



Knowledge management in knowledge-intensive service networks

Knowledge
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service networks

A strategic management approach

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Abstract

Purpose – The main purpose of this paper is to analyze knowledge management in service networks. It analyzes the knowledge management process and identifies related challenges. The authors take a strategic management approach instead of a more technology-oriented approach, since it is believed that managerial problems still remain after technological problems are solved.

Design/methodology/approach – The paper explores the literature on the topic of knowledge management as well as the resource (or knowledge) based view of the firm. It offers conceptual insights and provides possible solutions for knowledge management problems.

Findings – The paper discusses several possible solutions for managing knowledge processes in knowledge-intensive service networks. Solutions for knowledge identification/generation, knowledge application, knowledge combination/transfer and supporting the evolution of tacit network knowledge include personal and technological aspects, as well as organizational and cultural elements.

Practical implications – In a complex environment, knowledge management and network management become crucial for business success. It is the task of network management to establish routines, and to build and regularly refresh meta-knowledge about the competencies and abilities that exist within the network. It is suggested that each network partner should be rated according to the contribution to the network knowledge base. Based on this rating, a particular network partner is a member of a certain knowledge club, meaning that the partner has access to a particular level of network knowledge. Such an established routine provides strong incentives to add knowledge to the network's knowledge base

Originality/value – This paper is a first attempt to outline the problems of knowledge management in knowledge-intensive service networks and, by so doing, to introduce strategic management reasoning to the discussion.

Keywords Knowledge management, Tacit knowledge, Service industries, Networking

Paper type Conceptual paper



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Introduction

Current markets are characterized by high complexity caused by decreasing market entry barriers, increasing competition, shorter (product) life cycles, and increasing risk. Potentially, this complexity challenges the roots of corporate success; in particular, it fundamentally changes the meaning of knowledge management for business performance. Accordingly, Nonaka (1991) notes: "In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge". Obviously, the knowledge of a firm is the key resource that can lead to sustained competitive advantage (Dierickx and Cool, 1989; Grant, 1996; Teece, 1998; Gupta and Govindarajan, 2000). This is particularly true for the highly developed service sector, which constitutes the fastest growing industry worldwide (Hodgson, 2003). Because not all knowledge necessary to provide complex services can be accumulated in a single firm, the perceived uncertainty concerning future knowledge requirements is relevant for the evolution of inter-organizational networks (Tenkasi and Boland, 1996; Grant and Baden-Fuller, 1995; Powell, 1998). Therefore, the generation, combination, transfer, application, and storage of knowledge become key tasks for network management (Knight and Harland, 2005).

This paper attempts to offer practical solutions for managing knowledge processes in service networks. It will be shown that during the process of knowledge identification and generation, management needs to establish a culture of understanding other network partners. This cultural aspect needs to be accompanied by technological solutions such as groupware solutions, knowledge platforms or yellow pages, and new intra-network institutions such as knowledge clubs. Knowledge combination and transfer can be facilitated by incentives and sanctions such as a network partner evaluation system, or by rotating personnel. A practical solution during the application of knowledge phases is the creation of trust between the network partners. This can be achieved by formal or informal meetings between the partners. In order to avoid the loss of network knowledge, it needs to be mandatory for all network partners to properly document their knowledge. In return, the network must grant knowledge patents in order to indicate who has contributed that particular piece of knowledge. Overall, each network partner needs to be rated according to the contribution to the network knowledge base. Based on this rating, a particular partner is a member of a certain knowledge club, meaning that the partner has access to a particular level of network knowledge.

The remainder of the paper is organized as follows: based on a definition of knowledge and knowledge management, and on a systematization of networks and services, this paper analyzes knowledge management challenges in knowledge-intensive service networks. Subsequently, solutions to these problems are outlined, based on theoretical as well as empirical insights from the literature. Particularly, the role of tacit network knowledge is outlined. The paper concludes by summarizing the main results and outlining fruitful areas for future research.

Knowledge-intensive service networks as the object of analysis

Knowledge as a basis of core competencies

The concept of knowledge has been investigated in varied disciplines such as philosophy, psychology, sociology, or business sciences (e.g. Berger and Luckmann,

