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EXPLORING AND EXPLOITING KNOWLEDGE

RESEARCH ON KNOWLEDGE PROCESSES IN KNOWLEDGE-INTENSIVE ORGANIZATIONS

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Abstract

Knowledge, and how it is utilized, is the most important source of competitive advantage for a growing number of companies and organizations. Knowledge workers predominantly work from knowledge, with knowledge, and for knowledge. This study explores how employees in knowledge-intensive organizations actually utilize information and knowledge. The study has three research questions: 1) How do employees in knowledge-intensive organizations operate with information and knowledge? 2) How are organizational practices and technological tools related to the flow of information and knowledge? 3) How do different knowledge processes generate a knowledge flow? Based on the literature and a pilot study, a model of knowledge processes constituting a knowledge flow is used for focusing the research.

The empirical research consists of four case studies where altogether 68 interviews were conducted. Additional data includes case-specific company documents (e.g., process and organizational charts) and open-ended survey questionnaires. The studied cases represent knowledge work, where information and knowledge are the main inputs and outcomes of the work. The studied companies produced complex knowledge-based products or services. The work involved combining dispersed and fragmented knowledge and expertise in order to reach the desired outcome. The data were analyzed by applying theory-based reasoning and using content analysis for examining the interview transcriptions.

Value is added to knowledge by exploration and exploitation. While such operations as storing and transferring knowledge do not add value to knowledge as such, they are important for making knowledge available to those members of an organization who need it. Results show that knowledge work is complex, and several challenges can be encountered when operating with information and knowledge. Knowledge processes that connect dispersed knowledge and make knowledge available to the members of an organization are highly interlinked. The studied organizations operated with many types of knowledge (e.g., embodied and encoded knowledge), which needed to be managed differently. All the studied organizations had recognized the importance and value of encoded information and knowledge in making knowledge collectively available. Based on this, the studied companies tried to increase the amount and quality of codified knowledge. This aimed at improving the availability and reuse of information and knowledge. Related to that, the studied organizations aimed at more routinized and formalized processes for managing knowledge. Even though a technology-based approach for managing encoded knowledge can be seen easier than a human interaction-based approach, the studied companies had several problems in managing encoded information and knowledge. The problems were not usually related to technology itself, but to how it was used and applied in the organizations.

Modern IT applications have not been able to replace the quality, or need, of face-to-face interaction in collaborative knowledge work. Compatible skills and knowledge, and the ability to interact with other employees were important in knowledge exploration and exploitation. Members of an organization learn skills for interaction through collective efforts. In a new context, and with new collaborative partners, knowledge workers may lack compatible skills and knowledge for successful knowledge exploration and exploitation. This study contributes to our understanding of knowledge work and helps to analyze and explain how organizations can manage information and knowledge.

Keywords: knowledge processes, knowledge flow, knowledge exploitation and exploration, knowledge-intensive organizations

Tiivistelmä (abstract in Finnish)

Tieto ja tiedon hyödyntäminen on tullut entistä tärkeämmäksi alati kasvavalle joukolle yrityksiä ja organisaatioita. Tässä tutkimuksessa tarkastellaan kuinka tietointensiiviset yritykset ja niiden työntekijät hyödyntävät ja jalostavat työssään tietoa. Tutkimuksen aihetta tarkastellaan kolmen tutkimuskysymyksen avulla: 1) kuinka tietointensiivisten organisaatioiden työntekijät työskentelevät tiedon kanssa, 2) miten organisatoriset toimintatavat ja tietotekniset työkalut vaikuttavat tiedon hyödyntämiseen, 3) kuinka erilaiset tietoprosessit muodostavat tiedonkulun. Kirjallisuuteen ja pilottitutkimukseen perustuvaa mallia käytetään perustana tutkittaessa tietoprosesseja ja tiedon hyödyntämistä.

Tutkimuksen empiirinen osuus koostuu neljässä eri yrityksessä toteutetusta tapaustutkimuksesta, joissa haastateltiin yhteensä 68 tietotyöntekijää. Lisäksi aineistona käytettiin tutkimukseen osallistuneiden organisaatioiden dokumentteja sekä laadullista kyselytutkimusta. Tutkimukseen osallistuneet organisaatiot edustivat tietotyötä, jossa informaatio ja tieto ovat sekä työn lähtökohta että lopputulos. Tutkitut organisaatiot tuottivat monimutkaisia tietotuotteita ja –palveluita. Työ tutkituissa organisaatioissa edellytti hajautuneen tiedon ja asiantuntijuuden yhdistämistä ja hyödyntämistä. Tutkimusaineisto analysoitiin teoriaperusteisesti kirjallisuuden ja pilottitutkimuksen perusteella tehdyn mallin mukaisesti.

Tietotyössä lisäarvoa voi syntyä tuottamalla uutta tietoa tai hyödyntämällä olemassa olevaa tietoa. Vaikka sellaiset prosessit kuten tiedon varastointi tai jakaminen eivät sellaisenaan tuota lisäarvoa, ne ovat tärkeitä prosesseja tiedon hyödyntämisen kannalta. Niiden avulla voidaan integroida organisatorisesti hajautunutta tietoa. Tietoprosessit, jotka mahdollistavat organisatorisen tiedon hyödyntämisen, ovat kiinteästi yhteydessä toisiinsa. Tutkimuksen tulokset osoittavat, että tietotyö on monimutkaista ja monille haasteille altista. Työntekijöiden erilaiset ja epäyhtenäiset toimintatavat vaikeuttavat organisatorisen tiedon hyödyntämistä.

Tutkitut organisaatiot käsittelivät ja hyödynsivät informaatioita ja tietoa eri muodoissa. Soveltuvat menetelmät informaation ja tiedon käsittelemiseksi ja hyödyntämiseksi olivat riippuvaisia organisaatioiden tiedon hyödyntämisen tavoitteista sekä itse hyödynnettävän tiedon luonteesta ja muodosta. Vaikka viime aikoina on puhuttu paljon hiljaisen tiedon tärkeydestä ja merkityksestä, kaikissa tutkituissa organisaatioissa nimenomaan eksplikoidun ja kodifioidun tiedon hallinta oli keskeistä, ja samalla usein haasteellista. Tiedon kodifioiminen laajentaa mahdollisuuksia tiedon hyödyntämiselle organisaatioissa. Kodifioidun tiedon käsittely ja hyödyntäminen ei kuitenkaan ole niin helppoa kuin usein oletetaan. Tutkituissa organisaatioissa kodifioidun tiedon hyödyntämisen ongelmat eivät yleensä liittyneet tiedon käsittelyssä käytettyihin teknologioihin, vaan organisatorisiin toimintaprosesseihin ja –tapoihin.

Tutkimus osoittaa, että tietointensiiviset organisaatiot tarvitsevat yhtenäisiä toimintatapoja organisatorisen tiedon hyödyntämiseksi. Tiedon luonne tai muoto ei näytä vaikuttavan tähän. Tutkimus tuottaa uutta tieteellistä ja käytännössä hyödynnettävää tietoa tietotyön ja tietointensiivisten organisaation johtamisesta.

Avainsanat: tietoprosessit, tiedonkulku, tiedon hyödyntäminen, tietointensiiviset organisaatiot

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Espoo, December 2007

Eerikki Mäki

1 Introduction

Knowledge is the greatest asset of many organizations. Not just knowledge as such, but the ability to apply and leverage knowledge for attaining organizational objectives and gaining competitive advantage. The ability to utilize available knowledge resources differentiates successful organizations from less successful. Peter Drucker – one of the most influential management scholars of our era – argues that the productivity of knowledge work and knowledge workers is one of the biggest challenges of our time (Drucker 1999).

It is not difficult to imagine a caveman showing his tribe a new method of using a tool or hunting an animal. The caveman aimed at transferring his knowledge and skills for the benefit of his fellow creatures. Cuneiform writing and papyrus rolls are early examples of attempts to manage knowledge and means of knowledge transfer. Mankind has attempted to manage encoded knowledge for millenniums (Ives 1998, Korac-Kakabadse et al. 2002), and embodied knowledge from the beginning of the human race. Similarly, organizations aim to preserve and renew knowledge they have created and accumulated through their history. Knowledge in organizations may take the form of individual skills and competencies as well as organizational texts, routines and practices. This knowledge can be applied to achieving the current and future goals of the organization. Nevertheless, knowledge management objectives are not easily accomplished. Ruggles (1998) studied 431 US and European companies with knowledge management initiatives. Regardless of the vital importance of intraorganizational knowledge transfer, of the executives who participated in the study, only 13 per cent thought their company was successful in transferring knowledge within their organization.

Organizations manage knowledge more or less intentionally. A more intentional approach to managing organizational knowledge has attracted both practitioners and scientists in recent years. The increase of knowledge management-related books and dissertations over the time period from 1991-1995 to 2005 is 15-fold (Harman & Koohang 2005). The theme, defined by using words “knowledge” and “management”, has been especially popular in academic literature since the mid-1990’s. Figure 1 presents how the number of publications in the ABI/Inform and Elsevier Science databases has evolved between the years 1996 and 2005[1]. In the ABI/Inform database,

[1] The search operation was conducted on October 6th 2006.

the search was limited to full-text peer-reviewed scholarly journals including the phrase "knowledge management" in their title. In the Elsevier Science database, the search was limited to journals including "knowledge management" in their title. Subject areas covered a) business, management and accounting; b) computer sciences, c) decision sciences, e) engineering, and f) psychology[2]. The search operation excluded book reviews and calls for papers, but short comments and editorial papers were included. These two databases were chosen because they contain most of the relevant articles on the study focus area.

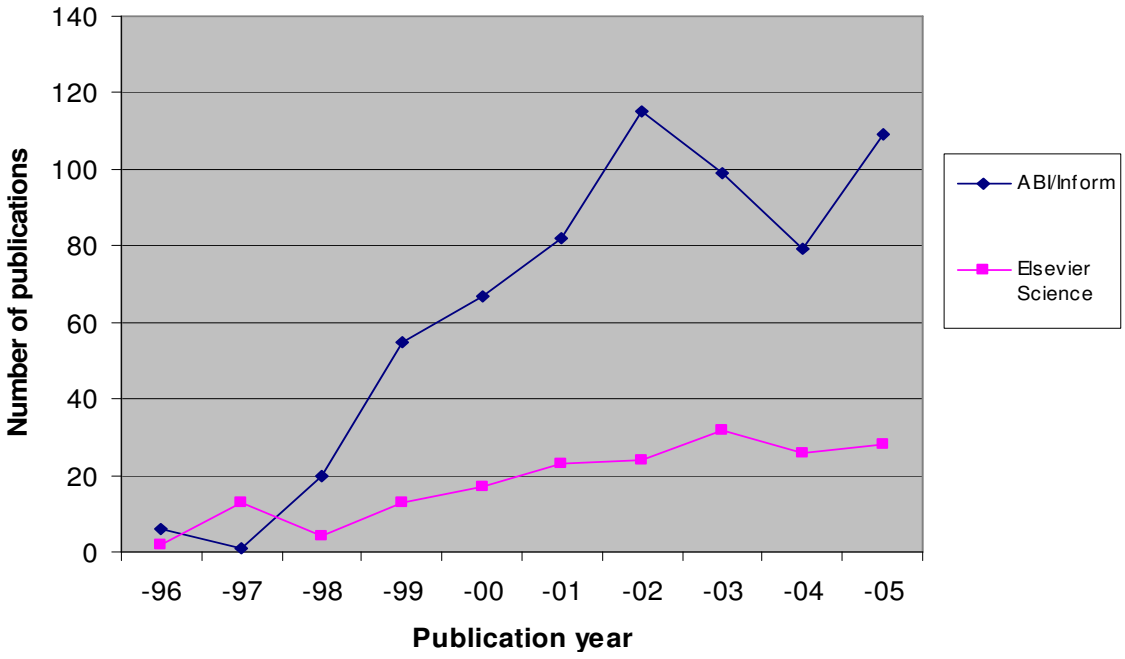

Figure 1. The number of publications including "knowledge management" in their title during the years 1996-2005.

The publications cover a wide range of subject areas, including implementation of knowledge management systems, protection of intellectual assets, e-commerce, data mining, and new product development, just to mention a few. There can be several reasons for the increased number of publications. As there are no clear boundaries or definition for the "knowledge management" as a discipline, Figure 1 needs to be interpreted cautiously. First, special issues of knowledge management may have increased the number of articles using the term. Second, the term

[2] The search operations, and how they can be defined, are not identical in the two databases. Both search operations were, however, meant to be as similar as possible and cover the disciplines of knowledge management.

knowledge management may be used to cover phenomena that earlier were called something else (e.g., information management). What is common to the publications is that the authors have increasingly started to use the term "knowledge management." Earlier, the authors might have written about the same subjects without using the term "knowledge management." Third, the fashionable term may have been added to many kinds of research topics. Fourth, the number of journals publishing on knowledge management themes has increased, which may have made it easier to get knowledge management articles published. On the other hand, the majority of knowledge management literature does not include the term "knowledge management" in its title (see the reference list of this study for a start). The example only tells us that scholars have started to use the term "knowledge management" more widely and more often. Still, there are many who emphasize the importance of knowledge and its utilization in present and future organizations and in the economy (e.g. Drucker 1999, Rastogi 2000, DeTienne & Jackson 2001).

Publications in the area of knowledge management can be roughly classified into two categories. The first type of publications are mostly interested in understanding how information and communication technologies (ICT) can be applied to improving information and knowledge utilization in different kinds of organizations and business environments. The second type of publications study behavioral and managerial aspects of knowledge management in organizations. In addition, some of the publications study knowledge management from a more holistic perspective, aiming to integrate technological and human approaches. Furthermore, management of intangible assets, i.e., intellectual, human, structural, and relationship capital (see, e.g., Stewart 1997), is another stream of research close to knowledge management, but this literature will not be reviewed in this study.

This study explores phenomena that in current management and organizational literatures are related to the theme "knowledge management." It is a wide theme without clearly defined boundaries. It covers many central issues of organizational behavior and management sciences, including topics such as learning, information management, communication, interpersonal and interorganizational collaboration, knowledge sharing, and knowledge creation. According to Baskerville & Dulipovici (2006), knowledge management theories can be categorized into three groups. Those that aim to explain the rationales behind knowledge management practices, those that aim to understand knowledge management processes, and those that try to evaluate the practical results achieved through knowledge management. In reality, maybe because the research

area is so new, the concepts and theories of knowledge management are still continuously evolving.

The concept of knowledge management is not accepted by everyone. Spiegler (2000) questions whether the idea behind knowledge management is new at all or just a recycled concept. Computer sciences researchers in particular have questioned whether knowledge management is anything new (Ekbia & Hara 2004) or argued that knowledge management does not differ from information management (Wilson 2002). The voices against the newness of knowledge management are at least partly justified. Many aspects of knowledge management can be considered to be information management. However, information management can be seen as a rather mechanic view of managing codified information and knowledge, while knowledge management includes elements related to human behavior and the life of social communities. Nevertheless, information management is an essential element of knowledge management. Information management technologies can be applied to attaining the objectives of knowledge management (Blumentritt & Johnston 1999, Shin et al. 2001).

It is also reasonable to ask whether knowledge management is another new management fad. Ponzi & Koenig (2002) showed that some past management trends (quality circles, total quality management, business process engineering) had a life span of 5 to 7 years in academic literature. Nowadays, management trends have become even shorter (Gibson & Tesone 2001). After a sharp increase in interest, research on these management trends diminishes almost completely. At the moment, we cannot see the same trend with knowledge management.

Knowledge as a resource and an object of current and future work is increasingly important (e.g., Drucker 1999, Scarbrough 1999, Pyöriä 2005), which highlights the significance of the topic of the study. This study aims at increasing understanding about how organizational information and knowledge resources are, and can be, managed and utilized in knowledge-intensive work and organizations. A knowledge-intensive organization refers to an organization where knowledge has more importance than other inputs (Starbuck 1992) (i.e., in contrast to labor-intensive or capital-intensive). Intangible resources (e.g., information and knowledge) as elements of work differ from tangible, physical objects (e.g. wood, steel). We might expect that the management and utilization of tangible and intangible resources also differ.

The past and ongoing research on knowledge in an organizational context has to a large extent improved our understanding on how knowledge can be managed and utilized in improving organizational performance. The vast majority of published knowledge management articles are theoretical or conceptual, although empirically based studies are also becoming more common. However, many of the empirical studies are single case studies or studies where the empirical part is in a minor role, or even anecdotal, supporting the theoretical and conceptual discussion of the authors. This is the conclusion I came to through trying to find good-quality, relevant, and empirically-based sources for the literature study of my work.

The objective of this study is to analyze and understand how information and knowledge are utilized in knowledge-intensive organizations. For this purpose, the study aims to apply strong empirical evidence in examining the research questions. Knowledge management is studied in particularly knowledge-intensive contexts (e.g., in new product development), and in contexts where knowledge is largely diffused (e.g., in virtual organizations and in interorganizational collaboration). A more detailed description of the objectives is provided in the Research questions chapter (pp. 79-81).

This study is structured in the following manner: I will first review and evaluate the current literature of the topics of this study. The literature review aims to cover the focal points of the study area, including knowledge work, management of knowledge, knowledge processes, and knowledge flow. The gap between the known and unknown is used as a basis for formulating the detailed research objectives and research questions for this study. Then, a research design for attaining the research objectives is described. Thereafter, the results of the empirical work conducted in this study are presented. Finally, the scientific contribution of the study will be evaluated.

2 Managing knowledge

This chapter reviews and discusses the theoretical perspectives and empirical findings of the issues related to the study's theme. Obtaining material for the literature review has been a long process. The subject area has interested me since the year 2000. Journal articles are the main sources used in the literature study. Books are only seldom used because so far there are not many comprehensive books on the subject area. Some of the books on the research area have gained an established status (e.g., Nonaka & Takeuchi – Knowledge creating company), but the main findings of this book are also published in articles (e.g., Nonaka 1994, Nonaka & Konno 1998, Nonaka et al. 2000).

This chapter aims at showing my command of the subject and justifying the objectives of the research. The chapter goes through the relevant themes concerning the topic of the study, including knowledge intensive work, different types of knowledge, and knowledge flow. The theoretical part of the study is organized in the following way. First, knowledge work and the characteristics of such work are discussed. Predominantly, knowledge work (or knowledge-intensive work) differs from manual work (or less knowledge-intensive work). An evaluation of the unique characteristics of knowledge work aims at helping understanding the study context.

Second, since the study is about managing knowledge, it is necessary to assess how the term knowledge is understood in the current knowledge management literature. This part of the literature study also describes the features of different types of knowledge and evaluates how information and knowledge differ from each other. In addition, how knowledge and its features affect an organization's ability to manage and utilize knowledge is discussed.

Third, different approaches to knowledge management are presented. This part discusses different knowledge management approaches and practices from strategic and operative perspectives. This chapter also includes considerations of the role of human behavior and technology in knowledge management.

Fourth, the final section of the literature study focuses on how the organizational knowledge utilization (or potentiality) can be explained using the model of knowledge flow and knowledge

processes. With any luck, the following chapters describing the research design and the methodology will be smoothly connected to the theoretical part of this study.

2.1 Knowledge(-intensive) work

Every job involves the ability to process and apply knowledge. Even a manual worker needs to have knowledge about how to accomplish his tasks. Some manual tasks are nowadays replaced by machines (e.g., computers). Machines perform tasks using knowledge embedded by humans. Nevertheless, the term "knowledge work" has increasingly started to emerge in daily conversations, referring to work that involves active employment of knowledge and intellectual effort. Yet, there is no definition for non-knowledge work (work that is the opposite of knowledge work.). Therefore, it can be assumed that some work and occupations involve more knowledge, and others involve less knowledge. Furthermore, the need to process knowledge varies over time and contexts and between subtasks even in one job. For example, a researcher's work often requires processing of knowledge, but the work also contains repetitive and routine operations, which do not need much intellectual effort. Consequently, we can talk about the *knowledge intensity* of work, which varies over time and between subtasks. Unfortunately, we do not yet have any objective measure for the "knowledge intensity" of knowledge work. In this study, the term is used in a more qualitative or descriptive sense.

Although the literature does not give us a clear or unambiguous definition of "knowledge work" or "knowledge-intensive work," it is possible to identify some characteristics that are often related to these terms (see Table I). The salient characteristics of knowledge work are synthesized into six different categories. These categories are here labeled as a) content of knowledge work, b) complexity of the work, c) knowledge and skills required, d) autonomy vs. control e) collective knowledge systems, and g) learning orientation. The borders of individual categories are not necessary very clear, and often the categories overlap.

Table I. Characteristics of knowledge(-intensive) work.

Characteristic	Author
Content of knowledge work	Alvesson (2001), Hayman & Elliman (2000), Kelloway & Barling (2000), Scarbrough (1999), Davenport et al. (1996), Alvesson (1993), Starbuck (1992)
Complexity of the work	Pyöriä (2005), Korac-Kakabadse et al. (2002), Alvesson (2001), Donaldson (2001), Hayman & Elliman (2000), Kelloway & Barling (2000), Scarbrough (1999), Drucker (1999), Collins (1997), Alvesson (1993)
Knowledge and skills required	Pyöriä (2005), Alvesson (2001), Hayman & Elliman (2000), Davenport et al. (1996), Blackler (1995), Despres & Hilltrop (1995), Alvesson (1993), Blackler et al. (1993), Starbuck (1992)
Autonomy over work	Hayman & Elliman (2000), Davenport et al. (1996), Tsoukas (1996)
Collective knowledge system	Styhre (2002), Scarbrough (1999), Tsoukas (1996), Blackler et al. (1993)
Learning orientation	Pyöriä (2005), Alvesson (1993), Blackler et al. (1993)

The different features of knowledge work are next explained in more detail. At the end, the different perspectives of knowledge work are encapsulated into a shorter and a more compact form.

a) Content of knowledge work

It is impossible to define a general content for knowledge-intensive work, but the literature gives both theoretical and practical guidelines of the characteristics of the content of knowledge-intensive work. Knowledge work comprises of knowledge workers enriching the input information (Hayman & Elliman 2000). Knowledge workers work *from* knowledge, *with* knowledge (Scarbrough 1999), and *for* knowledge. Starbuck (1992) highlights the importance of input information in defining KIFs (knowledge-intensive firms) in general. Knowledge work is the activity of the acquisition, creation, packaging, or application of knowledge (Davenport et al. 1996). Kelloway and Barling (2000) emphasize that knowledge work outcomes are important, and quality instead of quantity is imperative in knowledge work, although Alvesson (2001) states that criteria for good-quality outcomes are often difficult to define.

b) Complexity of the work

Knowledge work is relatively unstructured and organizationally contingent (Scarbrough 1999), or even ambiguity-intensive (Alvesson 2001). Knowledge-intensive organizations often work with

tacit knowledge, although Donaldson (2001) warns against mystifying or over-emphasizing the role of tacit knowledge. Pyöriä (2005) and Hayman & Elliman (2000) argue that knowledge-intensive work is non-repetitive and non-routine, even though Korac-Kakabadse et al. (2002) opposes this by stating that most intelligent work is repetitive and routine if one uncovers the patterns. In addition, all work varies in terms of complexity over time and task, and all work contains manual operations (Drucker 1999). On the other hand, even the simplest tasks require knowledge (Collins 1997), which prevents defining a clear cut-off point between professional jobs and other jobs (Alvesson 1993). In that sense, the point made by Kelloway & Barling (2000), which suggests that we should refer to workers instead of knowledge workers, is logical.

c) Knowledge and skills required

Knowledge-intensive work requires a high level of skills and expertise (Davenport et al. 1996). Activity theory (originating from the work of Vygotsky, the Russian psychologist) acknowledges that expertise may take different forms initiated from different histories, cultures, and encounters (Blackler et al. 1993). Some authors highlight that scientific and technical knowledge and skills are required in knowledge-intensive work, and these are to be acquired through formal education (Pyöriä 2005, Hayman & Elliman 2000). We can, however, point out that there are occupations and tasks that do not necessarily require formal education even though the jobs are highly knowledge intensive (e.g., an information technology specialist or the work of a politician). Alvesson (2001) also argues that theoretical knowledge plays a minor role in knowledge-intensive work. But then again, Alvesson (1993) and Starbuck (1992) emphasize the need for esoteric skills. This may obviously limit certain knowledge-intensive jobs as a privilege of the few. Despres & Hilltrop (1995) present the idea that knowledge workers manipulate and orchestrate symbols and concepts, and their skills may become rapidly obsolete. Blackler (1995) turns the attention to knowledge workers' need for symbolic-analytic skills, including problem identification and solving. However, elsewhere Blackler et al. (1993) say that the conventional rational-cognitive approach to and understanding of knowledge is currently being replaced by approaches that emphasize tacit skills and the significance of doing and deciding.

d) Autonomy over work

Manual work can be designed and organized according to firm standards or defined procedures. This means that the management is responsible for planning the work, and employees are

responsible for carrying out the needed operations. That is not the case in knowledge work. No references could be found where *more control* over knowledge workers would have been emphasized. Quite the contrary: knowledge workers are expected to have autonomy over the work they do (Hayman & Elliman 2000, Robertson & Swan 2003), and they are even likely to resist standard routines (control) (Davenport et al. 1996). Tsoukas (1996) suggests that individuals' knowledge consists of a) role-related normative expectations, b) dispositions, which have been formed in the course of past socializations, and c) local knowledge of particular circumstances of time and place. An organization (and its management) has greater or lesser control over normative expectations, but very limited control over the other two. Control means that the employer or the company management have mechanisms which they use for directing the behavior of employees. A lack of managerial control makes the whole term "knowledge management" appear in an odd light. This will be discussed further later in the theoretical part.

e) Collective knowledge systems

Working with knowledge is certainly an individual activity, and many share the view that most of the organizational knowledge is inside the employees' heads (e.g., Alavi & Leidner 2001, Tsoukas & Vladimirou 2001), while knowledge artifacts can represent organizational knowledge (McInerney 2002). Again, many authors say that collectivity and social context play a fundamental role in knowledge-intensive work (e.g., Tsoukas 1996, Styhre 2002). Knowledge is collectively generated meaning among employees (Thompson & Walsham 2004), which needs to have a (social) context if it is to evolve. Collectivity offers a platform for joint interaction, which in turn may provide opportunities for individual and collective knowledge development and learning (Blackler et al. 1993).

g) Learning orientation

Finally, learning is also seen as a fundamental element of knowledge-intensive work. The content of knowledge-intensive work itself offers learning opportunities for knowledge workers. Ambiguities, uncertainties, and contradictions provide opportunities for individual and collective development and learning (Blackler et al. 1993). Knowledge workers need to be able to adapt to new situations and be able to cope with uncertainty (Alvesson 1993). Pyöriä (2005) also emphasizes the requirements of flexibility, interdisciplinary coordination, and rapid learning.

So far it seems that there is no consensus on what constitutes knowledge work and what features can be related to it. Surprisingly, applications of modern information, communication, and collaboration technologies are not emphasized in any description of knowledge work[3]. Maybe ICT tools have become such common tools for knowledge workers that they do not have to be mentioned. Obviously, most knowledge workers today employ everyday technological tools that did not exist some decades ago.

In the literature, there are contradictory views on the complexity of knowledge work as well as the knowledge and skills that are required to perform knowledge work. Views are more consistent regarding the content of knowledge work, autonomy over work, collective endeavor, and orientation to learning in knowledge work. Combining these together, this study synthesizes the elements of knowledge-intensive work as:

> *The inputs and the outputs of the work are information and knowledge or knowledge artifacts. The work itself includes active, autonomous and independent acquiring, processing, and developing of knowledge (and information). The work requires collaboration with other employees and the ability to learn.*

Knowledge-intensive work and tasks can be performed in several ways. There is both regularity and diversity in the behavior and performance of knowledge workers. Knowledge workers are allowed or even forced to improvise in their work[4]. Knowledge workers contribute to their organization by solving both routine and novel problems (Wright 2005). There are not necessarily clear instructions or a formal procedure to follow. The knowledge workers can even be unaware of the forthcoming outcomes of the work (Bhatt 2000). The work process is more likely semi-structured than structured, providing knowledge workers the possibility to decide how they will actually carry out the work. Scientific management (Taylor 1911) and the tradition of organizing and developing work have emphasized the distinction between planning and performing. In knowledge work, both planning and performing are done by the workers themselves (Burstein & Linger 2003). Still, many of the principles applied in scientific management to develop Western

[3] But then again, we do not usually use tools or instruments to describe occupations, i.e., a farmer is not considered to be a user of a hoe or a tractor, but as someone who cultivates grain; or a doctor is not someone who uses a stethoscope, but someone who tries to cure people.
[4] The rescue operation of Apollo 13 is one example of improvisation in knowledge work.

organizations and work can also be applied to knowledge work and knowledge management (Day 2001).

2.2 Knowledge in organizations

Knowledge workers have internal resources and abilities (i.e., skills, competencies, and knowledge acquired through formal education, which they apply in their work). In addition to the individual level internal resources, an organization offers a platform or a context with organizational level external resources (i.e., information and knowledge held by colleagues, stored in shared databases, acquired from extraorganizational sources, etc.). If we accept the idea that knowledge workers work with information and knowledge, i.e., use information and knowledge as input, and generate information and knowledge outputs, it is worth taking a look at the concepts of information and knowledge in an organizational context. Information and knowledge used as input in knowledge work can be considered to be the (external) resources of knowledge workers.

2.2.1 Information and knowledge

The meaning of the terms information and knowledge in knowledge management literature is far from clear. A clear distinction and clarification between these two concepts throughout this study is unachievable. In current literature, the words “information” and “knowledge” can refer to the same or similar phenomenon. For example, Nahapiet & Ghoshal (1998) use the terms “knowledge exchange” and “knowledge combination” when referring to the knowledge transfer process. Elsewhere it is argued that knowledge cannot be shared (transferred) because knowledge becomes information as it leaves the human mind (Al-Hawamdeh 2002). Figure 2 aims to depict this reasoning.

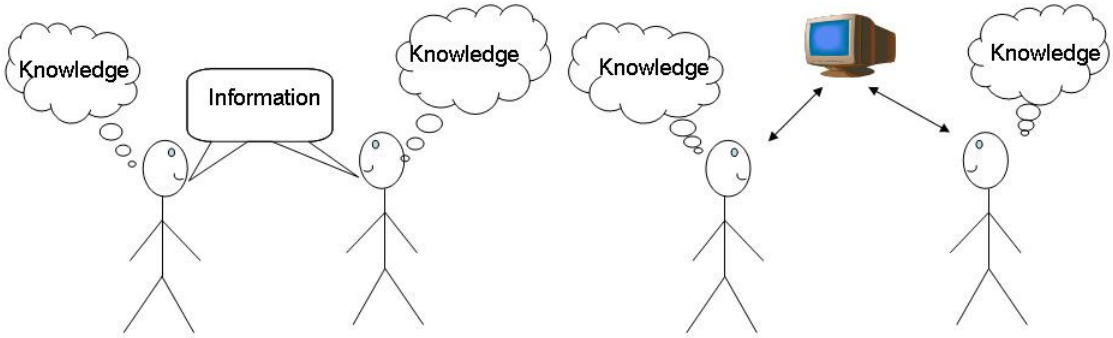

Figure 2. Information sharing and knowledge generation.

The difference between the concepts “information” and “knowledge” has some importance in this study. Some of the often mentioned characteristics of information and knowledge are presented in Table II.

Table II. Definitions of information and knowledge in the knowledge management literature.

Information	Knowledge	Reference
	Knowledge is the subjective product of the person in whose mind it is constituted, always relationally defined, and therefore does not transfer easily to others in a form which may be operationalized for the benefit of the organization.	Thompson & Walsham (2004)
Explicit knowledge (information).	"Know-how" or implicit knowledge, which can be captured and codified as information. Tacit knowledge, which cannot be captured and codified as information.	Al-Hawamdeh (2002)
Codified knowledge (=knowledge artifacts).	Knowledge is often used in the verb form (e.g., inquiring, learning, recognizing), indicating the active nature of knowledge. Knowledge and knowledge artifacts need to be separated from each other.	McInerney (2002)
Knowledge becomes information once it is articulated and presented in the form of a text, graphic, or in another symbolic form.	Knowledge is information processed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful, or accurate) related to facts, procedures, concepts, interpretations, ideas, observations, and judgments.	Alavi & Leidner (2001)
Information is regarded as an organized set of data	Knowledge is perceived as meaningful information.	Bhatt (2001)
	Knowledge as “individual ability to draw distinctions within a collective domain of action, based on an appreciation of context or theory, or both.”	Tsoukas & Vladimirou (2001)
	Information put in context, dependent on time and space.	Nonaka et al. (2000)
Data that have been arranged into a meaningful pattern	Application and productive use of information.	Roberts (2000)
	Six characteristics of knowledge that distinguish it from information: (1) Knowledge is a human act. (2) Knowledge is the residue of thinking. (3) Knowledge is created in the present moment. (4) Knowledge belongs to communities. (5) Knowledge circulates through communities in many ways. (6) New knowledge is created at the boundaries of old.	McDermot (1999)
	Knowledge originates from and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but in organizational routines, processes, practices, and norms.	Davenport & Prusak (1998)
	Five types of knowledge: embrained, embodied, encultured, embedded, and encoded knowledge.	Blackler (1995)

Efforts have been made to define how information differs from knowledge, and it seems that consensus in the knowledge management literature has not yet been reached. The difference between information and knowledge is volatile. Shin et al. (2001) conclude that information and knowledge are not completely different, but convertible into each other. A piece of information or knowledge can represent different meanings for different people, groups, or organizations (see Figure 3). Knowledge is context-dependent, and interpretations are based on previous experiences and knowledge, which explains why two individuals cannot share exactly the same meanings (Thompson & Walsham 2004). For example, the knowledge conveyed by this doctoral study is interpreted differently by every reader. Although a great number of academic papers start with defining information and knowledge, many authors in knowledge management literature use the terms "information" and "knowledge" as synonyms or without clearly defining the difference between the terms (e.g., Huber 1991, Goh 2002, Shankar & Gupta 2005).

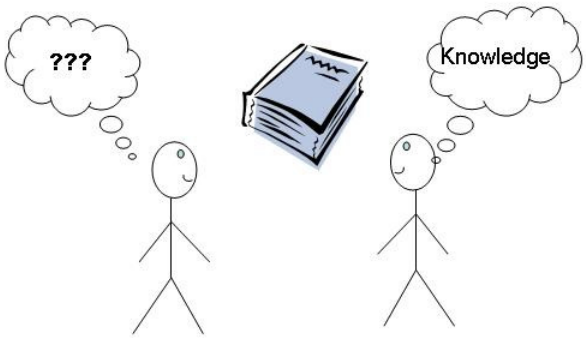

Figure 3. A same piece of information does not generate similar knowledge for different interpreters.

A commonly used definition for information is that it is an organized set of data (e.g., Roberts 2000, Bhatt 2001). Then, the meaning of the term "information" is very similar to the term "explicit knowledge," which is knowledge that is codified and can be represented using signs, a formal language or a coding system (e.g. Schulz & Jobe 2001). However, if information is to become understandable, one needs to recognize and comprehend the rules applied for organizing information. For example, I understand that the following sentence contains letters that are organized in a meaningful way, but since I don't speak French, I don't understand the message. *En favorisant le travail de groupe, en pratiquant un enseignement actif et en privilégiant les*

situations pratiques, l'IAE Aix s'assure que ses diplômés, considérés comme de vrais professionnels, excellent non seulement dans leur domaine de spécialisation mais également dans le management du changement et des relations interpersonnelles. Understanding the rule applied for organizing information could be one way to differentiate explicit knowledge from information.

Some similarities can be found between the different definitions of the term knowledge (see Table II). A major part of the knowledge management literature shares the view that knowledge is generated through reasoning, intellectual efforts and mental process, and the result of these cognitive processes (i.e., knowledge) resides within individuals (e.g., Alavi & Leidner 2001, Tsoukas & Vladimirou 2001, McInerney 2002). Knowledge is therefore first and foremost personal. Knowledge helps individuals to act, either mentally (make decisions and interpretations) or behaviorally. Interpreting information means an opportunity to become more knowledgeable. Learning through renewing and accumulating knowledge is one important characteristic associated with knowledge. Knowledge can also take different forms, some of which can be collectively known or represented, although this kind of collective knowledge might have various meanings for different interpreters (cf. Figure 2).

Tsoukas & Vladimirou (2001) refuse to accept that the concept of knowledge should be left ill-defined, even though the attempts during the last centuries have not shown much progress or resulted in consensus among researchers. Tsoukas & Vladimirou argue that making a clearer distinction between personal knowledge and organizational knowledge might provide better insights into managing knowledge (personal or organizational) within organizations. They conclude that organizational knowledge is personal knowledge applied in a certain context, i.e., in an organization. As Alvesson & Kärreman (2001) note, the concept of "knowledge" is ontologically incoherent, vague, and either too broad or too narrow; lacks objectivity and robustness, and its functionalism is poorly understood. Even ancient philosophers debated what the term knowledge means, and the discussion has continued ever since. This study does not make much progress on the matter, even though it is worthwhile noting that "knowledge" is one of the key concepts of this study. Thus, the precise meaning of the term "knowledge" is neither achievable nor required for the purposes of this study. Any kind of a definition would produce different kinds of meanings for each individual reader of the study. Fortunately, through communication and interaction human beings can generate, discuss and share their views on "knowledge" to satisfy context-specific needs. In the organizational context, or from a practical

point of view, the meaning of knowledge (as a concept) may be a trivial issue. What is more important is what knowledge represents and how this knowledge is utilized.

To summarize, we cannot easily make a perfect distinction between information and knowledge. This study follows the view that knowledge is *actionable information* (Tiwana 2000, 57). This view captures the idea that knowledge is constructed by people. In an organizational context, knowledge is produced when it is shared (Tsoukas 1996). It is humans that interpret information, and, depending on their capabilities and competencies, this information can become knowledge that makes (cognitive and behavioral) actions possible. Chapter 2.3 explains in more detail how the epistemological assumptions about information and different types of knowledge affect management of information and knowledge in organizations.

2.2.2 Different types of knowledge

Organizations and their employees possess different types of knowledge. Both practitioners and researchers need understanding of the characteristics of the different types of knowledge because these have an influence on knowledge accessibility, transferability, visibility, etc. The usefulness (or value) of knowledge cannot be assessed without taking into account the context where the knowledge is supposed to be applied. Information and knowledge also accumulate and may become obsolete (in terms of functionalism or truth-value) because of the changes in the context where they are to be applied. The review of the different knowledge types is not ontologically profound, but it aims at offering the reader analytical tools for pragmatic reasons, i.e., it aims at making it easier to follow the story.

The nature of knowledge – and our view on it – is important when we study knowledge in a specified context – in organizations. Two distinctively different perspectives can be taken (Nonaka and Toyama 2005). One approach is to consider organizations as machines that process information using clearly defined processes, structures, and objectives. This approach considers knowledge as an object. Another perspective is to take the subjectivity of the members of an organization into account. This view recognizes people as the carriers and processors of knowledge. As a result, knowledge is subjective, context-dependent, socially constructed, and embedded in practice. In this view, knowledge is created and validated through social processes (Nonaka 1994). Nonaka and Toyama (2005) try to avoid the dichotomy between these two approaches and suggest that objective and subjective approaches should be synthesized. Extreme

opposite poles rarely provide the best perspectives, which makes this argument reasonable. This may cause some frustration for people who do not perceive different shades of grey.

One of the most popular typologies for knowledge originates from the ideas of Polanyi (1966), who proposes a distinction between explicit and tacit knowledge. His ideas was further developed and popularized, e.g., by Nonaka (1994), Nonaka et al. (1994), and Nonaka & Konno (1998). Explicit knowledge can be codified, stored, and transmitted using formal language or symbols. It can be captured in texts, manuals, instructions, etc. Explicit knowledge (or information) is easy to transfer and retain in the organization. This attracts organizations to transform their tacit knowledge into an explicit form. However, this is costly (it takes time to transform tacit knowledge into an explicit form), and knowledge transformed into an explicit form may become poorer in quality because of a lack of, e.g., contextual elements (Markus 2001, Benbya & Belabaly 2005). Tacit knowledge, instead, is rooted in action and gained through experiences. It is usually context-specific, personal and embodied, hard (or impossible) to represent using any formal symbol system, and difficult to transfer to another person. Tacit knowledge includes mental models and schemas that help individuals to perceive and interpret the world around them.

Nonaka (1994), Nonaka et al. (1994), and Nonaka & Konno (1998) propose that organizations and their members create knowledge through different types of collective and personal knowledge conversion processes. These knowledge conversion processes transform knowledge from explicit to tacit knowledge (and vice versa) and from collective to individual knowledge (and vice versa). Through socialization, an individual gains organizational tacit knowledge; through externalization, an individual transforms her tacit knowledge into an explicit form; through combination, collective explicit knowledge resources are combined; and through internalization, an individual transforms explicit knowledge into personal tacit knowledge. For a more comprehensive discussion, see, for example, Nonaka (1994) and Nonaka et al. (2000).

At its simplest, recognizing the dichotomy between tacit and explicit knowledge can help organizations and their members to achieve their knowledge management objectives. Accordingly, an organization and its members need to perceive which parts of the knowledge resources are explicit and which parts are tacit, and then choose appropriate methods and practices for managing different types of knowledge. Typically, managing knowledge is not that simple. Although the taxonomy is applicable and logical in many cases, some researchers (e.g., Polanyi 1966, Alveson 1993, Tsoukas 1996) highlight that all knowledge has a tacit component.

In their study of call center operative work, Tsoukas & Vladimirou (2001) showed that even fairly repetitive work occasionally involves complex cognitive processes (e.g., focusing of attention, differentiating relevant and irrelevant information, making decisions, etc.), which could not have been executed by following the written manuals. Thus, detecting whether a task involves explicit or tacit knowledge is not that easy a task. Often, standardized and repetitive operations can be performed with information (explicit knowledge), and operations that require flexibility need the application of knowledge (tacit knowledge) (Blumentritt & Johnston 1999).

In psychology, knowledge is often divided into declarative (descriptive) and procedural knowledge. Declarative knowledge is knowledge that can be expressed in a descriptive form (e.g., laws, rules, facts). For example, through formal education, students usually learn a lot of knowledge that is declarative by nature. Procedural knowledge is knowledge about how to apply knowledge. This could be, for example, the ability to apply management theories when becoming a manager. Interestingly, there is not much difference between declarative and explicit knowledge or procedural and tacit knowledge. The terms "descriptive knowledge" and "procedural knowledge" are rare in knowledge management literature, though there are exceptions (Zack 1999b, Borgatti & Cross 2003, Holsapple 2005). As is often the case, different disciplines have generated different concepts for fairly similar phenomena.

Knowledge can be also considered to be collective (organizational) or personal (e.g., Cook & Brown 1999, Gammelgaard & Ritter 2005). Unsurprisingly, organizational knowledge is based on its individuals' knowledge. Nevertheless, organizational knowledge is not the sum of its individuals' knowledge – the ability to integrate and combine knowledge defines the value and applicability of organizational knowledge. However, if we accept the view that (true) knowledge can be only personal (as was discussed earlier), we must question whether there can be any *organizational* knowledge. Orlikowski (2002) offers one view on this. She studied distributed organizations, and her conclusion was that *collective competencies* (i.e., sharing identity, interacting face to face, aligning effort, learning by doing, and supporting participation) facilitate organizational performance. I think that collective competencies are close enough to organizational knowledge to allow comparison between these two concepts and justify the existence of organizational knowledge. Spender (1996) takes the opposite perspective. He questions the role of an individual. He argues that learning and knowledge processing always takes place in a social context, and therefore an individual cannot be isolated from the

organizational context. To conclude, making a precise distinction between individual and organizational knowledge is challenging.

Table III summarizes our discussion about different types of information and knowledge in an organizational context so far. We have come to the conclusion that organizations can definitely contain collective information. This information is codified in common and accessible databases, manuals, instructions, etc. Some of the information is possessed by individuals without access by other members of the organization. Knowledge is held by individuals. Organizational or collective knowledge takes the forms of organizational routines and practices and collective understandings developed through a common organizational history and interaction (Nonaka 1994, Nonaka & Takeuchi 1995, Tsoukas & Vladimirou 2001, Firestone & McElroy 2004). Organizational routines and practices and collective understandings can manifest themselves as etiquette for interaction, directions of knowledge flows, and unspoken specifications for important knowledge.

Table III. Organizational information and knowledge resources.

Individual information (explicit knowledge)	Individual knowledge (tacit knowledge)
Collective (organizational) information (explicit knowledge)	Collective (organizational) knowledge (tacit knowledge)

Spender (1996) uses a similar kind of classification for individual and social organizational knowledge as presented in Table III. He names explicit individual knowledge as conscious knowledge, explicit social knowledge as objectified knowledge, implicit individual knowledge as automatic knowledge, and implicit social knowledge as collective knowledge. Whatever classifications or names we give to knowledge, we must keep in mind that these are human constructs, agreements between people. It seems that we are not able to make an all-inclusive and comprehensive categorization for knowledge by using a two-dimensional approach where one dimension refers to the tacitness of knowledge (vs. the explicitness) and the other to the availability of knowledge (collective vs. individual knowledge). These categories overlap, and it is possible to make even more fine-grained differentiations within the categories.

What kinds of representations can different types of information and knowledge take, then? A typology generated by Collins (1993) and Blackler (1995) offers one perspective on knowledge types in organizations. Collins (1993) presents a typology of knowledge, abilities or skills. His typology includes symbol-type knowledge (which Blackler (1995) later named as encoded knowledge), embodied knowledge, embrained knowledge, and encultured knowledge. Blackler's review of knowledge types (1995) extended the typology to also include embedded knowledge.

Embrained knowledge includes individual cognitive and conceptual skills and abilities. *Embodied knowledge* refers to an individual's ability to apply knowledge in a certain context. *Encultured knowledge* stands for collective meanings and understandings in a selected cultural context. *Embedded knowledge* means knowledge adopted into organizational routines and systems (elsewhere this also includes the social networks of an organization, Argote & Ingram 2000). *Encoded knowledge* indicates knowledge that can be captured by signs and symbols. Features of different knowledge types are presented in Table IV. The justification of dividing knowledge strictly into tacit and explicit can be questioned (e.g., Tsoukas 1996, Alvesson & Kärreman 2001). The last column in the Table IV is therefore only indicative.

Table IV. Knowledge types in organizations (modified from Blackler 1995).

Knowledge types	Characteristics of knowledge types	Tacit / explicit personal / social
Embrained knowledge	Cognitive skills and abilities. Acquired, e.g., through formal education. Gives answers to what-questions.	Explicit (and tacit) personal knowledge
Embodied knowledge	Ability to apply knowledge appropriately in a certain context. Gives answers to how-questions.	Mainly tacit personal knowledge
Encultured knowledge	Encultured knowledge includes collective and shared meanings, understandings, and interpretations of a social community.	Mainly tacit social knowledge
Embedded knowledge	Embedded knowledge resides in systemic routines.	Mainly tacit social knowledge
Encoded knowledge	Knowledge expressed in formal language, e.g., in written texts.	Explicit personal and social knowledge

Compared to the classifications of knowledge types presented earlier, the classification presented in Table IV is very feasible for describing and evaluating knowledge within an organization because it takes into account the locations of organizational knowledge in more detail. Most of

the knowledge within an organization can be categorized according the typology presented by Blackler (1995). Consequently, knowledge resides in individuals, in social settings and in organizational systems, and takes the forms of more or less tacit and explicit knowledge.

When we consider knowledge that is transferred *across* organizational boundaries in the form of (knowledge) products or (knowledge) services, we find that knowledge becomes more difficult to categorize using the presented categorization. Some of the knowledge artifacts (i.e., products and services) might include encoded knowledge documented in the form of reports or written analysis. However, some of the knowledge products or services that are produced applying embrained, embodied, encultured, and embedded knowledge are problematic to categorize into any of the presented categories. A simple example is a PC. It would be easy to argue that it is a product of knowledge work. Nevertheless, it is not easy to say what kind of knowledge the product itself represents. Madhavan & Grover (1998) propose that knowledge creation includes transforming embedded knowledge into the form of a product, which they call embodied knowledge. In their reasoning, "body" refers to an object, not to a person. Their perspective differs from that of Collins (1993) and Blackler (1995), but both perspectives are understandable. This study considers knowledge to be an attribute of a subject(s) and social systems, but which can also be objectified into knowledge artifacts. Knowledge itself as an embodied knowledge object (using the definition of Madhavan & Grover (1998)) taking the form of knowledge products or services is not in the focus of this study.

Knowledge in organizations resides in various forms and in various locations (e.g., Blackler 1995, Spender 1996). First, knowledge is held by the individual members of an organization. This knowledge includes memories, learnt and experienced expertise, personal files, etc. Second, knowledge is embedded in organizational routines and operational practices. Third, organizations have collective repositories for codified information and knowledge. In this respect, we can distinguish collective and individual knowledge, and tacit and explicit knowledge. Creating collective knowledge is important for two reasons (Holmqvist 1999): mutual knowledge helps an organization's members to collaborate with each other, and knowledge does not leave the organization (that easily) if a member of an organization leaves.

There are two alternative ways for managing tacit knowledge. Either the knowledge is converted into an explicit form or left in a tacit form. Converting knowledge into an explicit form may generate problems. It becomes easier to imitate and easier to access by competitors (Schultze &

Stabell 2004). In addition, tacit knowledge may be too difficult to codify, too contextual, too rapidly obsolete, or too politically sensitive to be codified (Swan et al. 1999). Converting knowledge requires organizational resources, i.e., time. If the knowledge is left in a tacit form, then the managerial approach is more people-oriented. Thus, an organization needs to decide how to allocate resources, i.e., what knowledge should be converted into an explicit form and what should be left in a tacit form (Zack 1999b).

Lam (2000) proposes that at the micro level, knowledge in organizations could be viewed from the perspective that differentiates knowledge by using ontological and epistemological dimensions. In her model, the different knowledge types are put into categories with clear boundaries. She admits that this is a conceptual shortcut, and in reality the categories can overlap (for a comparison, see Table IV).

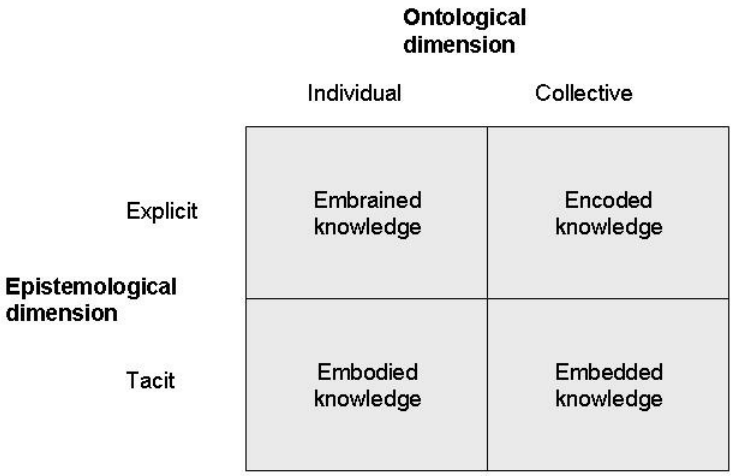

Figure 4. Cognitive level knowledge types (Lam 2000).

All organizations comprise a combination of different knowledge types. This study views knowledge as active and evolving, developed and embedded in social systems, and represented in various forms that do not form a clear dichotomy. This view acknowledges the dynamic nature of knowledge and follows the thoughts of Cook & Brown (1999), who call this view on knowledge as *"epistemology of practice."* For me, this view on knowledge is intellectually more lucrative and pragmatically more truthful than the view which considers information and knowledge as being mechanic and static resources of an organization. Managing knowledge requires

recognizing the differences between different types of knowledge. However, whatever categorization we select to follow, the different knowledge types cannot be (easily) classified into mutually exclusive categories. Spender's (1996) reasoning also follows this logic. He argues that reductionism is not a feasible approach, but organizational knowledge systems need to be considered from a holistic perspective, where knowledge is activity rather than knowledge about something.

2.2.3 Dispersed knowledge

No individual member of an organization can hold all the necessary information and knowledge that is needed to act according to the organizational objectives. Knowledge is always dispersed in organizations (Tsoukas 1996). It is embodied in people and embedded in systems and practices. Usually, people and intraorganizational units located in different parts of an organization need to collaborate and exchange information and knowledge to achieve their work-related objectives (Heaton & Taylor 2002). The flip side of integrating fragmented knowledge resources can result in information overload (Gammelgaard & Ritter 2005). Employees working toward a common goal in a dispersed mode of operations need to have sufficient common knowledge, they need to understand how their work is interdependent, they need to be willing to collaborate, and they need the technology and practices that help to integrate dispersed knowledge and expertise (Olson & Olson, 2000).

Today, organizations are becoming more complex and more distributed. Organizations and their units may operate in several physical locations without clear functional or managerial boundaries. Operative work can even be performed by several organizations. This new form of an organization requires a new name – a virtual organization. The use of globally distributed teams is increasing in industry (McDonough et al. 2001). Virtual teams and virtual organizations work interdependently across geographical, temporal, and organizational boundaries (e.g., Lipnack & Stamps 1997, Martins et al. 2004). One rationale behind the dispersed or virtual organization is that it may provide access to knowledge and resources that would not be available otherwise. What follows is that knowledge that is needed to accomplish the work is dispersed within and between organizations. These kinds of organizations may have only limited capability to integrate and transfer knowledge that is difficult to codify (see Table V). Physical and temporal distance lessens the means and opportunities for communication and knowledge sharing, and slows the flow of knowledge from the source to the receiver. For more discussion about the types of

collaboration technologies that can be applied for supporting asynchronous electronic communication, synchronous electronic communication, or synchronous face-to-face communication, see Andriessen (2003).

Table V. Possible interaction and communication practices in terms of time and location.

	Same physical location	**Different physical location**
Opportunity for synchronous communication / knowledge sharing	Repositories, Intranet, Internet, email, phone, teleconference, videoconference, technology based collaboration tools, face-to-face interaction	Repositories, Intranet, Internet, email, phone, teleconference, videoconference, technology-based collaboration tools
Opportunity for only asynchronous communication / knowledge sharing	N/A	Repositories, Intranet, Internet, email, technology-based collaboration tools

Virtual organizations are an extreme example of dispersed knowledge, but knowledge is dispersed even within an organization that is physically co-located (e.g., all the operations are performed in one building). We could actually speak about *the degree* of knowledge dispersion in organizations. Both virtual and co-located organizations face the challenge of integrating their dispersed knowledge.

Integration of dispersed knowledge is discussed here mainly from an operative perspective. For example, mergers and acquisitions are large-scale strategic intentions of integrating knowledge, but they are not in the scope of this study. An operative perspective on knowledge integration can include knowledge exchange between individuals and groups of people – either within an organization or between organizations. Knowledge integration includes elements such as defining the knowledge that needs to be integrated, locating dispersed knowledge, and transferring knowledge between the different locations. These themes are discussed in more detail in the chapter on knowledge flow, but an introduction to the theme is offered here.

There are at least three different types of knowledge integration. First, knowledge integration can be intentional and preplanned, where the different actors have formally or informally agreed the rules and practices for knowledge integration. Most organizations do this continuously: it is embedded in normal work processes. Second, ad hoc needs for integrating dispersed knowledge resources may also emerge. This kind of a situation is likely to emerge when a member or group

of an organization finds out (without preplanning or even accidentally) or anticipates that valuable and applicable information and knowledge exists somewhere. The amount and quality of social connections between an organization's members promotes this type of knowledge integration. Third, knowledge integration can also refer to a situation where knowledge is applied to a new context. Poor-quality glue which was successfully applied to Post-it notes is one example of this kind of knowledge integration (see, e.g., Art 1987). Besides formal and agreed practices that aim to integrate dispersed organizational knowledge, informal and ad hoc occasions and opportunities for knowledge-sharing are also good vehicles in supporting the utilization of organizational knowledge resources and the creation of new knowledge (Thomas et al. 2001, Mäki & Koskinen 2003, Scarbrough 2003).

Dispersed knowledge means knowledge that is asymmetrically available to the members of an organization (Zack 1999b, Griffit et al. 2003). It may also mean the high contextuality of knowledge. High contextuality of knowledge is often associated with poor transferability (Cummings & Teng 2003). Knowledge integration in virtual or dispersed modes of operations encounters several challenges, including, e.g., poor availability of knowledge, unclear responsibilities of transferring or receiving knowledge, and insufficient means to share knowledge (Mäki et al. 2004). In her study of nine collaborative university student projects located in three different continents, Cramton (2001) reported the following serious problems in dispersed collaboration and knowledge integration. First, the groups were ineffective in providing contextual information to their remote partners. Second, knowledge was unevenly distributed among the organizations. Third, groups were uncertain about the meaning of silence, i.e., they did not always know whether it was their turn to disseminate knowledge or wait for knowledge. In addition, accessing and transferring knowledge was challenging due to technical problems. In their study of NPD teams, Leenders et al. (2003) found that when creativity and flexibility was required, a high degree of virtuality was unproductive for the NPD team outcomes.

Integrating dispersed knowledge requires its transfer between the source and the receiver. It involves connecting the seeker of knowledge with the sources of knowledge (Weiss 1999). While passive warehouses and databases can sometimes be applied for transferring information and knowledge, knowledge transfer often requires active communication and interaction (Weiss 1999). This communication and interaction can be mediated by technological applications (e.g., email, phone, groupware tools) and more traditional means, i.e., physical meetings. Organizational, physical, knowledge-related, and norm-related distance between the source and

the receiver affects the success of knowledge transfer (Cummings & Teng 2003). All of the abovementioned distances tend to increase in bigger, more dispersed, and externally networked organizations. Thus, knowledge transfer and integration is vulnerable in organizations typical to our time. Decreasing the distance (organizational, physical, knowledge-related, and norm-related) means an increase in mutual understanding among the members of an organization. However, this may be costly or impossible to achieve, and the optimal or required degree of mutual understanding is hard to evaluate (Postrel 2002). Due to a lack of informal interaction, virtual teams face challenges in generating trust between team members, achieving effective interpersonal relationships, and achieving effective communication (McDonough et al. 2001). Nevertheless, virtual organizations should promote mechanisms that maintain and sustain their members' organizational identification and interpersonal trust because this encourages collective effort (Wiesenfeld et al. 1999). Active communication with remote units is also important for keeping all units focused on project goals and maintaining awareness of other units' activities (Boardman & Bozeman 2006).

Utilizing collective but dispersed intraorganizational knowledge resources can be a rewarding but simultaneously challenging task. For example, effectively shared and integrated dispersed knowledge may result in time savings and promote successful performance (Hoopes & Postrel 1999, Maznevski & Chudoba 2000, Hansen 2002). Challenges include finding relevant information and knowledge (e.g., Hansen 1999, Cross et al. 2001), accessing information and knowledge (Constant et al. 1994), and successfully transferring information and knowledge (Hansen 1999, Maznevski & Chudoba 2000). To successfully integrate complementary knowledge in an organizational context, someone first needs to be aware of where knowledge is located and where knowledge is needed. The main reason for lost opportunities is that the organization is unaware of available information and knowledge (McAdam & McCreedy 1999). Especially tacit knowledge, which is embodied in people, is poorly perceived or found (Haldin-Herrgard 2000). There again, the amount of explicit knowledge is increasing very rapidly, and being aware of existing and relevant explicit knowledge is also a challenging task.

There are several other essential features that have an influence on how an organization and its employees can integrate dispersed knowledge resources. First, *the type of knowledge* (Lam 1997, Hansen 1999, Weiss 1999, Cummings & Teng 2003) affects how knowledge can be integrated. Integration of embedded, tacit, and context-specific knowledge is always challenging. Accessing tacit knowledge requires that the source of knowledge (a person) can recall what she knows.

Herschel et al. (2001) showed that structuring the recall situation (i.e., asking specific questions instead of general ones) remarkably improves the amount and quality of recalled knowledge. So, because of the social nature of the knowledge transfer process, the seeker of information and knowledge can facilitate the content and quality of the received knowledge. Second, *the relationship* (Granovetter 1973, Hansen 1999, Hansen 2002) between the source and the receiver affects the integration opportunity. The relationship between parties may include direct and indirect relations, hierarchical and lateral relations, and relations of strong and weak ties. Direct and strong ties or relations provide easy access to knowledge, but they may be costly to maintain, and their ability to provide new knowledge is limited because strengthening the tie also makes the knowledge bases of the interacting people more similar. In addition, *motivation* and the *ability* to receive and share knowledge are also important in integrating knowledge (Cohen & Levinthal 1990, Gupta & Govindarajan 2000, Markus 2001, Hansen & Nohria 2004). For example, organizational units competing for internal resources are not motivated to share knowledge with each other (Tsai 2002).

Both technological applications and social relationships help to connect dispersed knowledge. Technological applications can provide access to and support the transfer of remote knowledge within an organization (Boutellier et al. 1998, Marwick 2001). Technological applications are practical and efficient in transferring explicit knowledge. Technology can even be applied to finding tacit knowledge. However, technology is poor in transferring such knowledge. Social networks are also good sources of information and knowledge, but the seeker of information and knowledge needs to be aware of what kind of knowledge the members of a social network have and also needs to have time for the intercourse. The knowledge source in turn needs to be willing to contribute, rather than just dump the information, and the source and the receiver need to have a relationship that promotes collaboration (Cross et al. 2001). Social capital (e.g., Nahapiet & Ghoshal 1998) is one kind of glue that can connect dispersed knowledge resources together. Loosely structured informal communities of people, e.g., communities of practice (Wenger & Snyder 2000), which cross functional, task-related, or organizational boundaries can also facilitate the integration of dispersed knowledge and expertise. These kinds of communities can provide access to diverse and fresh knowledge.

Technological applications can save time and money when applied to transferring knowledge in a dispersed organization. New technological applications change work and the way in which work can be executed (Blackler 1995). In addition, technology can even change organizational design,

social structures, and culture (Clegg et al. 1996, Alvesson & Kärreman 2001). While technology can decrease the need for co-located collaboration, so far it has not substituted the need for face-to-face communication and social interaction (Boutellier et al. 1998, Maznevski & Chudoba 2000, Cramton 2001, Johannessen et al. 2001, Thomas et al. 2001, Paasivaara & Lassenius 2003). On the other hand, there are some examples of successful collaborative work that does not involve face-to-face collaboration at all (e.g., Wikipedia).

Knowledge is often created and processed in different kinds of teams, and it involves interaction between people. If we accept the view that knowledge is highly personal and embodied in people, there are no easy solutions to the problem of employing dispersed organizational knowledge resources. Kyriakopoulos & de Ruyter (2004) showed that there is a curvilinear relationship between the NPD team outcomes and procedural memory (~ embedded and encultured knowledge). This kind of collective procedural knowledge is hard to generate in virtual teams.

Swan et al. (1999) present two alternative knowledge management models that can be applied when integrating knowledge in dispersed organizations. The cognitive network model relies on IT (information technology) applications that enable linear information and knowledge flows through static networks. The community network model is based on dialogue and sense-making through active networking and interaction. In the study of Swan et al. (1999), the multinational company that adopted the cognitive network model could not generate much knowledge sharing even at a local level. In fact, the company ended up with even more dispersed and differentiated knowledge bases between different sites (Scarbrough 2003). The multinational company that adopted the community network model (supported by technological applications) succeeded much better (Swan et al. 1999).

An attempt to distribute or integrate locally produced knowledge and practices within a distributed organization is difficult because of the embedded nature of local knowledge (Scarbrough 2003). Knowledge cannot be easily transformed from one social or knowledge-related context to another. This indicates that seeing knowledge as a purely tangible resource might be unjustified. Social processes are important in making collaboration, knowledge sharing, mutual understanding, and knowledge processes efficient. To utilize fragmented knowledge and competencies, an organization's members benefit from collective cognition (Gibson 2001), mutual understanding (Alavi & Tiwana 2002), a collective repertoire of practices, activities, and

knowing (Orlikowski 2002), and collaborative know-how (Simonin 1997), i.e., members need to *know how to collaborate* in order to integrate successfully dispersed knowledge.

2.3 Knowledge management approaches

So far, we have discussed the aspects and features of knowledge and knowledge-intensive organizations. Now we will discuss how (and if) knowledge can be managed as well as how knowledge management efforts affect the utilization of knowledge and the performance of employees and knowledge-intensive organizations. In this discussion, the term "performance" is understood as a descriptive, not a measurable, feature.

The literature identifies two fundamentally different approaches to knowledge management. First, the technological approach emphasizes the use of technological applications for collecting, storing and transferring knowledge. To aggravate, the ontological assumption of the technological approach is that knowledge is independent from human action and is an objective, tangible resource that can be transferred between different locations and contexts by using technology. Second, the human interaction-based approach suggests that knowledge is mostly embodied in people and that its transfer requires human interaction (which can sometimes be technology-mediated). This approach emphasizes that leadership, culture, and interaction promote knowledge utilization. To aggravate, the ontological assumption in the human-based approach is that knowledge is subjective and context-dependent and needs human interaction to be transferred, interpreted, and reconstructed.

Whether we consider knowledge to be a tangible/objective or an intangible/subjective resource, it influences managerial practices that are applied to achieving knowledge management objectives. Objective and subjective approaches in knowledge management literature are both well-represented (Nonaka & Peltokorpi 2006). Nevertheless, technological- and human interaction-based approaches are not exclusionary. Most of the current literature acknowledges that effective knowledge management systems combine the human interaction approach with the use of technological applications (e.g., Davenport 1997, Bhatt 2001, Thomas et al. 2001, Armistead & Meakins 2002, Hlupic et al. 2002, Holsapple 2005). What constitutes a good combination of human- and technology-based approaches is still in many ways unknown. The socio-technical perspective on knowledge management (Pan & Scarbrough 1999) emphasizes that social and technical subsystems should be integrated in a compatible way. One of the earliest documented

success stories in knowledge management – the case of Buckman Laboratories – successfully implemented a knowledge management system that integrated societal and technical elements (Pan 1998, Pan & Scarbrough 1999). Gold et al. (2001) propose that technology, organizational structure, and organizational culture form an infrastructure of knowledge. In their survey study of 323 organizations, they conclude that knowledge processes and knowledge infrastructure together establish a basis for organizational effectiveness.

Still, the vast part of knowledge management literature attempts to assess whether the technological- or the human interaction-based approach is more applicable in knowledge management. In their international Delphi study, Scholl et al. (2004) reported that knowledge management expert panelists (representing natural / technical sciences and social sciences and business administration) believed that psychological and social approaches to knowledge management are more challenging, though promising, than the technical approach. The authors further conclude, based on the views of knowledge management experts, that knowledge management is transforming from an IT-perspective to a behavioral science perspective. Clearly, these two approaches outperform each other in different situations. Situational factors that affect the superiority of the approaches may include the size of the organization, the type of knowledge being processed in the organization, the objectives of the organization, etc. In addition to these, knowledge workers may have personal styles and ways of working that influence their preferences in terms of choosing between technological- and human interaction-based approaches. A major part of the literature, even within the human-based approach, takes an implicit view of homogeneity across employees within an organization. The fact is, however, that people are different. This diversity may cause not only managerial challenges, but also challenges for knowledge workers in terms of requirements for flexibility, adaptation, and tolerance of dissimilarity (Ylitalo et al. 2006). Human and cultural issues are the most challenging part of knowledge management (De Long & Fahey 2000, Oltra 2005).

Knowledge management clearly aims at the efficient utilization of knowledge. However, there are many definitions for the term “knowledge management.” Table VI summarizes some of the most commonly used definitions. More definitions could have been found with not much extra effort (for example, Hlupic et al. (2002) presented 18 different definitions for the term “knowledge management”), but for the purposes of this study it is unnecessary to draw an all-inclusive list of definitions. It is noteworthy that most of the papers written on knowledge management lack any definition of the concept itself. Maybe the term has become so commonly used that the majority

of the authors consider there to be a common understanding of the meaning of the concept. I dare to argue that this is not the case.

Table VI. Definitions of the term "knowledge management."

Definition	**Reference**
Knowledge management means effective knowledge transfer, which in turn is based on a culture that includes co-operative involvement, trust, and incentives	DeTienne et al. (2004)
Knowledge management is perceived as organizational practices that facilitate and structure knowledge sharing among knowledge workers.	Huysman & de Wit (2004)
Knowledge management contains technical ("hard"), organizational ("soft"), and philosophical ("abstract") aspects.	Hlupic et al. (2002)
Knowledge management is an effort to increase useful knowledge within the organization. Ways to do this include encouraging communication, offering opportunities to learn, and promoting the sharing of appropriate knowledge artifacts.	McInerney (2002)
Knowledge management is a process of knowledge creation, validation, presentation, distribution, and application. These five phases in knowledge management allow an organization to learn and reflect as well as unlearn and relearn, which are usually considered essential for the building, maintaining, and replenishing of core-competencies	Bhatt (2001)
The real task of knowledge management is to connect people to people in order to enable them to share what expertise and knowledge they have at that present moment, given that cutting-edge knowledge is constantly changing. The solution is not to try to warehouse everything that one's workers have ever known.	Lang (2001)
Knowledge management can be defined as the achievement of the organization's goals by making the knowledge factor productive.	Beijerse (2000)
Four perspectives on knowledge management: the strategy/leadership perspective, which emphasizes long-term objectives and top management involvement; the knowledge content/practice perspective which is concerned with how knowledge is applied in practice; the technology perspective, which stresses the use of ICT applications; and, finally, the change management/re-engineering perspective, which highlights the importance of work design, organizational structure, and culture.	De Long & Seeman (2000)
Knowledge management means knowledge construction, knowledge dissemination, knowledge use, and knowledge embodiment.	McAdam & McCreedy (1999)

From the above, it is evident that the current knowledge management literature applies a very diverse range of labels to knowledge management. Most of the definitions highlight that the function of knowledge management is to support the realization of organizational goals. Many definitions also acknowledge the importance of human beings. In this study, *knowledge*

management means the tools and practices that are applied to accessing, preserving, generating, utilizing and transferring individual and collective knowledge. Tools and practices may include technological applications such as email, Intranet, and Lotus Notes. Accordingly, technological tools and applications are understood quite broadly in this study. Technology includes computer-based solutions and applications that aim at managing information and knowledge in organizations. The term is used from the perspective of technology users, i.e., how they employ technology-based tools in their work. Practices include behavioral patterns such as interaction between people. Simultaneously, knowledge management includes issues such as the development of competencies, the openness of communication and knowledge sharing, the use of divergent expertise in project groups, the layout and design of the work site, etc. Hence, knowledge management is a wide rather than a narrow managerial practice. Martin (2000) considers knowledge management to be a part of the overall management system.

Knowledge management aims at the efficient utilization of organizational and individual knowledge and information resources. Many authors argue that this can be achieved using technology (e.g., for storing and transferring knowledge and information) or managerial and leadership practices. Managerial and leadership practices here must be understood quite broadly. They cover such themes as creating routines and practices for knowledge sharing opportunities, nurturing a knowledge sharing culture, offering opportunities to learn, re-structuring and re-designing work in organizations, etc. The technological part of knowledge management seems to be simpler, while the human-oriented approach is more unclear and lacks precise practices and tools. DeTienne et al. (2004), Bhatt (2001), and Pan (1998) stress that knowledge management is about combining technological tools with the human-based approach. Management of knowledge is ontologically challenging. Since there is no consensus for the meaning of "knowledge," we need to consider whether all knowledge management efforts really are targeting to manage knowledge at all. Because the term "knowledge" is still very ill-defined among researchers and practitioners, Alvesson & Kärreman (2001) offer a provocative conclusion: *"we don't know very much about "knowledge," but we know how to manage it!"*

Also Mårtensson (2000) takes a critical view on the concept and approaches of knowledge management. She argues that current knowledge management approaches – which she sees more or less appropriate only for managing information – do not attain the idea of managing something that is inevitably attached to human beings. Wilson (2002) perceives knowledge management as a new label for the already well-established information management discipline. In fact, a lot of

knowledge management publications are published in journals that have traditionally published articles on the area of information management (which is not, of course, evidence that knowledge management is same as information management). These comments highlight the symbiotic relationship between information and knowledge in organizations. It is not always easy to make a distinction between information management and knowledge management. Information and knowledge are inseparable twins. If an organization needs to manage knowledge, it also needs to manage information. There are unconvinced voices what comes to the content of knowledge management, but there also doubts as to whether knowledge is manageable at all. In this study, I try to find a balance in this volatile and poorly defined scene.

Showing skepticism toward the concept of knowledge management, Alvesson & Kärreman (2001) have entitled their paper "Odd Couple: Making Sense of the Curious Concept of Knowledge Management." Also Scarbrough (1999) considers if knowledge can be regarded as a commodity that can be managerially controlled. Styhre (2002) echoes this by saying that the most obvious problem in the knowledge management literature is that knowledge is considered to be a tangible resource. Quintas et al. (1997) add:

> *'Knowledge Management' suffers from the same problem as many other management labels: it assumes that knowledge is a 'thing' (object) which is amenable to being 'managed' by a 'subject' (a manager). The analogy is with 'managing culture'– seeing culture as an independent set of variables which become embodied in organizations and which can be manipulated (managed) by suitably sensitized people. Yet it is now widely accepted that culture is not an 'add-on' to organizations. Culture is what an organization is rather than what it has.*

The term "management," which implicitly connotes control, is a difficult term to be related to knowledge and knowledge work. Knowledge workers' need for autonomy and the unstructured nature of knowledge work creates managerial dilemmas (Robertson & Swan 2003). Knowledge-intensive organizations need to resolve several types of managerial paradoxes including accidental vs. purposeful learning, organized integration vs. differentiation, and belonging based on competition vs. co-operation (Chae & Bloodgood 2006). The current paradigm for managing work and organizations may not be sufficient or applicable to knowledge work. While a company has a great deal of control over its tangible resources (e.g., machines, financial assets), the same

does not necessarily hold with the intellectual capital of employees. Even though managers may not be able to manage knowledge, they can manage organizational structures, procedures, and policies, which in turn affect knowledge utilization (Kawalek 2004). So, managing knowledge differs from managing knowledge workers or knowledge work. Organizational managerial styles for knowledge work vary, and organizations can choose between imposed and empowered approaches (Armistead & Meakins 2002), where the latter assigns more responsibility to the individuals (and the former focuses more on controllability). If we want to avoid using the feature of control, maybe the term "knowledge management" should be replaced by "knowledge leadership" as suggested by Kakabadse et al. (2001).

Knowledge is always managed in a certain context or environment. The context imposes limitations and opportunities on the knowledge utilization possibilities. Argote et al. (2003) suggest that the context of knowledge management can be defined using three kinds of attributes. First, the properties of different units need to be taken into account when studying knowledge management. A unit can be an individual within an organization, the organization itself, or a group of organizations. There are only few studies that focus particularly on individuals (e.g., Constant et al. 1994, Brown & Woodland 1999), but there are more studies that take a perspective on organizational knowledge management (e.g., Hansen 1999, Beijerse 2000, Watson & Hewett 2006) and interorganizational knowledge management (e.g., Larsson et al. 1998, Gupta & Govindarajan 2000, Ciborra & Andreu 2001, Carlsson 2003, Eunni et al. 2006). Clearly defining the unit of analysis is always a difficult task, and one could argue that none of the abovementioned studies focus purely on the individual, the organization, or organizations. Second, the properties of relationships between units (whether they are between individuals, groups within an organization, or organizations) affect knowledge management practices. Finding and accessing knowledge by using strong and weak ties (Hansen 1999) is one example of this. Third, the properties of knowledge affect its manageability. For example, Nonaka (1994) and Nonaka et al. (2000) focus a lot of attention on the differences between managing explicit and tacit knowledge.

Whether we are able to manage knowledge or not, knowledge management has objectives that can be explicitly expressed. Knowledge management initiatives can be opportunity-driven (i.e., examples given by other companies, the availability of useful ICT applications) or problem-driven (i.e., an organization addresses current or future problems) (Huysman & de Wit 2004). Based on their research, the authors argue that problem-driven knowledge management initiatives

are more likely to succeed than opportunity-driven ones. Evidently, different types of organizations have different types of knowledge management objectives. Even within the same industrial sector, companies can have different knowledge management objectives, i.e., the reuse of existing knowledge or the creation of new knowledge (Hansen et al. 1999). Some of the most common general-level objectives for knowledge management are summarized in Table VII.

Table VII. Objectives of knowledge management.

Objectives of knowledge management	Reference
The aim that organizations should support knowing – the generation of meaning – amongst their employees	Thompson & Walsham (2004)
Knowledge creation, knowledge discovery, knowledge acquisition, knowledge storing, and identification of knowledge needs	Bouthillier &Shearer (2002)
Knowledge identification, knowledge diffusion, knowledge replication knowledge generation, and knowledge commercialization	Korac-Kakabadse et al. (2002)
Knowledge creation, knowledge storing/retrieval, knowledge transfer and knowledge application	Alavi & Leidner (2001)
Accessing information	Kelloway & Barling (2000)
Create knowledge repositories, improve knowledge access, enhance the knowledge environment, and manage knowledge as an asset	Davenport et al. (1998)
Generate new knowledge, access valuable knowledge from outside sources, use knowledge in decision making, embed knowledge in processes, products, and services; represent knowledge in documents, databases, and software; facilitate knowledge growth through culture and intensives, transfer existing knowledge into other parts of the organization, and measure the value of knowledge assets and/or the impact of knowledge management	Ruggles (1998)
Knowledge acquisition, creation, packaging, application, and reuse.	Davenport et.al. (1996)
Knowledge conversion between explicit and tacit knowledge and creation of new knowledge	Nonaka (1994)

The objectives of knowledge management seem to be clearer and more uniform than the definitions of the concept itself. From the organizational perspective, the objectives of exploiting information and knowledge resources should aim to support the effective utilization of knowledge. Two kinds of objectives are most commonly cited (Table VII): the creation of new knowledge and enhancing access to information and knowledge. Creation of new knowledge can be seen as a primary target for an organization and access to information and knowledge as an instrumental motive that needs to precede knowledge creation. Creation of new knowledge must be viewed from two different perspectives. First, since knowledge creation is a human act (if we

accept this approach), individuals need to be equipped with sufficient skills and motivation to achieve this goal. Knowledge creation can then take place at the individual and organizational levels. Second, at the organizational level, the new knowledge that has been created must be transformed into knowledge artifacts (knowledge applications, e.g., new products and services). New knowledge does not always end up as new products or services, but it can still have value in the future.

Knowledge creation takes place through exchanging and combining knowledge (Nonaka 1994, Nahapiet & Ghoshal 1998), which means that organizations and their members need to have access to information and knowledge, i.e., they need to be able to acquire input information and knowledge for their knowledge creation endeavor. So, knowledge creation and knowledge acquisition are closely linked together. One cannot exist without the other. Based on the literature, a simplified model of the objectives of knowledge management is summarized in Figure 5. However, access to information and knowledge sources and knowledge creation are not the only activities that are needed. In addition to these, information and knowledge needs are to be defined at strategic and operational levels, required information and knowledge must be located, transferred and shared within the organization; information must be stored in organizational repositories in a reusable form, etc.

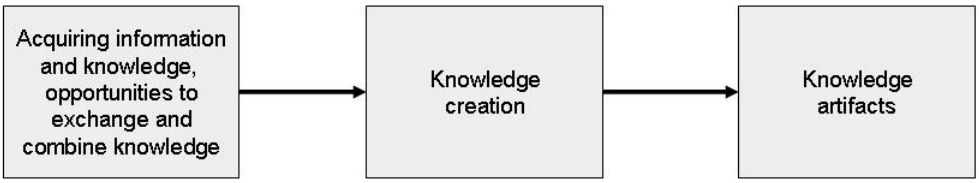

Figure 5. Objectives of knowledge management.

Access to information and knowledge resources and the creation of new knowledge do not happen by accident. They can be supported by managerial actions and technological tools. If management is understood as supervising work processes and maximizing the input-output ratio, then the Tayloristic approach might be feasible (Alvesson & Kärreman 2001). However, there is no evidence that normative control is the best choice for knowledge-intensive work. Thompson & Walsham (2004) say that *all* organizations should concern themselves *less* with the *management of knowledge* and more with the cultivation of the context required in supporting knowing.

McDermott (1999) also argues that attention should not be focused on knowledge but on communities and people who own and use the knowledge. Korac-Kakabadse et al. (2002) doubt that knowledge can be managed with the traditional paradigm (that aims at controlling resources). Organizations in the industrial age are organized and structured around tasks and functions that aim at managing tangible assets, but this kind of a paradigm may be inadequate for organizations aiming to utilize intangible resources (Mohamed et al. 2004). Since knowledge work is at least partly discretionary, i.e., knowledge workers choose when and how much to invest in their work (Kelloway & Barling 2000), intrinsic motivation plays a significant role in knowledge work (Kelloway & Barling 2000, Osterloh & Frey 2000).

Organizations are different, they have different knowledge management goals, they have diverse approaches to knowledge management, and they gain from different knowledge management practices (Smith 2004). No “silver bullet” has been found yet. For accessing information and knowledge, organizations and their members apply, e.g., social networks (Cross et al. 2001), job rotation (Lam 1997), company yellow pages (Benbya & Belbaly 2005), mentoring (Brown & Woodland 1999, Kuronen et al. 2007), common communication tools (e.g., email, phone), knowledge repositories (e.g., shared data basis, Intranet) (Swan et al. 1999, Benbya & Belbaly 2005), and informal events (Mäki & Koskinen 2003, Hoegl & Schulze 2005). Enhancing the accessibility of knowledge can improve and ease knowledge creation (Nahapiet & Ghoshal 1998). So, the tools and methods that improve knowledge accessibility are closely linked to knowledge creation attempts and opportunities.

Technology can be applied to several purposes of promoting the utilization of organizational knowledge resources. The technologies applied to managing knowledge are far from revolutionary. Most of the technologies reported in the literature are available, or already applied, in most Western organizations. First, technology can be applied to storing information and knowledge for later reuse (e.g., electronic databases). Second, technology can be applied to sharing and distributing information and knowledge between different members and groups of an organization (e.g., email, Intranet). Third, technology can support connecting different parts of an organization and foster remote collaboration within the organization (e.g., groupware, yellow pages). Fourth, technology can be applied to support decision-making (e.g., expert systems) or even automate it (e.g., enterprise resource planning). According to Moffett et al. (2004), technological tools applied to managing knowledge can be classified into three groups: collaborative tools, content management tools, and business intelligence tools. Damodaran &

Olphert (2000) studied an electronic information management system (EIM) in a multinational company. Their results show that such a system does not easily meet expectations. Contrary to expectations, the EIM system could not generate integrated solutions, was not widely used, could not provide a culture of knowledge sharing, and was not the key information source.

Alavi & Leidner (2001) found that current literature recognizes three main functions for knowledge management-related IT applications. First, they are applied to the coding and sharing of best practices. Second, they are applied to creating corporate knowledge directories. Third, they are applied to creating knowledge networks. Technology is currently mostly applied to storing and transferring information and knowledge, and it lacks elements that would enable interpretation and collective sense-making (Wickramasinghe 2003). Regarding the dimensions of social capital, most technological applications focus more on the structural dimension than the cognitive or relational dimension (Huysman & Wulf 2006). The study carried out by Karsten (1999) supports this finding. In her study of Lotus Notes implementation and adoption, only a minority of the 18 companies could apply Lotus Notes for collaborative intentions. In addition, Edwards et al. (2005) found that when using ICT tools, or planning to introduce new ones, to support knowledge management activities and initiatives, a clear emphasis is put on simple tools (such as email, shared database) instead of specific or complex tools.

While technology undoubtedly has positive impacts on the managing and sharing of explicit knowledge, some researchers (e.g., Roberts 2000, Johannessen et al. 2001) have discussed the impacts of technology regarding tacit knowledge. Does the use of technology reduce the utilization of tacit knowledge? Especially the resource-based view of the firm (e.g., Wernerfelt 1984), and additionally the knowledge-based theory of the firm (Grant 1996, Spender 1996), emphasize that the competitive advantage arises from the resources that are rare, imperfectly imitable, and hard to substitute. These are all focal features of tacit knowledge. Johannessen et al. (2001) further conclude that IT applications should be used for increasing the availability of information and knowledge, but they should not replace learning by doing, experimentation, and interaction, which all are mechanisms for transferring tacit knowledge and may enable converting tacit knowledge into explicit form. Transforming tacit knowledge into an explicit form is tempting because it might offer a more economical means to store and manage knowledge. However, Swan et al. (1999) give several reasons why transforming tacit knowledge into an explicit form can be unwise, i.e., knowledge may be too difficult to explain and encode, it may be too uncertain or inaccurate, it can change too rapidly, it can be too context-dependent, or it can be

too politically sensitive to be explicated. Converting knowledge into an explicit form is a double-edged sword: while it makes management of knowledge easier, it also makes the rare, imperfectly imitable, and hard to substitute knowledge resources vulnerable (Lam 1997, Schultze & Stabell 2004).

Knowledge management approaches can also be viewed from the perspective presented by Alvesson & Kärreman (2001). Their model is presented in Figure 6. The model discusses how managerial interventions and the knowledge sharing medium affect knowledge management initiatives. The *Extended libraries* approach relies heavily on ICT. Alvesson & Kärreman state that this approach is very close to the bureaucratic management mode. *Enacted blueprints* is very close to scientific management (Taylor 1911). This approach emphasizes efficiency and standardization. Planning and performing of the tasks are separated. In the *community* approach, managerial control is limited. The task of the management is to create and maintain an environment and atmosphere that supports knowledge sharing. According to Alvesson & Kärreman (2001), *normative control* is the most difficult approach to knowledge management. Normative control is difficult in terms of issues like culture. Huysman & de Wit (2004) warn about the management trap, i.e., managerial intentions to control knowledge in organizations. This may reduce voluntary knowledge sharing and initiatives taken by the employees.

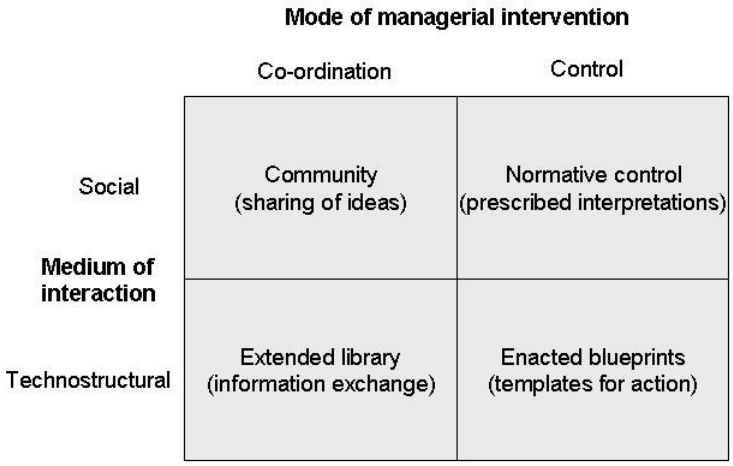

Figure 6. A typology of knowledge management approaches (Alvesson & Kärreman 2001).

The debate regarding the superiority of human-based or technology-based approaches to knowledge management is neither productive nor necessary. Technology- and human-based approaches to knowledge management should not necessarily be perceived as conflicting. There are areas where technology is superior compared to humans (e.g., storing huge amounts of information) and others where humans outperform technology (e.g., interpreting causal and contextual knowledge). Organizations need to design knowledge management systems that integrate human- and technology-based approaches in a meaningful way taking into account the unique characteristics of both approaches. These approaches do not need to be united, but connected (Mohamed et al. 2006).

2.4 Knowledge strategies and knowledge management strategies

The current knowledge management literature does not make a clear distinction between knowledge strategy and knowledge management strategy. I would like to contribute to this issue. I consider knowledge strategy and knowledge management strategy to be different, though interlinked, concepts. This discussion is not meant to be academic hairsplitting, but an attempt to clarify concepts and elaborate on how these two concepts interrelate. In the following, I aim to justify my reasoning and argumentation. Knowledge strategies are not discussed from a macro level perspective, which is typical of strategy discussion (see, e.g., Porter 2004). Instead, the discussion tries to elaborate on how knowledge strategy affects operative work. Surely there must be a link between the chosen strategy and how the strategy is practiced at the operative level.

In general, strategy refers to an organization's intended position in its population. Strategy has internal implications for the organization's operative practices. These implications are debated here. Organizations have different kinds of strategies that are chosen and applied to attaining the objectives of the organization. Strategic choices aim at achieving competitive advantage over the competitors. Organizational strategy can be viewed from various perspectives including time orientation, the scope of an organization's activities, and the choice of recourse allocation and exploitation (Johnson et al. 2005, 6-7). Naturally, organizations may choose different kinds of *knowledge and knowledge management strategies* as well. Knowledge management literature recognizes different knowledge strategies that can be chosen and applied to managing knowledge and utilizing knowledge resources. Organizational knowledge strategy should be congruent with the strategy in general (Zack 1999a, Riege 2005).

In particular, knowledge strategy addresses the organization's aims to exploit its knowledge resources in order to gain competitive advantage. At the strategic level, Zack (1999a) encourages organizations to create knowledge maps for uncovering the gap between current and desired knowledge. At the strategic level, this kind of discussion may include such themes as employee competences required in the future, knowledge and competences needed for a desired product portfolio in the future, future market opportunities, future technology requirements, etc. This consideration may include definitions of future knowledge artifacts and discussion on the information and knowledge requirements for generating such knowledge artifacts. In this study, knowledge strategy and knowledge management strategy are related to an organization's aims and means to *utilize* information and knowledge resources and *produce* information and knowledge.

2.4.1 Knowledge strategies

Organizations can basically choose between two alternative knowledge strategies. These are the explorative strategy (which aims at creating new knowledge) and the exploitative strategy (which aims at reusing existing knowledge) (March 1991, Levinthal & March 1993). The exploration strategy is more innovation-oriented, while the exploitation strategy aims at efficiency (Swan et al. 1999, Alvesson & Kärreman 2001). Returns from the exploitation strategy are more predictable and closer in time, while exploration is risky and uncertain but may promote the firm's survival in the long run (March 1991). In practice, the chosen strategy is a mixture of these two, and an organization needs to find a balance between the exploitation and exploration strategies. Focusing solely on exploration can mean that the organization never gains from its investments in exploration of new knowledge, and focusing solely on exploitation may lead to knowledge obsolescence or even to the destruction of the organization (March 1991, Levinthal & March 1993, Zack 1999a). The latter may come true particularly in emerging markets. In their study on new product development (NPD), Oshri et al. (2005) showed that transformation from exploration to exploitation strategy in product development reduced individuals' learning opportunities, impaired the quality of transferred (received) knowledge, and diminished the sense of being a respected employee. Oshri et al. (2005) further conclude that since expertise develops gradually, knowledge reuse (exploitation) in NPD is not possible without time reserved for learning (individual exploration).

Different parts and functions of an organization can simultaneously emphasize either exploration or exploitation strategies. Even though a company is devoted to exploration strategy, some functions can perform mainly on the basis of exploitation strategy. For example, a private health care company can be explorative in its marketing or process re-engineering initiatives but still offer medical services that are based on exploitation. Furthermore, research and development (R&D) operations in all organizations are likely to emphasize explorative strategy. Different knowledge strategies are often associated with different knowledge management strategies (Hansen et al. 1999), which may cause problems in cross-functional communication and knowledge sharing because different knowledge management strategies involve different types of knowledge.

Explorative strategy refers to the creation of new knowledge and exploitative strategy to the reuse and intraorganizational transfer of existing knowledge (see Figure 7). Explorative and exploitative strategies can originate from two knowledge domains: from existing knowledge (either an organization's internal or external knowledge) or from new knowledge that is either acquired outside the organization or produced in-house. Even innovation-driven and explorative organizations need to carry out, and benefit from, reuse and exploitation of their existing knowledge resources. At the operative level, employees may execute exploitative strategy even if the organizational goal is based on explorative strategy.

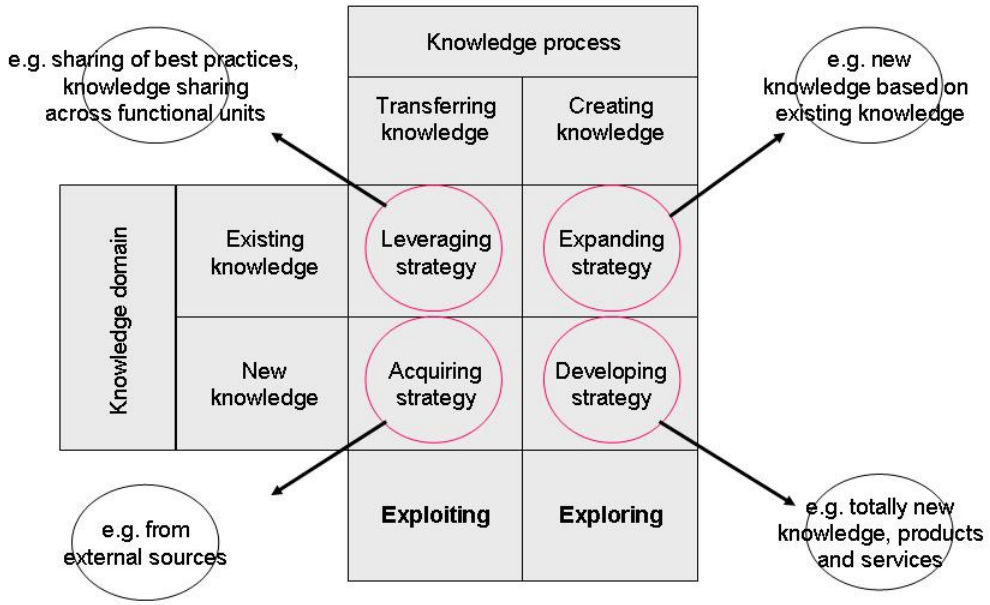

Figure 7. Knowledge strategies and processes (modified from Krogh von et al. 2001).

The leveraging and acquiring strategies in Figure 7 both resemble the exploitation strategy. While leveraging and acquiring strategies do not generate totally new knowledge, this knowledge can be "locally new" from the receiving organization's or function's perspective. The leveraging strategy aims at operational efficiency by the sharing of best practices and knowledge across functional units. This strategy aims at reusing organizational knowledge across the organization and tries to avoid reinventing knowledge. The acquiring strategy means obtaining knowledge primarily from external sources. The acquired knowledge is not totally new, but new for the organization or unit that has acquired it. This kind of knowledge can be acquired through, e.g., interorganizational collaboration (Kogut 1988). A capability to absorb knowledge (Cohen & Levinthal 1990) and link the acquired knowledge to the existing knowledge domain affects the feasibility of this strategy. Application of new knowledge attained through interorganizational collaboration may be difficult due to the ambiguous (Simonin 1999) and embedded nature (Lam 1997) of knowledge. Knowledge acquisition mechanisms in collaborative relationships can take the forms of technology sharing, interaction, personnel transfer, and strategic integration (Inkpen & Dinur 1998).

The expanding and developing strategies in Figure 7 both resemble explorative strategy. The expanding strategy means new ways of applying existing knowledge. Existing knowledge resources can be converted by combination (Nonaka 1994) for generating new knowledge. The use of divergent, cross-functional expertise can result in novel product, service, or process applications. For example, new product development teams aiming for next generation products apply expanding strategy in their work. Developing strategy builds new knowledge from scratch (as far as this is even possible). This strategy aims at generating radical innovations, entirely new ways of operating, or breaking conventional routines and thinking. This strategy is clearly explorative since the intention is to open new business opportunities and take a path with an uncertain end.

The applicability of explorative and exploitative strategy depends on the organization's current position in the market, on the maturity of the organization's industrial segment, and on the available or accessible resources. Both kinds of strategies can be viable even in the same industrial sector (Hansen et al. 1999), although knowledge – and thus feasible knowledge strategies – may vary over industrial contexts (Teece 2000). The chosen knowledge strategy has a long-term implication for the organization. In addition, the choice between explorative and exploitative strategy has managerial and operative implications for daily routines and work processes. To realize the potentiality of the chosen knowledge strategy, an organization needs to choose an appropriate knowledge management strategy to attain the objectives. Zack (1999a) proposes that SWOT analysis can be applied to generating a knowledge strategy, and Earl (2001) offers a step-by-step tool for the same purpose.

2.4.2 Knowledge management strategies

Technology-based and human interaction-based approaches to knowledge management were discussed earlier. This discussion can now be linked to knowledge management strategies. Hansen et al. (1999) propose two alternative approaches to implementing a knowledge strategy. They suggest that organizations may choose either a codification strategy or a personalization strategy for managing knowledge. The personalization strategy is associated with the human interaction approach and the codification strategy with the technology based approach. I consider that codification and personalization are not knowledge strategies, but knowledge management strategies. They simply address the choice of *managing* operative knowledge. They are

instruments of exploitation and exploration. It is a question of what comes first: objectives (knowledge strategy) or practice (knowledge management strategy).

The codification strategy means that an organization attempts to codify its knowledge, and employees are expected to reuse existing knowledge instead of creating new knowledge (Hansen et al. 1999). In this approach, an organization has a predetermined way of action. Knowledge is made available in electronic repositories, and it can be transferred using ICT. Even those organizations that have a strong commitment to a technology-based knowledge management strategy may try to establish interpersonal links to promote knowledge sharing. Scheepers et al. (2004) showed that adding information and knowledge into the electronic knowledge management system or attaining knowledge from the system neither facilitates necessary discussion between people nor provides much cultivation of knowledge. This implies that the technology-based approach is probably not appropriate for supporting explorative knowledge strategy. In this approach, knowledge renewal is slow and incremental since existing knowledge is reused whenever possible. Nonetheless, a knowledge repository accumulates knowledge from the experiences and projects carried out. The codification strategy is an efficient approach to implementing the exploitation strategy since the aim is to replicate actions and reuse existing knowledge whenever possible.

The personalization strategy means that an organization relies more on tacit and non-codified knowledge. In this approach, ICT can also be applied, but here it is employed for interactive communication and finding people and expertise (Hansen et al. 1999). An organization using the personalization strategy produces new knowledge and unique solutions for its customers. The knowledge in an organization is produced in collaboration with divergent experts. The personalization strategy has a lot of similarities with the exploration strategy since the aim is to produce unique new solutions (knowledge).

The chosen knowledge management strategy corresponds to the ontological assumptions of knowledge. The codifications strategy views knowledge as independent from human interpretation, while the personalization strategy considers knowledge to be dynamic and acknowledges that the meaning of knowledge needs to be continuously recreated. Obviously, real world ideas do not belong to either extreme but are located somewhere in between.

The model presented by Hansen et al. (1999) was further developed by Scheepers et al. (2004). One of the arguments presented by Hansen et al. (1999) was that organizations should choose a dominant and a supportive strategy for managing knowledge. Hence, either the personalization strategy is dominant and the codification strategy is supportive, or vice versa. They further argue that the proportions of dominant/supportive strategies should follow a ratio of approximately 80/20. The findings of Scheepers et al. (2004) partly support Hansen et al., but their results also contradict each other to some degree. Scheepers et al. showed that the effectiveness of knowledge use is not entirely dependent on the ratio of the two established knowledge management strategies. They showed that choosing a 50/50 ratio can lead to effective or ineffective knowledge use. So, even though the 80/20 ratio is successful in some cases, *the absolute* (instead of relative) amount of investment and engagement is even more important. Choi & Lee (2002) also discuss the benefits of focused (80/20) and balanced (50/50) strategies. They found that different knowledge creation modes (SECI-phases, see, e.g., Nonaka 1994) benefit from different knowledge management strategies, i.e., system strategy (the use of technological applications) results in effective combination and human strategy results in effective socialization. Regarding internalization and externalization, the chosen strategy had no effects in their study. They conclude that the chosen strategy should be adjusted to correspond to the current task.

Blackler (1995), Lam (2000), and Bhatt (2002) propose three different, though strikingly similar, models about how knowledge-intensive organizations can organize and perform their operative work. These models can be used for considering how organizations can implement their knowledge management strategies and practices. The models (see Figures 8, 9, 10)[5] are based on a fourfold table where the horizontal axes describe whether the work is based on the effort and expertise of individuals or whether the work is organized so as to utilize the capabilities of the organization / collective know-how. The vertical axes illustrates how tasks can vary from non-standardized, novel, non-routine, and non-specific to standardized, familiar, routine, and specific.

[5] The vertical and horizontal axes from the original figure by Blackler (1995) were changed so that the figure follows the same logic as Lam (2000) and Bhatt (2002). For the same reason, the “high” and “low” quadrants were changed from the original figure by Lam (2000). The changes were made to make the comparison of the figures easier.

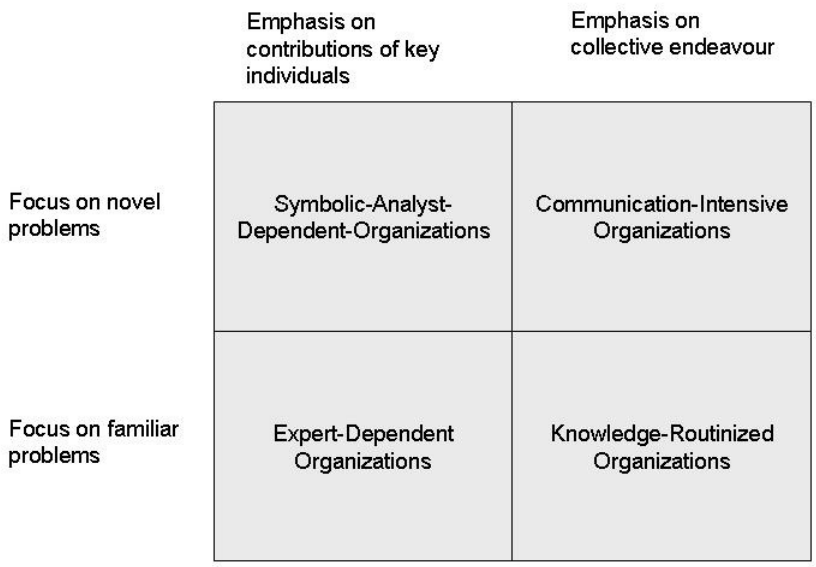

Figure 8. Organizations and knowledge types (modified from Blackler 1995).

An organization that focuses on novel problems is implementing an explorative strategy, and an organization that focuses on familiar problems is implementing an exploitative strategy (see Figure 8). In addition, an organization can choose a collective endeavor for completing the objectives, or the organization can emphasize the contribution of individuals. Blackler (1995) argues that the four different operating modes are based on different types of knowledge representations. First, expert-dependent organizations rely profoundly on embodied knowledge. As was discussed earlier, embodied knowledge consists of personal explicit and tacit knowledge. Second, knowledge-routinized organizations depend on embedded knowledge. Embedded knowledge resides in systemic routines and is collectively available. Third, symbolic-analyst-dependent organizations rely on embrained knowledge. Embrained knowledge consists of personal cognitive skills and abilities. Fourth, communication-intensive organizations depend on encultured knowledge, which includes collective and shared meanings, understandings, and interpretations. None of the organization types in Blackler's model are based on encoded knowledge. Even though the original paper does not mention encoded knowledge, it can be deduced that at least a certain portion of organizational knowledge is in encoded form.

Because expert-dependent and knowledge-routinized organizations focus on familiar problems, we can assume that these kinds of organizations emphasize exploitative strategy more than explorative strategy. Symbolic-analyst-dependent and communication-intensive organizations instead focus more on novel problems, which indicates the feasibility of explorative strategy.

Lam (2000) names an organization that is highly standardized and dependent on individuals as "professional bureaucracy" (see Figure 9). Dependency on embrained knowledge and formal education and training characterize this kind of an organization. Employees and functions are specialized, and there are clear boundaries between jobs and occupations. Individuals employ tacit knowledge in their own area of expertise. Interaction and sharing of tacit knowledge between different occupational groups is limited. The second type of organization is a "machine bureaucracy." It is characterized by efficiency, formal operations, and explicit rules and procedures, which aim at reducing dependency on individuals. It is devoted to encoded knowledge and the use of information systems. Knowledge creation is slow and incremental, and because of standardized routines, the organization is poor at novel situations. The third type of organization is an "operating adhocracy." This kind of an organization employs tacit embodied knowledge and depends on the autonomous expertise of individuals. The work is based on the diverse know-how and skills of individuals as well as on interdependent professionalism. An organization like this generates tacit knowledge through experimentation; interactive, non-standard, and creative problem-solving; and learning by doing. The fourth type of organization is a "J-form" (Japanese-style) organization. It relies on embedded knowledge residing within the operating routines and culture. This kind of an organization has organic, non-hierarchical, and cross-functional team structures. Knowledge flows are both vertical and horizontal, and learning outcomes are disseminated widely within the organization and captured at the organizational level.

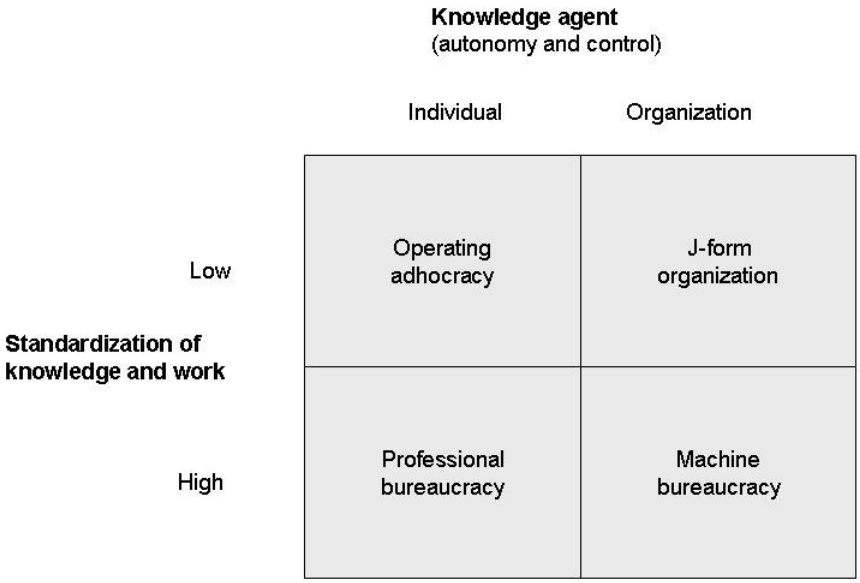

Figure 9. Relationship between knowledge agents and the standardization of knowledge and work (Lam 2000).

Because professional bureaucracy- and machine bureaucracy-style organizations aim at standardizing knowledge and work, we can assume that these kinds of organizations emphasize exploitative strategy more than explorative strategy. Operating adhocracy and J-form organizations instead focus on low standardization, which indicates more emphasis on explorative strategy. The knowledge types in the different quadrants of Lam's (2000) model do not correspond to the model created by Blackler (1995). This could be due to the difficulty of separating and differentiating knowledge types. The messages of the two authors are, however, quite the same. Lam (2000) uses very similar attributes on the horizontal and vertical axes as did Blackler (1995) (see Figures 8 and 9).

The model presented by Bhatt (2002) (see Figure 10) has many similarities compared to the two previous figures.

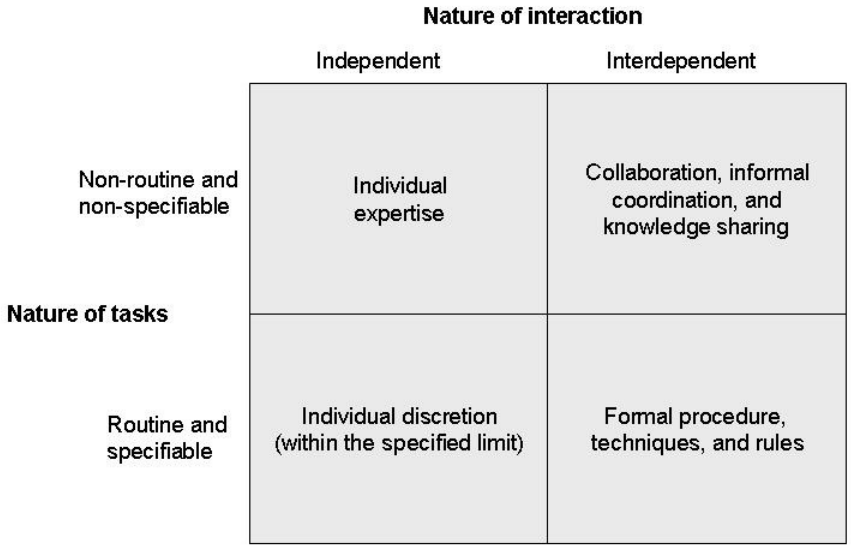

Figure 10. Relationship between individual knowledge and organizational knowledge (Bhatt 2002).

Figure 10 presents the relationship between the nature of tasks and the nature of required interaction. The horizontal axis shows how the required interaction varies from low (independent) to high (interdependent). The vertical axis demonstrates how the tasks can vary from routine and specifiable to non-routine and non-specifiable. Bhatt (2002) proposes different knowledge management strategies for different quadrants presented in Figure 10. The employees that independently perform tasks that are routine and specifiable should be empowered to do their jobs. They should be equipped with appropriate skills and given the responsibility to complete tasks given to them. Routine and specifiable tasks may also require collaboration with other employees. For situations like this, the organization should have specified rules, procedures, and policies for collaborative activities. ICT applications are good vehicles for improving the efficiency of the work. Both of the situations where tasks are routine and specifiable (the lower quadrants in Figure 10) can be considered to be versions of exploitative strategy.

An organization may also perform tasks that are non-routine and non-specifiable. These can be carried out by individual employees, or they may require the contribution of various employees. The successful completion of non-routine and non-specifiable tasks requires an organization's members to be equipped with specialized expertise. In addition, it may require coordination of

organizational tasks and sharing of knowledge between different groups of people within an organization. This also results in the dissemination and adaptation of best practices between different parts of an organization. Technology can be applied to sharing knowledge, but human interaction also needs to be applied since knowledge is often embrained and embodied expertise and therefore difficult to transfer using technology. The upper quadrants in Bhatt's (2002) model can be considered to represent explorative strategy.

Compared to the definition of knowledge-intensive work presented in Chapter 2.1, it is somewhat uncertain whether all the quadrants in the previous three figures represent knowledge-intensive work at all. For example, complexity and autonomy – salient features of knowledge-intensive work – may be somewhat absent in the lower quadrants of the presented Figures 8, 9, and 10. Blacker (1995) states that knowledge work in general is transforming from the exploitative mode towards a more explorative approach. The practice of knowledge-intensive work would then resemble the theoretical definition more closely. In addition, he proposes that future organizations will emphasize collective effort more than individual effort. Bhatt (2002) echoes Blackler's reasoning.

2.5 Knowledge flow

Members of organizations should work toward common goals (that is the fundamental reason why organizations exist). For achieving the goals, the organizations' members need to collaborate with each other. This makes knowledge integration achievable. In knowledge-intensive organizations, this means coordination and cooperation (Hoopes & Postrel 1999), i.e., sharing and combining knowledge resources. Knowledge flow is a process of knowledge passing between people or a knowledge processing mechanism (Zhuge 2002). Knowledge flow connects and transfers knowledge and competencies from where it resides to where it is needed (Nissen 2002). More practically, Kim et al. (2003) define knowledge flow as a process that connects knowledge producers and knowledge users. The role of any member of an organization may vary over time and task: a member of an organization can be either a knowledge producer or a knowledge user, and this role may change. The connection between the knowledge producer and the knowledge user can be established using the technological- or human interaction-based approach. Therefore, knowledge flows in organizations are based on information flows and communication processes (Shin et al. 2001). Knowledge flow, i.e., sharing and transferring information and knowledge

within an organization (and often also between organizations) is the glue that links information and knowledge sources and targets together.

Knowledge flow constitutes different knowledge processes that carry or help to carry knowledge. The literature identifies numerous knowledge processes, but on which of them should we focus our attention? Are they all relevant or necessary in generating an efficient knowledge flow? How are these processes interlinked? This chapter aims at illuminating these questions.

Ideally, knowledge flow brings the right knowledge, at the right time, and in the right form to where it is needed. Unfortunately, it is a challenging task to define exactly what the right knowledge is, when knowledge is needed, what the right form of knowledge is, or where the knowledge is needed. Usually numerous employees are involved in producing the organizational knowledge flow, which indicates the necessity of coordination and agreed and shared procedures (Hoopes & Postrel 1999). Organizations are becoming more complex, specialized, and dispersed, which offers both opportunities and challenges for efficient knowledge flows.

Taylor (1911) aimed at improving work performance and efficiency by breaking work down into tasks and identifiable processes and then defining and selecting the best way and tools for carrying out the work operations. At his time, Taylor analyzed and developed manual work. Knowledge-intensive work and knowledge processes may be different. Knowledge processes are less easily identifiable and breakable into separate processes. It seems somewhat artificial to put different knowledge processes into sequential order because knowledge processes are highly interrelated, ill-structured, usually overlapping, and their beginnings and ends are difficult to define accurately (Davenport et al. 1996, Amaravadi & Lee 2005). For example, how information and knowledge is stored affects how information and knowledge can be found or retrieved. For the reason of simplicity, however, this study breaks the knowledge flow into knowledge processes that constitute the knowledge flow. The choice of presenting knowledge processes in a separated and sequential order gives us an opportunity to illustrate how these processes work from the perspectives of individuals and organizations. I hope that the use of this kind of a mechanical or linear view does not twist the true nature of affairs too much.

The literature on knowledge management has identified and named numerous different knowledge processes (see Table VIII). Most of the models include 3–5 different knowledge processes, but, for example, Kuzca's (2001) model contains 39 different processes. Despite the

great number of different knowledge processes, it is possible to find similarities between the models and processes. Some of the differently named processes seem to be remarkable similar, e.g., knowledge creation and knowledge generation are often used as synonyms, just like knowledge sharing and knowledge transfer or knowledge connection and integration. However, the differences between the named processes (and their content) show that differentiating organizational and individual knowledge processes is not that simple a task to do. In addition, different authors have different temporal orders for the knowledge processes. This indicates that knowledge processes are difficult to separate from each other and that they overlap in time. The studies on knowledge processes have been conducted in different contexts, which may have generated different perspectives on knowledge processes. Knowledge processes and knowledge management practices have often been studied in contexts where knowledge-intensity is significant. The studies include, e.g., R&D operations (e.g., Cummings & Teng 2003, Weck 2006), innovation management (Swan et al. 1999, Cavusgil et al. 2003), and NPD (e.g., Mohrman et al. 2003, Hoegl & Schulze 2005).

Table VIII. Commonly cited and studied knowledge processes.

Knowledge processes	Reference
Transfer, reuse and store	Watson & Hewett (2006)
Creation, maintenance, distribution, review & revision	Bhatt et al. (2005)
Storing, retrieving, transfer	Gammelgaard & Ritter (2005)
Sharing	Riege (2005)
Use, dissemination, creation	Shankar & Gupta (2005)
Production and integration (both of which have sub-processes)	Firestone & McElroy (2004)
Creation, retention, transfer	Argote et al. (2003)
Transfer (source/target): identify, locate, establish availability, establish willingness, select transfer method	Kamara et al. (2002)
Acquiring and absorbing > creation	Soo et al. (2002)
Capturing, packaging, distributing, and reusing	Markus (2001)
Creation and transfer	Argote & Ingram (2000)
Knowledge development (including creation, review, revision, distribution, and adoption)	Bhatt (2000)
Creating, formalizing, organizing, distributing, applying, evolving	Nissen et al. (2000)
Collecting and connecting	Weiss (1999)
Finding, creating, packaging, applying, reusing	Davenport et al. (1996)
Conversion and creation	Nonaka (1994)
Acquiring, distribution, interpretation, storing > learning	Huber (1991)

Based on the literature, the most commonly cited and identified knowledge processes include knowledge acquisition, knowledge storing, knowledge transfer and sharing, and knowledge creation. While these processes are essential for knowledge flow, knowledge applications (i.e., knowledge outcomes in forms of products and services) are, naturally, what organizations aim to achieve. For example, knowledge acquisition or transfer *as such* does not add value to knowledge. However, they are important links in knowledge creation and the value adding process. Derived from the literature and from my own, hopefully rational, reasoning, a model of organizational knowledge processes and knowledge flow is presented in Figure 11. The logic behind Figure 11 is the following. First, knowledge workers and knowledge organizations need to *acquire input information and knowledge* for the basis of their intended knowledge outcomes. This input information and knowledge is transferred from the information and knowledge

repositories (e.g., knowledge embodied in people, encoded knowledge in technological systems, etc.). Second, the acquired input information and knowledge is then utilized, which means *knowledge exploration* or *exploitation*. Third, the exploration and exploitation generate tangible and intangible *knowledge outcomes*, of which some are for markets or for internal and external customers. Fourth, knowledge outcomes include residue and by-product information and knowledge that are *stored* in information and knowledge repositories for later use and reuse. The dashed arrow illustrates that not all information and knowledge is available when knowledge workers or knowledge organizations aim at acquiring input information and knowledge (for reasons related to knowledge, to the source, or to the receiver). The following chapters (2.5.1–2.5.5) explain the logic of Figure 11 in more detail and evaluate how knowledge processes and knowledge flows are affected by different factors.

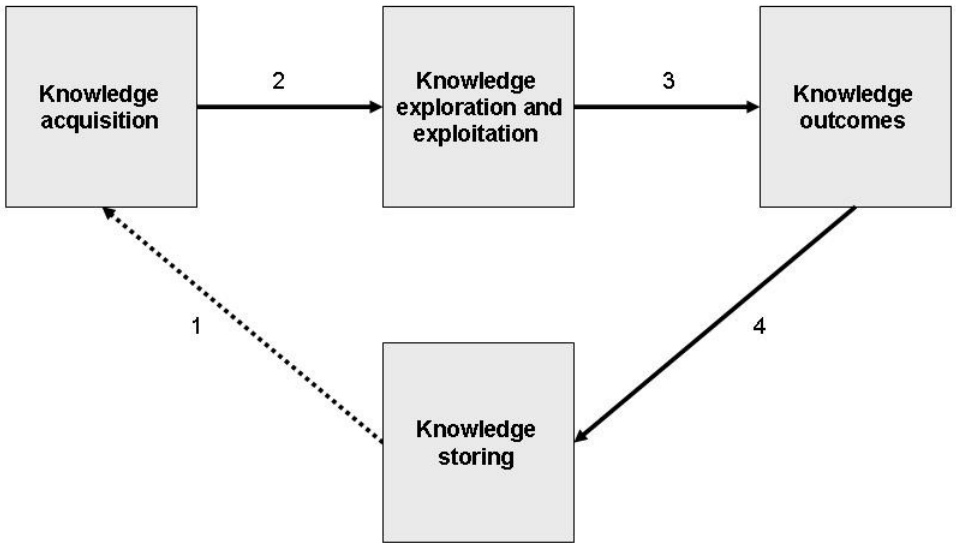

Figure 11. Knowledge processes and knowledge flow.

2.5.1 Acquiring information and knowledge

Information and knowledge acquisition can be considered from the organization's perspective (e.g., Huber 1991) and from an individual's perspective (e.g., Huber 1982, Gammelgaard and

Ritter 2005). At the organizational level, knowledge acquisition means, e.g., how an organization acquires knowledge by hiring new employees or acquires knowledge by company takeovers (Beijerse 2000). However, this study takes a more down-to-earth – or micro-level perspective – and explores how individual members or groups of an organization acquire information and knowledge when they are performing their operative tasks. This can be compared to information seeking and searching behavior, which includes problem identification, problem definition, problem resolution, and solution statement using the acquired information (Wilson 1999).

To follow this reasoning, the central idea behind knowledge-intensive work is that it involves developing and processing input information and knowledge for the intended output. Acquiring information and knowledge at the operative level should not be a complex task if the sources are known and there are appropriate media for transferring information and knowledge. Nonetheless, the report of the Delphi Group (2004) is upsetting. A survey conducted among over 300 managers showed that 68% of the respondents agreed or strongly agreed with the statement "Finding the information I need to do my job is difficult and time-consuming." In addition, 42% of the survey respondents reported that 20% of their total time is spent seeking information. The most frequently mentioned problem in information seeking was that information changes constantly. So, acquiring information and knowledge is not that simple after all. Despite the difficulties in finding information, over half of the respondents in the Delphi Group (2004) study agreed or strongly agreed that information seeking has become simpler and more effective over the past 2 years.

At the strategic level, information and knowledge acquisition addresses an organization's intention and decision to explore and/or exploit knowledge (Levinthal & March 1993). Information and knowledge acquisition takes different forms at the operative level depending on the strategic intentions of an organization. For example, the choice between exploration and exploitations strategies as well as knowledge domains affects the operative level performance (see Figure 7). At the operative level, information and knowledge acquisition addresses defining the task and the desired outcome of the task (Drucker 1999). So, the input information and knowledge that is needed to perform the task is anchored to the intended outcomes of the work. More information and more knowledge are not necessarily beneficial for the organization and its members. The acquired information and knowledge must have relevance for completing the task, for achieving the organizational objectives, and it must have potentiality to add value. Unfortunately, identifying relevant knowledge from irrelevant knowledge or predicting the future

value of acquired knowledge is not always that easy. Information and knowledge acquisition can be based on organizational memory (including procedural and declarative knowledge stocks) and information and knowledge flows from internal and external sources (Kyriakopoulos & de Ruyter 2004).

From an individual employee's perspective, the information and knowledge that needs to be acquired can be her own personal embrained, embodied, and encoded knowledge. Through interaction with other employees, it is possible to access their embrained, embodied, and encoded knowledge as well (Orlikowski 2002, O'Sullivan 2003). The information and knowledge to be acquired can also take the forms of collective embedded, encultured, and encoded knowledge. Encoded knowledge can reside in common knowledge repositories, or knowledge can be embedded in organizational systems and routines, or encultured knowledge can take the form of a uniform style of thinking. All of these are possible sources of knowledge acquisition.

Information and knowledge acquisition can be further divided into several sub-processes. These are a) defining what information and knowledge needs to be acquired, b) locating the required information and knowledge, c) accessing the information and knowledge, and d) transferring the information and knowledge from the source. It would be logical to think that these sub-processes take place in the described order, even though the boundaries of these processes may overlap. This is depicted in Figure 12. This kind of reasoning is based on pull strategy. Pull strategy fits well with the definition of knowledge work, which emphasizes the autonomy of knowledge workers (Hayman & Elliman 2000, Robertson & Swan 2003). In this reasoning, it is the knowledge workers' responsibility and liberty to define and acquire input information and knowledge. Knowledge flows that are based on pull strategy resemble symbolic-analyst-dependent organizations or communication-intensive organizations (Blackler 1995) or operating adhocracy or J-form organizations (Lam 2000) (see Figures 8 and 9).

On the other hand, knowledge acquisition can be based on push strategy, which emphasizes preplanned and standardized knowledge flows between the sources and the recipients. Knowledge flows that are based on push strategy resemble knowledge-routinized organizations (Blackler 1995) or machine bureaucracy (Lam 2000) (see Figures 8 and 9). These kinds of organizations utilize embedded knowledge. In knowledge-intensive organizations, knowledge flows are based on a mixture of pull and push strategies (Mäki et al. 2001, Mäki et al. 2004).

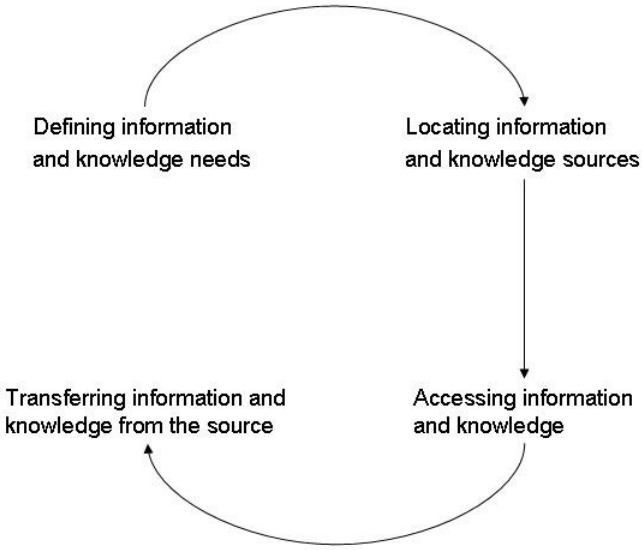

Figure 12. Acquiring information and knowledge.

It is logical to think that more information and knowledge exists in extraorganizational than in intraorganizational sources. Echeverri-Carroll (1999) showed that the ability to access and retrieve knowledge from external sources (i.e., from customers and suppliers) improves an organization's capability to generate new products and processes. However, intraorganizational information and knowledge is often more relevant, accessible, and ready to use than extraorganizational information and knowledge because locally produced knowledge is more easily understood and applicable (Cummings & Teng 2003). Therefore, at least in routine situations, it is more efficient to acquire information and knowledge from intraorganizational knowledge repositories and sources. The use of different types of knowledge management methods (e.g., company yellow pages, Intranet, etc.) have a positive influence on intrafirm knowledge accessibility (Bennett & Gabriel 1999). This fastens information and knowledge acquisition.

The seeker of information and knowledge can apply strong or weak ties (Granowetter 1973, Hansen 1999) for acquiring knowledge. Weak ties may support locating information and knowledge, although the flipside is that they are poor at transferring (especially tacit) knowledge (Hansen 1999). Distant and weak (both extra- and intraorganizational) sources can be more

difficult to approach, but they can provide *novel* information and knowledge when it is needed (Granovetter 1973, Hansen 1999). In their study of 317 firms, Soo et al. (2002) showed that both formal and informal and internal and external networking is strongly related to organizations' ability to acquire information and knowledge.

Defining information and knowledge needs is closely related to the objectives of an organization and the operative task at hand. Before being able to define what information and knowledge is needed, the knowledge worker (or group of people) needs to recognize what kind of a problem needs to be resolved and what the desired outcome is. The ability to define accurately the desired outcomes of the knowledge work goes hand in hand with the ability to define information and knowledge needs. Since knowledge-intensive work differs from manual work in terms of routines and autonomy, this definition of information and knowledge needs is mainly made by the knowledge workers themselves (Scarbrough 1999, Hayman & Elliman 2000). Defining information and knowledge needs is by no means an easy task because the work itself may be relatively unstructured (Scarbrough 1999) or ambiguity-intensive (Alvesson 2001). In their study of work in a call center, Tsoukas & Vladimirou (2001) showed that an ability to accurately define information and knowledge needs has unquestionably positive effects on the work outcomes. An ability to accurately describe and define information and knowledge needs can be based on theoretical knowledge or experience-based expertise. This capability can be a skill of an individual or a combination of a group's potentiality.

Organizations, their functions, and employees encounter both routine and novel situations. Defining information and knowledge needs differs in routine and in novel situations. In routine situations, an organization exploits existing knowledge, and the input information and knowledge do not need to be defined because the task is based on embedded and encultured knowledge (and the input knowledge is already defined earlier). In novel situations, when an organization explores knowledge, the definition of input information and knowledge is based on embrained and embodied knowledge. Besides personal knowledge, this can also involve applying collective, embrained, and embodied knowledge. Because the emerging situation is novel, defining input information and knowledge cannot be embedded or encultured in organizational systems or routines.

After being able to define information and knowledge needs, the next task is *locating information and knowledge sources*. The needle-in-a-haystack problem (Hansen & Nohria 2004) illustrates

that knowledge is not always easily perceived or found. This problem may arise from the low visibility of knowledge or poor skills of locating knowledge. An ability to locate information and knowledge sources is affected by two main aspects. These are 1) attributes related to knowledge storing and representation (i.e., where and how information and knowledge are stored) and 2) attributes related to the seeker of knowledge. First, organizational information and knowledge storing practices have an effect on how easily the seeker of knowledge can localize what she is looking for. If the organization emphasizes codification strategy, encoded information and knowledge should be collectively available (Hansen et al. 1999). In principle, encoded explicit knowledge should be easily located. Locating information and knowledge from organizational databases or by using ICT tools may take two alternative directions. The process may lead directly to the potential information and knowledge resources or the search may end up with locating a potential person to contact (Hansen et al. 1999). If the organization emphasizes personalization strategy, knowledge is more tacit by its nature, i.e., it takes the forms of embrained and embodied knowledge. Tacit knowledge can be difficult to locate because of its low visibility (Halding-Herrgard 2000). However, even explicit knowledge is not equally available to all the members of an organization. Compensation and reward systems can be applied to encourage individuals to make their personal explicit and tacit knowledge more accessible to others (Weiss 1999).

Second, the seeker of knowledge must have skills for locating knowledge. Besides technical skills needed to locate knowledge (e.g., an ability to browse databases and use technological applications), an employee benefits from meta-knowledge, i.e., an awareness of the possible knowledge sources. Searching for and locating relevant intraorganizational knowledge can be laborious if the sources are not well known. Senior-level employees are good aids for locating expertise and knowledge (Weiss 1999). They may know the relevant knowledge sources even if they are not knowledgeable themselves. Tenure (Weiss 1999) and social position (Tsai 2001) affect how easily an employee can locate and access knowledge. Although organizations contain huge amounts of codified information that could be accessed through technological application, information and knowledge are often located by contacting people (Cross et al. 2001, McKenzie 2005). Social network (which describes how social structures are composed through nodes and ties between the members of the social network) and social capital[6] can increase the opportunities

[6] Social capital defined by Nahapiet & Ghoshal (1989) is ‘‘the sum of actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or a social unit.”

and capabilities to find knowledge and expertise (Nahapiet & Ghoshal 1989). In addition, the organizational structure and design of the work organization affect how information and knowledge can be located.

Gaining *access to information and knowledge sources* is the next phase in knowledge acquisition. Just like with locating knowledge, channels for accessing information and knowledge can be personal or impersonal and formal or informal. Not all successfully localized knowledge is accessible. There are several reasons for that. In some occasions (especially regarding person-related knowledge), the motivation of the source is important. Because the source needs to invest time in providing information and knowledge, she needs to have either intrinsic motivation (Osterloh & Frey 2000) or extrinsic reward (Weiss 1999) for acting so. The source may be unwilling to provide information or knowledge if the seeker has previously been unhelpful (Constant et al. 1994). Therefore, accessing information and knowledge requires reciprocity between the source and the receiver, and their roles may interchange over time. This reasoning is also supported by social exchange theory (Watson & Hewett 2006). Access to information and knowledge may be hampered by a mismatch of expertise or personalities between the source and the receiver (Hansen & Nohria 2004). Codified information may be confidential and protected, which may impair accessibility. Access to information and knowledge can be controlled by gatekeepers (Weiss 1999) that need to be passed in order to gain access to the information and knowledge. Employees who are trying to access information and knowledge may face problems even regarding their own memory (Gammelgaard & Ritter 2005). They may have learnt something in the past, but the knowledge is no longer accessible. In addition, information and knowledge accessibility can be low because it may be possessed by rivals or it is too costly to acquire (Quintas et al. 1997).

Since knowledge workers receive important and relevant information and knowledge based on the active pull strategy and the more passive push strategy (Mäki et al. 2001, Mäki et al. 2004), both channels are adequate for acquiring information and knowledge. For example, regarding pushed knowledge, an employee must have her email address on lists where relevant important information is distributed or she must participate in meetings for the same reason.

If the required information and knowledge sources are successfully located and an access is provided, then the next step is to *transfer information and knowledge from the sources*. This requires an appropriate channel or media for the transfer operation and the receiver's ability to

absorb and understand what she is receiving. Knowledge transfer and sharing is discussed in Chapter 2.5.5. Before that, although it breaks the chronological order of knowledge flow (Figure 11), it will be shortly explained how information and knowledge is utilized, what kind of knowledge is generated in knowledge-intensive work, and how the knowledge outcomes are stored in organizations.

2.5.2 Exploiting and exploring information and knowledge

This is the process in the knowledge flow in which value is added to the information and knowledge. This is the most important process in knowledge work and knowledge-intensive organizations. The ability to reuse, create, apply, and utilize knowledge is influenced by the skills and competencies of individuals as well as opportunities provided by the organization to do so. Knowledge exploitation and exploration involves human mental and intellectual work, and it aims at different types of knowledge outcomes (the next phase of the knowledge flow, cf. Figure 11). Knowledge exploration and exploitation involve actions taken to apply acquired information and knowledge in a way that aims at attaining specified task-related objectives. This process may involve reusing existing knowledge, creating new knowledge, or combining these two.

The cost of reusing existing knowledge (exploitation) is lower than creating and recreating knowledge (exploration) because reuse saves time and effort (Hansen et al. 1999, Watson & Hewett 2006). Whenever possible, it is reasonable to think that knowledge reuse is more economical than knowledge creation. Some organizations or organizational units are devoted to knowledge reuse, i.e., exploiting existing knowledge (cf. Figures 8–10). Knowledge reuse is not cost-free because knowledge needs to be produced and stored first in order to meet future reuse needs (Markus 2001).

In a constantly changing world, previously generated knowledge and competencies may not be applicable to new situations (Levinthal & March 1993). Knowledge exploitation (i.e., reuse) may produce unproductive or unwanted results. Therefore, an organization (and its employees) needs every now and then to analyze whether its knowledge, competencies, and problem solving capabilities are applicable to novel situations (March 1991). While adaptation can help an organization to compete and survive in the short term, it may be hazardous in the long run. Though knowledge reuse may be more economical than the creation of new knowledge, some organizations or their functions are especially devoted to creating new knowledge. New product

development is one example of this. Although this may be an activity of an individual, most knowledge is created in collaboration and interaction with others.

2.5.3 Knowledge outcomes

Knowledge-intensive organizations aim at producing knowledge products and service for markets or for internal use. The outcomes of knowledge work may include such artifacts as a consultant report for managing organizational change, a scientific article on knowledge management or a new version of a Volvo automobile. These are concrete tangible artifacts for external and internal customers or interest groups. In addition to this, knowledge work results in residue and by-products – information and knowledge that can be used and applied in the future. This information and knowledge take the forms of embrained, embodied, encultured, embedded, and encoded knowledge (Blackler 1995)[7]. The outcomes are results of individual and group knowledge processing and learning. These outcomes may change organizational practices or they may be utilized in future operations and work tasks. Ontologically, this knowledge is captured both at the individual and the organizational level.

2.5.4 Storing information and knowledge

Knowledge in organizations is stored for later use. Argote & Ingram (2000) name three different knowledge reservoirs for stored knowledge: *members* of an organization, *tools* applied in an organization (including IT systems), and *tasks* referring to the operating procedures that are taken to achieve the goals of the organization. In addition, reservoirs are often combinations of these three. So, knowledge in organizations is stored in various forms and in various places (cf. Table IV). Most commonly, the literature refers to humans as knowledge containers or repositories[8] and to different kinds of electronic and manual repositories as stores for documented information (and knowledge). As was discussed previously, the dichotomy between information and knowledge is unstable. In addition, we can even consider that embedded knowledge is stored in organizational

[7] Blackler's work is based on previously published literature and studies, although his contribution to defining the categorization is substantial.

8 As a psychologist, I feel a little bit uncomfortable naming humans "knowledge repositories," since it has a very technical and cold connotation, but this term is used here just to describe that the human mind and brain contain knowledge.

systems and routines and that encultured knowledge remains in organizations in the forms of collective meanings, understandings, and interpretations.

Embrained and embodied knowledge include personal cognitive skills and abilities. How individuals "store" this kind of knowledge is out of the scope of this study. How collectives generate and store (these two are hard to separate) embedded and encultured knowledge is affected, e.g., by organizational behavior, rules, and culture. From the researcher's viewpoint, this is of utmost interest, although it is difficult to study or perceive perfectly. Individual and collective practices of storing encoded information and knowledge are the most observable praxes. Without fear of challenges, but because of research rational reasons, this study focuses mainly on how encoded information and knowledge is stored and how storing practices affect knowledge processes and knowledge flow.

Before knowledge reuse is possible, an organization needs to have a practice or a method for collecting and storing knowledge that can be made collectively available. Second, members of an organization need to be willing to reuse existing knowledge. Watson & Hewett (2006) propose and give empirical evidence to support the fact that *social exchange theory* explains employees' willingness to contribute to a collective knowledge system (e.g., add information and knowledge into shared databases). In addition, the authors propose and give empirical evidence to support the fact that *expectancy theory* explains employees' willingness to reuse information and knowledge stored into the collective knowledge system. In short, social exchange theory predicts that an individual's willingness to make a contribution is based on anticipation of an equal or reciprocal exchange in the future or on the desire to fulfill an obligation resulting from a past exchange. Expectancy theory, in turn, predicts that employees are willing to reuse existing knowledge if they believe that this knowledge is easily accessible, valuable, and helps them to achieve their objectives. Kankanhalli et al. (2005) found that a good quality of information (e.g., relevance, reliability, usefulness) is one of the most important reasons for seeking knowledge from electronic repositories. Positive experiences reinforce both knowledge contribution and knowledge reuse, i.e., members of an organization become more willing to add knowledge into the knowledge system and retrieve knowledge from the system if their experiences are encouraging (Watson & Hewett 2006).

Routines related to storing information and knowledge are often well developed in an organization, whereas methods for finding stored information and knowledge are much less

developed (Huber 1991). Therefore, Huber (1991) suggests that information and knowledge should be widely distributed and redundant to ease information and knowledge retrieval. Technology offers solutions to store unlimited amounts of information and knowledge into electronic repositories. Now, over 15 years after Huber's words, everyone knows that redundant information and knowledge sources produce outdated and contradictory information and knowledge. Knowledge storing makes no sense if knowledge cannot be easily found and reused later (Alavi & Leidner 2001, Edwards et al. 2005). NPD teams – a prototype of knowledge-intensive work – that are able to access declarative knowledge sources (typically encoded knowledge) perform better if measuring short-term financial performance (although this does not improve creativity) (Moorman & Miner 1997, Kyriakopoulos & de Ruyter 2004). Information and knowledge repositories (whether they are people or databases), are sources of information and knowledge acquisition (cf. Figure 11). Information and knowledge repositories may be located within an organization or outside the organization. Naturally, an organization has control mainly over the information and knowledge storing practices within its own organization. Figure 11 may give a false impression that information and knowledge flows are simple and fluent. In reality this is not the case.

There are several attributes that influence information and knowledge flows as well as the accessibility and applicability of stored information and knowledge. Knowledge in repositories must be current, updated, and users must have seamless access to them (McInerney 2002). In addition, knowledge repositories for encoded knowledge must meet certain quality criteria, i.e., technological applications for storing knowledge should be able to give context-specific information to ease knowledge reuse (Papavassiliou et al. 2003). According to Tiwana (2000, 297), explicit knowledge stored into knowledge repositories should include the following elements: *declarative knowledge*, *procedural knowledge* (i.e., processes and actions), *causal knowledge* (i.e., the rationale for actions and decisions), and *context knowledge* (i.e., contextual circumstances). These elements aim at supporting the reusability of knowledge. For example, without knowing the causal or contextual elements of knowledge, the reusability of stored knowledge can be impaired. Although expertise-seeking novices or secondary knowledge miners may be able to find stored knowledge, their skills and understanding for reusing and applying the found knowledge may be limited (Markus 2001). Consequently, later use is not without challenges because it is not always easy to know (at the moment of storing knowledge) who is going to use the stored knowledge and for what purposes (Markus 2001).

2.5.5 Transferring and sharing information and knowledge

After defining, locating, and providing access to information and knowledge, the required information and knowledge must be transferred between the source and the desired destination. The process of knowledge transfer aims at bringing knowledge (and information) to a location where it is needed and where it can be utilized (Nissen 2002). Knowledge transfer and sharing have received a lot of attention in the knowledge management literature. In the literature, the verbs "transfer" and "sharing" are predominantly used as synonyms. I am not going to differentiate myself from the crowd, although the verbs do have slightly different meanings, i.e., "transfer" emphasizes the technical aspects of knowledge moving from one place to another, while "sharing" emphasizes more the interaction between the source and the receiver[9]. Knowledge sharing and transfer do not add value to knowledge as such, but this process has the potentiality to do so. Knowledge transfer and sharing are among the most crucial and recognized processes in organizational knowledge management literature (see Table VIII). Simultaneously, they are the most vulnerable ones (Riege 2005). Why is knowledge transfer and sharing so important then?

Communication and knowledge sharing between people in an organization has two aims (Thomas et al. 2001). First, instrumental communication aims at delivering messages that are needed to accomplish job-related tasks. The forms and media of instrumental communication are usually preplanned, at least to some extent. Since information and knowledge are the objects of knowledge work, these resources need to be shared and combined among the participating people. Sharing of information and knowledge in an organizational context defines certain boundaries within the organization. It defines the different groups within an organization and explicates the different professional or other groups to which employees belong. Second, expressive communication is employed by social reasons. Expressive communication is used for sharing different types of experiences, for nurturing friendship, for getting to know others, etc. Instrumental communication (or lack of it) has more or less obvious and salient (short-term) implications for work performance, while expressive communication and interaction helps an organization's members to become familiar with each other. Expressive communication helps to build trust (Jones & George 1998) and social capital (Nahapiet & Ghoshal 1998) between organizational members. Trust and social capital are supposed to have positive, long-term implications, e.g., an increased knowledge pool and improved knowledge availability.

[9] Oshri et al. (2005) take the view that knowledge sharing is related to informal and knowledge transfer to formal procedures.

The knowledge transfer process can be viewed from many perspectives. These include, e.g., knowledge transfer between individuals or groups of people (e.g., Nonaka 1994, Hansen 1999), knowledge transfer between organizations (e.g., Holmqvist 1999, Simonin 1999, Grant & Baden-Fuller 2004), applied tools and practices (e.g., McDermott 1999, Swan et al. 1999, Mäki et al. 2004), and the type of knowledge that is being transferred (e.g., Hansen 1999, Halding-Herrgard 2000, Cummings & Teng 2003). All these perspectives have something in common: they aim to describe and explain why knowledge transfer fails or succeeds. The success of knowledge transfer can be difficult to measure or even evaluate (Cummings and Teng 2003). One way to evaluate the success of knowledge transfer is to evaluate the changes in knowledge or in the performance of the recipient unit (Argote and Ingram 2000). This can often be a useful conceptualization, but if the recipient unit already has the transferred knowledge, no changes would be observable even though we could argue that the knowledge transfer has been successful.

Ipe (2003) proposes that four factors influence the success or failure of knowledge sharing between individuals within an organization. The four factors are: the nature of knowledge, the motivation to share knowledge, opportunities to do so, and the culture of the organization. This is depicted in Figure 13.

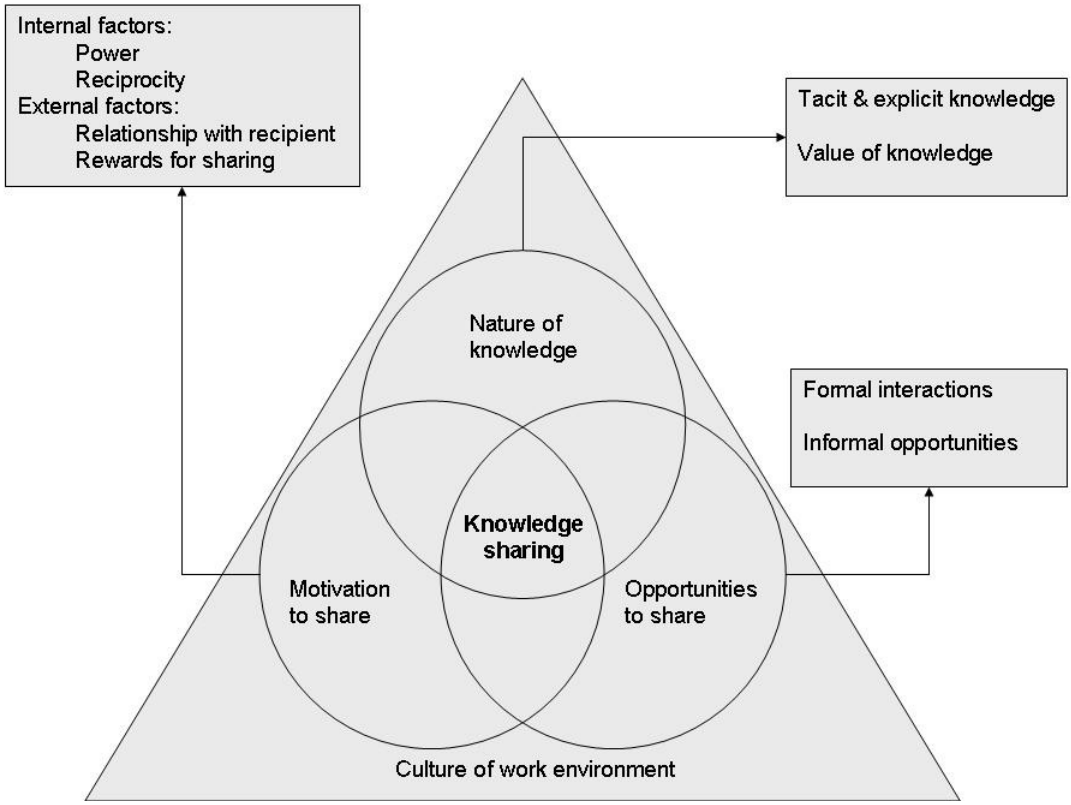

Figure 13. Factors that influence knowledge sharing between individuals in organizations (Ipe 2003).

It can be interpreted from Figure 13 that all four factors are important, and they must be simultaneously present or favorable to make knowledge sharing possible. First, there needs to be a motivation to share knowledge. Furthermore, Ipe proposes that internal and external factors mediate the motivation to share knowledge. Hendriks (1999) suggests that the quantity of knowledge sharing may perhaps be motivated and enhanced by external rewards but the quality cannot. Bock & Kim (2002) showed that external rewards are not very good at facilitating a knowledge sharing attitude. Knowledge sharing is a social act motivated by social purposes and internal factors, which may explain why external rewards do not promote a knowledge sharing attitude. As was discussed earlier, the motivation to share knowledge depends on a feeling of reciprocity: people are willing to share their knowledge if they get something back in return (Watson & Hewett 2006). External rewards applied to improving knowledge sharing can be risky because they may kill intrinsic motivation (Osterloh & Frey 2000). Removing external rewards

may also eliminate knowledge sharing. Osterloh & Frey (2000) argue that intrinsic motivation is particularly important when tacit knowledge needs to be shared. Knowledge sharing within an organization is asymmetric and unequal. Huber (1982) proposes that people with low status or power are motivated to share their knowledge with people with more status or power, and people with more status or power share their knowledge with people similar to themselves rather than with people with lower status or power. As a result, people with low status or low power are the least informed members of an organization.

Second, the nature of knowledge affects its transferability. Tacit and embedded knowledge can be challenging to share (Haldin-Herrgard 2000, Goh 2002, Cummings & Teng 2003). This is due to the difficulty of articulating such knowledge and the need for an interactive channel between the source and the receiver. In addition, this kind of knowledge is also difficult to receive (Szulanski 1996, Hansen 1999). Third, knowledge sharing requires opportunities to do so. Gammelgaard & Ritter (2005) illustrate that the interaction required for knowledge transfer between the members of an organization can vary from low to high (see Figure 14). If knowledge is transferred from one's own memory or from private or public databases, no interaction with other people is necessarily needed. On the other hand, knowledge transfer using (virtual) communities of practice or applying connections through social capital cannot be approached without interaction between the members of an organization.

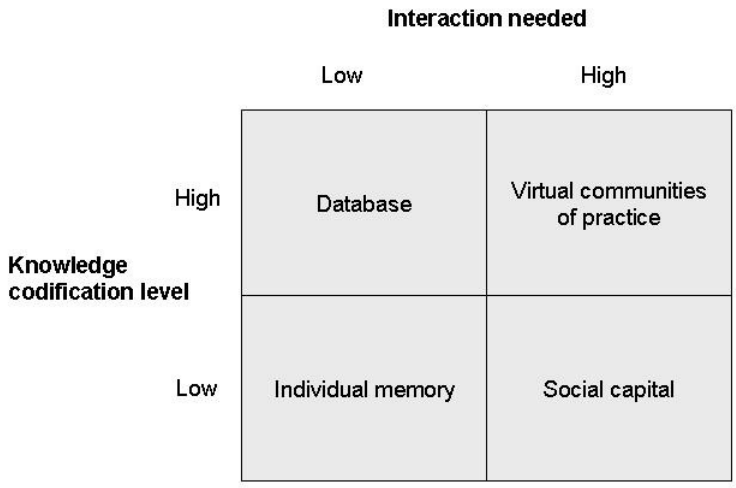

Figure 14. Knowledge transfer and required interaction (modified from Gammelgaard & Ritter 2005).

Knowledge is shared in formal and in informal occasions (Ipe 2003). Knowledge sharing opportunities are lost if the source and the potential receiver do not have a connecting forum (Hansen & Nohria 2004). Opportunities to share knowledge can be supported by social capital (Nahapiet & Ghoshal 1998) or the opportunity for interaction can be provided by technological applications (Gammelgaard & Ritter 2005). Additionally, the opportunity can be lost because the source is unaware of knowledge needs elsewhere in the organization (Haldin-Herrgard 2000). A central position in an intraorganizational network provides opportunities to share and receive knowledge (Tsai 2001). Fourth, organizational culture(s) affects knowledge sharing by adopted norms, values, and practices (De Long & Fahey 2000). Of the four factors in Ipe's model, the cultural dimension is the most ambiguous one. Cultural aspects affect an organization's members' motivation to share knowledge, opportunities to do so, and types of organizational knowledge. Attempts to improve knowledge sharing may fail because of cultural issues (McDermott & O'Dell 2001). The authors state that efforts to improve knowledge sharing should fit the normal – cultural – practices of an organization.

Ipe (2003) does not pay much attention to the receiver's motivation to receive knowledge or to the receiver's ability to receive knowledge. These are also important aspects because successful knowledge sharing is not dependent solely on the source but also on the receiver. Motivation to receive shared knowledge is affected by the perceived value of the knowledge (Gupta & Govindarajan 200) and the willingness to receive and adopt knowledge produced elsewhere (Gupta & Govindarajan 2001, Hansen & Nohria 2004, Huysman & de Wit 2004). Receiving and integrating knowledge from divergent professional groups is difficult because different groups do not have a shared understanding or ability to convey these messages (Hoopes & Postrel 1999). Therefore, information and knowledge must be presented in such way that the receiver is able to interpret it (Alavi & Leidner 2001). Close and intensive interaction is likely to generate more homogenous than heterogeneous meanings because actors start to generate a similar knowledge basis. This, in turn, makes knowledge sharing and receiving easier (Markus 2001, Postrel 2002). Szulanski (1996) studied whether knowledge transfer (i.e., the intraorganizational transfer of best practices in her study) problems arise from the characteristics of the knowledge being transferred, characteristics of the source, characteristics of the recipient, or the characteristics of the context. She concluded that the problems mostly relate to the receiver's inability to absorb knowledge, to the too laborious relationship between the source and the receiver, and to the causal ambiguity of knowledge (i.e., the difficulty to evaluate the applicability of knowledge in a new context). Instead of motivational factors, Szulanski (1996) infers that problems of knowledge transfer are due to imperfect capabilities to adopt knowledge and learn. An ability to interpret and apply acquired information and knowledge depends on the knowledge user's relationship with the knowledge source, the producer or the knowledge itself. Davy (2006) argues that the determinant feature of the success of knowledge transfer is the recipient because only she interprets the received information and, based on her motivation, capabilities, and skills, she is able to act on and utilize the received information.

According to Hansen & Nohria (2004), knowledge transfer problems can relate to the seeker or the provider of knowledge or to the ability or willingness to help (see Figure 15). Thus, the challenges of knowledge transfer can point to a lack of motivation to receive or provide knowledge, to the inability to find the knowledge sources in the first place, or to the inability to absorb and interpret the transferred knowledge.

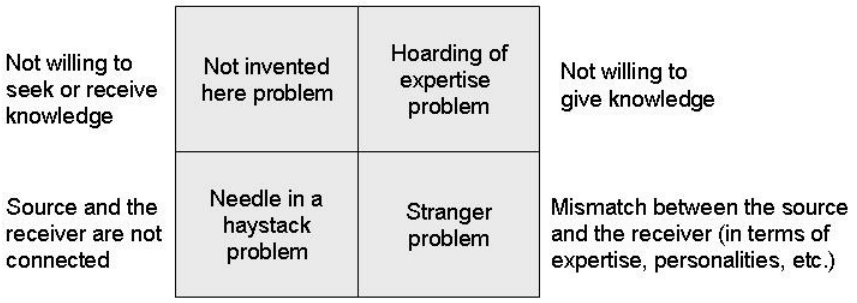

Figure 15. Barriers of interunit knowledge transfer (Hansen & Nohria 2004).

To summarize, information and knowledge sharing is important for many reasons. On the other hand, knowledge sharing is challenging for numerous reasons. Active push strategy may guarantee that people are well informed but may lead to information overload. Pull strategy requires activity from knowledge seekers. The use of a pull strategy presumes that organizations' members are well aware of the organizational knowledge resources and their locations.

2.6 Managing interorganizational knowledge

The interorganizational context for knowledge utilization can generate new challenges, although many of the dynamics presented earlier are also valid in this context. There are three primary reasons for interorganizational collaboration. Collaborative relationships between organizations can provide access to new knowledge and competencies, they may provide entry to new markets, and they can help to reduce costs (Kogut 1988). From the perspective of this study, the first reason is pivotal. For accessing partner knowledge, collaborating organizations establish a common space and context for cross-border activities. All kinds of collaborative relationships necessitate knowledge transfer across organizational boundaries. Knowledge can be transferred by personnel interaction, technology sharing, personnel transfer, and strategic integration (Inkpen & Dinur 1998). From the perspective of this study, the first reason is pivotal. Nonetheless, the success of knowledge transfer is vulnerable because of various reasons. Some of the reasons for poor transferability are attributable to knowledge itself. These include knowledge tacitness (Lam 1997, Simonin 1999), ambiguity (Simonin 1999), and embeddedness (Lam 1997, Cummings &

Teng 2003). Some of the reasons for poor transferability are due to partner-specific variables. These include partners' protectiveness of their own knowledge (Simonin 1999), a lack of motivation to receive or acquire knowledge (Larsson et al. 1998), cultural and organizational distance between collaborating organizations (Simonin 1999), and coordination of the knowledge transmission (Lam 1997).

Wood & Gary (1991) emphasize that collaborating stakeholders need to have shared rules, norms and structures for the interactive process. We can imagine that rules, norms, and structures in different organizations are predominantly different. How does collaboration succeed then? Holmqvist (1999) proposes an answer to this. Besides the organizational and individual knowledge of the collaborating organizations, Holmqvist (1999) proposes that a third type of knowledge is also needed: interorganizational knowledge including joint rules and joint routines. So, organizational tacit knowledge from the participating organizations needs to be converted into joint routines, and organizational explicit knowledge from the participating organizations needs to be converted into joint rules.

Grant & Baden-Fuller (2004) propose that in strategic alliances, it is more economical to access partner knowledge than to acquire partner knowledge. The former means that the partner knowledge is made available, and the latter means that the partner knowledge is adopted. Adopting knowledge may require learning and time spent on knowledge transfer, while accessing does not necessarily require either. Contrary to that, Larsson et al. (1998) propose that *learning*, and how it is managed, determine the success or failure of strategic alliances. To make learning possible, both partnering companies have to be receptive to knowledge and willing to give knowledge at the same time (Larsson et al. 1998). Inkpen (1996, 1998) has also emphasized the importance of learning in collaborative relationships. In addition to partnership-specific benefits, close collaboration may generate skills and know-how exploitable in future collaborative relationships (Simonin 1997, Inkpen 1998).

In her study of crime investigation conducted by several collaborative authorities, Puonti (2004) found that communication and knowledge sharing tools are usually planned for and applicable to vertical communication (within a specified organization), but they are poorly applicable to horizontal (interorganizational) communication and knowledge sharing. Furthermore, Puonti (2004) showed that very simple tools can facilitate interorganizational collaboration, i.e., a

template of project critical factors clearly showing the directions of information and knowledge flows and the responsible individuals in the flow.

2.7 Summary of the literature study

Knowledge in organizations takes various forms. This study adopts a view that information and different types of knowledge are not easily separable at the conceptual level. In this study, a clear distinction between the concepts "information" and "knowledge" is not necessary for theoretical but for practical reasons. Managing information and knowledge is a complex phenomenon. The literature study shows that organizations and their members use many kinds of tools and practices for managing information and knowledge. Some of the tools and practices are suitable for managing information and explicit knowledge, whereas different kinds of tools and practices must to be applied if tacit knowledge is to be managed. Knowledge exploitation (reuse of existing knowledge) and exploration (creation of new knowledge) go hand in hand in knowledge-intensive organizations. One cannot exist without the other. However, these knowledge strategies benefit from different knowledge management strategies. IT-based strategy is suitable for knowledge exploitation, while knowledge exploration is more likely to benefit from human-interaction based knowledge management strategy. So, types of processed knowledge, intended outcomes of the work, and applicable tools and practices are closely interlinked.

