

KNOWLEDGE MANAGEMENT IN AN SME

Knowledge Management as a tool to alleviate vulnerabilities to
knowledge losses in the case of a small high-tech enterprise

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Tämä opinnäytetyö on tapaustutkimus, jossa tarkastellaan tietämyksenhallintaa pienessä suomalaisessa korkean teknologian yrityksessä. Tutkimuksessa kartoitetaan yritys X:n kriittisen tiedon tunnistamista, diffuusiotasoa ja tiedonsiirron tehokkuutta. Tämän lisäksi tutkimuskohteena on tietämyksenhallinnan rooli tiedon jatkuvuuden hallinnassa kohdeyrityksessä.

Tutkimusdataa kerättiin kyselyn ja haastatteluiden avulla. Sen avulla kohdeyrityksestä muodostettiin kattava tietämyskartta, jossa yrityksen kriittinen tieto on esitetty jaoteltuna tiedon rakenteellisuuden ja harvinaisuuden perusteella. Lisäksi tässä opinnäytetyössä esitetään kaksi vaihtoehtoa tiedonsiirron pääasialliseksi toimintatavaksi: tietopankkiin keskittyvä strategia ja sosiaalista tiedonsiirtoa painottava strategia.

Yksi tutkimuksen päätuloksista on tietämyskartassa esiin nousseet klusterit: harvinainen sisäinen hiljainen tieto, operationaalinen tieto ja yleinen teollisuuden toimialalle tyypillinen asiantuntijuus. Tutkimuksen toteutuksen aikana todettiin, että tiedonsiirto kohdeyrityksessä on painottunut sosiaaliseen kanssakäymiseen, kun taas nykyinen tietopankki nähdään alihyödynnettynä ja järjestäytymättömänä. Lisäksi tutkimustuloksista voi päätellä, että kohdeyrityksessä saattaa mahdollisesti ilmetä nousevaa, alhaalta ylöspäin ilmenevää, tietämyksenhallintaa.

Avainsanat tietämyksenhallinta, pienyritys, pk-yritys, tietämysintensiivinen yritys, tietämyskartta, nouseva tietämyksenhallinta, emergentti tietämyksenhallinta

Muita tietoja Työhön liittyy tietämyskartta Yritys X:n toiminnoista.

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This thesis is a case study of knowledge management (KM) in a small Finnish high-tech case company X. The identification, diffusion level, and transfer efficiency of critical knowledge were charted. Moreover, the role of KM in alleviating the risk associated with the loss of critical knowledge tied to key personnel was investigated.

The research data were collected utilizing a questionnaire and interviews. A comprehensive knowledge map of Company X was compiled. In the map, the structure level of the knowledge was plotted against the diffusion level. Also, two alternative solutions for the knowledge transfer strategy in Company X were presented. These were a knowledge storage-centric option and a social knowledge sharing-based focus.

One of the key research findings was the emergence of distinct knowledge clusters in the knowledge map: rare internal tacit knowledge, operation-based knowledge, and common industry-specific knowledge. It was also found that most of the knowledge transfer within Company X was taking place via social interactions. The knowledge storage practices were unorganized, and the available knowledge was underutilized. Finally, there were implications of emergent bottom-up-styled knowledge management activities. The greatest impediment to KM development was found to be the time constraint, thus KM improvement actions need to be chosen with care.

Keywords knowledge management, small enterprise, SME, knowledge-intensive enterprise, knowledge map, emergent knowledge management

Other information The thesis includes a knowledge map of Company X.

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SYMBOLS AND ABBREVIATIONS

AI	Artificial Intelligence
CM	Configuration Management
ERP	Enterprise Resource Planning
HR	Human Resources
IP	Intellectual Property
IT	Information Technology
KIBS	Knowledge-Intensive Business Services
KM	Knowledge Management
KMP	Knowledge Management Process
KMS	Knowledge Management System
NAS	Network-Attached Storage
R&D	Research and Development
SME	Small and Medium-sized Enterprise

1 INTRODUCTION

“And knowledge management is a means, not an end.” (Bill Gates 2023)

One of the most valuable assets an organization can possess is its organizational knowledge. Unlike other assets, organizational knowledge cannot be easily acquired whenever needed. In addition, it does not necessarily scale with the growth and size of the organization without conscious effort. Acquisition of knowledge is often a slow and diffusive process; its categorization, storage, protection, accessibility, and transfer are not straightforward and can be time-consuming. But when the organisational knowledge is available, shared, and applied in meaningful ways it can help organizations make informed decisions, avoid repeating mistakes, allow them to identify best practices and solve problems fast. (Joe, Yoong & Patel 2013) In this thesis, the importance of building a robust knowledge management system is justified to enable a small organization to be more innovative, agile, and resilient in the face of challenges. This chapter describes the outline of the thesis research which investigates knowledge management in a small organization. Firstly, the motivation and background of the research are described and justified. Secondly, the knowledge base of this thesis is introduced. Thirdly, the purpose, objectives, and framework for the questions investigated in this thesis are defined. After that, the methodological approach of the thesis is described and argued for. As a continuation, the ethical and reliability factors concerning this thesis are considered. In addition, the timetable and resource needs of the thesis are laid down. Finally, the general structure of the thesis is represented.

1.1 Motivation and background

This thesis researches possibilities to alleviate knowledge loss-related vulnerabilities in high-tech enterprises with knowledge management (KM) strategies. The thesis carries out a case study in a small Finnish company working in the scientific research & development (R&D) sector. Company X is at

the time of this research in its initiation & growth phase where the emphasis of knowledge management is still on creating knowledge. The operational management point of view must often be prioritized over risk management. This thesis offers a risk management viewpoint as an addition to the current knowledge management strategies. The study is delimited to knowledge-intensive micro-enterprises in a growth phase to focus on the specific challenges of the case company. The literature review is focused on knowledge management in small and medium-sized enterprises (SMEs) as well as micro-enterprises to cover enough theoretical ground for the case study.

Company X, the target of this thesis case study, is a Finnish micro-enterprise dealing in high-tech R&D solutions. The industry is knowledge-intensive, and the staff of Company X consists mostly of scientists with either a Doctoral degree or a Master's degree in their respective fields. Therefore, it can be deduced that most likely the case company is recognized as a knowledge-intensive enterprise as defined by Joe et al. (2013). Furthermore, at the time of writing this thesis, Company X was in its growth phase and had acquired a few recruits in 2022. There were more human resource and company growth-related changes to be expected during 2023. Hence, this was a good time to look at the knowledge management strategy of the company. In an R&D enterprise such as company X, it is essential that the core knowledge is retained and built on, allowing fertile ground for continued growth.

Knowledge management is known in the business administration literature as the way of processing, incorporating, and overall experiencing information, data, knowledge, and wisdom in the context of business operations. (Johnson 2009, 12) KM in large corporations is a widely studied subject but SMEs and especially micro-enterprises have not enjoyed equal research attention. In addition, the literature suggests the knowledge management strategies of large enterprises and SMEs are dissimilar. (Cerchione and Esposito 2017; Zieba, Bolisani & Scarso 2016) Furthermore, inside the SME definition, there are different knowledge strategy requirements, for example, comparing the needs of a medium-sized enterprise to those of a micro-enterprise (Zieba et al. 2016). Moreover, SMEs are important for the economy of any country and provide capabilities for decentralized trade growth (Wong & Aspinwall 2004). In Finland,

in 2020, approximately 99.8 % of registered enterprises were SMEs (1–249 employees). Furthermore, 94.3 % of the total number of enterprises could be defined as micro enterprises (1–9 employees). SMEs provided approximately 55.4 % of the total turnover of Finnish enterprises. Micro enterprises consisted of approximately 17.2 % of the turnover. (Tilastokeskus 2022) Overall, a case study on knowledge management conducted in a Finnish micro-enterprise provided valuable insights into an impactful but less studied target group.

1.2 Purpose, objectives, and research questions

Knowledge in an SME with a small team is easily localized in individuals. Lack of resources in a typical SME environment can lead to the company memory not being retained and critical knowledge being possessed by only one or few key people. This increases the vulnerability of the company. (Desouza & Awazu 2006; Joe et al. 2013)

Research objectives:

The objective of this thesis project was to research possibilities to use knowledge management as a tool to alleviate the vulnerability to knowledge loss in small high-tech enterprises. In this thesis, the identification, diffusion level, transfer efficiency, and documentation of critical knowledge in case company X were charted.

