufacturing industry	System supplier, contracting manufacturer	Transaction networks with customers and suppliers, co-creation with research institutions and innovators	1,000
Outotec	Metals and mining industry	Original equipment manufacturer, service provider	Transaction networks with customers and suppliers, co-creation with research institutions and innovators	2,000
Sandvik Mining and Construction	Mining and construction	Original equipment manufacturer	Transaction networks with customers and suppliers, co-creation with research institutions, suppliers and innovators	2,300
Tamlink	Technology transfer	Innovation broker	Co-creation networks with research institutions and customer companies	70

the collaboration models and interaction between network actors. The natural way to start analysing the data is to first review it in the light of research questions (Silverman, 2005). This was followed in the analysis, using a deductive approach and coding the data with the help of research questions. The goal of the analysis was to find company practices relevant to this study. The first empirical analyses focused on reviewing the ways in which case companies utilize networked innovation, with whom they collaborate and what collaboration practices they have. Concurrently, the analysis aimed to describe how collaboration and knowledge management practices differ within knowledge exploitation and exploration.

In addition to the interviews, two theme discussions about networked innovation were organized for the company representatives in order to support the continuous interplay with theory and empirical observations. At both of the theme discussions, 10–20 participants discussed the benefits and challenges of more open innovation processes and knowledge management within inter-organizational innovation. The discussion themes were chosen based on the interviews and theoretical frames of the research. The researchers introduced the subject at the beginning of the theme discussion. Detailed group work was carried out in smaller groups. Subsequently, each of the groups presented their work and the participants discussed their views. The researchers documented the discussions and the summary was delivered to all participants.

In addition to the authors of this paper, four other researchers took part in the interviews and theme discussions. The researchers have complementary theoretical frames, from legal to business and network management approaches. A number of case descriptions and research papers about knowledge management and collaboration practices of case companies were written by the research group. The preliminary research framework was first represented and tested within single supplier–customer relationships (Paasi *et al*, 2010). The data for the first paper were collected in semi-structured interviews with management personnel at 36 organizations in Finland and in the Netherlands. In addition to the interviews, the present paper is based on deeper case analysis and theme discussions with the case company representatives. During the research process both the practical and the theoretical viewpoints were further shared and discussed with the case company representatives. Thus, the theme discussions with the companies supported the testing and development of the preliminary research framework. Therefore, theoretical, data and research triangulation were leveraged (Dubois & Gadde, 2002; Gibbert *et al*, 2008) and the empirical observations inspired changes of the view of theory and vice versa.

Case research and findings

The results of the case study are presented based on the research sub-questions and the application of the research framework of knowledge management within networked innovation (Table 2). The direct quotations from case companies are presented in italics for the sake of transparency in the discussion of the empirical evidence and theoretical approach. Furthermore, the direct quotations are presented in order to describe and exemplify the interpretations of the firms' representatives towards networked innovation.

Actors and their roles within networked innovation

The case analysis showed that all the case companies engage in networked innovation activities. Nevertheless, most of the company representatives stated that knowledge management in networked innovation is

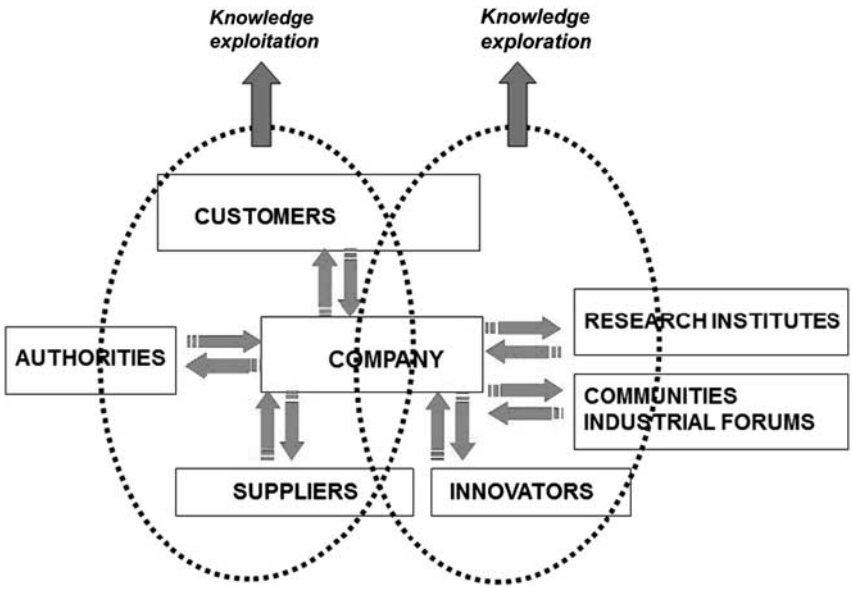

Figure 2 Typical inter-organizational innovation partners in knowledge exploitation and exploration.

challenging. Figure 2 summarizes the typical collaboration partners identified by the representatives of the case companies. This description of typical collaboration partners is based on both the interviews and the first theme discussions with representatives of the companies.

Based on these case data, collaborations with several types of partners – customers, suppliers, competitors, public authorities, communities, research centres, universities and individual innovators – were studied. The study gathers information on the different collaboration practices of companies and compares knowledge management practices in different circumstances. As Figure 2 shows, the case companies have quite traditional models for utilizing networked innovation. Furthermore, the analysis also indicates how the focus of collaboration with customers and suppliers is typically on knowledge exploitation, while collaboration with research institutes, innovators or different communities explores new knowledge. The next section analyses further the differences in the network structure and the relationships between the two models.

Most of the collaboration was done within closed networks or bilateral relationships with known partners. The representatives of the sampled firms typically identified open-source communities and standardization work as almost the only examples of collaboration that also involves undetermined or unknown actors. In the words of one interviewee, a representative of a metal industry company, *Such developer communities can play a role in the development of consumer products, but only our industry partners are able to take part in the development of our products*. Collaboration with research institutes, innovators or even with competitors targets knowledge exploration, and knowledge management was found to be easier in these cases. A good example of a typical approach to knowledge management practices and needs follows: *In a way, knowledge management is easier in these kinds of research projects, where there is high risk and it is unknown whether anything will ever be found. When it's time to engage in tangible business development, there's always a stronger awareness of IPR and knowledge protection*.

Although customers were considered to be good innovation partners within knowledge exploitation targeting new business development, it was mentioned that the management of knowledge within these relationships was the greatest challenge. The representative of a manufacturing company stated, *Projects with customers are interesting, but on the other hand are also the most difficult*. Especially for smaller supplier companies, knowledge management in relationships with larger customers was inconvenient, as pointed out by the representative of a smaller supplier company: *Large customers want to own all the results – they don't easily give up even the rights to utilize the solution in other industry sectors*. The case findings point out clearly that companies often have traditional practices and they do not intend to share the results, for example new knowledge or intellectual property rights generated within the inter-organizational innovation process.

Collaboration models and practices

The case companies had several closed but interactive joint-development projects with their customers and suppliers, and research projects with innovators or research institutes. Direct knowledge transfer and selling or buying IPR or other explicit knowledge between companies was quite rare. According to the interviews, preparatory work for future collaboration is in some cases informal, but collaboration usually starts with a nondisclosure agreement (NDA). One of the interviewees

representing a supplier company explained: *Confidentiality is absolutely essential. Our customers are very protective of their development projects*. Within knowledge exploration, collaboration can be based on informal discussion in order to gain new approaches. Still, a closed joint-development project typically starts with a NDA and collaboration agreements. A product company representative explained how contracts have an important role in collaboration practices: *When co-operation starts, we just slap a blanket agreement on the table*.

At the fuzzy front-end of the innovation process, where it is often impossible to even define future business solutions or required knowledge, the sampled firms make greater use of co-creation networks than knowledge transaction networks. Informal discussions with representatives from other firms are an important source of new approaches and knowledge. For example, one interviewee stated: *These research projects and informal discussions generate new ideas that we can harness later.* Within the agreements and negotiation process, the focus of the sampled firms was clearly on the management of explicit knowledge. They did not even recognize the tacit dimensions of knowledge created in collaboration. These explicit results or rights to utilize results were in some cases shared according to the participants' business areas. The following is an example of those cases: *Based on the consortium agreement the ownership of IPR is jointly agreed or each partner owns the IPR in their specific field*. However, within these cases the business interests of the participants must be well understood so that the closed innovation network, for example the consortium, can be configured with aligning interests and business targets. On the other hand, knowledge sharing concerning the background material is an important dimension within collaboration focusing on knowledge exploration. One of the interviewees even noted that companies have an aggressive approach in research projects: *At the moment, companies seem to want access to more or less all the research background materials during a single project*. This example describes a situation where the representative of a company may have understood the meaning of open innovation or collaboration in an exceptional way.