The studies related to knowledge-intensive work show that there is no single uniform type of such work. For example, different knowledge-intensive organizations have diverse knowledge-related objectives and varied availability of knowledge resources, the need to integrate dispersed knowledge among organizations varies, organizational designs among organizations differ, and organizational practices and technological tools applied to supporting work objectives differ. These all have consequences for organizational knowledge management efforts. Typically, knowledge-intensive organizations aim to produce knowledge products and services for their internal and external customers. These knowledge outcomes are produced through a combination and integration of information and knowledge resources. One great challenge for organizations of our time is to integrate and utilize highly dispersed information, knowledge, and expertise. Integration of information and knowledge resources at the organizational level is achieved through knowledge processes generating a knowledge flow. Efficient and effective knowledge flow is not achieved easily. The success of knowledge flow is affected by the type of knowledge being processed and transferred, the applicability of the technological tools and organizational

practices used to convey information and knowledge, and motivational factors and cognitive abilities of the members of an organization.

Knowledge exploration and exploitation are based on knowledge flow that is, and will be, repeated continuously throughout an organization's history. Knowledge flow generates knowledge outcomes that can be reused later. This is depicted in Figure 16. The literature study has shown the relationships and interlinks between different knowledge processes and issues related to knowledge flow. Many of these aspects are still poorly understood. This study aims to illuminate these phenomena. The model presented in Figure 16 has two purposes. First, it synthesizes how knowledge exploration and exploitation take place in organizations. Second, the framework is used in the empirical part of the study for generating, analyzing, and interpreting the data.

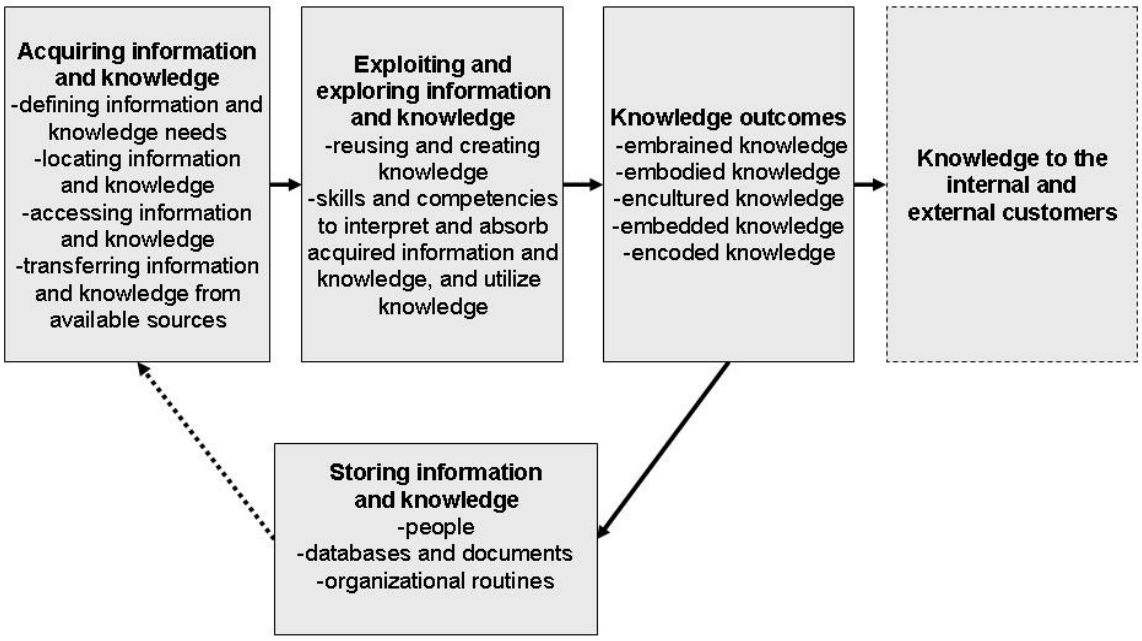

Figure 16. A cycle of knowledge exploration and exploitation.

3 Research approach

In general, science and scientific inquiry need to address three fundamental intraparadigm questions (Guba & Lincoln 1994). These are ontological, epistemological, and methodological questions. These relate to the nature of reality, knowledge that can be used for constituting and understanding reality, and justified methods for acquiring knowledge and evidence of the studied phenomena (~ reality). This study is based on an interpretive social science view, which typically differentiates humanistic and social sciences from natural sciences. In this paradigm, the researcher aims to understand and interpret social reality through the actions of the knowledgeable agents in a social system. Contrary to natural sciences, in social sciences the explanation for the actions cannot be drawn from causal or functional explanations, but instead intentional explanations are preferred (Elster 1983). This means, both from a scientific and managerial point of view, that regarding organizational studies we need to live with a certain amount of uncertainty and fluctuation. This is because we have only limited methods for studying intrapersonal behavior (e.g., motives, intentions, emotions, etc.). From the epistemological perspective, the knowledge of this study is produced by using dialogue between empirism and rationalism.

This research belongs to a tradition of social sciences. The study explores human behavior in social settings and people working for attaining organizational goals. There are two main schools of or approaches to carrying out such research (Silverman 1993, pp. 21). The first one is called positivism, which includes, e.g., the following characteristics (Robson 2002, pp. 20):

- Objective knowledge (facts) can be gained from direct experience or observation, and it is the only knowledge available to science.
- Science separates facts from values and is value-free.
- Science is largely based on quantitative data, derived from the use of strict rules and procedures, and is fundamentally different from common sense.
- The purpose of science is to develop universal causal laws.
- It is possible to transfer the assumptions and methods of natural science to social science.

Although positivism has an established position in natural sciences, the approach has been criticized in social sciences. The critiques include arguments such as: social phenomena exist in the minds of people, and therefore they cannot be studied using the same methods that are applied in natural sciences, and, for example, quantitative measurement cannot capture the real meaning of social behavior because standardization gives an artificial picture of the real world (Robson 2002, 23). The post-positivist approach attempts to respond to critics by arguing that objective reality does exist and that it is a researcher's task to discover it from beyond different biases (Robson 2002, 27).

The second paradigm (Silverman 1993, 21), the interpretive social science paradigm, is instead interested in observations, descriptions, social constructions, and meanings. This approach seems to have space for a more pluralistic view of the world than positivism. It argues that (social) reality is generated by people involved in a certain social context. Thus, we cannot understand reality without an understanding of the reality of the people in a studied social context. Interpretive research has its origin in hermeneutics and in phenomenology. This approach is also sometimes called a constructivist (Guba & Lincoln 1994) or naturalistic approach (Robson 2002, 27), emphasizing the social construction of the (social) world.

This study aims to understand what constitutes the reality of the phenomena explored in this study. From the ontological perspective, I place myself and my thinking closer to the interpretive and hermeneutic approach if the other end is considered to be the positivistic approach. I think that this choice is well justified as the study focuses on the behavior of people and their interpretation of actions in the social context. Some human "behavior," e.g., how cells operate, can be studied from the positivist perspective, but when one studies the intentional behavior of human beings (where there are conscious and unconscious motives, goals, social status, power structures, etc.), making interpretations using the positivist approach becomes much more difficult.

Human beings in social settings do not behave according to the laws of nature. Of course, gravity affects people in the same way as it does other objects, but people are also affected by motives, role expectations, beliefs, mood, etc. Many of the characteristics that are related to human beings and their behavior in social settings cannot be seen or measured using the methods of natural sciences. Although Silverman (1993, pp. 22) states that the least fruitful question to be asked is *"to what school of social science do you belong?"* this study positions itself closer to the

interpretive social science approach (or constructivism) or interpretive discourse (Deetz 1996) than to the positivistic approach.

Among the four discourses (normative, interpretive, dialogic, critical), normative discourse on knowledge management studies in information systems research is the most popular, and interpretive discourse is the second most popular (Schultze & Leidner 2002). In human interaction-based literature on knowledge management studies, this order might be interchanged. The interpretive discourse approach studies knowledge as embedded in organizational practices, whilst normative discourse sees knowledge more like an object or an asset (Schultze & Leidner 2002). The chosen interpretive view for the research approach is compatible with the earlier presented ontological and epistemological assumptions of organizational knowledge.

Human beings are often studied by observing their behavior or interpreting their spoken thoughts. Conscious and unconscious motives and beliefs (held by the object and the subject) may corrupt or distort the information and, thus, evoke interpretations that are against the true state of affairs. The world is how we see it, but we cannot guarantee that others perceive the world in a similar vein. Here, the role of the researcher becomes important. Any researcher's view of the world is biased, i.e., she focuses her attention on events that another researcher might consider unimportant. Therefore, a researcher's perceptions and interpretations of events are by no means totally objective. There is no, nor can there be any, universal truth about the phenomena that are explored in this study. However, I aim to depict a sharp picture of the studied phenomena and the methods used in the study. Hopefully this enlightens the reader on how the research is constructed and carried out as well as on how the data have been interpreted. Later, the quality of the study will be evaluated by becoming aware of possible limitations and deficiencies.

3.1 Research questions

This study aims to understand the characteristics of knowledge-intensive work. Based on the literature study, information and knowledge can be considered to be the input and outcome of knowledge-intensive work. Therefore, the study explores how input information and knowledge is made available and accessible in knowledge-intensive work and in knowledge-intensive organizations as well as how knowledge is either explored or exploited. At the same time, the study explores what kinds of organizational practices and technological tools are applied in knowledge intensive organizations to support information and knowledge flow as well as to

accomplish the objectives of the work. Simultaneously, this study examines how different knowledge processes constitute an efficient knowledge flow. Given that there is great consensus regarding the increase (both in numbers and in importance) of knowledge-intensive work (e.g., Drucker 1999, Scarbrough 1999, Pyöriä 2005), the study has importance, relevance, and justification both from scientific and practical perspectives.

The study has three research questions. They are specified as follows:

1. **How do employees in knowledge-intensive organizations operate with information and knowledge?**

The first research question is explorative by nature. It will study what kinds of organizational practices and technological tools knowledge workers and knowledge-intensive organizations apply to operating with information and knowledge. The research question aims at capturing the daily activities of the employees of knowledge-intensive organizations.

2. **How are the applied organizational practices and technological tools related to the flow of information and knowledge?**

The second research question is also explorative by nature. It will explore how the applied practices and tools are related to different knowledge processes and knowledge flow (see Figures 11 and 16).

3. **How do different knowledge processes generate a knowledge flow?**

The third research question is explanatory by nature. It will explore and give explanations to how different knowledge processes are interlinked and how they are related to knowledge flow.

This study combines exploratory and explanatory (Robson 2002, 59-60) perspectives to the research questions and, thus, finds out how organizational knowledge processes exist in knowledge-intensive work and explains the patterns related to the studied phenomena. For studying knowledge flow, knowledge processes as well as the tools and practices applied to managing knowledge, the study applies the knowledge flow model presented in Figure 16. The model is applied to generating and analyzing the data and interpreting the findings.

Knowledge processes in this study mean “the vehicles” that are needed to guarantee the intended knowledge availability and knowledge flow in the organizations. Davenport et al. (1996) define a

process as "*…a specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs: a structure for action.*" The same definition of knowledge processes is used in this study, even though the processes might be less structured and often more fuzzy and sequentially overlapping. Davenport et al. (1996) continue by saying that a process approach (applied to cover knowledge processes) also involves some serious challenges including variety and uncertainty in inputs and outputs and a lack of separation between processes, inputs, and outputs. So, the process approach to knowledge management is not without limitations. Often the organizational knowledge processes are difficult to differentiate from each other, and they can be perceived differently by different actors. Even though the process approach includes limitations and challenges, it is a widely applied approach in the research area (e.g., Alavi & Leidner 2001, Argote et al. 2003, Remus & Schub 2003, Wong & Aspinwall 2004, Amaravadi & Lee 2005, Bhatt et al. 2005). In addition, the process view captures the adopted ontological assumption of knowledge where knowledge is seen as the *"epistemology of practice"* (Cook & Brown 1999).

Knowledge in this study is considered to include information and knowledge that is needed to carry out the individual and organizational objectives of the work. This includes intra- and extraorganizational information and knowledge as well as personal and collective information and knowledge of the employees of the studied cases. Factors influencing the utilization of information and knowledge may include types of knowledge being processed and applied organizational practices and technological tools.

3.2 Research strategy and design

"A research design is *an action plan for getting from here to there*" (Yin 1994, pp. 19, original emphasis) where the *here* represents the imposed research questions and *there* the objectives to be achieved. Between *here* and *there* may include various actions and the researcher's choices to accomplish the objectives of the research. Research strategy and design are concerned with turning research questions into appropriate procedures (Robson 2002, 79-80). The procedures represent field work, data generation, data analysis, etc. The study is based on a qualitative case study approach. According to Mason (1996), qualitative research is

- Grounded in a philosophical position which is concerned with how the social world is interpreted, understood, experienced or produced.

- Based on methods or data generation which are flexible and sensitive to the social context in which data are produced.
- Based on methods of analysis and explanation building which involve understandings of complexity, detail and context.

The research design represents an embedded multiple case study (Yin 1994) where there is more than one case and more than one unit of analysis. Yin (1994) admits that defining the unit of analysis in case studies is not always an easy task. As a general guide, he proposes (1994, 22) that the unit of analysis should be aligned with the defined research questions. Similarly, in complex phenomena, the boundaries of units of analysis are ambiguous (Langley 1999). In this study, the *unit of observation* is mostly individual, and the *unit of analysis* is mostly organizational, but the latter also includes individual and group level perspectives. The unit of observation includes experiences, meanings, and explanations of knowledge utilization in the studied process, given by the respondents. The case study approach was chosen because it is appropriate when studying novel topics (Eisenhardt 1989). This study follows a flexible strategy (Robson 2002), which allows the researcher to adjust the research design details according to the emergent issues during the research process. Since the cases of this study were different, they needed to be approached somewhat differently. Accordingly, flexible designs are preferred in the interpretive and qualitative research tradition.

Even though inductive and deductive approaches are often seen as opposite poles of carrying out research, this study does not want to take that rigorous a standpoint. The study started with a more inductive approach when conducting the data generation in the first case. After gaining understanding of the studied phenomena, the research approach turned into a more deductive mode. Still, the study aimed to be open-minded and alert for new insights and all kinds of relevant findings. The reasoning in this study can also be described as abductive (Josephson 1996) since the study aimed to find the most plausible explanations for the available data, evidence, and perceptions. A simplified illustration of the data generation through the case studies is depicted in Figure 17. An initial frame for data generation represents the operationalization of the research objectives into meaningful data generation methods (i.e., interview themes). Data generation for case A represents the interviews conducted in case A. After conducting case A, a modified frame for data generation was constructed. The dashed circle in Figure 17 demonstrates how the frame for the data generation and analysis was developed. It can be seen as a pilot case of this study.

After the first case study (case A), a more rigorous frame for data generation was applied to cases B–D. All cases (A–D) were then analyzed similarly.

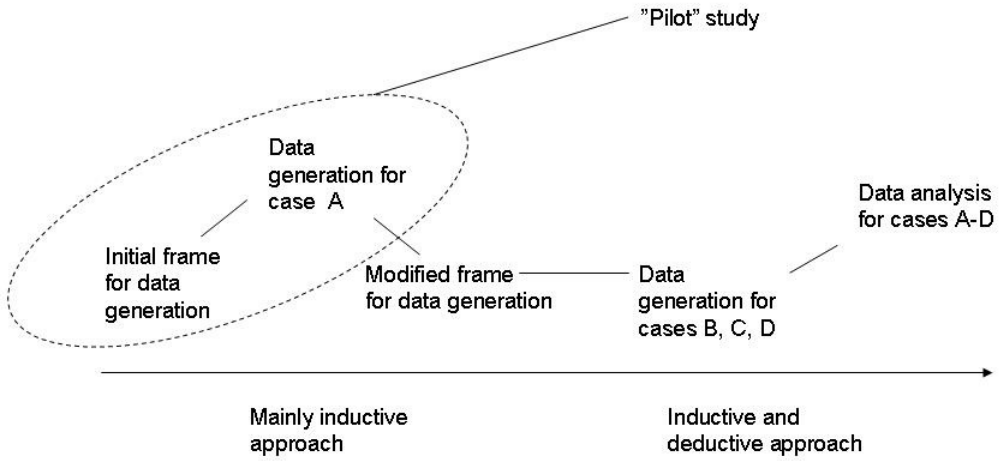

Figure 17. Case work and data generation.

3.3 Data

Data were obtained through four different case studies in four different organizations. Data was mainly generated using the interview method. Interview is a laborious method for generating data. Despite that, due to its flexible nature, the interview method is very suitable for studying the complex research phenomena and attaining the research objectives of this study. Additional data was obtained from case-specific company documents (e.g., process and organizational charts) and from open-ended survey questionnaires. The data included in the data analysis is qualitative data attained through interviews and open-ended surveys. Company documents in the different cases were mainly applied in order to attain pre-understanding of the cases. Information about the data and the cases of the study is presented in Table IX.

Table IX. Cases and data of the study.

Cases	Interview data	Additional data
Case A (field study conducted in 2000-01)[10]	11 thematic interviews	Company documents
Case B (field study conducted in 2003)[11]	10 thematic interviews	Company documents, survey data (N=62)
Case C (field study conducted in 2003)[12]	29 thematic interviews	Company documents, survey data (N=14)
Case D (field study conducted in 2004)[13]	18 thematic interviews	Company documents, survey data (N=122)

Interviews

Since the study was based on an iterative, inductive, and explorative approach, the interview method was chosen. The criteria for selecting the interviewees were a) they worked in the studied case and had personal experiences of the operative work of the case, b) if possible, they represented different operative functions or areas of expertise in the case, and c) if possible, more and less experienced employees from the case were interviewed. All of the criteria were met in all four studied cases. In practice, in all cases the interviewees were selected in co-operation with the case companies' representatives. The selected interviewees were in pivotal positions, and they were expected to be familiar and knowledgeable with the themes of the study (i.e., how knowledge was utilized in the studied case). The aim was to ensure that the interviewees had personal knowledge about the topics of the inquiry and that they represented different operational positions in the company. This requirement for the interviewees aimed to produce divergent perspectives on the studied topic. In addition, informants representing various areas of expertise and experience help to avoid key informant bias (Maxwell 1996, pp. 73) and, thus, generate rich and divergent data. The number of interviewees was agreed with the case companies' representatives. In all cases, the interviews seemed to reach the saturation point (i.e., information redundancy) (Glaser & Strauss 1967, Eskola & Suoranta 2005, 62-63), indicating that enough interviews were conducted in every case. The case-specific objectives were slightly different in every case study (because each case was a part of a different research project). However, all cases produced data related to the research objectives and questions of this study.

[10] The data were generated in co-operation with Laura Hyttinen and Marko Peltonen.
[11] The data were generated in co-operation with Niina Rintala and Kirsi Ziegler.
[12] The data were generated in co-operation with Katja Lahenius, Carita Lahti and Juha Nummi.
[13] The data were generated in co-operation with Jari Ylitalo and Kirsi Ziegler.

Research tradition has favored the term "collecting data" in describing the activity by which research data is accumulated. Here, this is replaced by the term "generating data" (Mason 1996). The simple reason for this is that data accumulation in the selected research approach is dependent on the interaction between the researcher and the data sources (interviewees). Kvale (1996) uses the term "co-authored" and Coffey & Atkinson (1996) the term "creation" to describe the same operation. The term "interview" derives from the words "inter" and "view," which excellently illustrates the meaning of interviews. The data generation takes place in co-operation with the interviewee and the interviewer. Naturally, the interviewee has a major role, whereas the interviewer acts as a midwife.

Kvale (1996) uses two metaphors to describe the role that an interviewer can take in the interviews. In the *miner* metaphor, the interviewer is understood as someone who attempts to mine the source and find what she is looking for. In the *traveler* metaphor, the interviewer is seen as someone who takes a travel with the interviewee. They jointly travel and explore the landscape of the research topic. Both roles were applied in the interviews conducted in this study. The miner role was adopted when there was a need to recall fact-based data, and the traveler role was adopted when the interviewees generated perceptions and interpretations of their own subjective experiences. The aim was to double-check the "facts" given by the respondents from other sources to ensure their truth-value (i.e., from other respondents or from case documentation).

Interviews were conducted using the thematic interview method (Hirsjärvi & Hurme 1995). The interview agenda was consistent among the cases, but it was used flexibly. The interviewer had a list of themes that would be discussed during the interview, but depending of the interviewees' knowledge and experiences, some themes were emphasized more and some less in the single interviews. Although the interviews aimed to find out also peoples' positive experiences or good practices related to the study theme, most of the interviewees recalled negative experiences and challenges of knowledge management. If they were frustrated about something that did not work, the interview might have been an opportunity to report the challenges. The thematic interviews only loosely followed the prepared structure. It must be emphasized, however, that the interviews were not "coffee table conversions" where the interviewee and the interviewer were in an equal position, but the interviewer had the responsibility to lead the discussion. Interviewees were given time and space to describe their experiences and give meanings to the issues at hand. This kind of an approach is recommended by Starbuck (1993) because it may produce relevant information that is not anticipated by the researcher. Interviewees were encouraged to recall real examples of

their work rather than just give answers to the questions. If an interviewee went too far from the interview topic, the interviewer guided her back onto the right track. The loosely structured data generation approach also helps the research to sustain theoretical sensitivity (Glaser & Strauss 1967).

Personally, I participated in 27 interviews of the total 68 interviews. This is because the data were generated in research projects in which I participated together with my colleagues. The other interviews were conducted by my colleagues. This can be considered a weakness of the study, but it can also be viewed from a positive perspective since other researchers brought new ideas and perspectives to the data generation phase. However, my input into generating the interview themes of this study was remarkable. Therefore, my participation in all interviews was not crucial because the data were generated according to my intentions. In each case, the research group discussed the feasibility of the data generation after the first interviews. If necessary, modifications to the interview themes were made. Some of the interviews were conducted using two interviewers. The list of interview themes is included in Appendix 1. The interviews took place in a quiet spot at the interviewees' work place. The purpose was to have a relatively informal atmosphere and consider the whole situation to be more like a conversation than an interview. The interviewees were promised that the interviews would be confidential and that when reporting the results, the interviewees' identities would not be linked to what they have stated in the interviews. The interviews lasted from one to two hours. Most of the interviews were tape-recorded. Recording the interviews did not seem to bother the interviewees, and the interview sessions seemed to be relaxed and open. The interview data were treated differently in different case studies before the data analysis. This is explained in Table X. The different treatment of different case data is due to a lack of resources at the time of the case studies.

Table X. Interview data handling.

Cases	Interview data
Case A (Number of interviews = 11)	Audio recording, transcribing 5 interviews fully and transcribing the relevant information according to the knowledge utilization from the remaining 6 interview tapes
Case B (Number of interviews = 10)	Taking notes in the interviews, writing up all the interviews
Case C (Number of interviews = 29)	Audio recording, full transcriptions by a professional typist
Case D (Number of interviews = 18)	Audio recording, full transcriptions by a professional typist

Additional data

Company documents and qualitative open-ended surveys provided additional data. Company documents were used in order to become familiar with the case context and to obtain background information of the particular case. Company documents included organizational charts, descriptions of technological tools, etc. Open-ended qualitative surveys were applied for research economical reasons. They were assumed to generate data more efficiently than interviews with a wider group of respondents.

In case A, I participated in the case organization's internal training session to gain understanding of the data management system used in the organization. Additionally, in case A, a survey was conducted to gain understanding about the case organization. The data from the survey is not analyzed any further in this study. It aimed at helping to acquire pre-understanding of the studied phenomena at the time of the study.

In case B, the additional data consisted of the company documents, which helped to gain understanding of the case company's objectives as well as comprehend how the work was organized and how different internal and external parts of the organization participated in the work. A web-based survey was also targeted to all employees of case B (N=62, a response rate of 30%). The questionnaire included open-ended questions about communication and knowledge utilization in the case company. Questions using the word "communication" are closely related to the objectives of this study because communication in the case organization was a vehicle to convey information and knowledge. At the time of the study, the case organization preferred to use the word "communication" instead of "knowledge sharing." Semantically, these phrases are very close to each other. Tools and practices for internal and external communication and knowledge utilization were of interest in the survey. All of the data obtained via the survey is not utilized in the study because the survey contained items out of the scope of this study. The specified survey questions used in the study data are depicted in Appendix 2.

In case C, a request to fill in a web-based survey was sent to 34 employees. 17 of them responded (a response rate of 50%). The survey carried out in case C included several questions related to knowledge flow and the utilization of knowledge in the case company. The survey generated written answers to the open-ended questions. The questionnaire included some themes that are not relevant for the purposes of this study and are therefore excluded. The relevant themes concerning this study, which are also included in the data analysis, are presented in Appendix 2.

In case D, a request to fill in a web-based survey was sent to 240 employees from both companies working in the relationship. In total, 122 responses were received (a response rate of 51%). The survey carried out in case D included several questions related to knowledge flow and collaboration between the partnering organizations. The survey generated written answers to the open-ended questions. The questionnaire included some themes that are not relevant for the purposes of the study and are therefore excluded. The relevant themes concerning this study, which are also included in the data analysis, are presented in Appendix 2.

3.4 Case descriptions

The study is based on a multi-case approach. The selected cases were chosen using theoretical sampling. Theoretical sampling means selecting cases based on their theoretical purpose and relevance (Glaser & Straus 1967, 48) and relevance according to the studied phenomena (Silverman 2005, 130). In reality, the researcher must first consider the accessibility of the purposeful and relevant cases. Not all the possible cases are available to the researcher, nor can the researcher have exact prior knowledge about what kinds of cases are theoretically relevant. Consequently, in this study, the cases were chosen to represent knowledge work, where information and knowledge are the main inputs and outcomes of the work. In all cases, the aim was to understand how knowledge was utilized in that particular case context and how organizational practices and tools affected the utilization of knowledge. The aim was not to carry out intrinsic case study research, where the researcher wants to understand a particular case, but instead use the cases as instruments for studying the phenomena (Stake 1994).

Selection of polar or extreme cases in a multiple case study design may provide rich and comprehensive illustration of the studied phenomena (Eisenhardt 1989, Yin 1994). It also helps to compare different cases to one another. This criterion was not fully achieved, even though there is variation between the chosen cases. From the perspective of purpose and relevance, the cases differed in several aspects: size, industrial sector, organization of the work, objectives of the work, complexity of the work, and maturity of the organization. However, in case study research – due to its explorative nature –, the researcher is not able to perfectly preplan what attributes will be used for selecting the cases (Glaser & Strauss 1967). For that reason, the cases of the study are not polar or extreme. Nonetheless, the selected cases need to be similar enough to make comparison between the cases meaningful and different enough to show how the studied phenomenon varies in different contexts (Glaser & Strauss 1967). These two criteria were met

because each case represents knowledge work where the objective was to process information and knowledge and produce knowledge-based outcomes. In addition, the context of the knowledge work varied across the cases (e.g., objectives of the work, knowledge being processed, applied practices, etc.).

Four different cases were studied in this study. They are named case A, B, C, and D[14]. Each case was an operative unit within a larger company (parent organization). Table XI presents short descriptions of the cases. The exact and accurate size (in number of employees) of the studied units is difficult to define because in all cases the intraorganizational boundaries between the companies' operative units were more or less vague. The employee numbers are reported as they were announced by the case companies' representatives. Again, it was difficult to define the exact functional boundaries of the cases because the studied cases did not operate in isolation; the employees of the cases took part in work-related activities and duties crossing the case boundaries.

Table XI. Characteristics of the case organizations.

Case	Size of the parent organization	Number of employees in the studied case	Case specific characteristics	Case's interaction partners
A	A few thousand employees	~ 35 employees	Planning of non-frequent large scale project delivery	Team members, customers, experts within the parent company, few contacts to external consultants
B	Several thousand employees	~ 200 employees	Distributed software development	Team members, internal customers (in the parent company), subcontractors
C	A few hundred employees	~ 50 employees	NPD in electronics industry	Employees from different internal functions (e.g., sales & marketing, production, company researchers), customers, external research institutes
D	Several hundred employees	~ 200 employees	Full scale IT service maintenance and development between the service provider and the customer	Interaction included employees from several functions of the two companies

[14] Anonymity was promised to the companies participating in this study.

Different knowledge processes constitute knowledge flow. The flow of knowledge was different in the different cases of this study. This is due to differences in organizational designs, actors involved, the objectives of the work, and the organization of the work. Knowledge is not processed in isolation, and the case organizations and their members logically had many different parties to interact, collaborate, and share knowledge with. The studied phenomena (i.e., knowledge processes and knowledge flow) naturally linked the cases to external actors (e.g., partners, customers, colleagues outside the case organization, etc.) as well. However, the studied phenomena were examined mainly from the perspective of the cases (organizational units). Table XII illustrates the knowledge flows in the different cases. As an example, in case A, a) knowledge flow within the case organization was studied, b) knowledge flow between the case organization and its customers was studied, c) knowledge flow between the case organization and the parent organization was studied, and d) knowledge flow between the case organization and the external partners was studied. The illustration is only suggestive, i.e., it does not depict the actual number of actors or the size or importance of any particular organization.

Table XII. Main knowledge flows in the studied cases.

	Knowledge flow within the case	**Knowledge flow across the case organization's boundaries**
Case A	- A team of 35 experts working toward a common goal - A need to combine expertise within the studied case	- Knowledge transfer with the customer - Acquiring knowledge from the parent organization - Transferring knowledge with a few external partners
Case B	- A geographically distributed team of more than 200 employees - A need to guarantee the availability and flow of up-to-date knowledge	- Transferring knowledge with the parent organization (internal customers) - Transferring knowledge with the subcontractors
Case C	- Employees from the company's different functions working in NPD - A need to convert tacit knowledge into an explicit form and combine knowledge from different functional units	- Transferring knowledge with the customers - Transferring knowledge with research institutes (external partners)
Case D	- A joint venture of two companies including 200 employees - A need to construct a platform for efficient knowledge flow in the cross-organizational context	- Transferring knowledge with the parent companies

Case A – planning of unique project deliveries

Case A represents large-scale non-frequent project delivery. Case A has been operating in its business area for decades and has well-established operational practices. The industrial sector changes slowly and incrementally. The organization of case A operates in Europe and delivers large-scale projects to its customers. The deliverables are a combination of traditional and high technology. The company has delivered several similar projects over the years, but almost every new delivery is one of a kind and must be tailored according to new technological opportunities and limitations and order-specific requirements. The informants' experiences of one particular project delivery planning phase were studied in this case study. The information and knowledge being processed and utilized in case A included technical expertise concerning the planning process of large-scale project deliveries.

The study (case A) focused on *the planning phase* of the project delivery. The phase includes the acquiring and processing of a substantial amount of information and knowledge in order to prepare a plan that fulfills the customer's requirements and expectations. The required information and knowledge needs to be gathered from various intra- and extraorganizational sources. The task does not only include combining existing information and knowledge, but also creating new knowledge through calculations, models, etc. The project deliveries are complex systems, and the planning phase involves combining several types of expertise. The employees taking care of the planning of the project delivery represent several areas of expertise, but they also acquire information and knowledge from other internal and external sources. The employees participating in the planning phase were of the same nationality and could use their native language in communication. They used English for communicating with external partners.

A planning period usually lasts from several months to several years depending of the size and the complexity of the project deliveries. The planning phase includes several sub-phases, e.g., a project identification phase and a feasibility study. The company has defined specified contents and targets for the individual phases, but they are not reviewed here. The boundaries of the phases are not clear either, and the company representatives even had some slightly differing views of the start and end of the studied planning process. The planning phase is vital because it determines the project deliverables, and many of the decisions made in the planning phase are unchangeable. The planning phase requires consideration of the feasible technical solutions, but also consideration of how the technical solutions affect the customer's business opportunities. The case company had profound knowledge and competences concerning the technical aspects of

the planning phase. The business aspects or value adding opportunities were much more difficult to predict because of uncontrollable external factors. In addition, project deliveries to different countries needed to take the local legislation into account.

The case study was carried out 2000–01. The selected interviews (N=11) included personnel from sales, technical management, and employees responsible for and specialized in pre-investment analysis. The interviewees included more or less experienced employees. The selection of the interviewees was made so as to obtain divergent perspectives on the studied phenomena. The study focused on exploring one particular project delivery that had been recently carried out. However, the interviewees also recalled experiences from other, similar project deliveries. From the perspective of the study objectives, this is not a problem because the interviews covered relevant themes concerning the case organization's knowledge utilization in the project planning phase.

Case B – distributed software development

The company of case B operates in global high-tech markets. The industrial sector of case B is relatively new and developing fast. Case B was a project on software development. The project employed over 200 employees in four different sites. Two of the sites were located in Finland and the other two in North America and in Asia. The number of employees in each site was 74, 68, 61, and 4, respectively. The site in North America was an acquisition that had been made a few years previously. The site in Asia had only recently been established. Organizing software development in a dispersed form is a somewhat new approach in the case organization. Case B was a project organization of a multinational company employing thousands of employees. The information and knowledge being processed and utilized in case B included different areas of software engineering expertise.

The project objectives and the organization of the work necessitated active interaction between employees in different sites. The work was organized in a team-based way, and the teams were specialized in different tasks, e.g., testing, user-interface, and system architecture. Typically, team members were located in several sites. They needed to actively, independently, and collectively acquire, process, share, and develop information and knowledge with the members of their own team and with the members of other teams located either in their own site or in other sites. Accordingly, the work was very knowledge-intensive and complex. Employees were of several

nationalities and from different cultural backgrounds. Only a few of them could use their native language in communication with other members of the case B organization.

The case B organization had one major external subcontracting partner, six internal (in the parent company) partners, and a few external suppliers. These relations also required active and frequent interaction, communication, and information and knowledge sharing. The customer of case B was its parent organization.

The case study was conducted in 2003. The data included 10 interviews and additional data from the web-based survey. Six different individuals were interviewed, four of them twice. The second round of interviews was conducted for introducing the preliminary results of the study and obtaining the interviewees' reaction/interpretation of the preliminary results. The second interview round provided a lot of novel information. The interviewees were in managerial positions, and they were members of the managerial board of the project organization. The survey was targeted at all the employees of the organization.

Case C – new product development in the electronics industry

Case C studied product development in the electronics industry. Case C operates in emerging markets. The company and its products have a history of less than ten years. The studied company was among the ten biggest in its area of business. The studied company had production in three sites, of which one was located in the US and two in Finland. The company also had permanent sales operations in the US and in the Far East in addition to Finland. The information and knowledge being processed and utilized in case C included market and technological expertise in developing new complex technological products.

The research in this case study was focused on understanding how information and knowledge was utilized and applied in one particular product development case. The studied product was based on technological innovation, and the market for the product was just emerging. The product is only one item in the company's product portfolio, but the company had invested a lot in this particular product because of its future prospects. At the time of the study, the company had already started manufacturing the studied product, but the product was being continuously developed further. The product was for business-to-business markets, and the case company's customers used the product for several different purposes. The company also delivered small samples of the product to different research institutes, but these deliveries were low in volume

and did not generate much profit. In general, almost every order needed to be customized to meet unique customer needs.

There were three major actors who participated in or were interested in producing knowledge in the studied case. First, the company itself had the greatest role in this operation. Within the company there were several functions (i.e., sales personnel, researchers, employees in production), which all had slightly different interests or responsibilities in knowledge generation. Second, customers had an important role because the product was produced according to the customers' expectations and needs. They wanted to know more about the applicability of the product. Third, the company collaborated with different research institutes, which had scientific interests regarding the technology applied in case C. The collaboration with research institutes aimed at testing and generating new knowledge needed for the product. All of the interviewed employees could use their native language within the company, but with external partners and customers they usually spoke English, which was not their native language.

The data generation for this particular case was conducted in 2003. The interviewees were selected so as to represent focal operations in the case company. The interviewees included employees from the sales department, R&D, production and quality personnel, and top managers. Altogether 24 employees from the case company were interviewed. In addition, five people from the research institutes closely collaborating with the case company were interviewed. All the interviewees were known to have knowledge about the progress of the studied product development case.

Case D – interorganizational IT service collaboration

Two collaborating companies embodied case D. Both of the companies in case D have a history of decades. Their collaborative endeavor, however, had lasted less than two years at the time of the study. The companies had established a partnership agreement concerning IT services. One of the companies was a customer for IT services, and the other company provided that service. The information and knowledge being processed and utilized in case D included standardized information technology services and knowledge related to new business and service applications. The customer company had made a strategic decision to acquire the provided service (knowledge) from external sources instead of producing it in-house. It was decided that the company no longer had the ability or resources to take care of its IT function, and so that service was outsourced to a different company. When the partnership agreement was established, the IT department from the

customer company was outsourced to the service provider. Thereafter, nearly two hundred employees worked for a new employer even though their work assignments had not changed much. However, the working culture and work practices in the new company differed remarkably. A much more formal and systematic approach to work needed to be adopted.

The collaboration between the two companies was based on a frame agreement, which covered routine and frequent operations. In addition, non-frequent and non-routine projects were continuously started. The scope, scale, price, resources, etc. for these projects were negotiated each time a new project was launched. The IT services needed in the customer company and provided by the service company included such routine support operations as helpdesk services, but the collaboration also included strategically important intentions to develop both companies' business prospects and efficiency as well as innovate new business solutions and opportunities. So, the services needed and provided included operations that were less knowledge-intensive as well as unique services that were more knowledge-intensive.

The case study was conducted in the beginning of 2004. The interviews and data generation took place at a time when the collaboration had been going on for approximately two years. The total number of interviews was 18, of which 10 represented the customer organization and eight the service provider. The interviewees had managerial roles in central areas of the collaboration context. Because of their managerial positions, it was expected that they could provide information from both strategic and operational perspectives. The interviewees included controllers, IT managers, account managers, and business unit managers.

The interviewees were selected from several different business functions to get a wider perspective on the interview themes. All the interviewees had personal experiences of this particular collaboration and, therefore, could be considered to be knowledgeable informants. The interviewees were told that the interviews would focus only on operations related to the joint collaborative activities and not on other functions of the organizations. (Both organizations and the interviewed employees also had work duties that were not related to the specified collaboration context.) This was very well understood, and all the data generated in this case study relates only to the joint collaboration.

3.5 Data analysis

Data used in the data analysis includes interview transcriptions and qualitative data attained through surveys. The analysis of these two data sets is somewhat different, and they are explained separately. There was one exception. Since the respondents in case B had produced very vivid and comprehensive survey data to the open-ended questions, this data were coded together with the interview data. In the other cases (A, C, and D), only the interview data were coded using the Atlas/ti program. The analysis of the interview data is explained first, because it is the main data source of this study. Before that, the reasons and justification for the chosen data analysis approach must be explained.

The two main approaches to analyzing qualitative data are grounded theory and theory-based analysis (Eskola & Suoranta 2005). The former means that through reading the data, the researcher gains insight and understanding of the relevant themes of the studied phenomena. It means that the researcher starts processing the data with no expectations or assumptions. We can question whether this is possible in reality. If the researcher has participated in the previous phases of the study, she must have some pre-understanding of the studied phenomena. The latter approach means that the researcher has a schema or a construct which is used for organizing and understanding the data. The grounded theory approach is more associated with the inductive reasoning, and the theory-based approach is more associated with the deductive reasoning. However, I would not want to consider deductive and inductive reasoning mutually exclusive. In this study, the empirical work (including data generation and analysis) moved from a more inductive to a more deductive approach. This shift is associated with an increased understanding of the studied phenomena. In the later phases, it was possible to focus attention more accurately. It became possible to test ideas and understanding using deductive reasoning. It must be emphasized that deductive reasoning must be segregated from the hypothesis-deductive method. In qualitative research, a hypothesis is defined as a "testable proposition" (Silverman 1993, 1). This can include the researcher's ideas and thoughts.