Research questions:

All in all, the key question of the thesis is, how should knowledge be managed during the growth phase of a small company to alleviate the risks of losing the critical knowledge tied to key personnel? The outcome of the thesis would be recommendations to the case company on improving its knowledge management system. These improvement suggestions are targeted at a small company in a fast-paced start-up environment.

1.3 Introduction to the knowledge base

The theoretical knowledge base in this thesis consists of relevant scientific publications and books published between the years 1991–2020. Most of the sources are acquired through Lapland University of Applied Sciences library services as widely as the licenses of the UAS allow. A few website sources could be used strictly as needed, but they would not be relied upon for the main definitions or conclusions presented in this thesis. The main keywords used to locate the publications and books are knowledge management AND (SME OR small enterprise OR micro-enterprise). Moreover, in the sourcing process for reference articles, Publication Forum is used to evaluate the scientific quality and relevance of the publications (Publication Forum 2022). The main journals included in this thesis have at least the level 1 clearance in the Publication Forum.

On the other hand, this thesis acknowledges the critique posed on the SME KM research literature. As mentioned in Subchapter 1.1, while KM is a well-established concept, the field of SME KM is still relatively undeveloped and less researched (Zieba et al. 2016). There are indications that the available literature on SME KM is lacking in a comprehensive set of mutually comparable studies (Massaro, Handley, Bagnoli & Dumay 2016) and that the research techniques routinely applied in KM of big corporations might be unsuitable for SMEs (Durst & Edvardsson 2012). In addition, SMEs are a diverse group in themselves by field of expertise and by sizes ranging between 9–250 employees, making a comparison of their KM challenging (Zieba et al. 2016). In conclusion, the referred previous research results on SME KM are always considered in their specific case framework, not as general SME phenomena.

In the literature review chapter, the main concepts of knowledge management are defined based on Weed-Schertzer (2020), Johnson (2009), relevant research publications, and *Harvard Business Review* articles. Knowledge management is defined as managing the wisdom, knowledge, data, and information existing in various forms inside a company. Knowledge management is recognized as a people-centric area as knowledge can exist

inside the heads of employees as well as in a data bank directly owned by a company. Through further literature sources, the subject of knowledge management in SMEs and micro enterprises is approached and defined. Alternative knowledge management strategies are introduced, such as emergent knowledge management, that comes into existence in a down-top manner, contrary to typical knowledge management strategies. (Zieba et al. 2016)

1.4 Research methodology and implementation

The research in this thesis was conducted with the case study approach, a sub-method under qualitative study research. In a case study, the frames of a case are defined by the researcher, and then the issue is approached with one or multiple methods to attain a good base of evidence for answering the research questions. A case study is always tied to its context, and it is an especially useful approach for human-related cases, where the issues are subjective. (Gillham 2000, 1–3, 6, 13) The case study is chosen as the approach of this thesis because a highly context-related method is well suited for conducting research in the frame of one micro-sized case company. Furthermore, knowledge management has a subjective domain of knowledge tied to certain personnel (Desouza & Awazu 2006) and a case study approach is suitable for considering the existence of this phenomenon in the research.

Methodologically the research is carried out by literature review, questionnaire, and interview methods. The literature review is done using scientific journals and books as the main sources of information. The questionnaire is a structured -type of interaction between the researcher and the case company personnel, with no open-ended questions (Yin 2015 140–143). The interviews of individuals in the case company are a qualitative type of interaction with an open-ended discussion setting (Yin 2015 140–143). This provides the thesis research with multiple types of evidence, gathered with different methods, for the final analysis of research questions.

The research process is divided into three phases. Firstly, a literature review is carried out. The review is continued bilaterally with the interviews, to cover the appearance of possible new topics during the interview phase. Secondly, the questionnaire is carried out at the case company. Thirdly, the interviews are conducted, using the questionnaire results as discussion starters. Finally, the desired results of this thesis serve as an overview of the knowledge landscape of the case company. Moreover, development recommendations are given for the company based on the research results.

1.5 Ethical foundations and reliability

In a case study, one must consider that the research data is always bound to the context of that specific case (Yin 2015, 8–9). Therefore, the results of this thesis research cannot be used as generalized knowledge management advice. In addition, the researcher is part of a case study, and the preconceptions and experiences of the researcher inevitably affect the process. Furthermore, the research process itself could also affect the case company and the results. (Gillham 2000, 7) Ensuring the validity of the collected data is considered in detail in the research design chapter.

The ethical foundations of this thesis must consider the small (less than 10 people) size of the case company, and how to conduct the interviews in a way so as not to make the interviewees uncomfortable speaking their minds. Yin (2015, 143–147) advises letting the interviewees direct the conversation and assume the responsibility of not leading the conversation in a direction that might harm the interviewee in any manner. Additionally, participants are made aware of how the datasets they give are processed and used, who has access to it and that the thesis is a publicly available document.

1.6 Schedule and required resources

The main research process of this thesis took place from the beginning of Q3 of 2022 to the end of Q1 of 2023. The thesis planning was conducted in Q3 of 2022, and the literature review process during Q4 of 2022 and Q1 of 2023. The questionnaire and the interviews were conducted in Q1 of 2023. Analysis and results were processed immediately after Q1 of 2023. The timetable was flexible, and it was adjusted to continue to the beginning of Q2 of 2023 if needed.

The resources required were the time from the thesis researcher, as well as time from the case company employees. Company X employees were required to fill in the questionnaire, requiring approximately 5 to 15 minutes per employee. Additionally, a few of the employees were required to reserve an interview time of about 30 minutes. There were no travel or other expenses required for this thesis work. No funding or other monetary gain is included in this thesis work.

1.7 General structure of the thesis

This thesis consists of five main chapters in total, and the references & appendices. The first chapter introduces the framework of this thesis research. The second chapter reviews relevant literature concepts on knowledge management and SME KM. Following, the third chapter presents the research design of the thesis work. After that, the fourth chapter introduces the findings of the research. Finally, the fifth chapter discusses the results of the research, summarizes the theoretical and practical implications, and suggests possible improvements for the knowledge management strategy in the case company.

2 KNOWLEDGE MANAGEMENT IN SME SECTOR

"Why are SME important in a time of crisis? They are flexible, have a simple structure, and local knowledge." (Gina Quin 2012)

SMEs often face unique challenges in implementing knowledge management practices particularly due to budget constraints, lack of specialized staff, and limited access to resources. To overcome these challenges, SMEs need to adopt simple and practical KM strategies, and at the same time incentivize their employees to create, identify, share, organize, and access organizational knowledge. (Desouza & Awazu 2006; Zieba et al. 2016) This chapter aims to make sense of knowledge and its management as business context concepts. To begin with, common ways to define and transfer different types of knowledge are discussed. Additionally, the basic idea of knowledge management is described. Furthermore, the KM concept is delved deeper into, with knowledge processes, KM strategizing, and knowledge mapping. Finally, KM in the case of small enterprises is explored.

2.1 Knowledge in the business management context

As a word, "*knowledge*" is commonly used under the different extents of implied know-how and know-why in everyday life. In business management literature, knowledge must be more precisely defined to research it efficiently.

2.1.1 The dimensions and definitions of knowledge

Firstly, knowledge is often divided into layers by its complicity, value, and difficulty in attaining it. Figure 1 presents the critical dimensions of knowledge as described by Johnson (2009, 12). These are, from wide to more specific concepts, information, data, knowledge, and wisdom. Information, for Figure 1, is defined as all sensory responses a human can register from their surroundings. Data is more specific information, for example, facts and patterns. Proceeding further to the middle of Figure 1, knowledge represents a greater

degree of mastery and comprehension. Knowledge, when it has practical usage in an enterprise, becomes business intelligence. (Johnson 2009, 12–14)

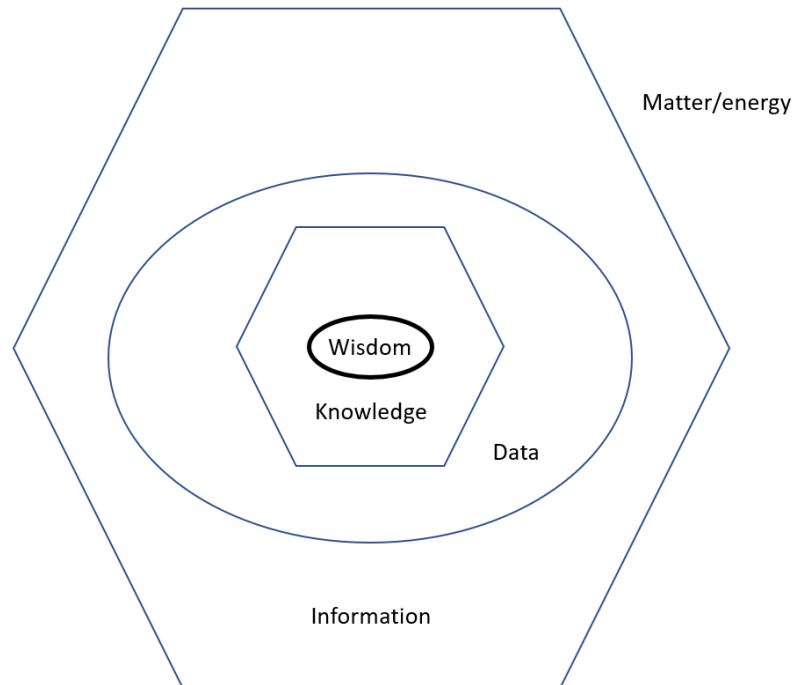


Figure 1. As adapted from Johnson (2009, 12), the key elements and definition of knowledge in KM.

In the middle of Figure 1, wisdom is maybe the most specified form of personal knowledge, located inside people. It considers the experience and personal discernment of a person combined with the knowledge and skills they possess (Weed-Schertzer 2020, 11–12). Wisdom is not easy to attain and is not reached merely via age or education level, making it a rare quality of special value. In a business context, the wise can alternatively be referred to as the “*deep-smart*”. These are the employees who maintain a company's wisdom by expressing and combining their personal direct experiences and intuition drawn from their inner knowledge and prowess to their work. (Joe et al. 2013) What's more, there are additional types of specific wisdom, such as emotional intelligence. Pure intelligence is often measured by a person's IQ, but emotional intelligence is not something easily measured or numerically defined. It means a person's awareness, intuition, and perception of the social world of feelings around them. This can manifest as, for example, their inner peace with themselves or higher-than-average abilities in social situations. (Goleman 1996, 44–45)

Secondly, knowledge is often divided into two dimensions: explicit and tacit or, respectively, tangible and intangible. Explicit/tangible knowledge is by nature easy to express, share and transfer in writing or spoken words. As a well-known example, workplace manuals and instructions represent explicit knowledge. Tacit/intangible knowledge is related to the personal dimension of the employees and therefore it is not easy to put into words. Namely, tacit knowledge includes experience, persona, skillset, personal approach, and cognitive input. (Weed-Schertzer 2020, 12–14) Originally, the concept of tacit knowledge was first presented in 1958 by Polanyi in his article “*Personal Knowledge - Towards a Post-critical Philosophy*” in reference to invisible knowledge that is hard to put into words (Nunes, Annansingh, Eaglestone & Wakefield 2006). When it comes to knowledge flow, the explicit is easier to communicate efficiently compared to the tacit dimension which is unavoidably tied to the human element. However, that is precisely the reason why strategies for its transfer from one employee to another in key tasks are important. (Weed-Schertzer 2020, 12–14) Moreover, KM should consider that some knowledge might simply be inherently tacit, and attempting to translate it into explicit form by force might lead to serious problems such as severed knowledge communication chains that were accidentally overlooked (Hansen, Nohria & Tierney 1999).

2.1.2 Managing the knowledge

Knowledge management regards knowledge as a means to create tangible value for an enterprise. In KM strategy, knowledge exists for fulfilling a specific objective. In general, the objective is to create business value, which translates into profit long term. (Weed-Schertzer 2020, 28) However, people are at the heart of knowledge management because, as explained in the previous subsection, knowledge inevitably has a human-tied element to it. As a comparison, bare information management considers data management, data sourcing, and documentation without the human connection factor. (Weed-Schertzer 2020, 37) Consequently, KM has pedagogical and social dimensions to it. Oftentimes, in big corporations, KM is connected to the organizational

learning strategy (Weed-Schertzer 2020, 6). In this thesis, the learning and social elements of KM are considered important, as they are required for efficient knowledge transfer. Weed-Schertzer (2020, 11–12) elaborates that the importance of KM stems from the dependent relationship between the business performance of a company and the wisdom of the people in it. Consequently, if a person retires or leaves a company, inevitably, something irreplaceable is likely to be lost. Therefore, it is important to collect or transfer the wisdom and knowledge of the people, as far as possible, before such a loss occurs. However, a KM strategy cannot be based on the sole aim of collecting and storing the wisdom of the people. A strategy like that would most likely have negative effects on the company culture, especially if the company already exhibits a high frequency of employee turnover. Considering that, the connection between KM and company culture must be acknowledged. (Weed-Schertzer 2020, 64–65)

The recent decade has seen knowledge becoming “*intellectual capital*”, a key asset of a company, and people turning into “*knowledge workers*” (Balcerzyk R. 2020) Originally, the concept of KM was likely made known around the 80s and 90s, as trends of recession and downsizing forced the companies to figure out how to retain their core knowledge while dismissing numerous employees (Nunes et al. 2006). In the 90s KM was a new and debated subject in the business literature. There were different opinions as to whether KM stands for computer-assisted information management or strategic usage of intangible company assets. (Salojärvi, Furu & Sveiby 2005) In the late 90s KM became well known and it was advocated by business consultants, organizational learning experts, and scholars. Technology companies started offering new knowledge storage platforms for businesses. KM was synonymous with innovation, productivity, and good decision-making. However, the early 2000s saw a decline in interest towards KM, with many companies choosing to outsource it. (Nunes et al. 2006) At the time of writing this thesis, the rising enthusiasm towards Big Data and data analytics has made KM a current topic again. The tenets of KM could help to collect and use company data strategically and to recognize the aspects that are critical for the thriving and growth of a company. (Ihrig & MacMillan 2015)

2.1.3 Knowledge processes and strategizing the knowledge flow

In knowledge management literature, knowledge is usually divided into different processes or phases of the business knowledge flow. Durst & Edvardsson (2012) used the following phases: identification of critical knowledge, documentation, utilizing the knowledge, and knowledge transfer activities. The documentation phase is also often referred to as codification meaning transferring knowledge into an implicit storable form. Khraishi, Paulraj, Huq & Seepana (2023) described the following processes: the creation of knowledge, innovating, acquiring new knowledge, knowledge storing, documenting, knowledge transfer & sharing activities, knowledge usage, and applying the knowledge in action. Obeso, Hernandez-Linares, Lopez-Fernandez & Serrano-Bedia (2020) used the terms producing knowledge (creation and procurement), storing knowledge (identification and codification), and knowledge flow (using the knowledge, sharing, and transferring it). Wee & Chua (2013) used the phases of knowledge creation, knowledge sharing, and re-applying knowledge. Nonaka (1991) describes the process of transferring knowledge between the tacit and explicit dimensions as "*the spiral of Knowledge*". It consists of four recurring processes. Firstly, "*socialization*" is the act of transferring tacit knowledge from one source to another - often in the form of apprenticeship under a master of the craft. Secondly, "*articulation*" is the process of transforming tacit knowledge into explicit form. Thirdly, "*combination*" is the act of putting independent elements of explicit knowledge together in different ways for divergent purposes. Fourthly and finally, in "*internalization*" explicit knowledge is absorbed by other individuals. It becomes a part of their internal world, combined with their unique subjective experience. Consequently, knowledge is again transformed into a tacit form, allowing for the spiral of knowledge to begin again. (Nonaka 1991) Figure 2 presents the knowledge processes as described by Obeso et al. (2020) and Nonaka (1991).

Procuring external knowledge assets	Identification of key knowledge	Knowledge sharing & transfer
Internal creation of knowledge, innovation	Knowledge codification	Used and applied knowledge
Producing knowledge	Storing knowledge	Knowledge flow

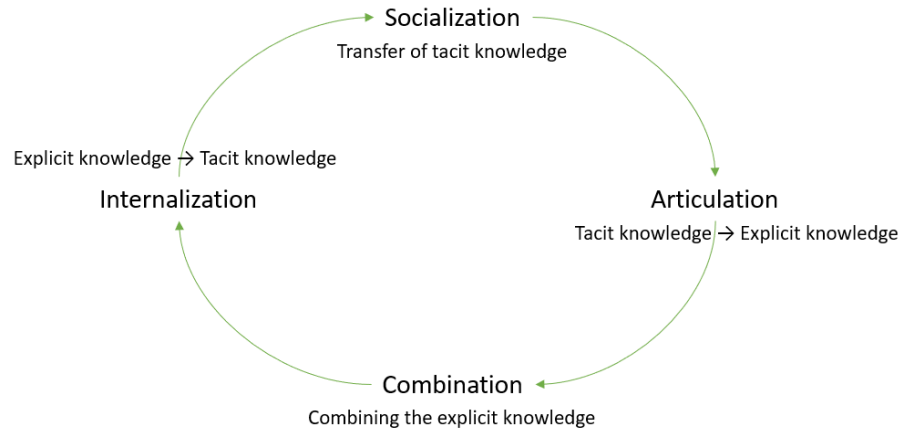


Figure 2. Knowledge processes pictured after Obeso et al. (2020) and Nonaka (1991).

Hansen et al. (1999) identified two distinct ways of approaching knowledge flow and knowledge strategy in the case of the knowledge-intensive consultancy industry. In the “*codification strategy*” knowledge is carefully translated into explicit form, stored in a data bank, and then accessed and used by the employees. On the other hand, in the “*personalization strategy*” knowledge is for the most part held by the individuals (who often are the creators of that knowledge) and shared in social actions between the people. Hansen et al. (1999) advised a company to choose their focus between these strategies, in approximately 80-20 ratio. Trying to encompass both approaches is advised against as counterproductive. Choosing between “*codification*” and “*personalization*” is deemed by the customer needs, company strategy, and even human resource (HR) preferences. Hansen et al. (1999) recommended starting with a comprehensive understanding of the company's value proposition and the role of the company's knowledge in creating that value. Without this understanding, making a correct choice would be impossible. Figure 3 describes the different focuses of “*codification*” companies and “*personalization*” companies.

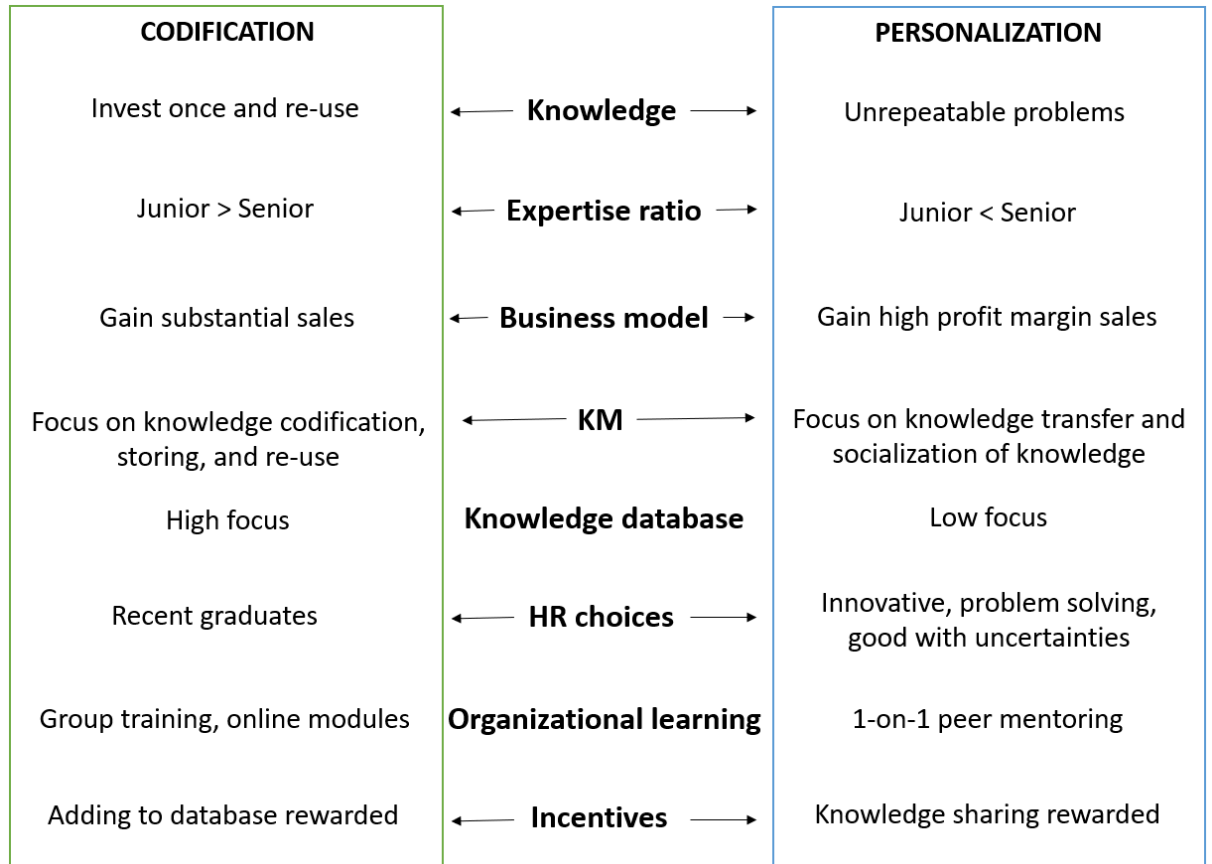


Figure 3. Knowledge strategies modelled after Hansen et al. (1999).

Generally, the codification strategy tends to work best for companies that provide relatively uniform, standard solutions, which are fully developed and tested, and use mostly explicit knowledge which is easily documented. These assets are used to create sales on multiple fronts. Additionally, their hiring focus is on junior-level people with good skills in knowledge application. Employee training is conducted as a group activity or in an online module. On the other hand, personalization is generally the strategy of choice for companies working on innovative solutions that require high levels of customization for each value offering. These projects often involve the usage of tacit knowledge such as scientific proficiency or business negotiation skills. Each solution is likely to be complex and applied only once or a few times, therefore a high-profit margin needs to be achieved from it. The unique and changing problems require more seniority in the employee build-up, and knowledge is best transferred in a personal mentoring setting. Overall, the KM strategy of a business should evolve with its product development and customer needs. Products mature, industry ecosystems change, and the customers might be the ones to evolve

too. All in all, the benefit of choosing the correct strategy lies in the connections between the KM strategy, HR strategy, business model, and information technology (IT) tools. (Hansen et al. 1999) Finally, one must remember that these frameworks are described in the context of the consulting industry and other industries might have additional considerations for KM strategizing.

2.1.4 Mapping knowledge - critical KM areas for company growth

The focus of the KM strategy should be on the critical areas that support the company's value creation and growth. Therefore, key knowledge needs to be identified. There is no point in micromanaging all the knowledge in an enterprise. Furthermore, understanding what the key knowledge assets of a company are, enables good decision-making. In most cases, key knowledge assets include the fundamental company's nucleus competence, added expertise fields, Intellectual property (IP), and deep-smart talent. (Ihrig & MacMillan 2015)

Knowledge mapping is one useful tool for identifying and classifying company knowledge. It has been used for example in the knowledge-intensive, highly advanced physics project ATLAS in CERN, the European organization for nuclear research. (Ihrig & MacMillan 2015) In Boisot's (1999, 41–69) information space tool, presented in Figure 4, knowledge is mapped according to its diffusion rate and structural level. Ideally, knowledge mapping is conducted as an iterative process that includes multiple stakeholders from different functions in the target company. Mapping should reveal hard-type skills, as well as soft skills such as company culture factors that could be breeding success. There might also be an observation of a type of knowledge that is not existing yet. (Ihrig & MacMillan 2015)

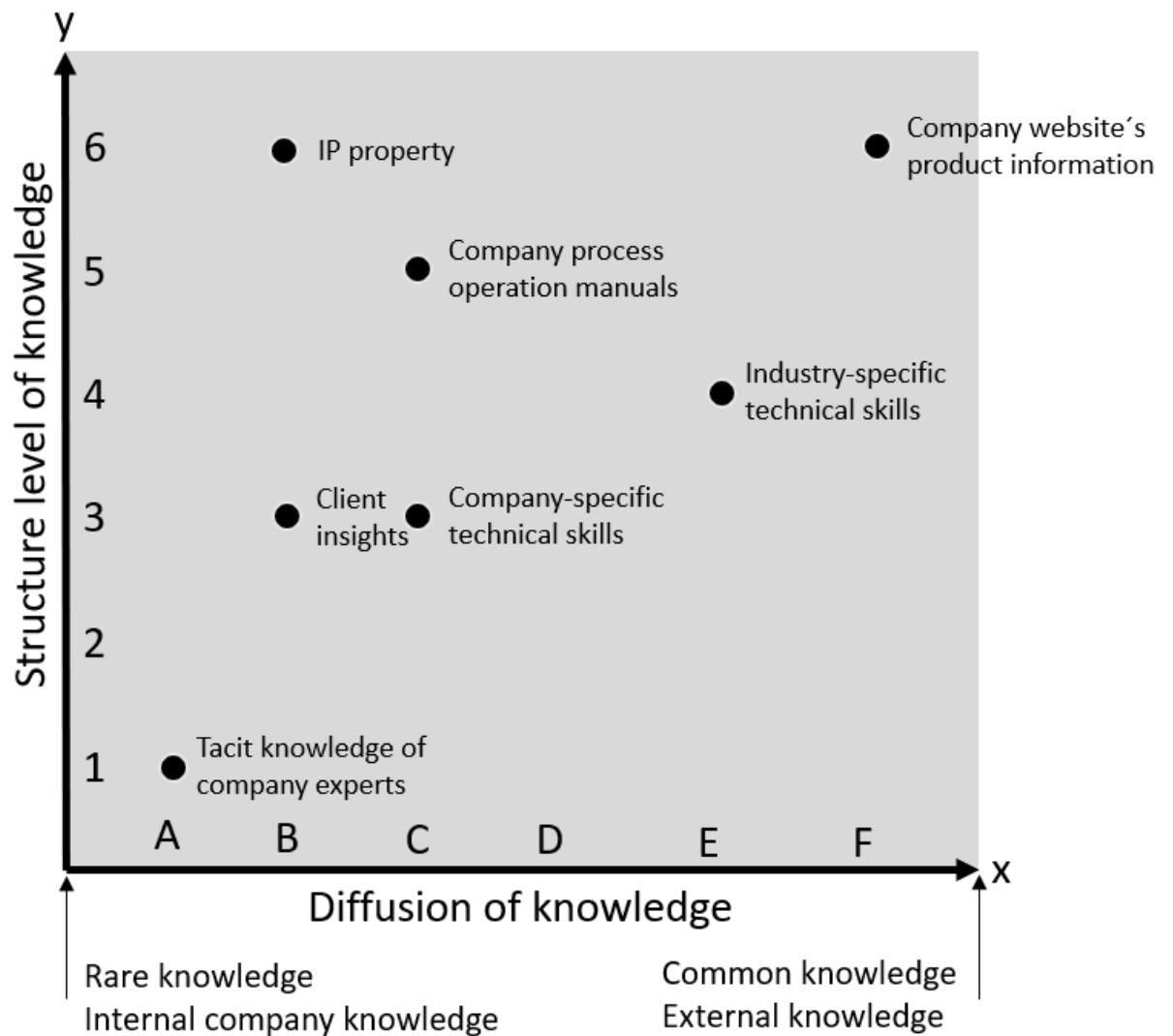


Figure 4. Knowledge map after Ihrig & MacMillan (2015) article and based on Boisot (1999, 41–69) model of information space. Examples of knowledge placement in the information space are given.

Figure 4 presents an example of a basic knowledge map (Boisot 1999, 41–69). In the map, the structure level of knowledge (y-axis) describes to what extent the cause-and-effect relationships in that knowledge are known and how well they can be controlled. As a set of examples relating to Figure 4, at level 1 an expert uses their tacit knowledge to produce results, but the process is intangible and hard to explain. At level 2 two experts can work together and exchange their tacit knowledge while doing so. Level 3 is where a task can be performed by a non-expert but requires rounds of trials and errors. At level 4 the relationship between the actions and their results is becoming clearer, and at

level 5 it can be documented. Level 6 signifies precise knowledge that leads to the desired result every time. These are usually patented solutions. (Ihrig & MacMillan 2015)

Knowledge diffusion measures how rare a certain piece of knowledge is, and it is presented in the x-axis of Figure 4. As a set of examples relating to Figure 4, at point A only one expert in the company has the tacit knowledge inside their head. At level B a minority (the experts) in the company has the knowledge and they can discuss it among themselves. Level C signifies knowledge held by multiple people within a specific sector of the company. Level D is awareness held by people in all sectors of the company. Level E stands for knowledge that is generally held by all companies in a certain industry field. At level F, the knowledge is familiar to a large population, including those outside that specific industry. (Ihrig & MacMillan 2015)

Knowledge mapping can help to visualize different KM strategies and innovate for monetization of the knowledge. The knowledge that should be better diffused internally should be moved along the x-axis of Figure 4. Tacit knowledge could be structured to create IP and therefore moved up along the y-axis of Figure 4. Alternatively, knowledge could be diffused out of the company to find new ideas from externals. Also, one way to create new ideas is by lowering the knowledge down the y-axis of Figure 4, for example, by applying well-structured knowledge to a completely new area. In general, it is usually beneficial to utilize the advantage of company IP because the competitors have access to the same open-source information as everyone. KM strategy should support the evolution of knowledge that is vital for a company's competitive edge. (Ihrig & MacMillan 2015)

2.2 Knowledge management in the context of SMEs

The purpose of this subchapter is to review relevant research publications on knowledge management in knowledge-intensive SMEs and micro enterprises while bearing in mind the limited comparability of the available literature studies on the subject (Massaro et al. 2016). As stated earlier in Subchapter 1.1, in Finland an SME is defined as an enterprise that employs 1–249 people and within the SME category a micro enterprise has 1–9 employees (Tilastokeskus 2022). A knowledge-intensive enterprise is defined by a notable need for creativity and problem-solving, usually with an uncommon application of knowledge. Their employees are generally of high educational and experience backgrounds, the work is greatly independent, and the people are an important asset for the wisdom they possess. (Nunes et al. 2006). Enterprise sectors that are regarded as knowledge-intensive include for example scientific R&D, engineering, consulting, law, and architecture (Joe et al. 2013). In this Subchapter 2.2 critical organizational knowledge in SMEs is identified, the general challenges SMEs face in KM implementation are acknowledged, and KM is suggested as a key tool to alleviate knowledge-loss-related vulnerabilities of SMEs. After that, the role of organizational learning in KM is discussed, KM systems in SMEs are explored, and the concept of emergent KM in SMEs is described.

2.2.1 Critical organizational knowledge in the SME sector

Joe et al. (2013) studied knowledge-intensive SMEs for valuable organizational knowledge that should be followed up on before experienced employees retire or leave the organization. They described five key knowledge categories found important by the retiring experts. Firstly, there is “*subject expertise*” in a defined field. In the natural sciences, that refers to all the experience a person has gathered over their career as an addition to their original science education. For example, one interviewed senior scientist explained how scientific knowledge and skills cannot be acquired hastily. With mentoring and support for continuous learning, it takes 4 - 5 years to acquire valuable scientific experience. Generally, organizations recognize a subject matter expert as someone who can design

well-organized, fast, and economically feasible processes. The experts often deal in highly specialized forms of knowledge in their respective fields, and they can answer promptly to new situations or problems due to their gathered experience. These experts contribute to the profitability and value of a knowledge-intensive company significantly. (Joe et al. 2013)

Secondly, there is the crucial knowledge area of “*business connections and networking*”. Human interaction-related knowledge was found tricky to transfer as it involves the personal wisdom, social demeanour, and established reputation of the person dealing with the connections. The experts know which stakeholders to network with and can hold productive relationships with multiple stakeholders. Thirdly, there is “*organizational memory*”. That encompasses knowledge of the company and the internal interactions and relationships there. It also includes the chain of developments the company has seen and the reasons behind them, the enterprise's history, and mentoring of junior employees. Fourthly, *business knowledge of processes and company value expansion* is critical knowledge to retain. Those complex processes were found to be often incompletely documented due to the tacit knowledge included in them or lack of time. Fifthly and finally, comes “*governance-related knowledge*”. That is described as the top-level management activities, knowledge of which is usually neither general nor held by many. (Joe et al. 2013)

2.2.2 Challenges in implementing knowledge management in SMEs

There are some generally repeating reasons given in the SME KM literature that explain why KM is an undeveloped and underexplored area in SMEs as compared to the big companies. KM is found to be a useful tool for SMEs to take up (Durst & Edvardsson 2012) but there are barriers preventing that. Small enterprises are usually characterized by their size, lack of resources, agility, and a relatively flat organizational structure (Durst & Edvardsson 2012) where the decision-making is concentrated in a few hands (Wong & Aspinwall 2004). The biggest obstacle to implementing an official KM strategy is found to be the investiture of time or money in a long-term process. The challenging business environments and situations faced by SMEs cause the short-term to always be

considered over the long term. In addition, although KM would be considered to positively affect innovation, it is often seen as something that does not give a good return on investment of the sparse resources. (Nunes et al. 2006) Nunes et al. (2006) studied knowledge management in two South Yorkshire (Great Britain) based knowledge-intensive SMEs, one of which had 18 and the other 75 employees. The management of the case SMEs did not see KM as crucial. While some explicit knowledge was stored, many of the employees did not actively partake in it, and thus the attitude of the management towards KM was mirrored in the employees. (Nunes et al 2006) Often the head/owner of an SME is so caught up in maintaining the company functions in the face of urgent issues, that there is no time to even consider KM (Wong & Aspinwall 2004). In small enterprises, it is usually impossible to have an employee dedicated to KM duties full-time. Consequently, there is no KM strategy and KM might just happen in practice without planning or organizing (Zieba et al. 2016).

Another limiting factor for small companies is the lack of HR resources (Desouza & Awazu 2006; Wong & Aspinwall 2004). SMEs can rarely compete with big companies in the number of available personnel resources or in attracting the top minds in their field. Instead, SMEs are often, by default, dependent on finding people with a can-do attitude and training them. (Desouza & Awazu 2006) However, SMEs can make up for their lack of resources by utilizing external resources. For example, an SME can follow up on the strategic directions of the big players and follow suit, trusting that the big companies have done their strategic due diligence via their vast resources (Desouza & Awazu 2006). Overall, SMEs need ways to improve their organizational memory, so that the wheel does not need to be invented again at certain time intervals (Desouza & Awazu 2006; Joe et al. 2013; Wong & Aspinwall 2004). In their knowledge processes, SMEs value agility and fast response capabilities to their competitive environment (Joe et al. 2013).

2.2.3 Knowledge management as a tool to alleviate vulnerabilities of knowledge-intensive SMEs

KM in SMEs has unique characteristics and challenges as compared to the big corporations (Cerchione & Esposito 2017; Zieba et al. 2016). Moreover, the SMEs themselves function in a variety of fields, making any uniform one-size-fits-all SME KM strategy impossible to create (Joe et al. 2013). However, it is widely acknowledged in the literature that value creation in knowledge-intensive SMEs is often dependent on the knowledge and wisdom located inside the owners or key employees. (Cerchione & Esposito 2017; Joe et al. 2013; Nunes et al. 2006; Zieba et al. 2016). This makes the knowledge-intensive SME sector vulnerable to knowledge losses related to a key employee leaving or retiring (Nunes et al. 2006). Furthermore, in a small enterprise, the specialized knowledge might be held by a few individuals only or even merely one person. If this knowledge directly concerns critical company functions, it would be particularly important to find mechanisms for knowledge transfer to alleviate the risks of knowledge losses or gaps. In addition, the name and authority of a single person might have an important role inside the company or in the customer interface. (Joe et al. 2013)

In the case of knowledge-intensive SMEs, their competitive edge lies in the expertise of the employees: a strength and a vulnerability (Nunes et al. 2006). However, one way to counterbalance the loss of an experienced employee is to hire new knowledgeable people. That is also a golden chance for the SME to facilitate the transfer of newly entered knowledge and the creation of developed knowledge. (Joe et al. 2013) As mentioned in subsection 2.1.3, this requires considering KM as well as creating a culture that favours knowledge sharing and boosts internal problem-solving capabilities. (Weed-Schertzer 2020, 64–67) In conclusion, KM as a tool can support knowledge-intensive SMEs in recognition of key knowledge, knowledge transfer, knowledge retainment, and even HR planning (Joe et al. 2013; Nunes et al. 2006).

Additionally, Obeso et al. (2020) researched 400 SMEs in Spain for the connections between knowledge management processes (KMPs) and company performance, including the role of organizational learning. The findings pointed

out a positive correlation between the organization's productivity and knowledge creation, acquisition of new knowledge, knowledge transfer, and knowledge usage. While documentation was found important, that alone did not boost productivity. The KMPs of an enterprise made the foundation of the organizational learning strategy. In turn, the learning could enhance the positive effect of KMPs on the company's capabilities of delivering results. (Obeso et al. 2020) These results support the view of this thesis on the importance of the pedagogical dimension of knowledge transfer and KM.

Finally, the effect of KM on company development is considered. Salojärvi et al. (2005) observed a relationship between the steady growth of an SME and the existence of a well-developed KM strategy in their study of 108 diverse SMEs in Finland. The average number of employees in the studied case companies was 29 and most of the companies were aware of KM concepts. The highest developed KM, the type that is supporting growth, was found in the new innovative companies and well-developed tenured businesses. For them, the key assets are their employees and customer networks. Companies that were less developed on KM were grouped as small conservative businesses and service companies working in the Finnish market. They were more product-oriented in their strategies. However, it was noted that the positive effect of KM might just be related to the net positive effect of good management practices in general. The pure effect of the KM strategy is difficult to isolate and prove. (Salojärvi et al. 2005)

2.2.4 When knowledge loss is not an issue for SMEs: the key role of knowledge transfer

While research publications focused on knowledge-intensive SMEs often emphasize the importance of the key employees and their expertise, there are some conflicting results found in the SME KM literature. Therefore, this thesis explores the following question: is knowledge loss really a problem in SMEs? This is a challenging question since SMEs are a diverse group (Joe et al., 2013) and much of the referred literature has many variables because they are focusing on a varied amount (1–400) of case companies in one country at a

time (Massaro et al, 2016). Therefore, this thesis must be cautious in drawing generalized conclusions on SME KM. The following paragraphs present studies where the case companies did not find knowledge loss in the case of an employee leaving to be a particular risk for them.

Wee & Chua (2013) studied four well-established Singaporean SMEs that had functioned for at least a decade in their field: a logistics company, a staff recruitment agency, an education company, and a consultancy enterprise. In these case companies, it was mostly the owners who were responsible for knowledge creation and business development. Employees drove the day-to-day functions but lacked knowledge of the overall business. The companies did not see knowledge loss as a problem because the employees were designated overlapping responsibilities, eliminating the chance of functional knowledge being centralized into individuals. It is also worth noting, that the case companies had taken measures to develop a good company culture in knowledge sharing among the employees who were working closely together. On the other hand, it was noted that the case companies were overly reliant on solely the owners for the creation of new ideas. Then again, these Singaporean case companies were mostly focused on maintaining their stable position in the industry, rather than aiming for fast growth. (Wee & Chua 2013)

Desouza & Awazu (2006) researched 25 SMEs (country not specified) of different types: restaurants, coffee bars, and laundry businesses, as well as more knowledge-intensive enterprises in technology (4 out of 25), and consultancy (7 out of 25). To the surprise of the researchers, knowledge loss was not considered a big risk by the case companies. For some companies, their recent tenure of operating could explain this attitude. Still, the older companies had safety measures in place for the case of experienced people leaving the enterprise: an effective shared common knowledge pool. In the studied SMEs, the specialized knowledge was centred on the owner and management while the employees partook in the common knowledge. Cases of a manager leaving were found rare, and in the cases where it happened, they still retained social ties to the previous company and actively helped in reconciling the knowledge gaps left by their absence. A notable observation in

the publication was that in the 25 case SMEs, knowledge transfer was mostly happening via social interactions. (Desouza & Awazu 2006) On the other hand, in contrast to the two previously introduced studies, where knowledge sharing is generally regarded as a strength, one study from 2007 showed that Turkish SME managers saw knowledge sharing as a risk to their positions (Bozbura 2007). This example shows that when knowledge equals power, the risk of knowledge loss can alternatively be seen as a positive personal leverage.

In conclusion, efficient knowledge transfer or a common knowledge pool seems to play a key role in maintaining functional company knowledge. Of course, the depth of this common knowledge is most likely not comparable to specific expertise in challenging actions. However, it can be learned that social actions in SMEs are crucial for knowledge transfer between people, and social bonds can be a strength in SME KM. Since the case companies presented in this subsection were not too worried about the knowledge loss tied to personnel, either they were unaware of the risk, or they had implemented a successful solution. All in all, there is something to learn from that.

2.2.5 How to facilitate knowledge transfer and knowledge sharing - the key role of organizational learning initiatives

Knowledge transfer tactics are directly connected to the type of organizational knowledge being transferred. While transferring a set of knowledge might be easy, added complications arise when the knowledge is put into practice. Most processes include practical knowledge and problem-solving skills that are usually gained through experience (Joe et al. 2013). In subsection 2.1.1 experts, wisdom, and the “*deep smarts*” were discussed. Organizational learning can be used to distribute the knowledge held by the “*deep smarts*” to a wider portion of the employees. That way some load can also be lifted off the “*deep smarts*” who are most likely needed in more projects than they can cover. (Leonard and Martin 2019) The biggest impediment keeping the “*deep smarts*” from sharing their knowledge is the time constraint: the more crucial the expertise held by a “*deep smart*” is, the less time they have for potential mentoring (Leonard 2016).

KM literature from Harvard Business Review provides advice on knowledge sharing and organizational learning. Leonard and Martin (2019) presented the role of “*nexperts*”, the people personally mentored by the “*deep smarts*”. In turn, these mentees can distribute their learnings further and contribute to the knowledge flow. One good way to engage people in learning was the pedagogical approach of a challenge: people are first given a problem to solve, and only later do they get the expert solution and advice. Optionally, there was knowledge codification into documentation that is quality checked by the experts before sharing them with other employees for independent learning. (Leonard & Martin 2019) Moreover, learning and co-learning should be encouraged so that employees feel confident to spend time on that and ask for advice from the “*deep smarts*” (Myers 2015) To facilitate knowledge transfer, a company can have dedicated sessions where experts and others (or experts and experts) can meet and transfer tacit knowledge face-to-face (Leonard & Martin 2019). In some cases, this could be a dedicated space in the office encouraging mutual interaction (Myers 2015). Including people with different skills to learn from each other can enrich the learning meetings (Hagel III & Brown 2017). Furthermore, it is beneficial for the learning to happen in the workplace, instead of a separate course environment. Learning on the go during daily challenges helps to put the learnings into practice immediately. (Hagel III & Brown 2017) In addition, the management needs to lead by example and initiate the first knowledge transfer actions (Myers 2015). Learning can also be induced between enterprises in a business ecosystem (Hagel III & Brown 2017). Finally, organizational learning strategy should consider the creation of new knowledge. To that end, one should differentiate between skills and capabilities. Skills alone are constricted and can become outdated. Capabilities are broader in definition, such as a spirit of inquiry, critical approach, taking chances, emotional intelligence, and innovativeness. (Hagel III & Brown 2017)

On the other hand, one must ensure that the company culture encourages knowledge sharing instead of knowledge silos. In intellectually demanding and independent work, people are usually likely to share knowledge. Moreover, knowledge transfer is found appealing when it is based on the autonomous

motivation that stems from inside the people. In contrast, controlled motivation created by external pressure is likely to deter people from sharing their expertise. Therefore, encouraging knowledge sharing in a workplace is a fine balance in rewarding the desired behaviour. People are less likely to share knowledge if they fear that the act of sharing can make them lose their leverage at the company. Also, if they feel that a certain colleague is depending on them in excess, they are deterred from sharing knowledge. (Gagné, Tian, Soo, Zhang, Ho & Hosszu 2019) An experienced employee should logically gain a desirable advantage from sharing their wisdom. Being held in high regard and rewarded for sharing wisdom can encourage sharing and learning in the company. (Weed-Schertzer 2020, 64–65) The gain a company acquires from a culture of sharing and learning is the ability of the personnel to solve the company's problems and challenges internally. Obstacles in internal knowledge sharing can potentially result in unnecessary use of external resources and consequently, extra expenses. (Weed-Schertzer 2020, 67)

2.2.6 Knowledge management systems in SMEs

Cerchione and Esposito (2017) researched in depth the use of different knowledge management systems (KMSs) in the SME sector. They performed an extensive literature study on the KMSs used by SMEs. They also did empirical research on the subject in 61 Italian SMEs in the fields of information technology (IT), high-tech, consultancy, and R&D. Table 1 introduces the exhaustive taxonomy of KM tools and practices in SMEs, collected and first presented by Cerchione and Esposito (2017). All in all, KM practices are found to be more embedded in SMEs, compared to the KM tools (Cerchione and Esposito 2017).

Table 1. An extensive taxonomy of KM tools and practices used by SMEs, presented after Cerchione and Esposito (2017).

KM process	KM tools in SMEs	KM practices in SMEs
Knowledge Creation	Data Mining	Brainstorming
	Data Visualization	Ideas
	Expert Systems	Competition
	Social Data Mining	Knowledge Elicitation
	Text Mining	Interview
	Collaborative filtering	Benchmarking
	Crowdsourcing Systems	Knowledge Filtering
	Mash-up	Rating
	Prediction and Idea Markets	
	Syndication Systems	
Knowledge Storing	Trust and Reputation Systems	
	Business Process Management	Casual Mapping
	Configuration Management Systems	Knowledge Mapping
	Content Management Systems	Knowledge Modelling
	Product Data Management Systems	Problem-Solving
	Product Lifecycle Management	Process Mapping
	ERP Systems	Social Network Analysis
	Databases and Data Warehouse	After Action Review
	Data Management Systems	Balance Scorecard
	Document Management Systems	Best Practices
Decision Support Systems	Contextual inquiry	
Knowledge Transfer		Knowledge Office
		Lesson Learned
	Cloud Computing	Case-Based Reasoning
	Learning Management Systems	Coaching/Mentoring
	Peer-to-peer Resource Sharing	Practice Communities
	Podcasting/Videocasting	Communities of Sharing
	Social Media	Focus Groups
	Wiki	Job Rotation
	Audio/Video Conference	Learning By Doing
	Blogs	Work Groups
	Chat	Facilitated Discussion
	Conversational Technologies	Meeting/Task Force
	E-mail	Informal Networks
	Knowledge Cafes	
	Seminars	
	Storytelling	

Cerchione and Esposito (2017) made three main discoveries. Firstly, SMEs tended to opt for traditional KM tools. These were listed as e-mail, database, methods for document managing, conference via audio or video, enterprise resource planning (ERP) bases, data warehouse usage, and product configuration management (CM) bases. These were favoured over modern, affordable, and easy-to-use options such as making podcasts and vodcasts, data mining, exploiting social media, mash-up, syndication systems, filtering knowledge in collaboration, and crowdsourcing. Overall, SMEs did not generally possess enough resources to follow up on the development of the new technology opportunities for KM. Secondly, SMEs favoured developing KM practices already familiar to them over creating a dedicated KM strategy. Additionally, practices focused on problem-solving and learning were more common than KM-oriented practices such as knowledge mapping. Reasons behind this second finding included knowledge being in the experienced personnel, and scarcity of resources for KM development. Thirdly, KM tools and KM practices each supported the functions of the other. However, if there were too many different KM tools and practices being used at one time, the benefits and usage of the tools and practices suffered. (Cerchione and Esposito 2017)

Cerchione and Esposito (2017) divided the SMEs into four categories based on their advancement in implementing KM tools and KM practices: “*guideposts*”, “*exploiters*”, “*explorers*”, and “*latecomers*”. “*Guidepost*” SMEs see the value of KM, invest in being up to date in their KM practices & tools, and use them intensively. “*Exploiter*” SMEs intensively use the KM few tools & practices at their disposal, but the tools tend to be traditional and new investments in KM are not made. “*Explorer*” SMEs invest in KM and explore a variety of new KM tools; however, they are not yet able to gain the full advantage of the tools, unlike the *guideposts*. “*Latecomer*” SMEs are not familiar with KM and do not see the value in KM tools & practices.

2.2.7 Emergent knowledge management in SMEs

Zieba et al. (2016) studied the prevalence of emergent approaches to KM in SMEs. Inside the SME group, they focused on the small and micro enterprises that function in the knowledge-intensive business services (KIBS). In the scope of their study, emergent KM is defined as knowledge sharing and KM practices that emerge in a bottom-up manner from the practical needs of day-to-day business activities. The employees organize their knowledge and learning when there is a need to do that to boost the efficiency of their work. Colleagues collaboratively learn and teach during daily functions and good practices might be developed further.

Zieba et al. (2016) conducted a multiple-case study on emergent KM in small enterprises. They interviewed the management of 12 small Polish enterprises, all of which were entities with less than 30 employees. Although the study was limited by its small sampling, the characteristics of emergent KM were observed in all the case companies. However, oftentimes the found emergent practices were not officially notified as KM. They were regarded as practical solutions in a particular area, consequently making the implemented KM into a collection of unconnected KM parts. Additionally, the KM strategies were unique, in the manner that they were tied to the specific context and functions of each case company. Small companies are a diverse group, and therefore the KM strategy suiting one might not be the right fit for another. Also, the small companies in the KIBS sector needed to be agile with their KM strategies, as the relevant knowledge and solutions might change at a fast pace. Especially in ground-breaking innovation-dealing enterprises, knowledge has an early expiration rate, and new knowledge and KM tools are continuously searched for. (Zieba et al. 2016)

The emergent KM practice worked in the setting of small enterprises as they generally have a low threshold for fast implementation of independent suggestions from employees combined with limited resources. It is generally not possible to have an employee dedicated to KM work full-time, making emergent practice-driven KM solutions commonplace. If there is no KM strategy, KM

happens in practice without planning or organizing. (Zieba et al 2016) Moreover, Zieba et al. (2016) found that in those small case enterprises, it was often certain key employees who were best aware of what knowledge should be collected and organized to answer the day-to-day challenges. Zieba et al. recommended developing better definitions for KM strategies in the SME sector because the realities of small enterprises need better descriptions. The emergent KM could function as an umbrella term and a starting point to begin taking a closer look into the diverse ways of KM in small entities. Furthermore, Zieba et al. (2016) advocated for awareness of the emergent practices by the management of SMEs. That way good practices emerging from the employees can be noted and developed, or even officialised as routine processes by the companies. (Zieba et al 2016)

3 RESEARCH DESIGN

The purpose of this chapter is to present arguments for the chosen research approach and the research plan of this thesis. Data collection and analysis in the thesis are discussed. Additionally, the validity and reliability of the collected research data are considered. The research design of this thesis is based on the specific environmental factors of small high-tech enterprises working in the R&D field. There was also a collaborative element to this research design, as discussions with the people in the case company have affected the design process.

3.1 Research Approach

The chosen research approach for this thesis was the case study. Yin (2015, 7–9) defines a case study as one sub-method of qualitative research. Qualitative research is described as a vast field of study methods capturing research data that would be difficult to study and describe numerically or under controlled experimental conditions. According to Yin (2015, 7–9), there are five main factors differentiating the qualitative study method from other research tools. Firstly, it delves into the meanings people carry in their lives and life situations. Secondly, it concentrates on representing the points of view of the people under study. Consequently, and thirdly, the context of the research must be paid attention to in detail. Fourthly, the phenomena found during the research are usually explained with either new or existing theoretical frames. Fifthly, it is essential not to rely on only one data source, but to gather data from various sources.

Rashid, Warraich, Sabi, & Waseem (2019) have gathered advice on designing a business context case study as a business & management student, up to the doctoral thesis level. They introduce three relevant philosophies underlying qualitative research. Each one has a different view and approach to the concept of knowledge. The first one is positivism which aims to study and test hypotheses to find an objective truth in a matter. The second one, critical theory, views knowledge as intrinsically political and a tool of power. The third

philosophy, interpretivism, regards knowledge as multiple subjective realities of the individuals under study.

A case study is defined by Rashid et al. (2019) as in-detail research on a specifically defined case to draw conclusions on the study subject in a certain context. A case study is always highly context related. According to Gillham (2000, 1), the framework of a case can be completely defined by the researcher, depending on what they seek to discover. The case is then explored, with one or multiple methods, for a variety of evidence to answer the research questions. Gillham (2000, 2–3, 13) notes that a case study is especially suited for studying human issues of subjective nature when one needs to move beyond the objectively verifiable truths. Positivist research, most notably used in natural sciences, obtains generally applicable and repeatable results. When researching human subjects, one should note that the results are specific to the study case context. (Gillham 2000, 6) Moreover, the quality of the evidence acquired in a case study is inevitably related to the research methods, and how they might affect the results (Gillham 2000, 4–5). Rashid et al. (2019) also caution that the case research would inescapably involve the values, cultural & societal norms of the researcher.

Based on descriptions of the nature of the case study from the previous paragraph, the method was deemed optimal for this thesis. As the case boundaries could be entirely defined by the researcher, it was a suitable approach in the case of a small company. According to Gillham (2000, 1, 21), neither the size of the case company nor the researcher's collaboration with the company is an issue in a case study. Different philosophical approaches to the concept of knowledge were considered in this thesis as it is researching knowledge management. The case study was executed in an R&D company consisting mostly of people with a background in the natural sciences or technology. Therefore, the challenge was to approach knowledge from the interpretive point of view in addition to the positivist viewpoint. KM in this thesis was approached from the points of view of individuals inside the company. The knowledge management case study research by Nunes et al. (2006), quoted multiple times in Chapter 2, also used the interpretive view towards knowledge.

3.2 Research methods

Yin (2015, 8–9) emphasizes the importance of gathering research data from multiple sources. The data collection of this thesis was based on two main methods: a literature review and a practical research study (questionnaire + short interviews). The purpose of the literature review part was to study a wider context of knowledge management in SMEs. Gillham (2000, 2) noted that one should not start a case study with pure literature research as the functionality of the theories is bound to the reality of the case setting. Consequently, the literature research part of this thesis was conducted in a liminal manner with the practical part to focus it on the case setting. The literature review was executed using scientific journals, books, and articles as the main sources of information.

Yin (2015 140–143) describes the two types of interviews used in qualitative research as structured and qualitative. In this thesis research, the questionnaire was a mostly structured interaction between the researcher and the people in the case company. It was a multiple-choice type, and there were no open-ended questions except for the questions intended for knowledge mapping. The purpose of this was to make the research more manageable in the scope of this thesis work. The questionnaire script is available in its entirety in Appendix 1. The individual interviews conducted during this thesis research were short, semi-qualitative type interviews with a script on the base structure of the discussion topics. Yin (2015 143–147) describes the qualitative interview as a discussion, and advice is given to the researcher to succeed in obtaining data in this setting. One should speak less and listen mostly. One must let the interviewee direct the conversation and remain a neutral researcher. The researcher has the responsibility to not lead the interviewee in directions that might be harmful or distressing to them, or harm either their reputation or mental well-being. One should have an interview guide (the base script) to stay on topic and begin analysing the answers already internally in the interview situation. This thesis followed these principles in interview situation design and implementation. The interview basis script used in this thesis can be found in Appendix 2.

3.3 Research process

The practical case study conducted at the case company focused on the identification, diffusion level, transfer efficiency, and documentation of critical company knowledge. The practical research was designed with four “*data collection units*” (Yin 2015, 91). The first unit was the questionnaire that covered the whole community of Company X. The following three units were individual interviewees. To begin with, all Company X employees were asked to fill out an anonymous multiple-choice type of questionnaire of 10 questions in total. There were questions on the status and awareness of knowledge management in the company as well as questions gathering intel for knowledge mapping. