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Knowledge Managing and Knowledge Management Systems in Inter-organizational Networks

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It is argued that the basic economic resource in the new economy is knowledge. An important source for competitive advantage in this economy is organizations' networks of external relationships. It is also argued that information and communication technologies (ICT) and Knowledge Management Systems (KMS) can play an important role in knowledge-intensive processes and flows. This paper presents a conceptualization of strategic knowledge managing within the context of inter-organizational networks. The conceptualization is based on the resource-based, dynamic capability, and absorptive capability views as well as ideas from the 'gift economy'. Three types of inter-organizational networks for strategic knowledge managing are defined: (1) extra-networks; (2) inter-networks; and (3) open networks. The paper discusses knowledge managing in the three network types and illustrates how ICT and KMS can be used to enable and enhance knowledge managing in inter-organizational networks—the core business process used for illustration is new product development. Copyright © 2003 John Wiley & Sons, Ltd.

INTRODUCTION

It is argued that knowledge is displacing natural resources, capital, and labour as the basic economic resource in the 'new economy' (Drucker, 1995). Commentators on contemporary themes of strategic management stress that a firm's competitive advantage flows from its unique knowledge and how it manages knowledge (Barney, 1991; Boisot, 1998; Spender, 1996; Nonaka and Teece, 2001). Some researchers even state that the only sustainable competitive advantage in the future will be effective and efficient organizational knowledge managing (Wikström and Normann, 1994; Nonaka and Takeuchi, 1995; von Krogh *et al*., 2000). Nonaka said: 'When markets shift, technologies proliferate, competitors multiply, and/or products become obsolete almost overnight, successful companies are those that constantly create new knowledge, disseminate it widely throughout the organization, and quickly embody it in new technologies and products'. (Nonaka, 1991). This has led to an interest in idiosyncratic knowledge that is valuable, rare, immobile, and exploited by a firm to give the firm a competitive advantage (Barney, 1991).

Organizations have always 'managed' knowledge more or less intentionally. The concept of creating, coding, storing, distributing, exchanging, integrating, and using knowledge in organizations is not new, but management practice is becoming increasingly more knowledge-focused (Truch *et al*., 2000; Collison and Parcell, 2001). Furthermore, organizations are increasingly dependent on specialist competencies and employees using their cognitive capabilities and expertise (Blackler, 1995; Reich, 1991; Newell *et al*., 2002).

The recent interest in organizational knowledge has prompted the issue of how to manage

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knowledge to an organization's benefit together with the use of information and communication technologies (ICT) and Knowledge Management Systems (KMS) for managing knowledge. Generally, knowledge managing (KM) refers to identifying and leveraging the individual and collective knowledge in an organization to support the organization in becoming more competitive (Davenport and Prusak, 1998; O'Dell and Grayson, 1998; Cross and Baird, 2000; Baird and Henderson, 2001). Research suggests that an important source for competitive advantage lies in organizations' networks of external relationships (Gulati *et al.*, 2000). The use of inter-organizational relationships and networks is an alternative to the use of hierarchy or market. It is known that firms use outsourcing to lower costs despite the firms having the necessary resources and capabilities internally. In the knowledge economy, inter-organizational relationships and networks are also created and used because firms do not possess the required knowledge-related resources and capabilities internally.

Though we have some answers to the question: 'Why do firms invest and engage in inter-organizational knowledge managing?' we have fewer answers to the question: 'How can firms strategically manage knowledge within the context of inter-organizational networks to improve firm performance?' The purpose of this paper is twofold. First, to present a conceptualization of strategic knowledge managing within the context of inter-organizational networks. Our point of departure is the resource-based view of the firm. Additionally, ideas and concepts like dynamic capabilities, absorptive capacity, and the 'gift economy' are used to develop the conceptualization. Second, to discuss implications of the conceptualization for the use of ICT and KMS in inter-organizational networks. In this paper we focus on knowledge managing in inter-organizational networks. We acknowledge that other means for organizations to acquire knowledge assets exist, for example through intra-organizational processes. Furthermore, Davenport and Prusak (1998) present enterprise strategies for knowledge generation and discuss five modes of knowledge generation, for example, knowledge acquisition by hiring individuals or buying an organization, or rental of skilled knowledge workers. An organization can also through different types of alliances and joint ventures, as well as through buying patents and licensing agreements, acquire knowledge. We focus primarily on designed networks; knowledge can of course also be created, integrated, and shared in informal and naturally emerging channels, relationships, and networks.

The remainder of the paper is organized as follows: the next section sets the scene by briefly discussing knowledge, knowledge managing, and KMS. Next we present and discuss our conceptualization of strategic knowledge managing within the context of inter-organizational networks. Our approach is conceptual-analytic (Järvinen, 2000), which means that we draw on the existing research and experience reported in the literature. This is followed by a discussion of some of the implications of our conceptualization for the use of ICT and KMS in knowledge managing—the core business process chosen for illustration is new product development. The final section presents conclusions and suggests further research.

KNOWLEDGE, KNOWLEDGE MANAGING AND KNOWLEDGE MANAGEMENT SYSTEMS

Numerous views of knowledge are discussed in the information systems (IS), strategy, management, and organization theory literature as well as in the philosophy and philosophy of science literature (Blackler, 1995; Sparrow, 1998). The different views of knowledge lead to different conceptualizations of knowledge managing and of the roles of ICT/KMS in knowledge managing (Carlsson *et al.*, 1996; Alavi and Leidner, 2001). Our starting point is 'knowledge as resource'. This is in accordance with the resource-based view (RBV) of the firm. The main reason for this choice is that this view can be used to address the links between knowledge, knowledge managing, and firm performance. There is a debate about what 'knowledge as resource' means. One strand argues that 'knowledge as resource' focuses on knowledge per se, meaning that knowledge is something that can be transferred, recombined, licensed, codified and put into a computer-based knowledge repository, and used to create value to a firm. Another strand argues that it is not knowledge per se that should be in focus, but 'knowing'. This means an emphasis on the context where knowledge is created, shared, integrated and put to use. The latter view has primarily a process and flow view, while the former has primarily an object view. The view taken here is the process and flow view, which means that the design and structuring of knowledge processes and flows form the basis for achieving competitive advantage. Hence, our focus is a firm's ability, through inter-organizational network-based knowledge processes and flows, to create new knowledge and to share and employ existing knowledge to solve problems, make decisions, and take actions.

Frameworks and models of organizations as knowledge systems suggest that knowledge managing consists of four sets of socially enacted knowledge processes, namely: (1) knowledge creation; (2) knowledge organization and storage/retrieval; (3) knowledge transfer; and (4) knowledge application (Pentland, 1995; Davenport and Prusak, 1998; Boisot, 1998). The frameworks and models represent the cognitive, social, and structural nature of organizational knowledge and its embodiment in the individual's cognition and practices as well as the collective (i.e. organizational) practices and culture (Alavi and Leidner, 2001). We refer to knowledge managing (KM) as a capability pertaining to knowledge creation, knowledge organization and storage/retrieval, knowledge transfer, and knowledge applications which enhances a firm's ability to gain and sustain a competitive advantage.

Knowledge management systems (KMS) refer to a class of information systems applied to managing individual and organizational knowledge processes and flows. They are ICT-based systems developed and used to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application. While not all KM initiatives involve the use of ICT and KMS, and warnings against an emphasis on the use of ICT/KMS for KM are not uncommon (Davenport and Prusak, 1998; O'Dell and Grayson, 1998; McDermott, 1999; Swan *et al*., 1999; Walsham, 2001), many KM-initiatives rely on ICT and KMS as important enablers. We acknowledge the warnings against a heavy emphasis on the use of ICT and KMS, but in this paper, given our conceptualization, we focus on how ICT and KMS can be used to support and enhance inter-organizational networks. For the networks, ICT and KMS is a necessary, but not sufficient, condition for effective and efficient knowledge managing.

KM IN INTER-ORGANIZATIONAL NETWORKS: TOWARDS A CONCEPTUALIZATION

Using existing theories, this section presents our conceptualization of knowledge managing within the context of inter-organizational networks. Our epistemological starting point is in business strategy theory, and specifically the resource-based view (RBV) of the firm. The main proposition of the RBV is that competitive advantage is based on valuable and unique internal resources and capabilities that are costly for competitors to imitate (Barney, 1991; Wernerfelt, 1984). Resources are assets available in the firm or which the firm can acquire. Capabilities are developed by combining and using resources; these resources can be capabilities. The knowledge-based view of the firm states that these resources and capabilities are knowledge-related and knowledge-intensive resources and capabilities (Grant 1996, 1997). A number of questions can be raised in relation to this view. First, what sources can be used to create, acquire, and integrate knowledge in knowledge-intensive processes, for example in new product development processes? Second, how can knowledge-intensive processes be designed in the first place, how can the processes be redesigned and adapted to changing technological and market conditions, and what resources and capabilities can be used to design the processes?

An answer to the first question can be found in the research suggesting that an important source for competitive advantage lies in an organization's networks of external relationships (Gulati *et al*., 2000; Nohria and Ghoshal, 1997; Kale *et al*., 2001). The RBV argues that competitive advantage is an outcome of resources and capabilities residing within the firm, but these capabilities can be 'directed' towards the environment of the firm. For example, a critical capability in an NPD process can be to use the Internet to communicate with customers to rapidly incorporate new or changed consumer preferences in new products. If the firm is able to exercise this capability faster than its competitors it can give the firm a competitive advantage. Support for the fact that capabilities can be 'directed' towards the firm's environment, can be found in the literature discussing how the RBV can be 'extended' to inter-organizational relationships (Eisenhardt and Schoonhoven, 1996; Choudhury and Xia, 1999).

An answer to the second question can be found in the discussion on the RBV, absorptive capacity, and dynamic capabilities. Most RBV-writings focus on stable rents that are costly, or impossible, to imitate. Some writers have addressed the dynamic nature of resources (Teece *et al*., 1997; Eisenhardt and Martin, 2000). From a KM-perspective this points to the importance of dynamic aspects of knowledge and knowledge processes. Teece *et al*. (1997) point out that the RBV recognizes, but does not attempt to explain, the mechanisms that enable a firm to sustain its competitive advantage. According to Cohen and Levinthal (1990), a firm's 'absorptive capacity' is critical to its innovative capacity. Absorptive capacity is a firm's ability to '... recognize the value of new, external information, assimilate it, and apply it to commercial ends' (Cohen and Levinthal, 1990). Recently, Zahra and George (2002a, 2002b) proposed a reconceptualization of

absorptive capacity as a dynamic capability '... pertaining to knowledge creation and utilization that enhances a firm's ability to gain and sustain a competitive advantage' (Zahra and George, 2002a). Zahra and George (2002a) argue that four distinct but complementary capabilities compose a firm's absorptive capacity: acquisition, assimilation, transformation, and exploitation. Acquisition is a firm's capability to identify and acquire external information and knowledge that is critical to its operations. A firm's routines and processes allowing the firm to process, analyse, interpret and understand the information and knowledge from external sources is referred to as assimilation. Transformation is a firm's capability to design and redesign the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge. Exploitation capability '... is based on the routines that allow firms to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations' (Zahra and George, 2002a). The primary emphasis is on the routines that allow firms to exploit knowledge. An important distinction is made between potential absorptive capacity and realized absorptive capacity (Zahra and George, 2002a). The former makes a firm receptive to acquiring and assimilating external information and knowledge and the latter reflects a firm's capacity to leverage the knowledge which has been acquired. Hence, the literature suggests that for innovative firms a crucial capability is the ability to recognize new external information and knowledge and through processes apply it to commercial ends. The dynamic capability and absorptive capacity views suggest that profits do not just flow from the assets structure of the firm/network and the degree of imitability, but also from the firm's/network's ability to reconfigure and transform. This ability is especially critical for firms in turbulent and high-velocity environments (Eisenhardt and Martin, 2000).

The above discussion points to two main uses of ICT and KMS in inter-organizational networks. First, as a general support in a firm's absorptive capacity; especially in its potential absorptive capacity. That is, to use ICT and KMS to identify and acquire external information and knowledge, and to process, analyse and interpret this information and knowledge. An example of the former is environmental scanning on the Internet using advanced search techniques and an example of the latter is knowledge discovery in databases—using data mining techniques—of databases containing external information. Second, as a support (resource or capability) in a specific knowledge process so that the outcome of the process will lead to a competitive advantage for the firm. For example, a firm can in an NPD process use the Internet to get customers' opinions about different product features. Using the Internet can lead to: (1) a faster process, speeding up the NPD process; and (2) an increased reliability in that more customers can be involved, leading to products with a better fit with customer expectations.

More than fifteen years ago, Thorelli (1986) stressed the importance of networks and the need for research on networks. Thorelli used the construct 'network' to refer to relationships between two or more organizations and argued that networks are hybrid intermediate forms and alternatives to markets and hierarchies. Other writers have used the term to refer to networks in an organization as well as between organizations. Following Laumann *et al.*, we define a social network as 'a set of nodes (e.g. persons, organizations) linked by a set of social relationships (e.g. friendship, transfer of funds, overlapping membership) of a specified type' (Laumann *et al.*, 1978). In knowledge managing the social network will be for enabling and supporting different knowledge processes. In Section 4, focus is on how the use of ICT and KMS can enhance and enable different types of inter-organizational social networks.

Although, the construct 'network' can be used to describe and explain observed patterns and processes, we advocate that it is used in strategic knowledge managing as a model and unit of design. We suggest that knowledge managing has to become network-focused if knowledge-intensive organizations are to gain and sustain competitive advantage from knowledge managing. Support for this can be found in a number of empirical studies. Von Hippel (1988) found that organizations' suppliers and customers were their primary sources of ideas for innovations. According to von Hippel, a network with excellent knowledge transfer among users, manufacturers, and suppliers will out-innovate networks with less effective knowledge sharing activities. In a study in the biotechnology industry it was found that the network of firms was the locus of innovation, not the individual firm (Powell *et al.*, 1996). Dyer and Nobeoka (2000) showed that Toyota's ability to effectively create and manage knowledge-sharing networks, at least in part, explains the relative productivity advantages enjoyed by Toyota and its suppliers. Liu and Brookfield (2000) found that Taiwan's successful machine-tool industry had a number of network structures. They also found that the networks in part explain the tool industry's success. These, as

well as other studies (e.g. Miles *et al*., 2000; Richter, 2000; Kale *et al*., 2001; Wynstra *et al*., 2001), demonstrate the importance of networks and that networks can be effective in all of the activities of knowledge processes—from knowledge creation to knowledge application and use. Castells takes the argument for networks to its limits:

> ... the network enterprise is neither a network of enterprises nor an intra-firm, networked organization. Rather, it is a lean agency of economic activity, built around specific business projects, which are enacted by networks of various composition and origin: *the network is the enterprise*. While the firm continues to be the unit of accumulation of capital, property rights (usually), and strategic management, business practice is performed by *ad hoc* networks. These networks have the flexibility and adaptability required by a global economy subjected to relentless technological innovation and stimulated by rapidly changing demand. (Castells, 2001)

As noted by several researchers, the notion of inter-organizational relationships and networks is not new (e.g. Venkatraman and Subramaniam, 2002); firms do not conduct all their business activities internally. It is well known that firms, based on transaction cost criteria, use outsourcing to lower costs despite the firms having the necessary resources and capabilities internally. In the knowledge economy inter-organizational relationships and networks are also created because firms do not possess the required knowledge-related resources and capabilities internally. Furthermore, inter-organizational relationships and networks can also be used to create new knowledge faster and embody it in new services and products which can reach the market faster or create a new market—the former is related to 'time to market' and the latter to 'competing for the market'. Inter-organizational relationships and networks are also created to share and disseminate knowledge, for example for the purpose of influencing emerging standards or for the purpose of influencing other firms to develop new products and services based on products, services, or knowledge of the disseminating firm.

Inter-organizational networks differ in their importance and criticality. Here we primarily focus on 'strategic networks'. Traditionally these networks

> ... encompass a firm's set of relationships, both horizontal and vertical, with other organizations—be they suppliers, customers, or other entities—including relationships across industries. These strategic networks are composed of inter-organizational ties that are enduring, are of strategic significance for the firms entering them, and include strategic alliances, joint-ventures, long-term buyer–supplier partnerships, and a host of similar ties. (Gulati *et al*., 2000)

Given the development of the Internet and other ICT, the durability requirement can be questioned. In some cases a network can have a strategic significance even if the network will not exist for a long period. For example, an Internet-based network used to capture ideas for a new product might exist just for a couple of days or weeks, but the network can have a major effect on an NPD process and in the end have a major positive effect on firm performance. A consumer network (consumer community), can be enduring, but the network (community) will have participants (consumers) entering and leaving the network. Hence, we refer to networks having or being likely to have strategic importance as strategic networks.

Inter-organizational networks can be of different types. We define three different types of inter-organizational networks for knowledge managing: (1) extra-networks; (2) inter-networks; and (3) open networks. Our classification is based on the possibility for an organization to design and govern a network (designed and governed by the firm vs. not designed and governed by the firm) as well as the openness of a network (open vs. closed networks). (It should be noted that there exists a growing body of literature on networks. Araujo and Easton (1996) and Oliver and Ebers (1998) say, after reviewing the literature, that the concept of networks varies in several dimensions, for example nature of links, nature of actors, orientation on structure and processes, and core areas of research interest.)

An *extra-network* is a network that is designed and governed by the firm. Participation in such a network is restricted (closed network). The network is a gated community, meaning that only specific nodes (individuals and organizations) are allowed to participate. For example, an extranet for specific R&D personnel in specific telecommunication equipment firms engaged in the development of new Bluetooth applications. An *inter-network* is also a network that is designed and governed by the firm, but participation in the network is not restricted. This type of network is open to anyone who wants to join and participate. An example is how Fiat used the Internet to have customers generating design ideas for its Punto model. Extra- and inter-networks are designed and governed by firms in order to use the external environment to create new knowledge, assimilate it, and apply it to commercial ends. An open network

is a network open for anyone interested and willing to participate in knowledge creation and sharing. The network is not designed or governed by the firm interested in using the external environment to create new knowledge, assimilate it, and apply it to commercial ends. A good example of this network type is the open source movement and the development of Linux and Apache (Raymond, 2001). It is estimated that the worldwide development community for the overall Linux operating system exceeds 40 000 developers (Raymond, 2001). Many open networks are based on 'gift economy' ideas. Hyde (1999) argues that gift economies are necessary for knowledge creation and dissemination in situations where creativity and ideas are crucial. Gift economies serve to bind people together, which means that they create and maintain social groups within established social boundaries. To become a member of a gift community, a person or organization has to qualify by giving and receiving gifts. Exchanging gifts means initiating and maintaining interactions. It is not only digital products or services being affected by 'gift economy ideas' (Raymond, 2001). Other examples are the use of 'copyleft' and the 'Open Cola' (recipes for Cola are shared free).

A network type can support different activities in knowledge-intensive processes. For example to use the Internet for product idea generation and product testing. Both activities are, using the Internet, in part outsourced to the customers. In relation to absorptive capacity, the three network types can be seen as new knowledge and information that, combined with other resources, can be implemented in business processes in order to develop capabilities to use the external environment for different knowledge-managing activities. A firm can have many inter-organizational networks. An absorptive capacity (dynamic capability) is to design, redesign, and terminate the networks, as well as to take stock of the possibilities ICT and KMS are offering, adapted to environmental conditions. The three types of networks are social networks, but we will here primarily focus on what ICT and KMS offer and how these technologies and applications can enhance inter-organizational networks. The Internet is the backbone for the three types of networks, but improvements in communication, computation, and concepts (Dahan and Hauser, 2002) can make the networks more valuable. Development in communications makes it possible to communicate fast and simultaneous with a large number of nodes (individuals or organizations) irrespective of time and space. The development includes increased connectivity and bandwidth. Increased computation capacity means, for example, that it is possible to dynamically adapt web-pages in real time while users are interacting. It also means an increased possibility to use complex mathematical algorithms to process data and, based on the results, adapt the interactions with the users. To increase conceptualization, audio and graphic capabilities of 'multimedia' computers are used, for example, to visualize products and product features. The next section shows how ICT can enable and enhance knowledge managing in the three types of inter-organizational networks.

KMS WITHIN THE CONTEXT OF INTER-ORGANIZATIONAL NETWORKS

Primarily, ICT and computer-based ISs (CBIS) have been used to gain and sustain competitive advantage through economies of scale or economies of scope. In the knowledge economy, ICT and CBIS (especially KMS) will also be used to gain and sustain competitive advantage through economies of knowing. In light of what we have presented, this section addresses the use of ICT and KMS in different types of inter-organizational networks. Before addressing the three types of networks, three changes and trends are worth noting: (1) easier access through knowledge portals; (2) increased mobility; and (3) infrastructure and architecture for network-based KMS.

One consequence of our conceptualization is that building, using, and maintaining networks is a critical capability, and can in some cases be a dynamic capability. ICT and KMS can be a significant means of enabling and supporting networks. They can link different nodes (people and organizations) and enable electronic communication across time and space. Increasingly, we will see that the gateway to ICT-based networks will be portals (Vering *et al.*, 2001)—in the case of knowledge managing: 'knowledge portals' (Mack *et al.*, 2001; Tsui, 2003). Knowledge portals (KP) are digital knowledge 'workplaces' that have been designed to provide a single access point to internal and external applications, information, and services for an organization's knowledge workers, partners, customers, suppliers, and other persons/organizations that an organization is cooperating with. The KP is an entry point to information, applications, and services available primarily via the Web. The information and knowledge, applications, and services made available through a KP can be personalized depending on participation in networks. The use of a KP will make it easier to develop and change networks, for example to add and delete participants as well as to add and delete information,

applications, and services. It will also make it easier for persons and organizations to access networks. Applications and services made available in a KP can include:

- Technologies to automatically capture and gather external information, for example, customer information.
- Document capturing, analysis, and organization technologies (including technologies for categorization and clustering of documents).
- Technologies for browsing and searching documents.
- Support for analysis, synthesis, and authoring of information (incl., for example, applications like statistical analysis and data mining tools).
- Communication tools, including, for example, e-mail, bulletin boards, instant messaging, IP telephone, audio- and video-conferences.

In the last years many KM-tool vendors have repositioned their product offerings to align with the growing portal market (Tsui, 2003).

A problem with many KMS is that the intended users have to come to the KMS, for example, by finding a PC hooked up to the Internet. Knowledge workers, partners, customers, etc., are not always tied to specific places when participating in knowledge-intensive processes. Increasingly, the needs of knowledge workers and other persons (like customers) involved in knowledge managing activities are real-time, situational, and unpredictable (Keen and Mackintosh, 2001). Mobile KMS can be a means for overcoming the real-time, situational, and unpredictability problem. This means that the gateway to an inter-organizational network in many cases will not only be a KP, but actually a mobile KP (m-KP). KP makes it possible to have a personal gateway to desired information and knowledge, applications, and services. Mobile-KP can further reduce persons' burdens of getting access to desired sources and resources at moments of relevance and truth. For example, an organization can make it possible for a customer—using a Wap-phone—to make comments (feedback) about a service or product at the moment of experiencing the product or service.

In the last years, hardware and software companies, as well as service providers, have been promoting a new approach to organizational information systems. The approach is based on the idea that organizations will increasingly buy and rent extensive parts of their ICT and services over the Internet rather than owning and maintaining their own hardware and software (Hagel, 2002). The approach is launched under a number of different concepts: '.Net' (Microsoft), 'Web services' (IBM), 'network services' (Oracle), and 'open network environment' (Sun). A result of this trend is that previous proprietary architecture—where companies built and maintained unique internal KMS—will to a growing extent be substituted by an open architecture where companies can rent data storage, processing power, specific applications, communication capabilities, and other services from different types of external service providers. Hagel and Brown (2001) and Hagel (2002) describe the approach as an architecture having three layers: (1) software standards and communication protocols; (2) service grid; and (3) application services. The first layer contains different foundation standards and foundation protocols—the former, for example, UDDI (Universal Description, Discovery, Integration), XML (eXtensible Markup Language), WSDL (Web Services Description Language), and WML (Wireless Markup Language), and the latter, for example, TCP/IP (Transmission Control Protocol/Internet Protocol), SOAP (Simple Object Access Protocol), and HTTP (HyperText Transfer Protocol). This layer allows data to be exchanged 'easily' between different applications and it also allows data to be processed easily in different types of applications. The second layer, the service grid, builds upon the protocols and standards and provides: (1) shared utilities, e.g. security; (2) service management, e.g. monitoring; (3) resource knowledge management, e.g. data brokers and data transformation; and (4) transport management, e.g. filtering (Hagel, 2002). The application service layer contains different application services. For example, Application Service Providers (ASP), such as Zoomerang, are offering web-based surveys and a number of other ASP have announced commercial applications for the design of web-based surveys. Some of these applications make it possible for a firm to, through a web-based menu-driven system, choose product/service features and feature levels to be tested. Given this information, the ASP sets up the web-page to be visited by the respondents. The ASP also sets up the database, collects data, and makes analysis. Using an application like that described, a firm can gather sophisticated market information in a few days and, for example, improve its new product development process. It can speed up the process and also get inputs from more customers or potential customers.

The described approach—renting and buying ICT and services over the Internet—and the three-layered architecture suggest a number of changes regarding using ICT and KMS in inter-organizational networks. For example, inter-organizational KMS will increasingly be built and

maintained using non-proprietary hardware, software, and data. Furthermore, these KMS can be more flexible and dynamic which could make it easier to develop and change inter-organizational networks.

KMS in inter-organizational NPD networks

Having described some general changes and trends affecting the development and use of ICT-based inter-organizational networks, we now address KMS in inter-organizational networks. For illustration we choose a critical core business process: new product development (NPD). There are several reasons for the choice. First, NPD is a business process that is highly knowledge-intensive and one of the key business processes for creating new organizational knowledge (Nonaka and Takeuchi, 1995; Madhavan and Grover, 1998). Second, in many industries NPD projects are under pressure to accelerate development cycles and decrease development costs, while increasing design quality and flexibility (Towner, 1997; Iansiti and MacCormak, 1997). Third, from a learning perspective for an organization, NPD is the context from which the organization is most likely to transfer methods (resources and capabilities) to other areas of the organization. NPD is seen as a main driver of organizational renewal. It is a continuous process of knowledge-related activities, in which the organization is adapted to its changing environment and technologies (Dougherty, 1992). Nonaka and Takeuchi say it most elegantly: 'Organizational knowledge creation is like a ''derivative'' of new-product development. Thus, how well a company manages the new-product development process becomes the critical determinant of how successfully organizational knowledge creation can be carried out' (Nonaka and Takeuchi, 1995). Hence, what we discuss should be applicable to other core business processes. Fourth, in NPD, as well as in many other core business processes, knowledge-related activities play a critical role, and thus provide excellent leverage points for ICT- and KMS-enhancement. Fifth, NPD projects are increasingly using external sources and resources to overcome the learning curves related to new markets and new technologies (Schilling and Hill, 1998).

NPD can be viewed and described in many different ways (Cooper and Kleinschmidt, 1986; Brown and Eisenhardt, 1995). For our illustration, we will use a model consisting of three major phases: (1) creation phase, exploration; (2) development phase, exploitation; and (3) diffusion and ending phase, exportation (Ancona and Caldwell, 1990). Exploration, exploitation, and exportation require different types of KM-activities. Therefore, networks, ICT, and KMS supporting NPD must facilitate diverse patterns of KM processes and activities. First, we discuss the use of extra-networks and inter-networks in the three NPD phases and exemplify how ICT/KMS can enable and support the networks and the phases. This is followed by a discussion on how open networks can be used in the NPD phases. (The reason for this separation is that a firm has a great possibility of governing the extra-networks and inter-networks, but it cannot govern an open network although it can, through its activities, affect knowledge-related processes in the network.)

Creation phase (exploration): opportunity identification, ideas and concepts generation

The role of customers as information and knowledge sources for new product and service ideas and opportunities is well documented in the literature (Lengnick-Hall, 1996). ICT-based extra- and inter-networks open up new ways to involve the customers in the creation phase. Using an *extra-network* in the creation phase a firm can create a 'gated-community' and involve those customers (nodes) perceived to be useful idea generators and innovators (the term customer denotes both current customers as well as potential customers; it denotes both industrial customers as well as consumers). For example Hallmark Inc. uses its Hallmark Knowledge Creation Community together with its lead retailers to generate ideas on new product designs, e.g. new greeting cards (Kambil *et al.*, 1999). Using an *inter-network* in the creation phase a firm makes it possible for any customer (node) to participate in the phase. It can lead to an input from a larger number of customers, but the firm must have an elaborate way to manage the many, and maybe diverse and inconsistent, ideas. There is a risk that the firm ends up with extraneous information that can complicate the creation phase and lead the NPD process astray. As noted above, Fiat used an inter-network to generate design ideas for its Punto model. Fiat invited customers to select features for the car on its web-site. More than 3000 people took the chance and gave Fiat valuable design information—this is a good example of co-creation using an Internet-based inter-network (Iansiti and MacCormack, 1997).

A number of ICT-based tools and services are available for use in extra- and inter-networks. As noted above, Zoomerang (zoomerang.com) offers a web-based application service that can be used by firms in the creation phase (it can also be used in the other phases). The service allows a firm to

seek out ideas. Through a web-based menu-driven system the firm can create a survey, for example for concept testing, and customize it in different ways. The created survey can be sent to customers from the firm's e-mail list or to a sample provided by Zoomerang. It can also be placed as a link on a Web-site. It is also possible to manage the survey, for example, controlling status and inviting new customers. Based on the responses, Zoomerang calculates the result and presents it in tables and graphs.

Dahan and Hauser (2002) present and review other web-based methods for generating and capturing knowledge from customers. One method is the information pump (Prelec, 2001). The information pump (IP) is a 'focused group' and in essence IP enables customers to interact (discuss) with each other through a web-based game. This is a way for customers to verbalize the product features that are most important to them. The customers pose and answer each other's questions. Individual incentives are 'bootstrapped' by comparing the information provided by one customer against that provided by other customers at the same time. A customer gets credits for '... presenting statements that are non-redundant on what has previously been said and that are recognized as relevant (an 'a-ha') by the others' (Prelec, 2001). One of IP's strengths is its ability to gather customers' language. This means that it can be useful in generating and testing integrated concepts that can be hard for customers to articulate or when customers have problems generating and evaluating specific features.

Although, KMS can be used in the creation phase, there are several critical question to be addressed before using extra- and inter-networks in the phase: (1) what customers should we try to involve and how can we establish links with them; (2) what incentives can create and foster customer participation; and (3) how should the acquired customer knowledge be integrated into our internal NPD-process. It is also critical to ask the right question to be able to acquire relevant knowledge. Some argue that involving customers in idea generation will lead to imitative and unimaginative products and services. Ulwick (2002) argues that organizations should stop asking customers what they want. Instead, they should ask what the customers want the products and services to do for them. Some of the available ICT- and Web-based tools can be used for generating ideas on what products should do for the customers.

Development phase (exploitation): design and engineer

Customers can also play critical roles in the development phase. Customer involvement can range from design to development and engineering. In the software industry it is common to have customers as members of NPD projects. For example, to use an *extra-network*, like Xerox (Sawhney and Prandelli, 2000), to involve a selected group of customers in product design and development—these customers represent the most valuable and important customers. Using an *inter-network*, the statistical software package developer and seller Stata encourages its customers to develop add-on modules for performing the latest statistical techniques. The best of those are adopted and incorporated in later releases of the firm's products. Using an inter-network in the development phase can be problematic if a large number of customers would be interested in participating. A problem will be to handle a large number of designs. Firms can also use ICT-based inter-networks, for example, to offer customers the possibility to design their products, within given constraints—more on this below.

User design (UD) can also be used in the development phase. UD has some similarities with what some firms, like Dell (Dell.com) and Gateway (gateway.com), are offering customers today. The firms offer customers the possibility to configure and order products by selecting features from drop-down menus. By using UD in an NPD process it is possible to show to a customer the results of choices interactively and to track the process (i.e. tracking the customer–system interaction). UD enables an NPD-project to understand feature interactions, even for complex products. It also allows customers to learn their own preferences for new products and product features. Using web-based UD makes it possible to show real and virtual features to a customer and to display changes interactively. This makes it possible for an NPD-project to have better knowledge when determining what products and product features to offer customers.

An alternative approach is actually to allow customers, using 'toolkit for customer innovation,' to design and develop their specific products (Thomke and von Hippel, 2002; von Hippel, 2001). A 'tool kit for customer innovation' is a user-friendly 'package' developed using new ICT and techniques and used by customers to develop the application-specific part of a product. The toolkit gives customers the possibility to '... develop their custom product via iterative trial-and-error. That is, users [customers] can create a preliminary design, simulate or prototype it, evaluate its functioning in their own use environment, and then iteratively improve it until satisfied. As the concept is evolving, toolkits guide the user to ensure that the completed design can be produced

on the intended production system without change' (von Hippel, 2001). Putting a toolkit in the hands of customers changes an NPD process. It means that a firm can abandon its attempts to really understand customer needs in detail and transfer the design and development of need-related aspects of products and services to customers. A firm can capture toolkit interactions and feed this knowledge into its NPD-processes. Given the development in technology and techniques we can expect to see more of toolkit design and development by consumers. We can also expect to see third parties developing toolkits that can be used to design a number of different products (e.g. cameras, DVD players) or a specific product (e.g. a copying machine) from different suppliers—the toolkit can be an application service (discussed in Section 4).