Theory-based analysis was applied to analyzing the data. "Theory" in this analysis is a combination of the interview themes and the researcher's theoretical understanding of the organizational knowledge management practices, processes, and knowledge flow. The "theory" in this sense has evolved during the study. It is based on literature and the findings and insights from the pilot study. Thus, grounded theory and theory-based analysis in qualitative study are more or less combined and hard to separate.

There were several main phases in the data analysis. These are explained in Table XIII. First, the data analysis started by reading the transcriptions open-mindedly. It had already been decided to apply the categorization matching Figure 16, which is a model that integrates current literature and the results from the pilot study. However, attention was paid to any new themes or possible categories arising from the text.

Table XIII Main phases of the data analysis.

Step	Purpose	Result
Reading all the transcriptions case by case.	To get a broad picture of the cases.	An overview of the cases. An idea of the potential codes and categories.
Coding some interviews from case D according to the selected categories.	To evaluate if the data can be coded into the selected categories. To evaluate the possible fit, overlap, and feasibility of the categories.	Confidence that the data can be categorized according to the selected codes. Boundaries between the categories became clearer.
Coding the data of case D.	To see if the whole interview data can be categorized in a meaningful way.	Events related to information and knowledge utilization categorized into seven different categories.
Coding the data of cases A, B, and C.	To ease the analysis and interpretation of the data.	Events related to information and knowledge utilization categorized into seven different categories.
Checking the coding and categorization of case C.	Checking if all the relevant data belongs to the correct category.	Confidence that no relevant data (quotations) were excluded. Confidence that the data categorization is reasonable and meaningful.
In-case analysis for each individual case.	To find out the dynamics of information and knowledge utilization within the selected categories in each case.	Case descriptions, including practices and tools that are applied to operating with information and knowledge, and a description of different knowledge processes and knowledge flow.
Cross-case analysis.	To evaluate similarities and differences between the cases.	Differences and similarities regarding knowledge flow and utilization of information and knowledge among the cases of the study.

Second, the interview transcriptions were coded (which also created the corresponding categories). The coding/categorization process is based on content analysis. Content analysis means that words, phrases, or concepts from the text data are extracted into meaningful categories (e.g., Silverman 1993). The codes were derived from the interview themes and from the initial

construct of organizational knowledge processes (cf. Figure 16). Data were organized and categorized using the ATLAS/ti software program. The program helps to master large-scale qualitative data sets. The program itself does not analyze anything. That is the task of the researcher. Organizing texts into accurate categories is by no means an easy task. It may sound like putting red, green, and blue balls into different baskets. That is not the case when organizing much more abstract and ambiguous issues. During the coding process, attention was focused on deciding and evaluating a) if a quotation is relevant for the purposes of this study and needs to be coded, b) if the quotation can be placed in an existing category or if there is a need for a new category, c) how many categories can be managed, and d) if similar rules should be applied during the whole coding process. The same reasoning was applied in the coding phase of each case. Examples of the quotations in different categories are provided in Table XIV. All the quotations are from case A. The quotations are translated from Finnish.

Table XIV. Examples of the data categorization.

Category	Quotation example
Defining information and knowledge needs	*"You get right information from the customer if you know what to ask. Part of being professional is to know what to ask."*
Locating information and knowledge	*"The problem is how to find someone who knows. It takes several years to become knowledgeable about the experts."*
Accessing information and knowledge	*"Sometimes it is difficult to reach the knowledgeable people because they might be traveling or working on another project. Then I must turn to someone else or check it from the literature."*
Transferring information and knowledge	*"The meeting minutes are documented and delivered to the project personnel so that everyone is aware of what has been discussed with the customer."*
Knowledge exploration and exploitation	*"When we operate outside of Finland, we might lack context-specific expertise… and a local consultant must be hired."*
Knowledge work outcomes	*"The documentation of the project is finalized only when necessary, when the project manager says that the documentation must be published."*
Information and knowledge storing	*"The required information is in a public database, sometimes very well hidden and very difficult to find. I often don't have the right to access certain project folders."*

The data of different cases were categorized in a cross-sectional manner (Mason 1996, pp. 128-129). This means that categorization (categories applied) between the cases is identical. Cross-sectional indexing has three main limitations (Mason 1996, pp. 111). First, the indexing categories may become too broad for more sophisticated understanding of the data. Second, a piece of text (e.g., interview quotations) can be related to several categories. Third, the data need

to be produced similarly enough (e.g., interviews in different cases need to be similar enough). The first and last limitation presented by Mason (1996, pp. 111) were avoided, but there were a few quotations that were related to more than one category. Nevertheless, this can be considered a strength. It shows how the categories are interrelated. For example, the quotation *"it is difficult to locate information in the database because the database is poorly organized"* refers to two categories of the coding system. First, it refers to the category of *locating information and knowledge*. Second, it refers to *information and knowledge storing*. In cases like this, the quotation was categorized into both categories because it tells about the (poor) storing protocol as well as the individual's abilities to browse company databases. It is important to notice that separation of different knowledge processes and examining different categories independently is somewhat artificial because the processes and categories are usually closely linked together. For example, the practice to store information and knowledge influences the transferability of information and knowledge.

Third, the applicability of the categories was evaluated. In fact, this phase was overlapping and simultaneous with the previous phase. The applicability of the codes/categories was verified as Eskola & Suoranta (2005) suggest. The portion of the data was first categorized according to the initial coding system. After that, some adjustments to the codes were made. The changes were small because the initial list of codes served the grouping of the data well. The categories created for the data analysis also matched the requirements presented by Dey (1993), who stated that categories need to have an internal aspect, i.e., they must be meaningful in relation to the data. In addition, categories need to have an external aspect, i.e., they must be meaningful in relation to the other categories.

Because the data generation was thematic instead of structured, it would be meaningless to calculate the frequencies of any topic or comment presented by the interviewees. This is because the interviews did not cover all the themes equally. Counting frequencies can also be misleading due to other reasons, e.g., an interviewee may recall salient but insignificant incidents or be unable to recall significant but less salient incidents. Nevertheless, many topics were stressed by several interviewees showing the importance of these particular topics or incidents. However, it would be possible to imagine a situation where only one interviewee recalls a specific incident which is of utmost importance to the organizational knowledge management. Thus, *counting only frequencies* may lead to wrong interpretations. Here the researcher's skills have an important role. She must interpret and understand the meanings and significance of the stories generated in the

interviews. However, to show the credibility of the categorized data, the number of quotations of each category is presented in Table XV. This is not done to assure or highlight the importance or meaning of any particular category, but just to give an idea about how much discussion was related to each category.

Table XV. Categories and the number of quotations in the categories after the data coding.

	Case A		Case B		Case C		Case D		Total	
Number of interviews	11		10[15]		29		17		67	
Code/category	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Defining information and knowledge needs	15	19	12	7	57	20	31	18	115	16
Locating information and knowledge	7	9	32	20	15	5	4	2	57	8
Accessing information and knowledge	16	21	40	25	34	12	15	9	104	15
Knowledge exploration and exploitation	4	6	22	13	34	12	76	44	136	20
Knowledge work outcomes	5	6	2	1	22	8	16	9	44	6
Information and knowledge storing	12	15	15	9	23	8	13	7	64	9
Transferring information and knowledge	19	24	42	26	103	36	19	11	183	26
Total number of categorized quotations	**78**	**100**	**165**	**100**	**288**	**100**	**174**	**100**	**703**	**100**

After categorizing the transcriptions, the quotations were then reread case by case. I looked back to the data generation phase and tried to recall the case context while reading the extractions. The quotations were compared to the field notes written during the research process. Instead of considering the interview data (transcribed texts) to be external reality or a collection of facts, the data were considered to be internal experiences of the informants. The case analysis aimed at finding patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities among the cases. The analysis aimed at finding meaningful subcategories and themes within the categories and considering the links and interrelations between different categories. The questions

[15] This data set also includes material from the qualitative survey.

I had in my mind while reading the categorized case extractions are presented in Table XVI. At the same time, writing about the case descriptions for the results chapter started.

Table XVI. Data analysis categories and questions in mind.

Category	Questions in mind
Defining information and knowledge needs	Who defined the information and knowledge needs? How were the needs defined? What kind of information and knowledge needs were defined? Challenges? => Resolutions?
Locating information and knowledge	Where was the information and knowledge located? Tools and practices applied to locating information and knowledge? Challenges? => Resolutions?
Accessing information and knowledge	Tools and practices applied to accessing information and knowledge? Challenges? => Resolutions?
Transferring information and knowledge	Push or pull strategy used for transferring information and knowledge? Tools and practices applied to transferring information and knowledge? Challenges? => Resolutions?
Knowledge exploration and exploitation	Challenges? => Resolutions?
Knowledge work outcomes	Types of produced knowledge?
Information and knowledge storing	Where, when, and how were the outcomes stored?

After conducting the in-case analysis for the four different cases of the study, the cross-case analysis between the cases was conducted. The cross-case analysis aimed at finding similarities and differences between the cases. Frankly, a case study approach offers only narrow grounds for a comparison of cases (Stake 1994). When comparing different cases, the reader might expect there to be a meaningful scale that can be applied for assessing the differences between the cases. This is not usually the case. The cases naturally differ from each other, but in qualitative research it is difficult to define any logical measurement scale for the attributes we are interested in. In addition, even the attributes to be compared can be difficult to define. For example, the size of an organization may not be a determining feature because typical and atypical small and big

organizations can exist (Brown & Duguid 1991). Furthermore, the studied cases might be different in too many ways for any meaningful comparison to be possible. So, the cross-case analysis must be considered to be more like a tool that is applied to summarizing the individual case study results. Only the most salient differences and similarities are reported, but they are compared only at a lingual level. The intention of the cross-case analysis is to bring the discussion of the studied phenomena to a more theoretical or conceptual level, but without the intention of showing or arguing how independent variables explain knowledge management differences between the studied cases.

Quotations are often used in interview-based research to vitalize reporting. Quotations can make the text more vivid, and they can offer good examples of the studied phenomena. However, since the reader does not usually fully know or understand the context where the quotation was generated, they can be misleading and give the reader the wrong impression. The reader may also assume that a given quotation is somehow representative even if the quotation is in fact marginal or deviant. In qualitative research, quotations may leave too much space for interpretation (and imagination). In a study (Corden & Sainsbury 2006) in which experienced qualitative-oriented researchers were asked to give reasons for verbatim quotations, the following reasons were mentioned: as a matter of enquiry, as evidence, as explanation, to deepen understanding, as illustration, to give participants a voice, and to enhance readability. The same group of experienced researchers found it difficult to give general rules for selecting quotations. In addition, when looking back on their careers, they recognized that their use of verbatim quotations had changed a lot over time. While acknowledging that verbatim quotations may deepen understanding and be illustrative, this study is skeptical of using them as evidence or explanation.

There is not much literature on how to choose good quotations. While it is evidently the author's duty to give quotations a context and explain how the quotations have been chosen and should be interpreted, it is still problematic to use such strong pieces of data that might give readers false impressions. Quotations may be misleading, which Silverman (1993, 205) calls single element explanations or interpretations. Eskola & Suoranta (2005, 215-217) are also cautious of using extractions for convincing the reader. Based on the above reasoning, this study is very economical with the use of quotations.

Data from the surveys was initially well organized because it was received in electronic form and the answers were "automatically" categorized according to the respective questions. Despite that, all the answers were checked and verified to make sure that the content of the answers corresponded to the questions. Some of the answers overlapped between the categories. In these cases, the answers were put into the correct categories. These changes were small. Overall, after a careful review, all meaningful answers were added to the data analysis, and the categorization of the survey data corresponded to the categorization of the interview data.

4 Results

This part of the dissertation will present the results of the study. The study aims to understand how individuals and organizations utilize knowledge in knowledge-intensive work and how organizational practices and technological tools support the utilization of knowledge. The results explain how knowledge processes in the studied cases generated the knowledge flow that was required for achieving the work-related objectives of a particular case. In this respect, the results are presented, analyzed, and interpreted using the models presented in Figures 11 and 16. Figures 11 and 16 hold the view that knowledge flow is constituted of different knowledge processes that are, at least to some extent, separable from each other. Empirical data were generated in four separate case studies. Results from each individual case will be presented first. Then, a cross-case analysis will be presented to view the differences and similarities between the cases.

Following the logic of Figures 11 and 16, I start by presenting the results that describe how the individuals and the organizations in the different cases acquired information and knowledge as well as the occurrence of knowledge flow. I continue by presenting how the acquired information and knowledge was utilized in the different cases (this refers to knowledge exploration and exploitation[16], cf. Chapter 2.5.2). Then, I go through the outcomes of the knowledge work. The outcomes generated in the case studies in the forms of artifacts, products, or services (i.e., end products) are not in the focus of this study. One reason for this is that I did not have an applicable method for assessing the quality of the outcomes of the case organizations' work. Besides, this area of interest is beyond the study objectives. Instead, the knowledge-related features of the outcomes are evaluated in order to understand the opportunities to apply knowledge, reuse knowledge in the future, and accumulate knowledge. Thereafter, I explain the practices that were applied for storing information and knowledge. Finally, I describe how the organizational knowledge processes and practices are interrelated (e.g., how knowledge storing affects its availability). In addition, a short summary of the main findings is provided after the results of each case.

[16] Knowledge exploration and exploitation are theoretically separable concepts. Empirically, exploration is difficult to distinguish exactly from exploitation because they are often interlinked. This study explores these concepts together, not separately.

4.1 Case A – planning of unique project deliveries

Case A studied a planning phase of the complex technology delivery project. The work organization in case A aimed at producing a plan for a construction project. A more detailed description of the case is provided in Chapter 3.4.

4.1.1 Acquiring information and knowledge

Information and knowledge needs were defined in co-operation with the customers. Usually the customers had a clear description of the intended project delivery. This description can be seen as the customer's view of knowledge needs. This information includes, e.g., the layout and schedule for the project delivery as well as the estimated costs. This gives the scope and limits for the project delivery. So, at the beginning of the planning phase, the information and knowledge needs were predominantly on external sources (e.g., based on customers' expectations as well as legislation). From the case company's perspective, there were usually several options for fulfilling the requirements. Taking the customer's needs into account, the case company needed to specify its own information and knowledge needs that would fulfill the customer's expectations. The case company needed to integrate many areas of expertise in answering the customers' inquiries. Completed tenders as a whole become so complex that they are challenging to understand by any single person.

The customer's explicated requirement (call for bids) was used as a starting point for the planning phase of the project delivery. The official invitation to submit a tender covers the formal requirements, and it is a ground for defining information and knowledge needs, but usually the customer also provides off-the-record information. This kind of information and knowledge was specified in less formal situations, e.g., in discussions with the customers. Some of the interviewees had noticed that time spent with customers was always beneficial even though the benefits were not always evident, easily perceived, or utilizable in the short term. Interaction with customers helped (sometimes slowly, but nevertheless) to understand their needs and to comprehend their views. The case company delivered projects to different countries, and it was reported in the interviews that it takes a fair amount of time to understand the different contextual conditions in the different countries (here the interviewees were referring to information quality, information accessibility, and forms of knowledge).

Additional information from the customer was always needed, but the practice of collecting this information was not very systematic (e.g., no common template or method was applied). Thus, employees in the case organization had personal heuristics about the knowledge needs and personal practices of defining the knowledge needs. Customers were not necessarily very good at providing useful information or knowledge at the beginning of the planning phase. It seemed that the customer organizations were not that knowledgeable about the potential options of the project deliveries. Therefore, it was essential to communicate and interact with the customers and define the knowledge needs together. However, based on the interviews, knowledge needs were defined more or less independently by the customer organization and the case organization instead of through very close joint effort. Often the plan for the forthcoming outcomes was a compromise between the customer's expectations and technological possibilities. The accuracy of the knowledge needs has a great influence on the operative actions, and it was often stated in the interviews that acquiring correct information and knowledge at the beginning of the project is crucial for its success.

The delivered projects needed to be tailored in every single case. The need to tailor project deliveries varied case by case, but there was always a need to define the unique knowledge needs of the project at hand. Many of the interviewees said that, in principal, defining a customer's information and knowledge needs could be systematic and follow a predefined protocol every time, but the data shows that a clear routine process for defining information and knowledge needs was more or less lacking. Within the case organization (when they needed to define internally their own information and knowledge needs for the expected outcome), the process was carried out more systematically. Based on the interviews, this kind of a routine was embedded in the organizational work practices.

The data suggest that in case A *locating information and knowledge* sources was relatively easy. The main external information and knowledge sources were customers and partner companies. The main internal sources for information and knowledge were knowledgeable experts within the case organization or parent company, company databases, and personal files.

Most of the interviewees said that knowledge in their organization is very much connected to people. Therefore, knowing knowledgeable people within the company was vital. A few members of the case A organization were particularly knowledgeable. They had a long work history and

had been involved in many projects over the years. These experts were approached if no other sources for knowledge were available (i.e., documented knowledge).

The company used to have phone books including information about personnel position and expertise. These phone books were said to have been very practical in internally locating (i.e., from the parent company or within case A) experts from different areas. Unfortunately, the phone books at the time of the study did no longer include this kind of information. This severely impaired the possibility of locating people within the company. Furthermore, it was repeatedly stated in the interviews that it takes several years to know and become familiar with people within the organization. Many of the interviewees thought that somewhere in the organization there resided valuable knowledge that they did not know how to locate or attain. The interviewees were not able to specify the type of knowledge that was not available. This is understandable: if they were not able to specify the knowledge, they were not able to locate it. This indicates that organizational knowledge resources were poorly visible. The poor availability of information and knowledge was also strongly supported by the survey data. Nevertheless, most of the interviewees said that information and knowledge they had been able to locate and acquire from internal sources was accurate and reliable, although incomplete.

Fragmentation was an often-mentioned feature of organizational knowledge. The interviewees said that both internal and external input information and knowledge needed to be gathered from various sources. It was said that the sources were not always easy to identify. At the individual level, this kind of meta-knowledge (knowledge about the potential knowledge sources) develops slowly and in parallel with the time spent in the organization. Younger interviewees were less capable of identifying various organizational knowledge sources.

Locating information and knowledge from the company's public database was easy, but only when the search concerned information and knowledge that were generated in one's own projects. If personnel needed to locate information and knowledge generated in other projects, the ability to locate information and knowledge was much more difficult. The company had a policy and rules for systematic storing of information and knowledge in the databases. However, the indexing system for produced information was so complex that many employees filled in the index cards insufficiently. Later on, the information was not easy to find. As a matter of fact, we asked a person who was an expert (and who had formal authority and administration rights over the

information management system) to find specified projects/information from the system, and not even he could easily carry out the defined procedures when asked.

There were more problems in *accessing* internal *information and knowledge* than external information and knowledge. Difficulty in accessing internal information and knowledge was an often-mentioned theme in the interviews. It was repeatedly stated in the interviews that knowing the right people was a key to accessing knowledge. These kinds of valuable intra-company contacts between personnel were gained through slow socialization. Working in the projects and meeting employees from divergent areas of expertise generated valuable future contacts. No evidence was found for very systematic or exceptionally intentional attempts to fasten the establishment of these valuable connections between the employees. The connections were formed through normal work practices. Many of the interviewees said that people were much faster sources of knowledge than, for example, collectively available documents. Some of the project managers who had valuable knowledge (in the form of encoded project reports) about completed projects were reluctant to give the reports when asked. The reason for this did not become clear through the interviews. However, holding out information and knowledge was not seen as very common. Sometimes the needed knowledge was possessed by an employee who was not available at the moment when the knowledge was needed. Then, the task was either postponed or less accurate knowledge was used instead. Both resolutions had potential negative consequences.

The company had a tailored information management system for the company's purposes, but it was not widely used for accessing cross-project or earlier produced information. Two reasons for the low usability of the information management system were mentioned in the interviews. Most of the interviewees said that the root cause for the poor accessibility of the stored information in company's public database was due to storing instructions and protocol. Documented information in the system was not too easy to find. In addition, accessibility to explicated information and knowledge was often poor because employees had only limited rights to access the databases. They also even had difficulties in finding a person who could provide them access to specified databases.

The outcomes of previous projects were used as input information for the forthcoming projects whenever possible. Knowledge produced in previous projects was highly valued whenever new projects started. Even though the projects were not identical, a majority of the interviewees said

that knowledge produced in earlier projects was evaluated as good input information for any incipient project. If earlier produced knowledge was usable, it saved time and reduced redundant and overlapping work. However, the outcomes of the finished projects were deficiently available. The project reports from earlier projects were at least partly confidential, and they were not publicly available to all of the company's employees.

The Internet has had a huge positive impact on accessing different kinds of valuable public information and knowledge. However, the quality or applicability of accessed public information and knowledge was sometimes questionable. Here the interviewees referred to information and knowledge that is acquired from external sources. The original purpose of the acquired information and knowledge may have been different from the needs of the present moment. In addition, information and knowledge acquired from external sources was often incomplete. Again, it was not always known how the knowledge had been produced, which reduced the reliability of the information and knowledge. Many of the interviewees said that internally produced information and knowledge was valued more than externally produced information and knowledge.

Information and knowledge transfer had basically three directions. Information and knowledge needed to be transferred *to, from, and within* case A. The success of the information and knowledge transfer in these three situations depended on different reasons. Information and knowledge transfer to and within case A concerns knowledge acquisition, which is discussed next. Information and knowledge transfer from the case A organization is more related to knowledge outcomes (and how the outcomes are transferred and applied by other parties), and that is discussed later in this chapter.

Information and knowledge transfer was the most quoted knowledge process in the interviews. The means for transferring information and knowledge were similar to those applied in most organizations, e.g., meetings, phone calls, email, common databases, working in a group, etc. Many of the interviewees made the notion that knowledge did not automatically come to them. Instead, knowledge needed to be actively acquired. In other words, knowledge was not pushed toward them, but people needed to pull knowledge required for accomplishing their tasks. This was especially salient for knowledge flow that crossed the case's organizational boundary. Within case A, information and knowledge was both pushed and pulled between the case personnel.

As a general rule in the studied company, the aim was for members of project groups to be located physically close to each other in order to improve knowledge transfer within the project groups. However, it was not always possible or reasonable to move people temporarily. Many of the interviewees said that physical distance greatly influenced knowledge transfer between the team members: if the distance was great, less knowledge was available and transferred between the group members.

The personnel in case A were physically located quite close to each other. In addition, the group size was relatively small. These reasons eased information and knowledge transfer between the members of the case organization. Face-to-face discussions were overwhelmingly the most favored means of transferring internal information and knowledge. Many of the interviewees said that the company's culture had traditionally emphasized face-to-face discussions between employees. Due to that, as stated by several interviewees, electronic public databases were much less developed and employed for information and knowledge transfer. As a substitute for face-to-face discussions, phone calls and emails were also employed for acquiring and transferring information and knowledge. This usually required that the interacting people were familiar with each other. Email was seen as a superior tool for transferring explicated information and knowledge. The advantages of emails included that they reach many recipients with little effort, they give recipients time to consider whether an answer is needed, and they create a log of the conversation.

Every project arranged frequent project meetings aiming to transfer knowledge within the project organization. However, it was noticed that these meetings were not very highly prioritized (because of other obligations or poor motivation), and therefore knowledge between project members was not homogeneously diffused. It was often stated in the interviews that there were too many different kinds of meetings and it was not possible, or even reasonable, to participate in all of them. Nonetheless, most of the interviewees said that some of the knowledge was not transferable by any other means than face-to-face meetings.

Coffee and lunch breaks were important forums for knowledge transfer. They were opportunities to obtain information and knowledge that were not even on the "search list," i.e., they provided knowledge that was not even looked for but that appeared to be valuable. In addition, face-to-face discussions during the coffee and lunch breaks were used to clarify and deliberate messages that had already been transferred via emails. Many of the interviewees said that informal meetings

were good opportunities to get know other employees and their areas of expertise. Often this kind of knowledge turned out to be useful in the future.

Information and knowledge transfer from external sources, i.e., from the customer organizations, was somewhat easy if the information and knowledge to be transferred was well defined. None of the interviewees saw the transfer process itself as a problem. The parent company of case A can also be considered an external source in this study. The parent company had a lot of valuable information and knowledge that could be transferred to and applied by the case A organization. This kind of information and knowledge was transferred in the forms of documentation from earlier projects or by inquiries to people who had beneficial knowledge.

The turnkey project deliveries usually took several years. A number of interviewees said that the length of project deliveries weakened the ability to transfer knowledge from one project to another. This was especially true with consecutive projects because the key personnel no longer worked in the projects and because the complete project documentation was difficult to find. Transferring knowledge between projects that were carried out simultaneously was easier. The data suggests that there were no explicit instructions on how information and knowledge should be distributed among the different project delivery actors. Having the same senior level employees on the project boards was a commonly used practice for transferring knowledge between projects and was seen as a very good practice.

4.1.2 Exploiting and exploring information and knowledge

Problems in *knowledge exploration and exploitation* were not often mentioned in the interviewees. The personnel had skills and competencies that were needed to generate a plan for the project delivery. The company also provided several software tools that helped in making calculations and the modeling of the project delivery.

However, based on the interviewees, the planning of the project deliveries reused existing information and knowledge insufficiently. A lot of information and knowledge produced in other projects or other phases of the project deliveries were not available in the planning phase of the project delivery. The illustration in Figure 18 depicts the phenomenon. Instead of reusing existing information and knowledge, a lot of information and knowledge was produced in the studied case. Based on the interviews, a similar situation is very common in project deliveries in general.

An opportunity to reuse already existing information and knowledge was therefore missed. Since the project deliveries are unique, the reuse of information and knowledge from past projects is somewhat limited. Nevertheless, because the information and knowledge from past project deliveries were greatly valued, the personnel responsible for the planning phase considered this kind of information and knowledge to be important and useful.

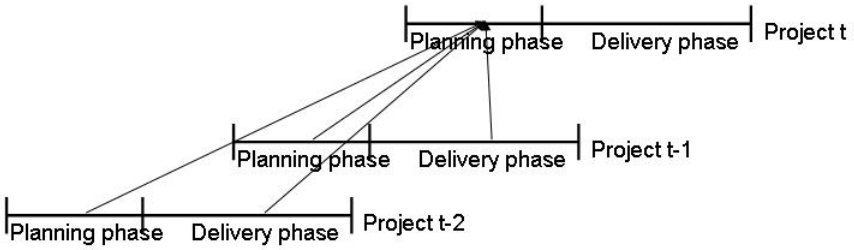

Figure 18. An illustration of the knowledge reuse opportunities. The planning phase of the project delivery at a given moment (t) could potentially benefit from earlier (t-1, t-2, t-n) project delivery planning phases and project deliveries.

According to the interviewees, employees had personal procedures that aimed at organizing and systemizing their work. As was said by some interviewees, this is very natural to human behavior. However, this resulted in a lot of variability in the work procedures of different people. The company did not have a strong command on how the work should be carried out. This left a lot of choices for individual preferences. Autonomy over one's own work procedures somewhat impaired the organizational capability of matching different phases of the work flow. This was not seen to seriously impair the work flow, even though many of the interviewees welcomed more systematic work processes because they saw that this would support collaboration between different experts and ease new employees' adaptation to work.

The company lacked some skills and competencies, and these were acquired from the markets. These usually included country-specific information and knowledge provided by different consultants. However, their role in the planning phase was minor. The company had also

established contracts that enabled the use of some commercial tools in the Internet. Cheapness and velocity were the greatest advantage of these tools.

The technology in the company's business area develops continuously, which means that employees also need to update their skills and knowledge. Scientific articles and conferences provided new external knowledge for the employees. Knowledge acquired through external sources was seen as important because it allowed benchmarking and access to novel knowledge. Naturally, the employees also learnt and had an opportunity to update their skills through their daily work and interaction with colleagues.

4.1.3 Knowledge outcomes

This study does not aim to evaluate the quality of the specified knowledge outcomes in the studied cases. Instead, the types of knowledge outcomes are explored in order to understand how knowledge can be utilized and applied elsewhere and later on in the organization. Accordingly, knowledge outcomes include embrained, embodied, encultured, embedded, and encoded knowledge.

The work of the case organization was targeted at generating a detailed plan for a project delivery. This is naturally in the form of encoded knowledge. Before introducing the plan, a lot of calculations and modeling had to be done. This also involved decision-making about possible technological options and choosing between different alternative solutions. Because the plans for the project deliveries were made in a specified context, the reasons and justification for selecting between different options were important for understanding the decisions in the future. However, the interviewees said that afterwards it was not usually possible to follow the logic of the decisions because they were inadequately documented. Knowledge remained in an embrained and embodied form and as property of individuals. As a result, this information and knowledge was difficult to reuse and utilize in future projects by other employees of the company.

In preparing projects, the project participants produce different kinds of feasibility analyses before the project can start. It was said that these kinds of analyses could possibly be used also by other simultaneous or future projects. However, the employment and utilization of these analyses elsewhere in the company was low. In these kinds of situations, the knowledge was heavily embedded in people working in the projects, and documentation was a poor vehicle for

transferring knowledge between projects. Many interviewees stated that documentation was not actively disseminated to other projects which might benefit from the knowledge. A lack of a common practice for pushing knowledge was said to be the reason for this. In addition, whenever knowledge needed to be transferred across intraorganizational boundaries, the transfer process itself was impaired in terms of speed and quality. It was often mentioned that organizational units did not necessary know what other units were doing or what kind of knowledge would benefit them. Besides, people were also less interested in the expertise or knowledge needed by other units.

There were two major targets to where the case organization needed to transfer information and knowledge it had produced. First, the case organization transferred information and knowledge to the customer organization. Second, the case organization transferred information and knowledge to the project organization, which would later deliver the project. Additionally, information and knowledge produced in case A was transferred to the organizational databases for later use. This third type of transfer had no specified objectives at the time of the transfer. A few interviewees said that they did not actually know where or to whom the information and knowledge they had produced went or who needed that information and knowledge. In particular, this concerned knowledge flow from the case A organization to the parent organization.

Produced knowledge was only partially stored in the databases. For instance, on many occasions, it was not possible to track the reasons for different kinds of decisions even though the outcomes were documented. The ones who had made the decisions and stored the knowledge had documented only the outcomes and not the basis for the outcomes. Later, the justification for the decisions was only known by the people involved in the knowledge production in the first place. This means that learning mainly took place at the individual level, and other members of the organization had only limited opportunities to learn. This generates missed opportunities and redundant work. It was also often mentioned that failures were not analyzed or documented well enough. Some of the interviewees would have welcomed a procedure that could prevent failures from reoccurring.

It was often acknowledged in the interviews that people had different kinds of work-related learning histories. The stimulus for learning varied as well as the outcomes. People had been involved in different kinds of projects, and what they learned was a result of their experiences. Thus, colleagues could never have exactly the same learning history, which affected how they

could understand each other. Some of the interviewees said that when discussing complex and interdisciplinary issues, there was no other alternative than to believe and trust what the other experts said if the issue was beyond their own area of expertise. To understand their colleagues' reasoning, the interviewees often needed awareness of their colleagues' past projects and experiences.

4.1.4 Storing information and knowledge

The company had a specific computer-based system for storing encoded knowledge. Satisfaction with the system was very low. First, entering information into the system was considered to be very complicated. Information needed to be indexed in many ways, which was seen as a very slow and often difficult task. An accurate indexing system was employed to ease information retrieval, but it was said to fail to achieve this kind of a gain because of the indexing system being too complex. Second, many of the project folders had limited accessibility for employees who had not been a part of that specific project organization. This prevented information and knowledge sharing between projects. Many of the interviewees said that the system was not used because usually the needed information was retrieved more easily from other sources. Nonetheless, many of the interviewees agreed that a uniform and well-structured system for storing codified knowledge would be very helpful. Again, it was said that the input-output ratio for maintaining and updating such a system requires at least short-term sacrifices (in terms of spent time) for gaining long-term benefits. Specifically, some interviewees said that providing information and knowledge into the collective databases needs to be in balance with information and knowledge received from the system.

Members of case A used different practices and repositories for storing knowledge. The interviewees also said that public databases were not prioritized for storing knowledge from ongoing projects. Often only the final outputs were stored for public use. Because the projects often lasted several years, this delayed the availability of knowledge at the organizational level. The ongoing projects were documented, but, obviously, not everything can be documented. There were certain critical issues that needed to be documented every time. However, the system applied for documenting explicit knowledge leaves space for individual judgment, and thus the documentation varies between different individuals and projects. Explicated information and knowledge was stored into various databases. Some of these were personal, while others were in public use (available to a specified group of people). Many interviewees said that the indexing

system of the public database was difficult because it was often hard to decide where the documents should be placed. This generates a problem when documents need to be retrieved and slows information searching. Many of the interviewees argued that technology is not a foolproof solution for storing knowledge. Instead, the interviewees stressed that a lot of knowledge is embodied in people and needs to be transferred through human interaction.

Summary of the case A results

The main findings of case A are summarized in Table XVII. The work in case A had traditionally been very interaction-oriented. This made it possible to acquire embodied information and knowledge. However, good practices for cross-project information and knowledge acquisition had not been very well developed. Acquiring encoded information and knowledge from previous projects was a great challenge in the studied case. In general, acquiring relevant and useful input information and knowledge for achieving the objectives of the work encountered serious challenges in case A. Employees in case A had appropriate technical skills and knowledge for attaining their objectives and exploring and exploiting knowledge. Storing of information and knowledge for later use in case A was insufficient due to the poor user interface of the IT systems and the deficient practices applied.

Table XVII. Main positively and negatively associated factors in knowledge flow in case A.

	Positively influencing factors	Negatively influencing factors
Acquiring information and knowledge	The information and knowledge sources were limited and well defined Well established means to access embodied knowledge Small number of people involved Well established practices to define information and knowledge needs internally Informal occasions provided valuable information and knowledge The importance of this phase was acknowledged	Poorly developed practices for cross-project knowledge transfer Lack of common routines and practices for accumulating information and knowledge Poor availability (locating and accessing) of internal encoded knowledge resources IT tools poorly supported finding knowledgeable people and expertise, or even encoded information No serious systematic efforts to improve the accessibility of embodied knowledge Fragmentation of information and knowledge resources within the case and its parent organization Difficulty to integrate many areas of expertise Adopted pull strategy for information and knowledge acquisition required meta-knowledge about organizational knowledge resources Non-standardized methods for collaborating with customers
Knowledge exploration and exploitation	Well developed embodied expertise among the personnel	Lack of causal and contextual elements in the codified knowledge, impairing the reuse of existing information and knowledge Efforts to reuse existing information and knowledge, but often exploration strategy needed to be applied because of the unavailability of existing information and knowledge Outcomes often embodied individual knowledge that did not easily become embedded or encultured knowledge
Information and knowledge storing	No significant findings	Complexity of the case organization's data management system, i.e., difficulty to add information (documents) to the data management system due to the complex indexing system Information and knowledge was stored into the public database after the projects (not continuously) A lot of knowledge in an embodied form, which impaired knowledge becoming collectively available

4.2 Case B – distributed software development

Case B focused on studying a distributed software development project. Over 200 employees in four sites embodied a project organization of a software development. A more detailed description of the case is provided in chapter 3.4.

4.2.1 Acquiring information and knowledge

The data suggests that the personnel in case B had only few problems in *defining information and knowledge needs*. The work had clear objectives following the expectations and instructions of the parent organization. The case organization's duty was to develop software that would meet the requirements given by the parent organization. Naturally, the case organization needed to define and specify the sequence of its operations and define the information and knowledge it needed to produce before starting the next phases of the software development. In addition, the work could not be planned or designed in detail from the start to the end. Every now and then the project organization needed to evaluate if the defined milestones had been reached and then define the forthcoming operations and activities. Again, everything could not be anticipated, and respondents said that active communication and collaboration within case B was needed for defining information and knowledge needs. Defining information and knowledge needs in case B was based on data and facts. Occasionally it was difficult to distinguish relevant information from irrelevant information, which made the definition of information and knowledge needs difficult. Many of the respondents had a feeling that their major subcontractor based their decisions and definitions of information and knowledge needs more on feelings or embodied knowledge. Sometimes the defined information and knowledge needs included unclearly defined specifications. It was said that this includes risks of extra and unnecessary work and delays. However, the data suggest that there were no great challenges in defining information and knowledge needs at the organizational or the individual level.

Difficulty in *locating information and knowledge* was cited often. Basically, the information and knowledge required in case B resided within the case organization, in the parent organization, or was held by external collaborating partners. Information and knowledge within the case organization constituted the most important sources. Two reasons for an impeded ability to locate information and knowledge were mentioned frequently. First, locating information and knowledge from the organization's database was difficult. Case B used Lotus Notes, Intranet, and

databases for storing and transferring encoded information and knowledge. Case B produced a massive amount of information and knowledge that were stored in an electronic form. An employee looking for information from the database needed to be familiar with the contents of the different databases. It was suggested that the training period for new employees should include an introduction to different databases, their contents, and use. It was not very clear how the different IT systems (i.e., Lotus Notes, Intranet, different databases) differed concerning the content of information and knowledge.

Second, embodied knowledge was even more challenging to locate than encoded information and knowledge. It was frequently mentioned that it was difficult to find the right person in the organization. This was despite of the relatively small size of the case organization. Interviewees said that continuous changes in the organization made it difficult to follow who or which unit was responsible for which subject areas. The interviewed managers admitted the unclarity of the responsibilities within the case organization. In addition to challenges in locating the right people within the case organization, the data implies that the challenges in finding the right person also concerned the parent organization and the major subcontractor organization. Interviewees said that organizational charts would have been helpful in defining the right contacts. Again, it was difficult to know and find people with certain knowledge and competencies. It was suggested that the organization should have a system for telling who is online and who is not. This would help contacting people in urgent situations.

Access to information and knowledge also caused problems in the studied case. One obvious reason for poor accessibility to information and knowledge was the multi-site context. Sites were located in several time zones, which reduced the ability to access people in different sites. Employees had difficulties in participating in project net meetings because of the time difference between Europe and North America. Even simple email communication was remarkably slow. When employees requested information and knowledge from their colleagues in different sites (e.g.., by email or leaving a voice message) they often did not receive a reply. Interviewees often stated that they did not even know why their request had not been replied to. The respondents listed possible reasons for not receiving a reply. The reasons included that the colleague was too busy, her area or responsibility had changed, or simply that the subject was not interesting to or prioritized by the receiver of the request. One of the informants used the phrase "*you need to beg for information*" describing the difficulty of accessing information and knowledge within the case B organization. Most of the employees had never met their colleagues who worked in different

sites. This was said to impair the accessibility of information and knowledge. Interviewees also said that approaching people from different cultures generated problems. People said that they did not know the correct way to express themselves when requesting information and knowledge from people from different cultures. This was despite a very strongly uniform organizational culture. National cultures seemed to dominate over the organizational culture in many situations of communication.

Employees said that they did not have access to databases that were not officially part of their project. Nonetheless, these databases were expected to contain relevant and valuable encoded knowledge. Problems related to the availability of codified knowledge were, however, more associated with an inability to locate knowledge rather than to a hindered access to knowledge.

The bureaucratic way of operating was said to be a major obstacle in the way of accessing information and knowledge from the major subcontractor. The employees in the studied case organization were used to working very informally, e.g., at least the sites in Europe had very low hierarchical structures. The external partners did not operate in this way, and thus both sides needed to adopt their partner's operative culture. Based on the data, case B and its external partners have not been able to establish satisfactory cross-organizational work practices.

Information and knowledge transfer was the most cited category in the data. Only few respondents recalled good and feasible practices. Instead, most respondents reported challenges in transferring information and knowledge. The respondents reported both internal (information and knowledge transfer within case B) and boundary-crossing (information and knowledge transfer with collaborating partners) challenges. The problems in information and knowledge transfer within case B were different compared to the problems found in information and knowledge transfer between case B and its collaborative partners. Information and knowledge transfer within case B is discussed first. Then, the challenges in information and knowledge transfer between case B and its collaborative partners are presented.

The information and knowledge transfer challenges within case B are associated to three major themes, namely applied technology, organizational design, and applied practices. Some of the challenges are interrelated. First, a lot of comments were made about the applied technology and its inefficiency to transfer information and knowledge within the case organization. Due to the disperse location of sites, the employees frequently used phone and net meetings for transferring

information and knowledge. Many of the respondents said that it was often difficult to follow the discussion through these media. The problems were associated to bad voice quality (e.g., people could not hear what others said) and to the poor etiquette and management of phone and net meetings. It was often stated that net and phone meetings required better managerial skills than normal meetings. Even though net and phone meetings had been used frequently in the case organization for several years (as well as in the parent organizations), the company still had not been able to establish and embed a common management practice for these virtual meetings. Again, technological tools for transferring information and knowledge sometimes lacked the efficiency that could have been reached in face-to-face encounters. However, technological tools were often the only means of transferring information and knowledge due to the dispersed organizational design. Logs generated when information and knowledge were transferred using email were said to be very useful if the information needed to be returned to later.

Second, the dispersed organizational design impaired information and knowledge transfer within case B. A limited opportunity for synchronous communication and knowledge transfer between employees located in different time zones was one of the biggest barriers in the way of efficient knowledge flow. As was reported, technological applications could not adequately replace face-to-face contacts. Employees recognized that ad hoc face-to-face discussions were important. These were seen as good opportunities to transfer information and knowledge that otherwise would not have been transferred. Face-to-face discussions were also seen as important, or even necessary, for future virtual collaboration and successful information and knowledge transfer. The dispersed organizational design meant that employees needed to invest extra effort and attention to make sure that different parts of the organization had all the necessary information and knowledge. Interviewees said that remote sites were not always informed about decisions.

Finally, work practices varied between the different sites. Since different sites needed to collaborate continuously, this was seen as a problem. Hierarchical differences between the sites caused frustration for people working in the low-hierarchy sites. For them it was normal that information and knowledge should be transferred between people who are in need of information and knowledge and produce that information and knowledge. However, the site in the North America favored hierarchy-based information and knowledge transfer. Managers usually needed to be contacted even though the information and knowledge transfer was done between different specialists. This slowed the information and knowledge transfer and could not guarantee accurate and efficient information and knowledge transfer. Interviewees also said that different

professional groups had not been able to form an efficient mutual flow of information and knowledge. A particular database was the only way to exchange information and knowledge between "*nameless and faceless*" developers and testers. In addition, it was stated that the balance between push and pull in information and knowledge transfer was not equal between the sites.

Some of the sites lacked a proactive attitude toward information and knowledge transfer, and other sites needed to pull information and knowledge that should have been predominantly pushed. Some of the respondents thought that this was because there were a great number of employees who were not familiar with the planned knowledge flow process. Regular meetings or information about the progress of work would have also helped to understand the interconnections between different sites and operations needed in achieving the overall objectives. Case B held several regular meetings (either face-to-face or by using net or phone meetings) with specified agendas. In addition, ad hoc meetings were organized if something urgent emerged. Interviewees said that regular discussions on specified topics beat the "if necessary" forums because regularity shows the importance of the topic.

Case B employees said that proactive information and knowledge transfer from the main external partner was almost nonexistent. It had an important role in accomplishing the objectives of the project organization, and therefore it was expected that it should have taken a more active role in information and knowledge transfer. Transferring information and knowledge between case B and the main subcontractor should have been standard practice, but the comments given by the respondents suggest that the work of the subcontractor was poorly integrated into the work processes. In the survey, almost 80 per cent of case B's employees reported transferring information and knowledge with the main external partner. In addition, almost 50 per cent of case B's employees reported transferring information and knowledge with the internal partners. Employees of case B said that it was difficult to find the right people when contacting the main subcontractor's organization. This suggests that the information and knowledge flow between case B and the main subcontractor was not as efficient as it could have been. The large number of employees in direct contact with case B's partners illustrates the lack of coordination and management of external relationships. This poor coordination of information and knowledge transfer across organizational boundaries came as a big surprise to the management of case B.

4.2.2 Exploiting and exploring information and knowledge

Understanding and absorbing information and knowledge seemed to be a challenge in case B. The challenges relate to two main issues. First, the issue of language caused problems in case B. Language is one of the most important vehicles for conveying messages and knowledge. The official language of the company and of case B was English. However, only few employees spoke English as their native language. Employees in different sites naturally preferred to use the local language if possible. Many employees reported having occasional problems in understanding both the written and spoken English of their colleagues. At the same time, the employees of the main subcontractor spoke English as their native language. These native English speakers used a wide vocabulary and spoke quickly. Case B employees said that it was difficult to follow native speakers in spoken conversations. Case B employees also said that the external partners did not seem to understand the expectations of case B even though a lot of time was spent on explaining these expectations.

In addition, terminology and the meanings given to words differed between the sites and professional groups. It was suggested that the organization should discuss and agree on the meanings of used terminology. It was recognized that employees need to be aware of words and expressions that can be understood in many ways.

Second, the inability to understand and absorb information and knowledge was sometimes due to imperfect prior understanding of the issue being discussed. The work required combining several areas of expertise. Sometimes it was difficult to understand different professional groups. In addition, the level of expertise varied even within professional groups. This reduced ability of understanding and absorbing information and knowledge caused by insufficient expertise was not seen as a severe problem by the respondents. Respondents said that this was a challenge that could be overcome. Overcoming the challenge required time to attain a common understanding of the discussed issues. Therefore, the challenges related to understanding and absorbing information and knowledge were not unsolvable. However, these challenges did seem to impair and delay information and knowledge flow and utilization.

The inability to interpret correctly social cues and expressions of people from different cultures was also mentioned as a factor generating problems and uncertainty. These social cues were often conveyed through emails or phone calls. Presumably these channels were poor at transferring social cues and prone to misunderstandings.

The theme *skills and competencies* only seldom came to the attention of the respondents. The personnel of case B were motivated and able to accomplish the objectives of the software development project. A lack of technical skills was not mentioned as a hindrance to the progress of the work. Due to the dispersed organizational structure, case B regularly used net meetings and teleconferences in communicating between different sites. Respondents said that a lack of skills in using the meeting technology and in managing the meeting protocol reduced the efficiency of these virtual meetings.

4.2.3 Knowledge outcomes

The project team in case B aimed at producing software in the form of encoded knowledge. Naturally, the work also involved the utilization and production of embrained and embodied knowledge. There was little evidence of outcomes in the form of encultured and embedded knowledge. On the contrary, the dispersed organization did not seem to generate uniform encultured and embedded knowledge. Instead, the knowledge was often embedded in local practices.

One challenge related to the outcomes of knowledge work was that it was difficult to follow the progress of the work at the project level. Employees in different sites and in different teams produced knowledge-based outcomes, but the employees had difficulties in perceiving how these outcomes contributed to the objectives at the project level. Another challenge related to the outcomes of knowledge work was that it was doubtful whether the use of an external partner improved the outcomes of the work. Case B respondents were skeptical as to whether the use of external resources improved the quality of the work at all. In addition, respondents were concerned that the use of an external partner could cause extra coordination challenges. Only these two challenges were mentioned by the respondents. However, the issue here is not the quantity of the challenges, but how damaging the challenges could be to the outcomes of knowledge work.

4.2.4 Storing information and knowledge

The work of case B aimed at producing encoded information and knowledge. This type of information and knowledge is most easily stored in an electronic form. Due to the dispersed nature of the organization, it would have been expected that additional effort would have been put

into making remote information and knowledge more accessible. This was, in fact, the intention. The success of that intention, however, is another story.

In case B, several technological tools and applications for storing information and knowledge were applied. These include Lotus Notes, Intranet, and network directories. In principal, different applications were intended for storing different types of information and knowledge. Here different types of information and knowledge refer to more general information and knowledge (which is not updated or does not need to be updated constantly) and information and knowledge which accumulates continuously and is updated constantly. Despite the different purposes of the applications, some employees found it difficult to decide what applications should be used in different situations. The interviewed managers thought that the purposes of the different applications used for storing information and knowledge was clear, but this message was not heard from other respondents.

Many respondents commented that the stock of stored information and knowledge was enormous and that it was often beyond an employee's ability to ensure that the right piece of information had really been found. In addition, it was often said that it was difficult to tell if information and knowledge was up-to-date when retrieving information and knowledge from the various databases.

Summary of the case B results

The main findings of case B are summarized in Table XVIII. In case B, acquiring information and knowledge was challenging because it could not be easily located or accessed. Quite a few employees said that a dispersed multi-site working environment is a challenging organization and, besides the advantages it may provide, its drawbacks should also be carefully considered. In order to achieve its work-related objectives, the case B organization needed to integrate information and knowledge produced in the different sites on a regular basis. However, the organizational design of case B does not make it easy to do this.

Table XVIII. Main positively and negatively associated factors on knowledge flow in case B.

	Positively influencing factors	Negatively influencing factors
Acquiring information and knowledge	Objectives of the work fairly clear Well defined information and knowledge requirements	Inability to find the right person to contact Required intensive interaction with several functional units within the case organization Unclear responsibilities due to organizational changes Information and knowledge was not pushed to where it was needed Extensive, poorly coordinated, and redundant communication with internal and external customers and partners Both encoded and embodied information and knowledge difficult and time-consuming to find Employees find the purposes and contents of different IT repositories unclear No confidence that the right and updated information had been found Dispersed multi-site environment slowed information and knowledge flow Multi-cultural context decreased the accessibility of information and knowledge Language differences between people impaired interaction Unfamiliarity (among many employees) with the intended knowledge flows and sequence of actions
Knowledge exploration and exploitation	Well developed expertise and motivation among the personnel	Problems in understanding the language and terminology of different national or professional groups Difficulty to establish efficient work practices with external partners Combining diverse expertise was often difficult Work generated local practices that did not become embedded or encultured knowledge in the case organization as a whole
Information and knowledge storing	No significant findings	Too many IT applications and repositories for information and knowledge storing (it was not always clear where to store information and knowledge and what application to use)

4.3 Case C – new product development in the electronics industry

Case C embodied a product development project in the electronics industry. A more detailed description of the case is provided in Chapter 3.4.

4.3.1 Acquiring information and knowledge

Defining information and knowledge needs was considered from two different perspectives. First, the dominant voice came from external sources, i.e., from markets in general and especially from the current customers. Both direct and indirect sources were used for defining information and knowledge needs. Direct information came from customer orders and from discussions with customers. Indirectly, future information and knowledge needs were evaluated using secondary sources, e.g., through market analysis or examining general information regarding market development. Both sources were mentioned to be problematic. In the interviews, it was frequently mentioned that even customers did not know how their own markets would develop or what their future technological choices or preferences would be. Further, many of the interviewees said that the future in general is so unpredictable and uncontrollable that good long-term plans are very difficult to attain. However, some of the interviewees doubted if defining information and knowledge needs was too customer-oriented. There were no serious attempts to try to define information and knowledge needs in close collaboration with the customers, but, rather, there were attempts to try to satisfy customers and respond to their (often vague) needs. This kind of a reactive strategy in defining information and knowledge needs had caused an inefficient targeting of resources. Interviewees said that the level of activity was sufficient, but there was a lack of clearly defined targets.

Second, the company's own research and development efforts targeted at defining what information and knowledge needed to be acquired or produced in order to fulfill the gap between possessed expertise and required expertise. Even though the company was not fully satisfied with using customer information for defining the information and knowledge needs, many of the interviewees doubted if this definition could be made solely by using internal knowledge. Different functions had different information and knowledge needs. These differences were usually recognized, and the value of multiple perspectives was acknowledged. However, combining these needs was difficult. It was a complex task to define various information and knowledge needs within the company and its various operations, and many interviewees wished

for more routine and systematic processes for combining heterogeneous internal perspectives. Since the technology which was applied in the studied product development case was still evolving, it was difficult to define precisely what information and knowledge would be needed in the future. Thus, sometimes improvements to the product were made through trial and error. The personnel could not anticipate all information and knowledge needs in advance, and thus many ad hoc solutions were made. One managerial-level interviewee admitted that good results could be achieved by using various methods, and the autonomy to decide how to proceed must be left to those who actually carry out the work. The development work was considered to be too vague for a clear long-term road map. Instead, it was considered that the employees themselves should reflect on their work and that the process should to be somewhat self-steering.

The company combined proactive and reactive strategies for defining the information and knowledge needs for its product development. The company tried to be proactive in defining future knowledge needs, but at the same time it actively looked for signals in the markets and other interest groups. This latter approach is more reactive. Both strategies elicited important information and knowledge needs, but, as noticed by some interviewees, the strategies have very different premises and very different implications for product development.

Defining information and knowledge needs was somewhat challenging, but *locating information and knowledge* resources did not cause many problems, or at least this was seldom mentioned as a problem in the interviews. The required information and knowledge was located either within the company or outside the company. Information and knowledge that was located outside the company was dispersed in many different locations. Information and knowledge was situated within different research groups across the world, in scientific articles, within competitors, and with customers. The Internet and personal contacts were the most commonly used practices for locating defined information and knowledge needs. The Internet was a source for both technical and market information. In addition, the Internet was useful for following the developments of competitors. It was acknowledged that external information and knowledge is dispersed and that it is difficult to reach any certainty regarding the location of worthwhile information and knowledge. However, through information browsing it was also possible to find valuable information and knowledge that was not even defined or looked for.

Within the company, information and knowledge were possessed mainly by three different groups: 1) sales and marketing personnel who formed a link between customer information and

the company, 2) production personnel who gathered information about the production process, and 3) the company's researchers who were responsible for testing and developing different features of the product. Even thought the company was relatively small (~400 employees), many interviewees had noticed that internal expertise was not always easily found or utilized as effectively as possible. One interviewee said that technical information had certainly been generated in the company and existed somewhere, but it was sometimes easier to reproduce information by oneself than try to find information that already existed. In addition, a few interviewees said that they did not use the company databases to try to find encoded knowledge (even though they were pretty certain that it existed there) because it was easier to approach knowledgeable colleagues. Embodied expertise, which is weakly visible, did not always come to the attention of others. Many interviewees said that organizational charts would have helped to locate people within the organization, but, unfortunately, these kinds of tools were not available. A long working history helped in locating internal information and knowledge, and employees with a long working history were used as informants in locating information and knowledge.

Both external and internal *information and knowledge was occasionally challenging to access.* Competitors' information and knowledge was naturally the most difficult to access. Gaining access to customers' information and knowledge was easier but, again, not problem-free. It was known that some customers did not give positive feedback because they were afraid that this might cause a rise in prices. This reduced the ability to improve the studied product. In addition, customers were sometimes unable to provide the required information, which resulted in delayed deliveries. Some interviewees had tried to establish professional relationships with the customers' technical personnel in order to improve access to the customers' expertise. Furthermore, it was widely acknowledged that culture had a huge impact on accessibility. Customer information and knowledge in Europe and in the US was somewhat easy to access, while customers in the Far East were more reluctant to share information and knowledge.

Information and knowledge held by the research institutes was fairly easy to access. The company had some close and long-lasting relationships with specified research institutes, and communication and knowledge sharing with them was relatively open. Through this kind of collaboration, the company could access new scientific knowledge and even obtain new knowledgeable employees.

Accessing internal information and knowledge was easier, although some challenges were also recognized there. Some interviewees said that they felt uncomfortable approaching knowledgeable people if they had not met them before in person. The most knowledgeable people were sometimes not approached because it was assumed that they would be too busy. Besides psychological proximity, physical proximity also eased the access to knowledgeable people within the organizations. Physical proximity was one of the most often mentioned means of increasing the accessibility of expertise knowledge. Physical presence also increased the priority of requests for information compared to, for example, emails. A couple of interviewees said that organizational information and knowledge does not necessarily accumulate very well and that mistakes are repeated because lessons learned from earlier experiences do not reach the whole organization. Many interviewees said that access to prior experiences and knowledge would have prevented making the same mistakes again. However, it was commonly understood that the accumulation of organizational knowledge is difficult to organize in such a systematic way that each individual learning outcome would be collectively known in the whole organization.

Transferring information and knowledge was the mostly cited category in the interviews, and the theme was discussed from many different perspectives. These perspectives included themes like the directions of information and knowledge transfer, the tools and practices applied to information and knowledge transfer, the transferability of different types of information and knowledge, and the roles of different participants or actors in knowledge transfer. One of the greatest challenges in the studied case seemed to be transferring information and knowledge over time. At the beginning of the studied product development case, information and knowledge was relatively easily transferred within a small group of people. This was despite the fact that information and knowledge mainly took the forms of embrained and embodied knowledge. Later, when the production had started, the required information and knowledge was needed in a more explicit form. Hence, the challenge was how to transfer information and knowledge from R&D operations to production operations.

Information and knowledge were transferred within the company as well as between the company and its customers and collaborating partners. Information and knowledge transfer with external actors was a two-way process, even though the company was more often the receiver than the source of transferred information and knowledge. The company undoubtedly transferred a lot of knowledge to its customers in the form of products, but this kind of knowledge transfer is not in the focus of this study. Instead, the focus of this study is to examine information and knowledge

that was transferred and utilized for managing operative and strategic decisions in the manufacturing process and in product development. The applied practices for transferring knowledge were nowhere near revolutionary. Telephone, email, and face-to-face discussions were used for transferring information and knowledge between the company and its interest groups (e.g., customers and collaboration partners). Many informants made a distinction between operative and strategic knowledge transfer between the company and its customers. Operative transfer included information and knowledge that needed to be transferred in order to carry out customer orders. Strategic transfer included information and knowledge that needed to be transferred in order to anticipate customers' future needs and to improve products in the future.

Many interviewees had acknowledged that both the operative and strategic information and knowledge transfer between the company and its customers should be improved. The knowledge flows were not efficient or good enough to guarantee that the needed information and knowledge would reach the individuals or groups of people who were in need of it. It was recognized that the company did not necessarily receive all the information and knowledge from its customers to fulfill the operative requirements. In addition, the company did not provide it customer with all the important information. The company was afraid that information provided to its customers might be leaked to competitors. There were differences in how customers were trusted as regards this issue, and, hence, some customers received more information from the company while others received less. Earlier experiences and a common history affected how much information and knowledge were transferred to the customers. Information and knowledge transfer between customers was, however, seen as important, and visits to customer sites were arranged to attain better understanding of the customers' production and processes. Many of the interviewees said that it was very important to try to understand the customers' businesses better. This kind of understanding helped to improve operative and strategic actions and plan information and knowledge transfer. However, particularly in the USA, the customer contact personnel changed so often that it was difficult to establish good personal and professional relationships.

According to the interview data, information and knowledge transfer within the company was much more intensive than knowledge transfer across the company's borders. Internal information and knowledge transfer was also considered to be more important from the operational and strategic perspectives. Again, information and knowledge transfer within the company was frequently mentioned as a challenging task. Based on their experiences, the interviewees highlighted several problems in information and knowledge transfer within the company.

First, the organizational design impaired information and knowledge transfer within the company. At the time of the study, the company had production in two different sites in Finland. Even though the sites were quite close to each other, the distance was considered to have negative effects on information and knowledge transfer. The interviewees said that opportunities for unscheduled face-to-face discussions were very important. These opportunities were sometimes lost because personnel were physically too far from each other. Physical proximity was also mentioned as an opportunity to increase "mental" proximity. The distance between personnel also had an impact on available information and knowledge transfer means. Face-to-face discussions are difficult to organize if people are far from each other, leaving electronic information and knowledge transfer tools as the only available options. After the study, the company closed down one factory and, thereafter, had production only in one site in Finland.

Internal information and knowledge transfer between the production function in the USA and the Finnish sites was not very extensive. Since the US operations did not cover R&D or NPD, there was no need for very intensive information and knowledge transfer either. The information and knowledge transferred between Finland and the USA was easily codifiable and, therefore, also easily transferable by using ICT. The time difference between Finland and the US also impaired the information and knowledge transfer between the sites on different continents. This particularly related to the sales and marketing personnel in the USA and in Finland. In general, personal contacts and familiarity with the counterparts were often mentioned as a good starting point for successful information and knowledge transfer.

Second, unclear and different information and knowledge needs in different parts of the organization were obstacles in the way of information and knowledge transfer. It was generally recognized that different people and different functions had different information and knowledge needs. In addition, it was also recognized that regular information and knowledge transfer between different functions was necessary. However, information and knowledge were often personal and context-dependent, and transferring them was difficult. For example, employees in the sales and marketing department had no need for perfectly documented customer information because they were involved in the process where that information was produced and, hence, were already familiar with that information. The transfer of this kind of ill-documented information and knowledge to other parts of the organization was difficult. First, the inaccuracy and context dependency of this information meant that receivers had difficulties in interpreting the information correctly. Second, the sales personnel were expected to spend their time contacting

customers and, thus, were not often present at the production plant. Transferring information and knowledge more effectively would have required face-to-face discussions, which were difficult to organize, or more precise codification, which was not favored by the sales and marketing personnel. Both of these resolutions would have had negative effects on efficiency from the perspective of the information and knowledge producers (sales and marketing personnel). Nonetheless, many interviewees from the production or R&D functions believed that people in sales and marketing had valuable information and knowledge that had not been transferred to other parts of the organizations where it could have been utilized.

Many interviewees also stated that they were sometimes unclear about who/what are the correct or relevant sources or targets of information and knowledge. This particularly concerned interviewees with short working histories. Many of the interviewees (in the role of an information and knowledge source) said that it was not always easy to ensure the effectiveness of the knowledge transfer. It was said that not knowing the effects of the transferred information and knowledge might reduce future information and knowledge transfer interests and activity. Due to a difficult market situation, the company had recently reduced its number of employees. Some interviewees said that this had had negative effects on voluntary and proactive knowledge transfer. Motivational barriers in the way of information and knowledge transfer were not, however, often mentioned in the interviews. There was a lot of variability between interviewees in their desire to obtain general information and knowledge. This kind of information and knowledge had no effects on the short-term operations of the receiver but had potential future benefits. Some of the interviewees complained about information overload, while others felt that it is important to have knowledge about what is happening in other parts of the organization. Individual differences in this matter were big.

Third, tools and practices applied to information and knowledge transfer did not always match well with the types of information and knowledge being transferred. Some of the senior-level employees had actively considered efficient means to transfer different types of information and knowledge within the company. They had also recognized that in many cases individuals and groups have so diverse needs for knowledge transfer that is difficult to define or choose the most efficient means for knowledge transfer as a whole.

Individual differences and preferences played a significant role when employees chose means for knowledge transfer. Some favored meetings, while others preferred, for example, emails. It was

often mentioned that a lack of good and coherent structure in emails substantially impaired the success of knowledge transfer. Unstructured emails generated a need to ask for further information and reduced the efficiency of communication. Information and knowledge transfer using email was extensive and often the most efficient mode of information transfer. However, it also caused many problems. If an email had too many recipients, the information lost its ownership, and it became unclear who is responsible to reply if the email contained any questions. In other cases, emails were not posted to employees with the best ability to answer the questions (this is, of course, also related to the problem of locating information and knowledge sources). Some interviewees said that they sometimes experienced difficulties in encoding embodied knowledge or expertise because the knowledge was too tacit and vague.

Meetings between different functions were arranged regularly for transferring information and knowledge. The data suggest that these meetings were most beneficial to employees with the shortest careers. Employees with a long work history were already much more familiar with the information and knowledge that were transferred in these meetings. In many cases, however, meetings were the best way to combine dispersed expertise.

4.3.2 Exploiting and exploring information and knowledge

Understanding and absorbing information and knowledge was not a big issue even though the company operated in an area where technology development was fast. Knowledge creation predominantly required the involvement of three different groups within the company. These were sales and marketing personnel (who provided access to customer information and knowledge sources), R&D personnel, and employees working in the production process. As was explained earlier, information and knowledge transfer between sales and marketing and other parties was the most difficult area. In addition, the worst internal difficulties in absorbing and understanding boundary-crossing information and knowledge were experienced between the marketing personnel and other personnel. Because the marketing personnel were much less advanced in their technological expertise, they were sometimes unable to convey information to production personnel and to employees working in R&D. Many interviewees said that there were only a few individuals who truly comprehended all the essential elements of the studied product and its production. Accordingly, most of the interviewees also recognized and acknowledged their own limits in understanding and absorbing information and knowledge. It was said in the interviews that it is not necessary for everyone to know everything but, instead, that it is

important to be able to integrate the expertise of different employees. However, a few interviewees stated that the specialization of employees and functions generated too large knowledge and expertise gaps between people, which in turn impaired interpersonal understanding.

Absorbing information and knowledge from external sources was based on partly incomplete messages. This was especially true as regards information received from the customers because often the customers did not completely know their own needs or the case company's employees did not understand the needs of the customers. In addition, customers did not always provide enough information and knowledge in order to enable accurate interpretations. Language difficulties experienced with customers from the Far East were also cited in the interviews. Absorbing technological expertise from collaborative partners (e.g., research institutes) was said to be much easier. The markets were volatile and unpredictable, and technological development was fast, but market information was, nevertheless, much more difficult to interpret compared to technological information.

A lack of skills or competencies was not often mentioned in the interviews. Skills and competencies were needed in order to develop, test, and understand how the product and its technology could be further developed. There were a few key individuals in the company who were acknowledged as having the most advanced skills and competencies. They were also the primary sources of knowledge when exceptionally challenging problems occurred. It was often mentioned in the interviews that the technology is so complex that it takes time to fully understand it. However, the interviewees did not recall any major challenges in integrating intraorganizational skills and competencies in NPD or production.

4.3.3 Knowledge outcomes

There were two temporally different phases in the studied case, which generated different outcomes. The first phase was a concept development phase, which ended with a plan and specifications for starting the production of a new product. The outcomes of this phase were embrained, embodied, and encoded information and knowledge. The outcomes of this phase were utilized and applied when starting the production. The latter phase was called the knowledge application phase. The information and knowledge which had been produced earlier was to be embedded in the product which would be developed by the company. The need to produce

embedded knowledge (i.e., convert embrained and embodied knowledge into an embedded from) was a great challenge for the studied company.

So, the knowledge outcomes were generated in two separate phases: information and knowledge intended for application, and information and knowledge applied to the products. This study does not focus on the product or on the knowledge applied to the product as such, but instead the focus is on the processed information and knowledge. Thus, the focus is more on the applicable information and knowledge instead of applications of information and knowledge. At the beginning of the NPD process, a lot information and knowledge were produced without a clear view of its applicability (i.e., of the importance or value of the produced information and knowledge). This knowledge included, e.g., calculations needed for defining the specifications of the product. This information and knowledge was then processed by the members of the studied case organization.

In general, the information and knowledge produced in the early phase of the NPD process was vague and more personalized than information and knowledge produced later on in the process. Many of the interviewees reported that transforming embodied expertise into an encoded and embedded form was challenging. Thus, collective availability of knowledge could not be ensured.

4.3.4 Storing information and knowledge

As presented above, there were two separate phases in the studied NPD process, which also differed in terms of the means and practices used for information and knowledge storing. The first phase covered the concept development of the forthcoming product, and the second phase included operations in production and product development. In the first phase of product development, the methods and practices used to store information and knowledge were unsystematic. In the second phase, the studied case aimed for more systematic practices in storing information and knowledge.

Various actors took part in information and knowledge storing. These actors had personal and non-uniform practices for information and knowledge storing. This was particularly true in the early phase. Many interviewees pointed out that the forms and locations of information and knowledge storing were unsystematic. One particular (physical) folder was often mentioned in the interviews. This folder contained crucial measurement information related to the product and was

located on the bookshelf of one manager. Employees had access to that folder if they needed any information stored in it. Some information and knowledge was stored in an electronic form, while a lot of information and knowledge took the form of hard copies in personal files. During the data generation phase (i.e., the empirical part of this study), the case company adopted a product data management (PDM) system. The system was intended for more systematic management of explicit and codified information and knowledge. Typically, a lot of embrained information and knowledge were held by some key individuals, and the PDM application was intended for improving the collective availability of encoded and exactly specified information and knowledge. However, a lot of knowledge was embodied, and, thus, it poorly converted into explicit form.

Summary of the case C results

The main findings of case C are summarized in Table XIX. Due to a long time span of strategic decisions, the studied case had difficulties in defining what information and knowledge should be acquired. Not only was this theme often discussed in the interviews, but the interviewees also highlighted its significance for the organization. Acquiring short-term operative information and knowledge was easier. Internal information and knowledge integration and transfer was occasionally challenging in case C because of organizational design, several dissimilar interest groups, and imperfectly known sources and targets of knowledge. In addition, knowledge in case C was largely in an embodied form, which hindered its transfer.

Table XIX. Main positively and negatively associated factors on knowledge flow in case C.

	Positively influencing factors	Negatively influencing factors
Acquiring information and knowledge	Good relationships with several research institutes, which provided access to external knowledge and expertise An effort to integrate various internal perspectives	Difficulty to attain knowledge from the customers Embodied internal knowledge was not easily available Insufficient meta-knowledge about internal knowledge resources Difficulty to balance between reactive and proactive approaches when defining knowledge needs Mixture of short- and long-term orientations Combination of knowledge from different functional units of the case organization The targets of knowledge transfer within the case were unclear Difficulty to transfer information and knowledge between different professional and functional groups within the case organization
Knowledge exploration and exploitation	Highly developed knowledge and competences concerning the technology	Transformation from knowledge exploration to knowledge exploitation was difficult Difficulty to combine internal knowledge resources Inability to convert tacit knowledge into an explicit form Different operational units of the case organization operated with different types of knowledge (in terms of knowledge tacitness) Only few employees had a profound understanding of the technology
Information and knowledge storing	No significant findings	A lot of knowledge was not encoded Poorly adopted system for managing encoded knowledge (implementation of PDM system was still ongoing)

4.4 Case D – interorganizational IT service collaboration

Case D comprised a close collaborative relationship between two companies. The collaboration required intensive information and knowledge transfer between employees working in the interface. A more detailed description of the case is provided in Chapter 3.4.

4.4.1 Acquiring information and knowledge

A majority of the interviewees considered this theme from both an organizational and an individual perspective. Interviewees emphasized two separate issues in *defining information and knowledge needs*. First, from the customer company's perspective, the evaluation of information and knowledge needs was based on long-term strategic prospects. The decision to outsource the IT services was based on the customer company's evaluation of its future technology and knowledge needs. The company came to the conclusion that it would be more viable to acquire the required knowledge from external sources. From the service provider's perspective, this was a lucrative opportunity because the partnership offered access to a new business sector. Interviewees from both companies underlined that the difficulty to predict markets and future technologies was a great barrier to defining precisely what information and knowledge would be needed in the long term. This kind of strategic visioning is somewhat out of the scope of this study because the aim of the interviews was to gain insight into the operative reality. Second, defining information and knowledge needs was considered from the collaborative perspective, i.e., defining what kind of information and knowledge was required from both companies to make the operative collaboration successful. In this regard, the companies had rather different roles and approaches. The customer company made the definition and expected the service provider to act accordingly. The customer company was oriented towards defining information and knowledge needs and solving problems immediately, while the service provider wanted to spent time on defining the problems more precisely and removing the causes of the problems. Defining information and knowledge needs was also evaluated jointly. Interviewees from both companies had experienced some dissatisfaction with the results. It was widely agreed that it was difficult to define information and knowledge needs because the objectives of the collaboration were not clear enough.

Locating the required information and knowledge was not an issue in this case. In general, information and knowledge was located in the collaboration context (i.e., neither of the

companies needed to acquire information or knowledge from external sources or far from internal sources). The daily operative collaboration was carried out by a limited number of people, many of whom already knew each other. Locating employees with the required information and knowledge was easy.

Access to information and knowledge was a fairly complex phenomenon. Most of the information and knowledge needed in daily operations was very accessible. However, several incidents indicated poor access to information and knowledge. First, the frame agreement on the content of the partnership was not widely accessible. The business units in the customer company did not know exactly what had been agreed about the collaboration. The confidentiality of that codified information forced the business units to act with uncertain information. Interviewees from the service company said that the customer company was not too eager to discuss long-term actions with the service organization, which prevented access to information and knowledge. Second, the interviewees in the customer company claimed that the service provider offered too expensive knowledge and expertise or that it was delivered too slowly. Too high a price was often given as the reason for rejecting access to knowledge and competences offered by the service provider. In addition, the offered knowledge and resources did not always match the defined needs.

Third, the customer company had previously dealt with several IT subcontractors, but now the new service provider wanted to handle the IT services exclusively. Some interviewees from the customer company stated that important knowledge and competences were therefore no longer accessible and that the new service provider could not substitute all of the losses. Moreover, many interviewees were aware that information and particularly knowledge was organizationally dispersed and that versatile expertise was not so easily accessed when needed. Fourth, the customer company had previously had very informal work procedures. If IT services were needed, it had been easy to phone a colleague and request the service. The new service provider had clear processes, and if a service was needed, a formal “request for service” had to be sent. Interviewees from the customer company considered the procedure too bureaucratic, and it was thought to limit access to information and knowledge. In addition, some interviewees from the customer company said that they felt uncomfortable because information about the progress of service requests was not available.

Several tools and practices were applied to processing *information and knowledge and transferring* it between employees. Tools here refer to technical apparatuses, while practices refer

to systems which have been constructed for people to use for processing information and knowledge (e.g., organizational design, formal work processes, and meetings). Obviously, these are often to a large degree combined and linked together. Telephone and email were the most often applied tools used for transferring information and knowledge. In addition, various regular meeting practices were applied for transferring information and knowledge between different professional and interest groups. Interviewees from both companies emphasized that most of the information and knowledge was acquired and received from informal sources (e.g., informal discussions with members of both organizations). The higher the organizational level where a meeting was held, the poorer the meeting was as a practice for transferring information and knowledge. The importance of particular information and knowledge was raised in these kinds of formal meetings, but the meetings were considered to be inefficient practices for transferring information and knowledge. There were plans to streamline the formal meeting practices. Regular meetings with few participants, instead, were considered necessary and effective practices for transferring information and knowledge. A majority of the interviewees participated in several such meetings. None of the interviewees considered information and knowledge transfer to be very problematic.

Unclear roles sometimes delayed the information and knowledge flow, e.g., it was not fully clear whom to contact when information and knowledge was needed or where to sent information. In addition, there had been situations where the counterparts had interpreted the urgency of information needs differently and, therefore, needed actions had been taken too slowly. Several interviewees stressed that good chemistry, trust, and familiarity between people was needed to guarantee spontaneous information and knowledge sharing. Many of the interviewees acknowledged that too little information about the consequences (e.g., changes in the work practices) of the partnership had been disseminated. Even in the midst of an information overload interviewees expressed that distributing information is vital for improving organizational meta-knowledge.

4.4.2 Exploiting and exploring information and knowledge

Difficulties in *understanding and absorbing information and knowledge* were frequently mentioned in the interviews. There were several reasons why successfully transferred information and knowledge were not fully understood or absorbed. First, a wide variety of new terms, previously unknown to the counterpart, were introduced when the two companies started their

collaboration. However, it was not initially ensured that the new terms were mutually interpreted and understood in a similar manner. Even the documented knowledge was understood differently. Some interviewees reported that, when looking back, it is obvious that more time should have been spent on getting to know each other better. Second, the working cultures of the two companies differed to a large degree, and close collaboration and interaction was needed to reach mutual understanding. Particularly the interviewees from the customer company claimed that, because the service provider rotated its employees continuously, this mutual understanding needed to be built over and over again. This led to insufficient knowledge about the partner and its needs and expectations. Many interviewees from both companies admitted that their partner's lack of understanding could also be the fault of the messenger. Third, the service company used international expert resources who did not understand the local context. While being respected in their area of expertise, these specialists could not always take into account the cultural and national context. Fourth, language caused difficulties in understanding. The customer company was very Finnish, while the service company's official language was English, and some of its experts could not even speak Finnish. Fifth, some interviewees from both companies said that age differences between the employees of the companies impaired mutual understanding.

The *skills and competencies* in both companies were sufficient in the intraorganizational context, but they were not combined properly in the interorganizational collaboration. This had several negative consequences. Some skills and competencies were lost when the two companies publicized their partnership agreement because some of the customer company's employees resigned. The customer company had always had a culture where individual and personal know-how was respected and expertise was very much embodied. In many interviews, it was made clear that expertise was heavily dependent on individuals and their skills and competencies. Some interviewees were aware that some areas of embodied expertise were hard to replace, which made the company vulnerable. Some of the interviewees realized that the service company's intent to transform embodied expertise into embedded and encoded knowledge caused feelings of lost autonomy and freedom. The skills and competencies of the employees who remained but started to work for the new employer were also partly lost. Many interviewees from the customer company said that experts who had been very competent in the past somehow seemed to have lost their capabilities when they had to start working according to the service provider's new rules and work processes. Many new tools and practices were also introduced to these employees who, however, did not have adequate skills or competencies to work with them. The service company

provided employees with training for the new tools and practices, but, at the time of the interviews, these new skill and competence requirements had not been totally adopted.

The close collaboration between the companies also required new skills and competencies. This was especially true for the customer company. Interviewees from the customer company admitted that they had not been prepared for that. New skills and competence requirements included project negotiations with the service provider. Previously, IT projects had been provided by the company's own staff, and, in a way, they weren't given a price. In the new situation, however, every project included bargaining of the scope, scale, and price of the project deliveries. The service provider had a lot expertise in this area, but the customer company, in contrast, lacked equivalent proficiency. The lack of skills and competencies was not recognized or admitted in all of the business units in the customer company. From their point of view, life had been much easier in the past when there had not been that much of a need to take expenses into consideration. The skills and competencies of the two companies were imbalanced in the project negotiation phase, but also in the project delivery phase. The service provider was superior in both phases. There was a need for the customer company to learn new skills and competencies quickly. At the same, many interviewees said that the service provider should have shown some empathy and tried not to demonstrate its superior skills. A majority of the interviewees expressed that technical expertise is not enough to achieve good results but that interpersonal skills are also needed. Many interviewees said that learning new skills and competencies should have been done jointly and in collaboration. On the other hand, many interviewees from the customer company doubted whether the service provider had world-class expertise in this particular business area, emphasizing the importance of understanding the business context when applying knowledge.

4.4.3 Knowledge outcomes

The collaboration between the companies aimed to produce knowledge products and services, i.e., applications of knowledge. The focus of the study is not on the services or products as such, but, instead, the study is interested in the forms and representations of the information and knowledge in the studied context. Prior to the collaboration, the customer company had preferred and valued embrained and embodied knowledge and personal know-how. For example, the maintenance of many systems and IT applications was heavily dependent on the individuals who had developed them. In addition, different kinds of applications were developed with little company-level coordination. As a result, the web of applications was redundant and not always

compatible, and its functioning was dependent on key individuals. Interviewees from the customer organization said that this had worked well so far, but, because of its vulnerability, the whole system had been outsourced to a company that could better coordinate it in the future. On the other hand, employees in the customer company typically had very long work histories. This had enabled them to transform embrained and embodied knowledge into encultured knowledge.

The service provider, instead, was very systematic in encoding knowledge and transforming knowledge into its systems, i.e., into the form of embedded knowledge. In the collaboration, these two companies needed to fit two very different approaches together. They were moving towards an approach where more emphasis is put on encoded and embedded knowledge. Even the interviewees from the customer company acknowledged that this was a good direction to be moving towards, although the transformation phase did cause a lot of pain and frustration. The interviewees from the customer company were more likely to think that not all knowledge can be coded and transformed into processes. For example, some interviewees from the customer company said that they would rather work with the same service company employees all the time, even in rather routine operations. This indicates a view that not all the knowledge can be transformed into processes and that accumulative embodied expertise is often very valuable.

4.4.4 Storing information and knowledge

As a result of knowledge outcomes, the two companies favored, or were forced to favor, different kinds of repositories for information and knowledge. The customer company had been relying on personalized knowledge, while the service company preferred encoded and embedded information and knowledge.

The companies did not have a common database that would have been accessible by both partners. The interviews did not reveal a need for such an arrangement, either. Instead, both companies had their own procedures for storing and managing documented information. In particular, interviewees from the customer company said that they sometimes had difficulties knowing where information was stored in their organization. This also included databases to which the interviewees had access. One interviewee from the customer company stressed that often things could be done faster if less time was required for documenting. However, many interviewees from the customer company were aware that critical knowledge was possessed by just a few individuals and that the availability of that knowledge should be better protected. It was

said that documentation is a task that requires human effort. A lack of time was often mentioned as a reason for not documenting knowledge. The primary reason, however, seemed to be the organizational culture, which did not demand very much documenting. For these reasons, the documentation in the customer company was defective. Some of the interviewees raised the question of whether documented knowledge can be utilized and reused in a context that is dissimilar from the context where the knowledge was originally produced and documented. Some interviewees said that documenting knowledge is good because it increases the visibility of knowledge.

Summary of the case D results

The main findings of case D are summarized in Table XX. Two salient features affected knowledge utilization in case D. First, the business objectives for the collaboration had been imperfectly defined. Due to that, information and knowledge needs were also difficult to define. Second, and more importantly, skills, competencies, and knowledge of the employees of the two collaborating companies did not match the requirements of the collaboration. This was widely recognized in both companies. In addition, new skills and knowledge needed to be acquired and developed to make the collaboration successful.

Table XX. Main positively and negatively associated factors on knowledge flow in case D.

	Positively influencing factors	Negatively influencing factors
Acquiring information and knowledge	A clear structure and means for knowledge transfer was designed, which enabled transferring managerial information The customer company needed to adopt a more formal and structured means for knowledge transfer.	Expected business outcomes (objectives and benefits of the collaboration) were not fully clear, which made it difficult to define information and knowledge needs Different operative practices between the collaborating companies Embodied knowledge not collectively available Dissatisfaction of the price determination of required/provided expertise and knowledge Knowledge (e.g., work in progress) was not sufficiently transferred to the customer organization
Knowledge exploration and exploitation	Potentially large knowledge and competence pool A transition from embodied knowledge to embedded knowledge	Lack of mutually agreed objectives for knowledge exploitation and exploration Unclear terminology and definitions of the collaboration contents Different temporal orientations between the collaborating companies Imbalance between the skills of the employees of the collaborating companies Incompatible work practices between collaborating organizations Difficulty to utilize knowledge and expertise in a new organizational context Difficulty to combine effectively different levels of skills and competencies of the employees from the two companies Customer organization's unanticipated and urgent need to acquire new skills and competencies A need to be more orientated towards encoded and embedded knowledge, instead of embodied expertise
Information and knowledge storing	A more systematic approach to encoding and storing information and knowledge was adopted	Different approaches to accumulating and retaining knowledge within the organizations. The customer company was orientated towards embodied expertise, while the service company favored encoded and embedded practices

4.5 Cross-case analysis

The cross-case analysis evaluates the findings from the individual cases and attempts to find meaningful explanations for the patterns of knowledge exploitation and exploration in the studied cases. Making comparisons between the studied cases can be a challenging task because the intuitive rationale behind the comparative approach is to find factors that explain the discovered differences and similarities between the cases. Such causal explanations are hard to defend convincingly. As Stake (1994) notes, there are probably too many differences between the cases and too many possible explanatory factors. Meaningful and convincing *causal explanations* are difficult to produce in small-N case studies. The rich and divergent data from the different cases leave room for pluralistic interpretations. Therefore, explanations for the similarities and differences between the cases' knowledge management practices and their consequences will be cautious.

Different knowledge processes are highly interrelated. Therefore, when analyzing them, they cannot be considered separately but instead as a group of processes that constitute the organizational information and knowledge flow. The aim of the data analysis is to understand the root, or primary, reasons for efficient or inefficient information and knowledge flows. In this study, three different issues related to knowledge flows as well as to their embodiment and implications are discussed.

1. Based on the theoretical modeling, success or failure in **acquiring input information and knowledge** can relate to four different issues. These are: 1) the ability to define what information and knowledge needs to be acquired, 2) locating the required information and knowledge, 3) providing access to information and knowledge, and 4) transferring information and knowledge from the source. The problems related to the four categories can be caused by numerous reasons, and they include both individual and organizational issues.

Case B was the only studied case where defining information and knowledge needs did not cause problems. This concerns both the individuals working in case B and the whole case organization. This is most probably due to the clear objectives of the work. In contrast to the other studied cases, the desired objectives of the work were easy to define and achievable through normal operative work, and therefore not much effort was needed to define what kind of input information and knowledge was needed to be acquired at the organizational or individual level.

The expected outcome of case A was also clear, but the complexity of the expected outcome is a possible reason for why difficulties in defining information and knowledge needs were often referred to in the interviews. In case C, the company needed to balance between short-term and long-term orientation, which made it difficult to define the best outcome of the work accurately. This, in turn, impaired the ability to define information and knowledge needs. In case D, the expected outcomes were not clearly defined between the two collaborating companies. As a result, the direction of the activities was vague, and information and knowledge needs were difficult to define. In cases C and D, the desired outcome of the work was more unclear and needed to be discussed and agreed on among several interest groups. In sum, the data suggest that the ability to define accurately the desired information and knowledge needs depends on the clarity of the objectives of the work and on the constancy of those objectives.

Compared to the other studied cases, the personnel in case B reported the most problems in locating encoded information and knowledge. Case B was a multi-site dispersed organization, which needed to apply ICT for storing and transferring information and knowledge because of its dispersed organizational design. The crucial role of encoded information and knowledge (instead of embodied knowledge) in case B can explain this. In case B, IT-based applications could not guarantee that information and knowledge was visible and perceivable. The other studied cases did not report many difficulties in locating encoded information and knowledge. The availability of alternative information and knowledge sources (i.e., embodied knowledge) may explain this. Particularly in cases A and B, the fragmentation of encoded and embodied information and knowledge generated challenges in locating the required expertise. In sum, the data suggest that the ability to locate information and knowledge sources depends on the dispersion and forms of information and knowledge as well as the chosen knowledge management approach's compatibility with the forms of organizational information and knowledge resources.

The employees of cases A and B more frequently reported problems in accessing information and knowledge. In case A, the problems in accessing encoded information and knowledge concerned mostly information and knowledge that were produced by other organizational units and information and knowledge that had been produced previously in the organization. In case B, the organizational design made embodied expertise and knowledge difficult to access. Moreover, case B did not even have effective practices for locating such knowledge. Additionally, case B employees reported problems in accessing encoded knowledge when the aim was to pull this kind of knowledge from the sources. Case B had the most diverse cultures (organizationally and

nationally) among its employees. This was reported to be a barrier in the way of information and knowledge accessibility. What is common to cases A and B is that in both cases the work was heavily dependent on the application of encoded information and knowledge. For that reason, cases A and B greatly emphasized the storing of encoded information and knowledge in electronic repositories. In cases C and D, information and knowledge was often in an embodied form. This study offers a possible explanation for why encoded information and knowledge was less accessible than embodied knowledge. Approaching embodied knowledge is more flexible than approaching encoded knowledge. If an employee does not have access to a particular database where required knowledge exists, she cannot try to persuade the machine to give her that knowledge. On the other hand, knowledgeable members of an organization can be difficult but usually not impossible to access. In sum, the data suggest that, to date, IT applications and their use do not guarantee access to organizational information and knowledge sources. It is still important that employees become aware of organizational knowledge resources through, e.g., socialization.

Problems in transferring information and knowledge were reported particularly in cases A, B, and C. In case D, knowledge transfer in the collaborative interface was not a challenge (i.e., knowledge was transferred, but operating with it was challenging). In the other studied cases (A, B, and C), difficulties in knowledge transfer were referred to often. Based on the model by Ipe (2003) (cf. Figure 13), the difficulties are related to two main reasons. First, the type of knowledge affects it transferability. The knowledge in cases A, B, and C was often in an embodied form, which reduced its transferability. Second, in the same cases, opportunities to share knowledge were limited. The multi-site organization of case B was an apparent reason for this. In cases B and C, some employees did not know why and where to transfer their knowledge. This shows that not all employees in these organizations knew how their individual efforts contributed to the objectives of the organization. Someone in the organization could have possibly benefited from the knowledge that was not transferred. Again, the dispersed mode of operations in case B may explain this lack of knowledge transfer. In case C, knowledge transfer difficulties were particularly related to knowledge transfer between functional units.

The data shows that *"right knowledge, at the right time, in the right form, and in the right place"* is difficult to achieve. The transferred knowledge in the studied organizations was not always right, knowledge was not always transferred at the right time, nor was the form or target of transferred knowledge always right. At a more theoretical level, these problems relate to the

challenge of balancing push and pull strategies in knowledge transfer. Pull strategy can be applied if an organization's members have knowledge about organizational information and knowledge resources. On the other hand, push strategy can be applied if an organization's members have knowledge about what other members or parts of the organization are doing.

2. Based on the theoretical modeling, **exploiting and exploring information and knowledge** can relate to individual and organizational issues. Individual issues include cognitive skills and the level of expertise of organization's members. Organizational issues include technological tools and organizational practices that are applied to managing the flow of information and knowledge.

Exploiting and exploring information and knowledge are essential aims of any knowledge-intensive organization because these are the processes through which value is added to information and knowledge. The studied cases aimed at exploring (creating new knowledge) and exploiting (using and reusing existing knowledge) knowledge. In knowledge-intensive work, this involves utilizing human intellectual capacity as well as skills and competencies acquired through formal education or expertise gained through experience. Because new knowledge is created using existing knowledge (Nahapiet & Ghoshal 1989), the concepts of exploration and exploitation are, in practice, inseparable. The distinction between exploitation and exploration strategies presented in Figure 7 does not offer much help either. All of the studied cases had characteristics of both exploitation *and* exploration. All of the studied cases needed to integrate organizationally dispersed knowledge and expertise in order to achieve the objectives of an organization. Employees in cases A, B, and C did not report many problems in knowledge utilization. They had sufficient prior knowledge to absorb and understand information and knowledge as well as skills and competencies for operating with information and knowledge[17]. Case C was transforming from an explorative approach to a more exploitative approach. The NPD process had arrived at an incremental phase where product improvements were based on existing knowledge. In addition, because the company had started manufacturing the product, knowledge needed to be embedded in the systems and routines. This required changes in operational practices, and, due to this, case C had some challenges in changing its informal explorative approach to a more formal exploitative approach.

[17] This may, of course, be difficult to evaluate. Sometimes, employees may become aware that they lack needed skills, competencies, or knowledge. On the other hand, it is also possible that they do not recognize the shortage of their skills or knowledge.

Only employees of case D reported major problems in exploiting and exploring information and knowledge. Compared to other studied cases, the salient difference is that two collaborating companies embodied case D, while the other cases were units of one organization. The employees from the two companies in case D had sufficient knowledge and expertise for achieving the aims of the collaboration, but they lacked the necessary skills to transform their input information and knowledge into the desired output. Employees from both companies needed to work in a new context where they lacked compatible skills. In addition, the employees of the customer company needed to acquire totally new competencies, and they had acknowledged this shortage. Since the collaborative relationship was not very old, the companies had not yet learnt much from each other. Knowledge work is based on the complementary skills and expertise of the members of an organization, but the objectives of the work are only met if these resources can be integrated in an intended and meaningful way.

3. Based on the theoretical modeling, the **forms of exploitation and exploration outcomes** have an influence on how information and knowledge are preserved and can be reused in the organizations.

Case A and case B had difficulties in transforming embodied and local knowledge into common and shared embedded and encultured routines. However, this was an objective of both organizations. Again, the organizational design of case B can be seen as one reason for unsuccessful efforts. In case A, the reason is not that obvious. One possible explanation is the firmly established operating practices of case A (also including the parent organization). Cases C and D had both recognized the need to steer their direction away from personalized knowledge toward more collective knowledge. Among the studied cases, storing information and knowledge was the most challenging in case A. At the time of the study, case A had recently introduced a new IT application for storing information and knowledge. The user interface generated a lot of frustration and impaired the quality of stored information and knowledge (e.g., in terms of poor indexing). This, in turn, impaired the motivation to even look for information from the system or the ability to locate it. In case B, employees were not always certain which application to use for storing information and knowledge. In cases C and D, the emphasis was still more on embodied knowledge, and the problems of storing encoded knowledge did not come up that often in the interviews.

An encoded form of information and knowledge outcomes helps in storing these resources. Nevertheless, the data shows that the reuse of produced encoded information and knowledge is a serious challenge without a clear protocol for storing information and knowledge. A lack of an organizationally uniform protocol for storing encoded information and knowledge impairs locating and accessing these resources when they are needed in the future. The lack of analytical discussion of feasible IT applications for storing and transferring encoded information and knowledge was salient in the studied cases. Different IT applications were used for purposes that did not meet the expectations or requirements of the users.

5 Discussion

This part of the study goes through the main findings of the study, evaluates the scientific contribution of the study, discusses the practical implications of the results, evaluates the quality of the study, and gives some ideas for future research.

Knowledge-intensive organizations explore and exploit knowledge. The inputs and the outcomes of knowledge work are different types of information and knowledge. Knowledge-intensive organizations produce knowledge outcomes for their customers as well as outcomes that can be later reused (as input information) in the organization. Often, if not always, knowledge work involves integrating dispersed knowledge and expertise. The study aimed at exploring how employees in knowledge-intensive organizations operate with information and knowledge, how organizational practices and technological tools are related to the flow of information and knowledge, and how different knowledge processes generate knowledge flow.

5.1 Scientific contribution

This study shows that the potentiality of available technological tools is utilized inefficiently in knowledge-intensive organizations. Organizationally non-uniform practices for using IT technologies in information and knowledge management decrease collective utilization of knowledge resources. As a consequence, existing information and knowledge is insufficiently utilized, and the organization and its members recreate information and knowledge that already exist. Applied organizational practices and technological tools for operating with information and knowledge appeared to be far from revolutionary. The literature recognizes sophisticated technological tools and applications for managing knowledge and supporting the collaboration of knowledge workers (Liao 2003). In this study, however, technological tools were mainly applied to storing and transferring knowledge. When interaction and collaboration was needed, face-to-face presence was favored when possible. The applied technological tools could not sufficiently replace face-to-face interaction. Of the three main functions of IT-based knowledge management applications (i.e., creating corporate knowledge directories, coding and sharing best practices, and creating knowledge networks) (Alavi & Leidner 2001), the last two were almost non-existent in the studied organizations, and the use of knowledge directories was imperfect in many ways.

Bhatt et al. (2005) suggest that organizations and people adopt technology much slower than technology develops. Maybe knowledge-intensive organizations and their members are not mature enough or ready to adopt more sophisticated IT applications. In addition to the suggestion made by Bhatt et al (2005), this study showed that the imperfect use of IT tools was due to their poor usability and organizationally inconsistent ways of using them.

In addition, the study aimed at exploring how the applied organizational practices and technological tools are related to the flow of information and knowledge. Based on the results, knowledge-intensive organizations can apply various kinds of organizational practices and technological tools to realizing knowledge flow. However, it is still in many ways unclear how to evaluate the efficiency and quality of these different procedures. All the studied cases applied both a human-based approach and a technology-based approach to managing knowledge. The current literature suggests that effective knowledge management systems combine a human interaction approach with the use of technological applications (e.g., Davenport 1997, Bhatt 2001, Thomas et al. 2001, Armistead & Meakins 2002, Hlupic et al. 2002, Holsapple 2005). A good combination of these approaches could not be identified in the studied cases, although the study did identify many ways to improve knowledge flows. In general, it can be said that the applied practices and tools could not guarantee an efficient flow of information and knowledge in the studied cases. Riege (2005) proposes that challenges in knowledge flow are related to individual, organizational or technological barriers. Although these three barriers can often be compounded, individual and organizational barriers were the most salient in the studied cases. The technological barriers found in this study did not usually refer to the technology itself, but to how the technology was applied and used. So, the reasons for the success or failure of knowledge flow relate to human behavior and to how work is organized.

A lack of abilities or skills to exploit and explore knowledge was a big challenge only in the case that involved intensive interorganizational collaboration. According to the results, interorganizational collaboration is challenging because of the needs for compatible skills, competencies, and knowledge of the members of the collaborating companies. Obviously, required skills, competencies, and knowledge develop through collaboration and become more compatible. In the other studied cases, a lack of or incompatibility of skills, competences, or knowledge did not generate problems. Instead, factors more closely related to organizational practices were emphasized in cases A, B, and C. Unstructured and organizationally contingent features of knowledge work are identified in the literature (Scarbrough 1999, Alvesson 2001). In

the studied cases, non-uniform work practices impeded the exploitation of knowledge and integration of information and knowledge. More uniform practices were welcomed by both management and employees. Autonomy, a typical feature of knowledge work (Hayman & Elliman 2000, Robertson & Swan 2003), can be a barrier to collective efforts and the integration of knowledge if work practices between members of an organization vary too much. However, information and knowledge flows in knowledge-intensive organizations cannot be based entirely on an objective view on knowledge. Knowledge exploitation and exploration usually requires skills and willingness to interact with other people. This is especially true in organizations that aim at exploring knowledge.

Finally, the study aimed at exploring how different knowledge processes generate a knowledge flow. Although this is not the first study on knowledge processes, the study gives new profound understanding on how different knowledge processes are interlinked and how they generate an efficient knowledge flow. The model of knowledge processes and knowledge flow (cf. Figures 11 and 16) has proven to be a good approach for analyzing and understanding knowledge work and knowledge flows in knowledge-intensive organizations. The knowledge process model portrayed in this study is a simple presentation of the organizational knowledge flow. Although the studied phenomena is rather complex, the model offers a non-complex framework to understand organizational information and knowledge flows. However, the factors affecting the information and knowledge flows are complex, and managing the organizational knowledge processes is by no means an easy task. Even though this study explored only a limited number of cases, the results imply that knowledge processes and, thus, knowledge flows in organizations that aim to explore knowledge and organizations that aim to exploit knowledge can be affected by somewhat different reasons. An organization that aims to explore knowledge can encounter problems even in defining what information and knowledge needs to be acquired. An organization that aims to exploit knowledge more easily encounters problems in transferring knowledge. However, because of the small number of studied cases, I leave this issue to be discussed in more detail in future studies.

All the studied cases aimed at decreasing dependency on individuals and their personal knowledge. Instead, employees' collective efforts to complete the objectives of the work and the use of collective organizational knowledge resources were pursued. At the same time, all the studied organizations aimed at more standardized operations. None of the cases demonstrated saliently observable conscious intentions to develop knowledge management strategies. Instead,

knowledge management practices were implicitly developed in the studied cases. The studied organizations aimed at becoming (although maybe not that intentionally) knowledge-routinized organizations (Blackler 1995) or machine bureaucracies (Lam 2000) (cf. Figures 8 and 9). Blackler (1995) predicted that in the future organizations will emphasize encultured knowledge. This study did not generate any data to support this prediction. On the other hand, the use of collective knowledge and collaborative efforts require the involvement of encultured knowledge. Each studied organization aimed at attaining practices that are based on encoded and embedded knowledge rather than embodied knowledge. Thus, it can be asked if we are going to witness the same progress and development in knowledge work as what happened to manual work a century ago (i.e., the standardization of work) (Taylor 1911). If so, will creativity and exploration be replaced by efficiency? Or using another perspective: will chaos and inefficiency be replaced by control?

5.2 Practical implications

Concerning practical implications, the results of the study address three different issues. First, managing encoded knowledge is more challenging than expected. In the studied organizations, existing encoded information was poorly utilized. Existing encoded information and knowledge was not always found because it was not clear where to look for it or because it was insufficiently indexed in the electronic repositories. The reusability of existing encoded knowledge can be improved if the knowledge includes elements of *declarative knowledge* (i.e., the content of knowledge), *procedural knowledge* (i.e., processes and actions), *causal knowledge* (i.e., the rationale behind actions and decisions), and *context knowledge* (i.e., contextual circumstances) (Tiwana 2000, 297). While encoded knowledge is typically declarative by nature, it may lack other elements. Storing encoded information and knowledge into electronic repositories is easy, but more attention should be paid to how that knowledge is stored, when it is stored, and where it is stored as well as to providing access for possible knowledge reusers. Indeed, storing information and knowledge does not have much value if reusability cannot be guaranteed.

Second, a clear view of the desired outcomes of the knowledge work and how individuals' work is related to the organization's objectives are necessary grounds for collective efforts. Awareness and clarity of the desired outcomes help to acquire relevant input information and knowledge in the first place. This is easier for organizations that apply exploitative strategy than for organizations that apply explorative strategy. In addition, awareness and clarity of the desired

outcomes as well as how different individuals and units of an organization contribute to the desired outcomes help in connecting dispersed information and knowledge. Although technological tools can be utilized for generating collective understanding of organizational objectives and connecting dispersed information and knowledge, an introduction to work and employee socialization are especially important in knowledge-intensive organizations. Understanding other employees' knowledge and competencies is essential in gaining access to their knowledge and for successful collaboration between different members of an organization. The results of this study are very much congruent with the ideas of McDermott (1999) and Thompson & Walsham (2004), who propose that knowledge management is not about managing knowledge but that, instead, attention should be paid to people and to supporting their opportunities to operate with knowledge. In this regard, for organizations that aim to utilize divergent expertise, the right direction might be, as predicted by Blackler (1995), toward becoming a communication-intensive organization.

Third, a lot of knowledge in knowledge-intensive organizations is in an embodied form. It may be too time-consuming or difficult to transform all embodied knowledge into an encoded form. Transferring embodied knowledge requires interaction between people. Therefore, opportunities for transferring embodied knowledge must be embedded in organizational practices and routines. Based on the results, IT applications do not meet the need for co-located and, in particular, face-to-face interaction. Additionally, an organization's members' awareness of available meta-knowledge is improved mainly through formal and informal interaction between other members of the organization.

Compared to more "standardized" work, knowledge workers and knowledge-intensive organizations have more variation as regards how work and tasks can be carried out. There are many ways to achieve the objectives of the work successfully. Sabherwal & Becerra-Fernandez (2003) showed that the effectiveness of individual-level knowledge management is related to the effectiveness of group- and organizational-level knowledge management. Thus, management should consider how the members of an organization manage information and knowledge. Whether more controlled or more predetermined practices and operations are good or desirable for knowledge-intensive organizations is not an easy question to be answered. Time will tell whether the unique characteristics of knowledge work will decrease or vanish. This study shows that knowledge workers welcome more uniform and standardized practices because these help to do the job. The model (Figure 16) generated in this study can be applied by practitioners who aim

to develop knowledge work and knowledge-intensive organizations. It offers both practitioners and researchers a framework that can be applied to analyzing and developing information and knowledge processes and flows in various kinds of knowledge-intensive contexts.

5.3 Evaluation of the study

This study provides new scientific knowledge on knowledge work and knowledge-intensive organizations. At the same time, the study also contributes to managerial and practical perspectives on knowledge work and knowledge-intensive organizations. The study has illustrated the complex nature of knowledge exploration and exploitation. At the same time, the study demonstrates how the work of knowledge-intensive organizations can be analyzed and understood through different knowledge processes constituting a knowledge flow. There is no such thing as a perfect study. I will now address the potential limitations and deficits of this study by assessing its quality. The quality of research can be assessed through reliability and validity. In general, validity is related to the research design's ability to provide "correct" answers (~ i.e., answers corresponding to reality). Reliability, in turn, is related to the research design's ability to provide the same answers whenever and by whomever the research is carried out (Kirk & Miller 1986, 19) as well as to the ability of the research instruments to produce accurate and consistent findings (Mason 1996, 145). In this regard, perfect reliability and validity are difficult to attain when studying social phenomena using a qualitative approach. It is possible that I have consciously or unconsciously ignored something important. It is also possible that I have not perceived or recognized something that is important. Therefore, I have tried to describe accurately how the data was generated and how it was analyzed and interpreted so as to give the reader an opportunity to evaluate possible sources of deficiency.

In quantitative research, the concepts of validity and reliability have precise meanings. These meanings cannot be directly applied to qualitative studies. Although the two traditions do not share the same meanings or implications of validity and reliability, the concepts are used for differentiating "good" and "bad" research. The interview method was the main instrument of generating data. As suggested by Kvale (1996), the issue of reliability will now be addressed in terms of the reliability of the interviews (i.e., data generation), the reliability of the transcriptions, and the reliability of the data categorization. In this study, the reliability of the data generation is influenced by several issues. First, in the interviews, the interviewer's objective and neutral role was emphasized. Anonymity was guaranteed to the individual interviewees. It was expected that

these issues would facilitate obtaining honest answers from the interviewees. The aim was for the interview questions to be neutral, and the interviewees were asked about both negative and positive experiences related to the interview themes[18]. Naturally, an interviewee may have noticed some conscious or unconscious social cues of the interviewer, which then had an effect on their response. In (thematic) interviews, this can be difficult to avoid. However, at no point during the interviews did I get the feeling that an interviewee was being intentionally untruthful. The accuracy of the data generation was also improved by tape-recording most of the interviews and then transcribing them.

Most of the interview tapes were transcribed by a professional typist. The quality of the audio tapes was very good, and the typist did not seem to have problems in transcribing the tapes (i.e., there were only few holes or question marks in the transcribed texts). The content of the audio tapes matched the texts well. The interviews from case B were not tape-recorded, but, instead, notes were taken during the interviews. This may have impaired reliability. Finally, the reliability of the data categorization is discussed. Multiple interpreters can be used for categorizing data. This was not done in this study. It is probable that another researcher would have ended up with a (at least slightly) different categorization. However, I spent several months categorizing the data and aimed at paying extra attention to the accuracy and consistency of the categorization. Moreover, I asked two colleagues who had participated in individual case studies (case C and D) to read the data analysis and results of these cases. Their opinion was that the categorization had been conducted correctly.

Validity relates to the truthfulness of the findings and to the legitimacy of the interpretations. The validity of this study is now considered from two perspectives proposed by Mason (1996). First, the validity of the data generation methods is assessed. A researcher can choose from different methods for studying the phenomena of interest. The chosen method(s) should be appropriate for producing truthful answers to the research questions. The most commonly used methods in organizational studies include surveys, observation, and interviews. The interview method was the primary data generation method in this study. The interviewees were chosen to represent different types of expertise; they were chosen from different hierarchical positions; they were from different kinds of knowledge-intensive organizations; and more or less experienced people

[18] My experience is that interviewees often express more negative than positive experiences. The interviews in this study tried to avoid this problem.

were interviewed. All of these factors are expected to improve the validity of the results and help avoiding key informant bias (Maxwell 1996, pp. 73).

The interviews were conducted using thematic interviews, which generated unique encounters with the interviewees, although the themes in all cases were more similar than different. A more structured approach to the interviews would have allowed making comparisons within and between cases more systematic. Nevertheless, I chose to use thematic interviews for three reasons. First, I think that the study themes and the interview subjects would have been difficult to approach using structured or semi-structured interviews because of the wide and complex nature of the study. Second, the interviewees represented different areas of expertise, and the interviews needed to be focused according to the expertise of the interviewees. Third, the different cases required somewhat dissimilar approaches because the case-specific objectives were to some extent dissimilar. The use of thematic interviews, instead of semi-structured ones, can limit opportunities to make cross-case comparisons. However, due to the mainly inductive nature of the study, I think that the chosen interview protocol was well justified. Case-specific documents and survey data were applied to methodological triangulation (Jick 1979). The use of observations as a data generation method was modest. I personally believe that observations can provide valuable data, although it is a very time-consuming instrument, because through observations a researcher can attain information which is less available through interviews.

Second, the validity of interpretation is assessed. I have attempted to write the empirical part of the study transparently so that the reader can follow how the study was conducted and how I came to form my interpretations. Throughout the study, I have discussed with my colleagues about how to interpret the data. One method of assessing validity is getting feedback from the informants. The results of the individual cases of this study were presented to the representatives of the respective case organizations. The feedback sessions were quite short, and the results of the case studies were reviewed only at a general level. However, none of the comments questioned the results or the interpretations of the individual case studies. In the feedback sessions, the results were presented using PowerPoint presentations.

Finally, the generalization of the results is discussed. Generalization in qualitative research is not easily achieved (Mason 1996). In qualitative research, *analytical* (Kvale 1996, 233) or *theoretical* (Mason 1996, 153-156) generalization is more applicable than statistical generalization (that is usually applied in quantitative research). Generalization implies how the findings from one

context can be applied to understanding another context. I would like to suggest that the model (Figure 16) generated in this study can be applied to various kinds of knowledge-intensive organizations for studying, analyzing, and understanding the exploration and exploitation of knowledge. The model was viable for studying the different cases of this study even though the cases differed from each other in many ways. The cases of this study, nevertheless, all involved knowledge work. Organizations are very compound systems, and we cannot find two identical ones. This implies that knowledge processes and knowledge flows in different organizations are also different. However, this study gives many insights into the important factors to be taken into account when carrying out research on knowledge-intensive organizations or attempting to develop them.

5.4 Proposals for future research

The study opens many avenues for future research. First, longitudinal studies might shed light on the evolution of knowledge work and knowledge-intensive organizations. Studies on this phenomenon might be able to find out if knowledge work is becoming more standardized and, if so, how is this transformation being managed? This type of study needs to take into account, simultaneously, the knowledge workers need for autonomy and their desire for more uniform work practices. On the other hand, if knowledge work is not becoming more standardized, more studies are needed to understand how the managers of knowledge-intensive organizations manage and can manage their organizations and employees. This study did not find any major role for management. Second, the link between the chosen knowledge strategy and an effective knowledge management strategy was not fully explained by this study. Therefore, it would be attractive to study and compare organizations that aim "purely" at knowledge exploration and organizations that aim "purely" at knowledge exploitation. This might provide information on effective knowledge management strategies in different kinds of knowledge-intensive organizations. Furthermore, how to differentiate "exploitation" and "exploration" at theoretical and operational levels needs to be examined further. Finally, future studies should aim to understand how new kinds of collaborative technologies (e.g., social media) can be applied and adopted in the endeavor of knowledge exploration and exploitation.

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Appendix 1

Interview themes in the case A

Background information:

Position / work description
Organizational unit
Work experience in current position
Work experience in the case company

Questions related to the studied project delivery

How do you contribute your project?
What did you learn from this case that is valuable in future project deliveries?
Did you get additional information after competitive bidding had started? (information that were given to the competitors)
Did you get all needed information in time? Why not?
Can you consider this as a successful project?
Was the project delivered according the plan?
Did the planning phase follow the formal structure?
Can you evaluate the success factors of the planning phase?
How is the success assessed? Financial / technological aspects?
How is dispersed and multidisciplinary information and knowledge managed during the planning phase?
Who is responsible of taking care of the big picture?
How the decision processes are documented?
How the project organization is formed? How is it guaranteed that needed expertise is available?
Can you evaluate the logistics of information and knowledge flows? Is right information at the right place at the right time?
Where the needed information and knowledge is?
Problems in acquiring information and knowledge
Technological tools for storing and processing information and knowledge?
How the knowledge from previous projects is available?
What kinds of practices are applied for knowledge sharing between project personnel?
How similar different projects are?
What external sources are used for knowledge acquisition?

Interview themes in the case B

Interviewee's own history in the case B

What is your job history and position in the case B at the moment?
When did Case B get started?
What is the purpose of Case B?
How did Case B get started? What is the history of Case B?

Describe the structure of Case B

Could you please describe the structure of Case B?
What kind of connections / partners you have outside Case B?
What are the issues that are discussed?
How often do you communicate with different parties?
What kinds of media are used for communication?
What are the reasons for selecting communication media?
What problems can be identified in different media? Do you recall any examples?
Are there problems in communication inside the Case B? What kind?
Are there any problems in communication with Case B partners? What kind?
Can Case B personnel discuss openly with the employees in the parent organization about work related issues?

Project communication

Please describe what you do in your normal workday.
What kinds of tasks it may include?
With whom do you communicate at your work?
How do you communicate with them?
How often you communicate with them?
What are the issues you communicate?
Do you communicate / collaborate with people from other projects in Case B?
How is managerial communication and informing of employees organized? What kinds of media are used?
What kind of objectives you have for collaboration (with external partners)? How do you benefit from collaboration?

Knowledge and work

What are the outcomes (or targets / desired outcomes) of your work?
What happens to the knowledge you have created?
Where do you get the information (raw material) that you need to accomplish your tasks / work?
How to define the required information / knowledge?
Do you always know what information / knowledge is needed?
Is the knowledge you receive reliable? How do you know that?
Is the knowledge you receive in a right form? (Easy to understand and work with?)
Do you find it easy to understand the information / knowledge you receive?
Do you think that the receivers of your messages are able / can understand what you mean? What are the reasons for that?

Knowledge localization

Where is the knowledge that is required?
Are there tools or procedures to localize knowledge? What kind? Do they work properly?

Knowledge accessibility

How do you get the knowledge you need?
Do you have any difficulties on accessing knowledge that you know exists somewhere?
What kind of difficulties?
Is knowledge related to the people or is it accessible from databases?

Knowledge transferability

What kinds of tools are applied for knowledge transfer and sharing? Please list them.
Have you ever noticed that wrong kind of tool (transfer media) was chosen for knowledge transfer?
What kind of communication problems there are in your organization?
What kind of communication medias you prefer? Why?
How are the content of the message and communication media related together?

Knowledge storage

Is there "common known" instructions for storing knowledge?
Do all employees store knowledge (and information) in a similar way?
Do you have easy access on knowledge you need?
Do you think that knowledge storing is organized well?
Do you have ideas to improve knowledge storing practices?
Is the knowledge in your (company') databases well updated?

Interview themes in the case C

Interviewee's own history in Case C

What is your job history and position in the Case C at the moment?
Have there been changes in you work lately? What kind of changes?
How do you perceive the future of your organization?
When did Case C get started?

Describe the structure of Case C

Collaboration in managerial teams? ways of communication? communication issues? frequency of communication? Problems related to communication?

Identify partner organizations Case C has?

Research partners?
Customers?

Collaboration in networks?

What are the most important objectives do you have for collaboration?
How networks are structured and controlled?
What problems or difficulties are in networks?
What norms, rules, and standards your company has in innovation networks?
How do you recognize the success factors of your network?
Do you trust to the parties you collaborate with? Where is that trust based? Do you trust that they fulfill agreed obligations?

How do you understand the term 'innovation'? (What things do you associate with innovation?)
Why is the innovativeness important for your organization?
How much time is used in innovation process within and between organizations?
How do you participate in your organization's innovation process? (With reference to organization diagram, product research and development process diagram)
How do you define your role in innovation process?
How do you communicate (information/knowledge) about innovation?
How well do you know your organization's networks?
How well do you know your organization's innovation processes? (Networks behind the processes and how they operate)
How do you perceive the ability of your organisation's personnel to participate in the innovation process?

Innovation and collaboration?

What are the reasons why you are ready to share your innovative ideas with your collaboration partners?
What are the reasons why your partners are ready to share their innovative ideas with you?
How innovation network works from your point of view?
Is the amount of the network participant optimum?
How new innovative ideas are created in networks?
How new innovative ideas are shared in networks?

Describe the (the studied) process?
Meaning of (the studied product) for Case C?
Do you communicate / collaborate with people from other projects in Case C?
Benefits related to this?

Knowledge management inside Case C?

Knowledge and work

What are the outcomes (or targets / desired outcomes) of your work?
What happens to the knowledge you have created?
Where do you get the information (raw material) that you need to accomplish your tasks / work?
How to define the required information / knowledge?

Do you always know what information / knowledge is needed?
Is the knowledge you receive reliable? How do you know that?
Is the knowledge you receive in a right form? (Easy to understand and work with?)
Do you find it easy to understand the information / knowledge you receive?

Knowledge localization

Where is the knowledge that is required? (Inside team, organization? Outside?)
Is there tools or procedures to localize knowledge (or people that have knowledge)? What kind? Do they work properly?

Knowledge accessibility

How do you get the knowledge you need?
Do you have any difficulties on accessing knowledge that you know exists somewhere? What kind of difficulties?
Is knowledge related to the people or is it accessible from databases?

Knowledge transferability

What kinds of tools are applied for knowledge transfer and sharing?
Have you ever noticed that wrong kind of tool (transfer media) was chosen for knowledge transfer?
What kind of communication problems there are in your organization?
What kind of communication medias you prefer? Why?
How are the content of the message and communication media related together?

Knowledge storage

Is there "common known" instructions for storing knowledge?
Do all employees store knowledge (and information) in a similar way?
Do you have easy access on knowledge you need?
Do you think that knowledge storing is organized well?
Do you have ideas to improve knowledge storing practices?
Is the knowledge in your (company') databases well updated?

Interview themes in the case D

Interviewees background information (history and position in the organization, current work tasks / responsibilities)

"Facts" about the case D

History of the case D
How the interviewee has participated on collaboration
Organization and processes of the collaboration
Formal and informal collaboration forums
Interviewees role in collaboration

Interorganizational collaboration

What do think are the critical factors of interorganizational collaboration?
How these are seen in the case D?
Communication
Decision making
Conflict resolution
Knowledge transfer within the case D
How do evaluate the collaboration in case D
Who are key people in collaboration
What are the main challenges in collaboration

Appendix 2

Appendix 2 includes information about the qualitative surveys conducted in the cases A-D.

Case A
A survey was conducted, but the data is not analyzed in the study, because of the small size of the respondents, and very specific focus of the quantitative survey

Case B
The survey carried out in the case B included several questions related to communication and knowledge flow within the case organization and between the case organization and its close collaboration partners. The survey generated written answers to the open-ended questions. The questionnaire included some themes that are not relevant for the purposes of the study and they are excluded here. The relevant themes concerning the study were:

Problems in communication within the case organization or with the external partners
Problems in getting information or knowledge that is relevant to your work
Communication problems related to cultural differences between case organization's members
Communication problems related to different locations of case organization's members

Case C
The survey carried out in the case C included several questions related to knowledge flow and utilization in the case company. The survey generated written answers to the open-ended questions. The questionnaire included some themes that are not relevant for the purposes of the study and they are excluded here. The relevant themes concerning the study were:

Problems in getting information or knowledge that is relevant to your work
Problems that are related to knowledge management
Collaboration problems with other internal functions or units
Collaboration problems with customers or partners

Case D
The survey carried out in the case D included several questions related to knowledge flow and collaboration between the partnering organizations. The survey generated written answers to the open-ended questions. The questionnaire included some themes that are not relevant for the purposes of the study and they are excluded here. The relevant themes concerning the study were:

Difficulties in getting knowledge that is essential for your work
Ideas to improve the accessibility of knowledge