1966; Polanyi, 1966; Popper, 1972; Squire, 1987; Nonaka and Takeuchi, 1995; Jasimuddin *et al.*, 2005). In an economic context, knowledge is often complemented with the differentiation between knowledge, information, and data. That distinction is inspired by information theory (Bollinger and Smith, 2001; Kakabadse *et al.*, 2003). As the basis for core competencies, organizational knowledge arises from the integration of the individual specialized knowledge of members within the firm (Grant, 1996). Through this combination of individuals, and through shared goals, cause-and-effect beliefs, or general shared beliefs, knowledge structures at the organizational level emerge (Hedberg, 1981; Daft and Weick, 1984). Organizational knowledge appears in procedures, rules, norms, strategies, and technologies, and is a result of interrelations between individuals acting on behalf of the organization (Nelson and Winter, 1982; Weick and Roberts, 1993). Clearly, it should not be inferred that organizations have minds in the same sense that human beings do, but rather that only through the individuals acting on behalf the organization can organizational knowledge evolve (Inkpen and Dinur, 1998). On the other hand, no individual has the abilities needed to provide services in the way that an organization can. Assigning the tacit-explicit continuum used to analyze individual knowledge, organizational knowledge can be described as mostly tacit (Inkpen and Dinur, 1998), whereby (completely) tacit knowledge can be defined as knowledge that cannot be verbalized or formalized (Polanyi, 1959). No individual can grasp and explain the overarching organizational knowledge of a firm and it cannot be transferred from one organization to another.

In this paper both the individual and the organizational perspective are relevant for analyzing problems of knowledge combination, transfer, application, and storage. Problems of transferring knowledge and making use of knowledge are analyzed on the individual level. The organizational perspective is necessary in order to analyze the combination of distinct competencies of the network partners, while considering the individual as well as the organizational level is needed during the phases of knowledge storage.

Complexity and services

There are many classical approaches for systematizing services (Chase, 1978; Lovelock, 1983; Schmenner, 1986; Wemmerlov, 1990). Our study uses Schmenner's (1986) classification as the basis. It is, however, modified through the use of service complexity, rather than individualization, because the first includes the second. Complexity refers far more purely to that quality of systems in which a large number of different circumstances can be assumed within a given time span, which renders the understanding and management of those circumstances more difficult. A large number of possible circumstances lead to manifold and relatively unpredictable or uncertain behavioral possibilities. Apart from the complexity of services, labor intensity plays an important role. Labor intensity (or capital intensity), refers to the proportion of personnel costs to those of machinery and equipment (Schmenner, 1986, p. 22, Table 1).

Both criteria relate to the knowledge intensity of the services offered. There is a continuum ranging from very simple, mainly machine-made and standardized services, to highly complex, human-made, and individualized services, as depicted in Figure 1. For instance, dry-cleaning or car-washing would be in the lower left-hand quadrant, and consulting services and the like would be in the upper right-hand quadrant.

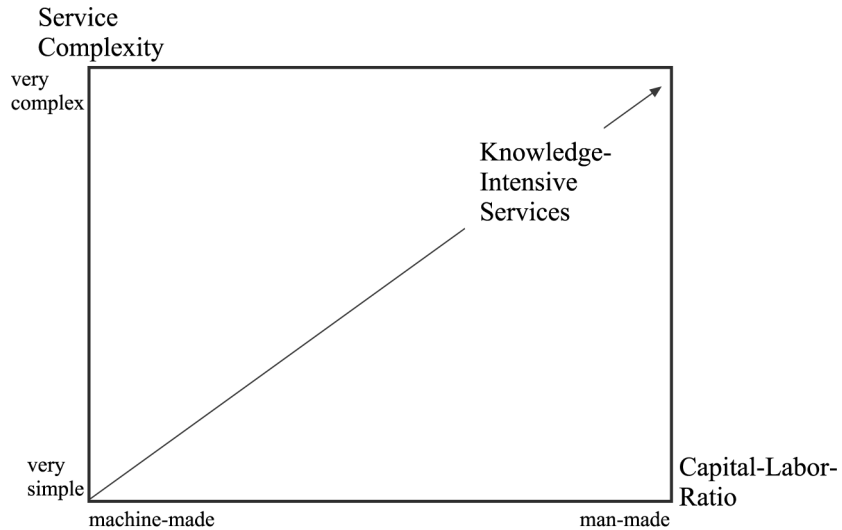


Figure 1.
Knowledge-intensive
services

Systematization of networks

Just as is the case for services, there are many different approaches toward the systematization of networks (Jarillo, 1988, 1993; Hakansson and Snehota, 1989; Oliver, 1990; Miles *et al.*, 1992; Alter and Hage, 1993; Wasserman and Faust, 1993). For the purpose of this paper, three criteria are of particular interest, since networks strive to minimize costs, maximize utility, and coordinate activities leading to these two cost and utility goals. These factors are:

- (1) the type of agents doing transactions,
- (2) the resource dependency of network partners; and
- (3) the type of network coordination.

The rationale behind engaging in a network-like form is the search for the exchange mechanism that minimizes the sum of production costs, transaction costs, and cooperation costs deriving primarily from negotiating the contract and controlling agreed-upon rules. It is crucial to determine the type of actors interacting in the network. These include social networks (e.g. Wasserman and Faust, 1993) modeling relationships between persons, internal networks (e.g. Miles *et al.*, 1992) modeling personnel relationships in a firm, and inter-organizational networks (e.g. Jarillo, 1988) modeling relationships between firms. Since knowledge is created mainly by informal means, the importance of personnel, and especially of internal networks, becomes apparent. For the purpose of this study, we first consider the inter-organizational network which consists of several firms. These players are tied together with increasing intensity from contracts to licensing agreements to profit-center organizations. In such an inter-organizational network, several internal networks exist, as well as networks within the network (i.e. internal networks from the perspective of the network as a whole). With respect to knowledge creation, the interacting agents are persons: one is a knowledge-seeker and one is a knowledge-provider. Considering the fact that a knowledge transfer is rarely a

singular event, but more often is an iterative exchange process, the roles of knowledge-seeker and knowledge-provider will be switched regularly (Szulanski, 2003).

Adding to that (essentially) transaction-cost-based approach toward networks, a more managerial approach poses the following question: which type of configuration best fits the relative, resource-induced power between the service-central (back office) and the service-provider (front office)? The rationale behind this resource-based approach toward networks is not to minimize costs, but to maximize value through gaining access to other firms' or other persons' valuable resources, especially their knowledge (Das and Teng, 2000; Teece, 1998). Resource dependency theory proposes three factors that determine the degree of dependency between two units (Pfeffer and Salancik, 1978):

- (1) resource importance;
- (2) availability of alternatives; and
- (3) degree of discretion.

Maximum dependency occurs when one unit has unfettered discretion over an important resource to which no alternatives exist.

It is obvious that there is reciprocal dependency in networks. The actors try to promote the form of organization that best reflects their perception of dependency, specifically the relationship between resources given and resources received (Pfeffer and Salancik, 1978). The third systematization criterion is the coordination intensity of the network. Coordination methods are shown within a domain which is based on two main criteria – the level of autonomy on the one hand and the level of commitment on the other. The level of commitment refers to the degree to which parties participating in the network coordinate their behavioral patterns. A high level of commitment means that most areas of activity are constrained. The level of autonomy then specifies how much freedom the actors have at their disposal. These two factors determine the level of coordinating intensity of the network.

Figure 2 outlines the positioning of service networks in a two-dimensional space, differentiating between a core network in which the partners are highly dependent upon each other and coordinate their activities rigidly, and a peripheral network where dependency and coordinating intensity are low.

This scheme applies to inter-organizational and internal networks alike. The coordinating intensity in an internal network is determined largely by the employment contract, whereas autonomy and commitment determine the level of coordinating intensity in inter-organizational networks and network internal networks.

Knowledge-intensive service networks

Knowledge-intensive service networks can be defined as cooperative arrangements of a certain coordinating intensity between more than two legally independent partners on the inter-organizational level (firms) and more than two actors on the internal level (persons), which, nonetheless, are not (entirely) independent in terms of economic cooperation. The network partners produce a mainly human-made, highly complex service. The relationship between the participating actors goes beyond pure market aspects (spot contracts). That is, they continue for a particular time frame and are not once off but ongoing (at least several times) in the market. Likewise, there is an

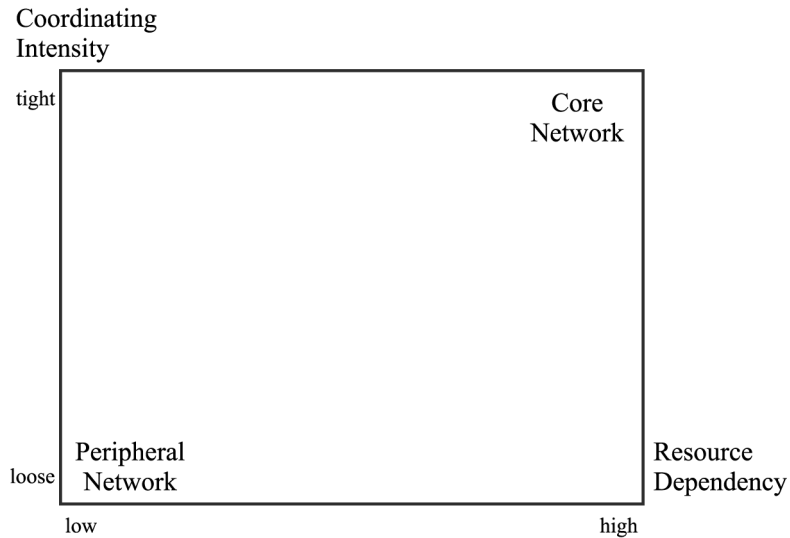


Figure 2.
The core and the peripheral network

exchange of resources, particularly knowledge, between the participating network partners, which, in turn, results in (mutual) resource dependency. A good example of such a knowledge-intensive service network is the cooperation between highly specialized consultants who work for a continuous time with a client in a mergers and acquisitions project. Another example might be the work of several highly specialized companies such as geologists, managers and architects and (local) real estate companies developing new tourist destinations. Moreover most scientific projects, such as the PIMS or ARF Copy Test Project, are good examples of knowledge-intensive service networks as well.

Knowledge management concept for knowledge-intensive service networks

The service production process from a knowledge perspective

As mentioned, the service markets are currently characterized by high complexity. The underlying effects responsible for these are digitalization, globalization, and innovations in information and communication technology (Augier *et al.*, 2001). In addition, these developments force firms to participate in networks in order to be successful. The partners in these networks focus on their distinctive competencies.

The result of this trend towards specialization is that complex, knowledge-intensive services requiring the integration of different types of specialized knowledge can no longer be produced by a solitary firm (Grant and Baden-Fuller, 1995). It can be assumed that one major success factor for these knowledge-intensive service networks is the effective and efficient management of knowledge.

Figure 3 shows the production process for normal services produced by an individual firm, and the production process for complex, knowledge-intensive services. At the level of an individual firm, services are produced through combining the individual knowledge backgrounds of the firm's personnel with information provided

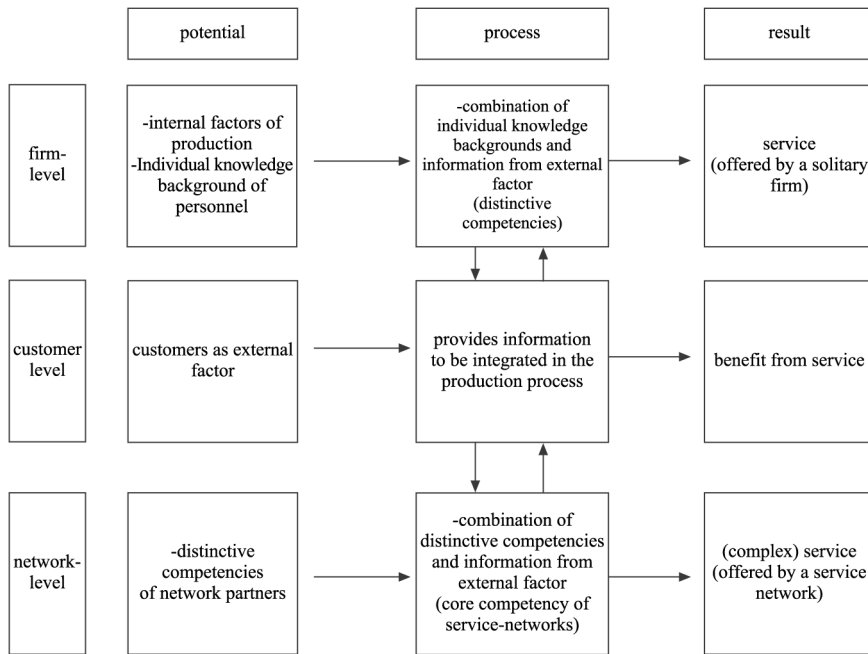


Figure 3.
Knowledge-intensive service production process

by the external factor. The integration of the external factor is the constituent element of services (Chase, 1978). On an abstract level, and especially in the context of knowledge-intensive services, information provided by the external factor must be integrated in the process of service provision (Bettencourt *et al.*, 2002).

The ability to combine internal potential (based on the individual knowledge backgrounds of personnel) with information from the external factor to produce a service can be described as the distinctive competency of the individual firm.

The core competency of the knowledge-intensive service network can be seen in the ability to combine the distinctive competencies of the network partners with the external factor in order to produce unique services for the customer. That can be a simultaneous combination of (asymmetric) competencies of the network partners at the time the service is produced, or a transfer of knowledge that enables the network partners to permanently execute certain tasks. One may, for instance, imagine a typical merger and post-merger integration project: In the process of a merger, experts in management, post-merger integration, law, and finance are required to work together by pooling their asymmetric resources in order to successfully merge two firms. Specialized knowledge (e.g. knowledge about strategy and markets of the merging companies, knowledge about contract law, knowledge about finance) is necessary for successfully completing the process. This knowledge is often provided by management consultants, investment banks, and law firms. These firms sometimes work together on a contract basis, but other times the specialized firms may form a network.

Challenges for knowledge management in knowledge-intensive service networks

The attempt to combine the distinctive competencies of the network partners presents several challenges for knowledge management in knowledge-intensive service networks. Building on the service production process and the process of knowledge management applied to a network context, these problems will be discussed in the following sections. The analysis is structured using the knowledge management process with the following four phases:

- (1) knowledge generation/identification;
- (2) the combination/transfer of knowledge;
- (3) the application of knowledge; and
- (4) the storage and embodiment of the experiences.

The differentiation between the phases follows mainly analytical purposes, while in practice the phases often overlap.