Diffusion and 'ending' phase (exportation): testing and support

In the diffusion and ending phase customers can provide information and knowledge through acting as testers of the 'final' product. They can also provide information and knowledge based on their experiences on various aspects of product use. An extra- or inter-network can be set up for testing a product. In the case of digital products, like software, customers can act as beta testers and the product to be tested can be distributed to the testers over the net. In the case of an *extra-network* this means that the organization will select a few customers to act as testers. In the *inter-network* case this means that the firm will allow all customers to act as testers. Compared to doing the test in-house, using customers as testers can lead to a speed-up of the testing process, decreased cost for the test, and a more varied test of the product. The testing of a product, like software, can continue even after the product has been launched. For non-digital products, virtual concept testing offers an alternative way to test products (Dahan and Hauser, 2002). In virtual testing, consumers view new product concepts and products and indicate what concepts they are likely to buy at varying prices. With the development of multimedia concept representations and increased bandwidth, virtual concept testing can reduce the time and cost of testing. Also, it can lead to an increased number of concepts being tested as well as an increase in the number of testers.

Consumers can also play a critical role in the diffusion and ending phase as expert users of the product—consumers as expert user (Nambisan, 2002). Some organizations are creating online communities for their customers (McWilliam, 2000). In these communities the customers can exchange experiences (knowledge) on ways of using the product, new ways to use the product, and problems in using the product and how to solve these problems. In general, exchange of knowledge on how to enhance the overall value of the product. Online communities can be a valuable source for customers, but they can also be a valuable source for the product firm. The exchanged knowledge in a community can be captured and fed into the firm's NPD processes. Firms like Artificial Life (artificial-life.com) offer tools that can be used to retrieve and analyze information from online discussions using neural networking, fuzzy logics, and statistical analysis (McWilliam, 2000). Artificial Life also offers smart bots that can be used to bring a human-like presence and appearance to the points of contact between a firm and its customers (smart bots are intelligent software products that integrate computer interaction and natural language understanding). Using these types of products it is possible for a firm to make online communities easier to use and more attractive. It is also possible for the firm to turn electronic discussions into knowledge that can be used in NPD processes.

The third type of inter-organizational network is an open network. An open network is a network open for anyone interested and willing to participate in knowledge creation and sharing. From a firm's perspective, an open network is problematic to use as source for creating and capturing useful knowledge, since the network is not designed or governed by the firm. A firm can participate in an open network and the participation can be linked to all three NPD-phases. Increasingly, open networks affect 'traditional' NPD processes, most notabe is the open-source movement and the development of Linux. In the software industry, firms are increasingly forced to react to the open-source movement and they also increasingly have to 'manage' knowledge processes in these new environments. IBM's decision to place in-house tools in the public domain exemplifies this (Thompke and von Hippel, 2002; Sawhney and Prandelli, 2000). Recently, IBM placed $40 million of in-house tools for developing software into the public domain to encourage people to develop programs that run on Linux. This means a major change from how IBM traditionally develops software and might have a major impact on how IBM 'manages' software knowledge. Being part of an open network means that a firm is outsourcing a portion of a knowledge-intensive process to participants (like customers) in the open network (Thompke and von Hippel, 2002). This can be an effective approach for speeding up the development of

new products better suited to customers needs or for tapping into the knowledge created and shared with the open network.

Our conceptualization and examples suggest that the networks differ in critical ways. Moving from extra-networks to open networks the following are likely consequences for a firm using the networks for knowledge-managing activities in NPD:

- Decreased possibility of governing the network leading to a lower degree of disciplined knowledge managing, for example a lower level of NPD as disciplined problem solving.
- Decreased degree of stability of the network leading to more chaotic knowledge managing—can also lead to creative destruction.
- Increased degree of openness to the external environment and an increased amount of information and knowledge is available. This can lead to a higher level of NPD as a 'communication web'.

CONCLUSIONS AND FURTHER RESEARCH

Using a conceptual-analytic approach we developed a conceptualization of knowledge managing in inter-organizational networks. The paper is a step in the development of our understanding of 'economies of knowing'. Further theoretical work is needed to tighten the conceptualization. Empirical research is also critical in helping us understand how firms get to be good at knowledge managing in inter-organizational networks, how they sometimes stay that way, why and how they improve their knowledge managing, and why sometimes knowledge managing declines. We also need more theoretical and empirical work on how ICT can be used for strategic knowledge managing in inter-organizational networks. The presented conceptualization and exemplifications can be used to generate new research issues in inter-organizational knowledge managing. A number of issues have not been addressed in the paper, for example, legal aspects, like licensing and patents issues related to products and services that are developed in inter-organizational networks.

The paper suggests that the potential for using ICT and KMS in inter-organizational network is there, but no one can guarantee the outcomes. Although there is a growing number of enabling and emerging technologies that can be used in knowledge-based inter-organizational networks and used to develop absorptive capacity (a dynamic capability), strategy research stresses the importance of path dependence that influences a firm's decision to develop new processes, adopt new technology, or to provide new products and services (Zahra and George, 2002b).

In our example we have used NPD and customers, but the underlying idea, the technology, and the techniques presented can be used in other core business processes where firms like to use inter-organizational networks to create and capture knowledge. Also, other stakeholders and groups like suppliers, partners, and complementors can be used as sources (nodes) in the networks.

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