Some of the companies also recognized the importance of serendipity in the innovation process; case examples of serendipity were found in both knowledge exploration and exploitation. First, one supplier company described how they found a new business opportunity: *While attending a business course, one of our employees had informal discussions with another course participant, and based on these discussions we were able to develop and provide a solution for a really big international player's device*. Secondly, new ideas and improvements can be found in close cooperation as described in another example from the customer side: *With subcontractors, it happens that a light goes on in our heads all of a sudden and then we come up with the solution together.* These cases of serendipity also show how innovation can occur both in closed networks with tight relationships and in loosely coupled open innovation networks. Thus, the key to success is the interaction between the network members and a strategic understanding of new knowledge and business opportunities.

Furthermore, the target of the second theme discussion was to challenge the case companies to consider if there are new ways to utilize networked and more open innovation processes over company borders. The summary of network and alliance approaches (Table 1) was presented as the starting point for the theme discussion to gather information on the openness of different collaboration models. From the knowledge management point of view, it turned out to be important to recognize whether unknown actors were taking part in collaboration. This second theme discussion also highlighted that in order to ensure open discussions within a project group, it is important to understand the benefits and interests of partners and to construct a network in which the interests are appropriately balanced. Thus, in several cases the consulting companies, which focus on knowledge-intensive business services, have played an important role in configuring these co-creation networks or project groups.

Discussion about case findings

The case analysis showed that in order to have a strategic approach to the firms' knowledge management practices it was useful to distinguish the two models of networked innovation as defined in the preliminary research framework. Furthermore, the differences and the typical characteristics of the two models were identified based on the empirical evidence.

Knowledge exploitation *vs* exploration

The empirical data on company practices showed that there is typically a specific purpose for collaboration related to networked innovation. Nevertheless, it can be stated that the challenges of knowledge management faced by actors in co-creation networks seeking to create new knowledge and future business opportunities with multiple partners are markedly different from those faced by actors in transaction networks focusing on knowledge transfer between partners. Therefore, the collaboration and knowledge management practices of companies were also different within different network models. Table 4 summarizes the typical characteristics and the differences between the network models.

Regardless of the ongoing discussion about open innovation (Chesbrough, 2003, 2006), most of the firms were utilizing networked innovation quite traditionally within closed networks and with known partners. Typical examples were knowledge exploitation by means of product development with customers and suppliers, or knowledge exploration through research projects with research institutes and other innovators. Although the first discussion can be informal, the sampled firms counterpointed the need for NDAs and agreements

Table 4 Summary of case analyses related to KM practices within inter-organizational innovation

	Transaction networks	*Co-creation networks*
Nature of knowledge	Exploitation of existing knowledge (selling and buying).	Exploration of new knowledge and approaches or solutions to problems.
Innovation process phases and objectives	Integrate present knowledge within development phase.	Search and co-produce new knowledge within fuzzy- front end or design phases.
Network structure and relationships	Closed co-operation with customers and suppliers. Bilateral relationships.	More open and dynamic co-creation with research institutes, communities and innovators. Multilateral and interconnected relationships.
Actors and roles	Roles, responsibilities and rights are clearly defined beforehand.	Roles, responsibilities and rights are negotiated and decided during the collaboration.
Collaboration practices	Preparatory work for future collaboration can be informal, but collaboration usually starts with a NDA. Agreements are typically bilateral.	Collaboration can be based on informal discussion in order to gain new approaches. Closed joint-development projects start with a NDA and collaboration agreements. Agreements are either bilateral or multilateral.
Knowledge management practices	The key challenge is identifying relevant new ideas developed externally and gaining access to them. Firms target to the ownership of new solutions and technology.	The identification of background knowledge and agreements about its protection comprise one of the main issues of collaboration agreements. Results (or rights to utilize results) can be shared according to the business areas of participants.

on sharing results, process and background material. The composition of the collaboration network or project group was therefore critical; the case companies emphasized that co-creation with competitors was not desirable. In order to ensure mutually beneficial collaboration, it is important to understand the potential benefits of collaboration to each of the participants.

The case analysis showed also that although multiple actors are involved in the innovation process, the collaboration is seldom open to everyone. Furthermore, the company practitioners stated that the objectives of networked innovation and the partners strongly influence their choices of knowledge management methods. Especially, the knowledge protection policies were defined on the basis of the other participants – the firm's position with respect to the innovation partners also influences its possibilities to negotiate between its own and the network's strategic targets. Network dynamics and timing pose challenges to knowledge management, for example network actors can be in different phases of the innovation process. For instance, one of the network actors might consider the objective to be the exploration of new knowledge and future business opportunities, while others operate within their present business model and expect that the benefits will be realized faster. The role and the network position of the firm are critical factors in the selection of suitable methods for innovation network development as well as knowledge management. Still, the firms and managers often lack experience of several collaboration models or an understanding of their strategic meaning, and this may lead to the utilization of inappropriate collaboration and knowledge management practices.

However, these networked innovation relationships are taking on a growing number of forms involving a greater variety of practices. The discussions with the case firms showed that the overall perspectives on competitive edges in the sampled firms are already changing. As the representatives of the firms gain a deeper understanding of networked innovation, their ability to manage it also improves. The case firms' perspectives on open and networked innovation differed in line with their size and network role. For a small software company, the scope of sharing is broad even in the core area of its business. On the other hand, larger companies in the technology industry have just realized that in some situations it might benefit them if the technology they have developed with their partners becomes more widely used. In industries with long product life cycles, it is more important to make IPR agreements before starting development work, and firms have 'more time' to wait for the contracts. Thus, a critical review between sharing and protecting the company's own knowledge base could offer radically new innovative solutions for the firms.

Theoretical implications

Based on the extant literature and the case findings, this paper reviews network and alliance research related to innovation and presents the framework for knowledge management within networked innovation. More

specifically, while most of the current studies have grounded their arguments in either innovation or network research, the study emphasized the need to examine the issue from the perspective of strategic knowledge management within networked innovation. Such a perspective concerns a firm's expectations for innovation and creation of future business opportunities in an uncertain and complex business environment. Based on both the preliminary framework and the empirical evidence, *two contributions to the existing theory were suggested: (1) the concept of networked innovation and (2) the two models of knowledge management within networked innovation.*

The first contribution to the theory concerns the characteristics of networked innovation and perceptions of firm representatives towards these characteristics. Earlier innovation and network literature presents several – partly overlapping – concepts of inter-organizational innovation, and thus this study focuses on its practical dimensions and management. The networked innovation was defined as having the following characteristics: (i) although multiple actors are involved in the innovation process, the collaboration is seldom open to everyone, (ii) there is always a specific purpose for collaboration and (iii) the collaboration covers both knowledge transfer and co-creation activity between the actors. The gathered empirical evidence on the characteristics of inter-organizational innovation is consistent with the literature of strategic networks and alliances. First, the literature distinguishes intentional close nets and alliances from macro-level open industrial networks (Inkpen & Tsang, 2005; Möller & Rajala, 2007), and thereby the company representatives perceived closed networks and project groups to the most typical forms of networked innovation. Secondly, both the knowledge management (Sanchez & Mahoney, 1996; Zack, 1999) and network approaches (Håkansson & Ford, 2002; Wilkinson & Young, 2002; Dhanaraj & Parkhe, 2006) point out the importance of strategic needs. Also the company representatives emphasized that how there must be a clear connection between the benefits of collaboration and the business models of participating firms. Thirdly, as summarized in Table 1 the previous literature considers networked innovation for both knowledge exploitation and exploration. Although the company representatives perceived that knowledge exploitation within closed networks is more common, all of the case companies also have experiences of knowledge exploration.

However, the link between the collaboration model and strategic needs for knowledge management often seemed to be missing in company practices. In accordance with Dahlander & Gann (2010), the empirical evidence showed that this is a fundamental factor explicating why inter-organizational innovation yields greater benefits for some firms than others. With a strategic approach to knowledge management, firms are able to utilize networked innovation when they understand their partner's business models and strategic intents, for example their motivation to collaborate. This understanding also enables firms to negotiate about roles, responsibilities and rights between the collaborators. Moreover, the collaboration and interaction processes within networked innovation – rather than simply the formation of innovation networks – were found to play a crucial role. Yet as stated by several authors, although with different concepts (Håkansson & Ford, 2002; Chesbrough, 2003; Dhanaraj & Parkhe, 2006), the reasoning behind the existence of interactions between the network actors cannot be ignored when considering the role of networks within networked innovation.

A second contribution of the research is the distinction of the two basic collaboration models of networked innovation: transaction and co-creation networks. Within transaction networks, explicit knowledge such as intellectual property rights is simply transferred from one actor to another, while there are always relationships, communication and interaction of some kind between the actors within co-creation networks. The risks and possibilities of innovation are higher within these co-creation networks. Furthermore, the legal protection of intellectual property is often impossible within these co-creation networks. Hence, where the legal IPR-based protection of knowledge is weak or uncertain, the firm's ability to utilize networks and informal methods may strongly influence its competitiveness. In knowledge co-creation networks, this requires ability to understand and envision future business opportunities (Möller & Rajala, 2007; Valkokari, 2009).

Thus, organizational knowledge has both an explicit and tacit dimension and these dimensions are always interdependent, as earlier argued by Polanyi (1966). By indicating that different types of knowledge are connected and interdependent, the study described the challenges related to knowledge management within networked innovation, for example only a limited part of knowledge and intellectual property can be legally protected by formal intellectual property rights such as patents, copyrights and trademarks. While the results of collaboration are seldom known at the beginning, semiformal protection methods such as contracts and confidentiality agreements are important within networked innovation. Recently, this has also been pointed out in the literature of intellectual property rights and patent law (Lee, 2009; Lee *et al*, 2010).

Limitations and further research

The contributions of this study must be considered with some limitations in mind. First, the case data on networked innovation practices are based on interviews and theme discussions with a limited number of firms. This study aimed to obtain quite a broad perspective of the subject and even compare practices over different network roles and industries. Therefore, the research design enables both the case companies and the

researchers to learn from different industry paradigms. While this kind of approach and selection of cases allows for a general overview to be developed, it also raises validity limitations (Gibbert *et al*, 2008). However, the number of firms per industry sector was too small to perform any sectoral analysis of the results. The study nevertheless points out that firms need new concepts to understand and manage networked, open and distributed innovation.

The empirical evidence showed that firms utilize more co-creation networks than knowledge transaction networks at the fuzzy front-end of the innovation process where it is often impossible to even define the future business solutions or required knowledge. Further studies based on process theories and action research and more detailed analyses could shed more light on how to manage knowledge within mutually beneficial collaboration and how the firms can balance between the open and closed dimensions of networked innovation. It would therefore be useful to examine the innovation processes of firms and describe how collaboration models and practices evolve in different phases of the innovation process.

Conclusions and practical implications

This paper has studied the knowledge management practices of firms within networked innovation. The interviews and the theme discussions with six case companies showed that all of the firms engage in innovation activities over company borders. Based on the earlier literature, the collaboration models were divided into two main categories within the theoretical framework of the study. Furthermore, the key characteristics of models were defined by empirical research on the companies' practices in the context of networked innovation. This sheds more light on the differences in knowledge management practices between knowledge exploitation and exploration. Practical viewpoints on the current situation of networked innovation in companies, for example how they perceive the models of networked innovation, were also offered in this paper.

The purpose of this paper was to broaden the research of companies' knowledge management practices from single supplier-customer relationships to networked innovation between multiple actors. The empirical evidence showed how multiple actors increase the complexity of collaboration and consequently emphasized how network partners must share the view about the objectives of the collaboration. Furthermore, strategic approach to collaboration and knowledge management is a prerequisite for this, while it enables firms to understand their partners' intents and motivation to collaborate.

A clear implication of the framework is that knowledge management and collaboration practices should be different within two models of networked innovation. First, within co-creation networks collaboration is more exploratory in nature, for example coping and interacting in the networks to innovate and create new knowledge. Secondly, within transaction networks, the actors focus on exploiting existing knowledge. As the networked innovation process requires the firms to co-produce the innovation outcome with each other, a strategic approach should be employed in knowledge management in order to understand the importance of knowledge in both the present and the future. The companies may capture more knowledge and other benefits – like future business opportunities – from their network participation if they are willing to open their knowledge to the other network actors.

To sum up, the defined concept of networked innovation and the distinction of two types of knowledge management of networked innovation do not provide a complete solution to the puzzle of networked innovation and how it relates to the management of organizational knowledge. By connecting knowledge management to a network approach, the concept of networked innovation enriches the field of research and highlights the importance of a strategic approach to knowledge management.

Practical implications

Regarding knowledge management within networked innovation, the paper also offers implications for management. Firms and their managers have to open their knowledge and networks in order to create new business opportunities in complex business environments. Based on the empirical analysis and the research framework (see Table 4) the present paper highlights, how when managing networked innovation, it is necessary for managers to (1) clarify roles and responsibilities, (2) consider both the objectives of collaboration and conflicts of interest, (3) create and manage contracts in a mutually beneficial manner and (4) share and recombine knowledge to build unique knowledge for all network actors. During all stages of such networking processes, a firm has to deal with explicit and tacit knowledge needs, the search for competencies and the use of available intellectual property. Hence, the knowledge management strategy of firms should be better connected to collaboration models and the utilization of external knowledge, as was also pointed out in the literature of open innovation by Chesbrough (2006).

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