Challenges concerning knowledge generation and identification. Knowledge is seen as a critical resource that enables individuals and, on a higher level, organizations to solve problems and to be competitive. A knowledge-intensive service network must solve complex problems in order to provide services of outstanding quality to customers. The quality of the service offering depends on the transparency concerning existing knowledge resources within the service network. In the *potential dimension* the optimal combination of individual knowledge and external information from the customer can only be achieved if every network partner (if possible, every individual in the network, depending on the size of the network) reveals his or her capabilities. This revelation does not imply that knowledge has to be codified completely, but parts of the existing knowledge should be explicated in order to appraise the abilities of an individual or a network partner. The mere revelation is only the necessary condition. The creation of transparency is the sufficient condition for effective combination and, likewise, for transfer and application of knowledge. The importance of the identification of knowledge resources, even within a single company, has been shown by Szulanski (1996, 2003). Ignorance was identified as a primary barrier impeding the transfer of knowledge within the firm. The knowledge holder did not know that his knowledge was needed. On the other hand, the knowledge seeker did not know that someone else in the firm had the particular knowledge he was looking for (O'Dell and Grayson, 1998).

Therefore, it is an essential task for a network knowledge management to identify existing knowledge resources in the network. As a result, all individuals taking part in the service production process must have a general idea of the knowledge base of the network. In order to achieve this task, network knowledge management must overcome several barriers. One problem could be knowledge-hiding, meaning that individuals or organizations do not reveal their capabilities, trying only to profit from the knowledge of other network partners. The other extreme is an overestimation of capabilities. Organizations may pretend to be capable of doing something or of having some kind of knowledge resource in order to be a member of the network.

If not all knowledge resources necessary to fulfill the service are existent within the network, knowledge must be generated either by transferring knowledge from outside the network or by developing new knowledge internally. Generating knowledge

presents additional barriers for network knowledge management. Typical transfer problems could occur (von Hippel, 1994; Szulanski, 1996, 2003; Becker and Knudsen, 2003), including problems concerning the motivation of the source to make knowledge available, and the motivation of the recipient to utilize this knowledge. In addition, the nature of the knowledge could present problems, especially for the recipient, who must be able to learn to use the transferred knowledge. Another problem becomes apparent when observing the nature of knowledge resulting, to some degree, from causal ambiguity of knowledge (Dierickx and Cool, 1989; Reed and DeFillippi, 1990). Network knowledge management has to determine what kind of knowledge is needed to fill the resource gaps.

Challenges during the combination and transfer of knowledge. The combination and transfer phase of knowledge could be attached to the *potential* and to the *process dimension* of the service production process. A network knowledge management problem lies in finding the most effective and efficient mix between combining distinctive know-how versus transferring know-how in order to make it usable for some or all network partners. Knowledge transfer is appropriate to avoid redundancy or the recurrence of time-consuming and costly mistakes (McAdam and McCreedy, 1999). Successfully transferring and reconstructing knowledge can multiply capabilities within the network, because the knowledge provider does not lose the knowledge transferred, while the recipient can build up a useful new capability for the network. Franchise networks, for example, rely heavily on the transfer and replication of knowledge (Langenhan, 2003). On the other hand, the transfer of specialist knowledge is expensive and time-consuming, or sometimes impossible, because of the tacitness of individual knowledge and, in particular, of organizational knowledge (Jensen and Meckling, 1992; Jensen, 1998). Additionally, the explication and transfer of specialist individual or organizational knowledge could endanger the competitive advantage of organizations because the core competency becomes imitable (Spender, 1994; Loebecke *et al.*, 1999; Argote and Ingram, 2000). As mentioned, a fundamental condition of knowledge transfer is the willingness and motivation of the knowledge holder (an individual) to share her or his knowledge. Secondly, the individuals must be able to explicate knowledge on the one hand (knowledge holder), and to integrate and reconstruct knowledge on the other hand (knowledge seeker). Apart from the general difficulties of explicating and transferring tacit knowledge, a common educational background is helpful in order to understand the context in which the knowledge is embedded. Based on the insight that the transfer of individual knowledge is an extremely difficult task and not the most efficient approach to integrating knowledge (Grant, 1996), the coordination of knowledge holders must be considered in the process dimension.

Challenges during the knowledge application phase. The application of knowledge becomes relevant during the *process phase*. The transferred and combined knowledge pieces must be integrated with the external factor in order to provide the knowledge-intensive service. Only if knowledge is put into practice can core competencies evolve (Brown and Duguid, 1998). In the context of services it is important to consider that production and consumption of the service are taking place *uno actu*. The customer benefits from the knowledge as part of the problem-solving capacity of the service delivered. At the same time, this service is produced by a combination of individual knowledge components. Therefore, the phases of knowledge

generation, and especially of knowledge combination and knowledge application, can only be separated for analytical purposes.

Network knowledge management must ensure that the transferred knowledge is applied and, if the combination of knowledge holders is preferred, that the collaboration is working smoothly. Problems concerning the application can result from the not-invented-here syndrome (Katz and Kahn, 1982; Hayes and Clark, 1985): it may well be possible that valuable knowledge is simply ignored or even rejected because it comes from an outside source. Further problems can occur because of misunderstandings and problems concerning the collaboration between the network partners.

Challenges concerning knowledge storage and embodiment. The main challenge for knowledge management during the *result dimension* is to reduce or eliminate the threat of losing core competencies. This is a task on the network partner level as well as on the network level. On the level of the network partners, every network partner tends to capture as much knowledge as possible from the collective knowledge and the partners' capabilities, while giving away as little knowledge as possible from his or her own organization. Because of the collaboration during the service provision process, it is possible that network partners imitate or copy the distinctive competencies of one another. A successful imitation would lead to the loss of competitive advantage of that particular network partner. This phenomenon of simultaneous co-operation and competition between firms is called co-opetition (Loebecke *et al.*, 1999).

Apart from developing solutions to overcome the co-opetition problem regarding knowledge sharing, the network knowledge management has to deal with the knowledge storage problem, to make possible the permanent availability of the knowledge created during the service production. The network is not stable over time; single network partners may leave the network, making their knowledge inaccessible for the network. Another danger evolves from the fact that knowledge is not everlasting. Individuals as the holders of knowledge tend to forget, for instance, facts and routines, leading to decomposition of organizational and network capabilities.

Possible solutions for managing knowledge processes in knowledge-intensive service networks

Solutions for knowledge identification and generation

As mentioned above, one task of network knowledge management is to provide an overview of the knowledge and the capabilities existent within the network. This creation of transparency enables the actors in the network to communicate, and to transfer or combine their knowledge. As Borgatti and Cross (2003) have analyzed, a baseline condition for the transfer of knowledge is the awareness of a particular individual as a possible source of solution to a current problem. Research also indicates that once expertise of a person is made public, the exchange of information between members of a group increases (Thomas-Hunt *et al.*, 2003). These positive effects of knowledge transparency could generally be achieved by two different approaches. One is signaling, which means that each network partner is responsible for explicating her or his knowledge. Positive effects of signaling are low administrative costs. On the other hand, it is doubtful that the method of signaling alone is capable of initiating the explication of all relevant and valuable knowledge (Sarvary, 1999). Signaling approaches will lead to failure when people do not provide valuable knowledge to the

system. Searching for specific knowledge in such a system will be of little value for knowledge seekers. As a result, those knowledge seekers will not spend time to contribute their valuable knowledge to the knowledge management system.

The second way to address the knowledge identification issue is screening, which means that the network knowledge officer or another authority within the network is in charge of constantly screening the network's knowledge base. Knowledge screening has proven to be more efficient than knowledge signaling, and is therefore the preferable solution for the identification problem. Although the benefits of knowledge screening systems are hard to measure, while the costs, which could not be neglected, are notably present, the possible benefits are outstanding (Sarvary, 1999). Only a screening process can provide the complete revelation of knowledge from the actors in the network, and therefore can provoke the innovative combination of resources. It is the task of the network management to establish routines, to build and regularly refresh meta-knowledge about the competencies and abilities existent within the network.

Besides creating transparency in the network, knowledge management must create an environment that facilitates the sharing of knowledge between the network partners. Knowledge seekers must be able to communicate with knowledge holders. The exchange of knowledge could be fostered by technology, but cultural and leadership aspects, as well as aspects of measurement, must be considered as well (O'Dell and Grayson, 1998). In an analysis of aspects of bringing people together, technological solutions like e-mail, groupware solutions, intranets, and elaborate search and retrieval software are recognized as facilitators of knowledge sharing. These technological solutions can help people to communicate and to exchange information. O'Dell and Grayson (1998) describe some solutions for these problems, such as using databases enhancing and supporting the direct personal exchange of knowledge. However, for the transfer of highly tacit knowledge, possibilities must exist to arrange personal meetings (for example, yellow pages as one application of the intranet). In that sense, O'Dell and Grayson (1998) note: "Technology has a helpful role to play, but it will not be the driver of sharing best practices because all the important information about a process is too complex and too experiential to be captured electronically, and because the incentives for and barriers to sharing are not really technical". The following sections will focus on some of the human barriers of knowledge transfer, and of knowledge management in general.

Solutions to knowledge combination and transfer problems

Motivational problems related to the combination and the transfer of knowledge are rooted in the absorptive capacity of the receiving person or organization (Cohen and Levinthal, 1990; Simon, 1991; Levinthal and March, 1993; Szulanski, 1996; Gupta and Govindarajan, 2000).

Concerning motivational problems on the individual level, it is necessary to establish motivating situations so that knowledge holders are willing to transfer their knowledge to knowledge seekers within the network (Osterloh and Frey, 2000; Osterloh *et al.*, 2002). The motivation of an individual could be differentiated as either extrinsic motivation or intrinsic motivation. Extrinsic motivation occurs when employees are able to satisfy their needs indirectly, most importantly through monetary compensation (Osterloh *et al.*, 2002). In contrast, intrinsic motivation results

from an activity that is satisfying by itself. Intrinsic motivation is valued for its own sake and appears to be self-sustained (Calder and Staw, 1975; Deci, 1975; Osterloh *et al.*, 2002).

In order to facilitate the transfer of knowledge within a network, some authors suggest that intrinsic motivation should be addressed predominantly. For instance, Osterloh and Frey (2000) propose that intrinsic motivation should be applied in areas where markets and prices play a minor role. As knowledge always consists of explicit and implicit parts, it could be argued that not being able to use pricing mechanisms to coordinate and measure the transfer of those tacit knowledge parts has the result of extrinsic motivation that could not be used to support knowledge transfer. Additionally, the so-called crowding out effect must be considered (Osterloh and Frey, 2000). This effect analyzes the trade-off between intrinsic and extrinsic motivation. It is argued that once extrinsic motivation is applied – for example, in the form of financial rewards for explicating and sharing knowledge – the intrinsic motivation will decrease. The result of this effect would be that if financial rewards are obtainable, knowledge is only shared, thus making knowledge transfer expensive and inefficient.

In addition to intrinsic motivation at the level of the network partners, a balanced use of incentives and sanctions is preferable, for the primary reason that cooperation theory provides evidence that a “tit-for-tat-strategy” is optimal (Axelrod, 1984). Furthermore, it might be very useful to implement an evaluation system through which all network partners can evaluate each other. A favorable peer assessment is socially accepted and can function as a basis for financial benefits. Continually unfavorable scores will ultimately lead to exclusion from the network.

Even if the motivation and coordination problems are solved, it is possible that the knowledge transfer process will fail, based on an inability to adapt the knowledge received. The receiver of knowledge must reconstruct the transferred information and be able to use that knowledge (Polanyi, 1959). This process of reconstruction is a learning process (Lin and Lee, 2003). The network knowledge management has to avoid frictions that could deteriorate this learning process. A common language, multiple learning possibilities, and a learning-friendly culture should be established and maintained by the network knowledge management in order to support the transfer of knowledge within the network.

If the transfer of knowledge is too difficult because of the tacitness of knowledge, because of learning problems, or because of motivational problems from the source or recipient of knowledge, the rotation of personnel as another form of knowledge combination could be an effective way of using the knowledge within the network. “The rotation of personnel [...] can be a very effective means of mobilizing personal knowledge” (Inkpen, 1996). By bringing together people with different experiences and abilities from different network partners, network knowledge management can foster a common understanding as well as new innovative knowledge combinations in order to gain and sustain competitive advantage for the network as a whole.

Supporting knowledge application

In a service network, the production and consumption of a particular service takes place *uno actu*, meaning the transferred and combined knowledge has to be integrated

with the external factor. In contact with the external factor, the agent does not only use his or her individual knowledge to perform the service, but also includes knowledge from the network partners. It is, in fact, the main idea of a network to combine knowledge in order to avoid redundancy in the problem-solving process. To be of value to the organization, the transfer of knowledge should lead to changes in behavior and to changes in practices and policies, and to the development of new ideas, processes, practices, and policies.

Research on knowledge management indicates that individual knowledge holders have a tendency to resist using knowledge created elsewhere (i.e. by their network partners) since they do not trust the quality of the shared knowledge (Hayes and Clark, 1985; Katz and Kahn, 1982). Hence, knowledge is developed by each individual, resulting in redundancy, which ultimately leads to suboptimal resource allocation. Therefore, the main problem facing network management is to find solutions for the not-invented-here syndrome. Three possible approaches to solving that problem can be identified (Michailova and Husted, 2003):

- (1) influencing the environment in the network;
- (2) providing the right infrastructure for knowledge sharing; and (strongly related to the latter)
- (3) introducing appropriate incentives at the network level.

Trust in the quality of the knowledge provided by the network partners is the basis of overcoming the not-invented-here syndrome. An organizational culture of trust and commitment is of supreme importance to knowledge-intensive service networks in particular. Since distrust often comes from not knowing the knowledge provider, it helps to have employees get to know each other better. This can be done by organizing informal meetings or by formal job rotation.

If trust is the basis, IT may function as the physical backbone to overcoming the not-invented-here syndrome. While knowledge assets are grounded in the experience and expertise of individuals, the network must provide the physical, social, and resource allocation structure so that knowledge can be shaped into competences. How these competences and knowledge assets are configured and deployed will dramatically shape competitive outcomes and the commercial success of the enterprise (Teece, 1998). Knowledge must therefore be readily available for use by the network partner. If that is the case, a strong incentive exists to use that particular knowledge instead of developing one's own.

Supporting the evolution of tacit network knowledge

After the combination of explicated knowledge has resulted in the delivery of a service, the network is faced with the problem of losing knowledge. First, knowledge concerning certain service delivery process steps can be lost by failing to properly document the process, the associated problems, and the level of success. Therefore, it should be mandatory for the participating partners to make their experiences available in a documented form. This could be organized by implementing a central data warehouse functioning as a knowledge warehouse, or by making documentation available for automated retrieval systems. Second, as shown before, knowledge is a central building block for a knowledge-intensive service network's core competency. Only if the network partners contribute their distinctive competencies and prevent

them from being imitated can competitive advantages be sustained. Knowledge patents, an indication of who contributed a valuable resource to the process of service delivery, can be a solution to the problem of losing knowledge inside the network. The leakage of knowledge to actors outside the network is an even greater problem. This can be prevented by patenting important knowledge. Where this is not possible – and that is the case for most services – knowledge must be developed constantly, which is especially relevant for the core network. Tighter functional cooperation is a barrier to imitation, since knowledge is embedded in a socially complex environment (Lippman and Rumelt, 1982; Dierickx and Cool, 1989). Therefore, the network must identify different levels of importance: the more sensitive the knowledge, the more important it is to obtain a sufficient level of coordination between partners. More than other aspects, the creation of a cultural atmosphere based on mutual trust, where no insider would communicate sensitive knowledge to actors outside the network, is the key to preventing a leakage that would lead to an erosion of the core competency and of the competitive advantages of the network.

Practical implications

It has been shown in the previous analysis that knowledge is the key to gaining and sustaining competitive advantage, especially for knowledge-intensive service networks. Knowledge is a resource that is valuable because it helps to achieve a corporate goal. It is also rare because it is not available in excess of demand. Moreover, knowledge is especially hard to imitate and substitute because it is tacit, causally ambiguous, and developed in a path-dependent, historic process. Therefore, in order to remain successful, it is the task of the strategic management to implement a knowledge management strategy. Such a strategy must provide practical solutions during the four phases of the knowledge management process:

- (1) knowledge generation/identification;
- (2) the combination/transfer of knowledge;
- (3) the application of knowledge; and
- (4) knowledge storage.

Theoretical reasoning and empirical evidence show that establishing a network culture of trust, and understanding other network partners' needs, are particularly crucial during the process of knowledge identification and generation. Technological solutions such as intranets can help the facilitation of the exchange between knowledge providers and knowledge seekers.

Network partner evaluation systems, along with incentives and sanctions, are helpful when knowledge is to be transferred. If knowledge is largely tacit, rotating personnel is an appropriate means of knowledge management. Again, the establishment of a favorable network culture is important when it comes to the application of knowledge. Particularly, formal and informal meetings between the network partners help to reduce distrust and create a common network identity. The loss of network knowledge is particularly problematic in knowledge intensive networks with frequent changes among network partners. Therefore, it needs to be mandatory for all network partners working on a particular project to document exactly what has been done and in which way each partner has contributed to the

success of the project. In return, the network must grant knowledge patents to indicate the source of that particular piece of knowledge.

To sum up, solutions to the knowledge management challenges in a service network include personal aspects, technological aspects, and organizational and cultural aspects. Personal aspects are relevant to guarantee the efficient transfer and application of knowledge on an individual level. Organizational and cultural aspects are relevant to permit the frictionless collaboration between the network partners on an organizational as well as on an individual level. Technological aspects must be considered in order to support the sharing and use of knowledge. As a practical solution, the authors of this paper suggest that each network partner should be rated according to his or her contribution to the network knowledge base. Based on this rating, a particular network partner is a member of a certain knowledge club. Being a member implies having access to a particular level of network knowledge. The network management can offer strong incentives to add knowledge to the network's knowledge base and to prevent knowledge from leaking to outside parties by establishing such a network partner evaluation routine.

Further research

It has been shown that cultural aspects are of particular importance for successful knowledge management in service networks. An area for future research would therefore be to establish measures to evaluate the organizational culture of such a knowledge-intensive service network. In line with the idea of market orientation (Narver and Slater, 1990) – the corporate culture that most effectively and efficiently creates the necessary behaviors for the development of superior value for buyers, and thus continues superior performance for the business – a network orientation could be conceptualized and subsequently measured in an empirical setting.

Another area where much future research is needed is related to the difficulty in measuring and evaluating knowledge. This is especially challenging for the case of tacit knowledge. Only with a measure of importance of the knowledge components that contribute to the service provision can the management evaluate the contribution to the network by the individual network partner. Based on that measure, incentives and sanctions can be developed to ensure better creation, explication, application, and securing of the network's knowledge base.

Establishing a knowledge club has been proposed as a possible solution to knowledge management problems in networks. Since this is a rather new concept in the management literature, but not so much in the consumer behavior literature, a fruitful area for further research could be to apply the research results found in the formation and evaluation of peer-to-peer networks to a business-to-business setting. Such a study would move toward a more comprehensive empirical test of the conceptual model of knowledge management in knowledge-intensive service networks.

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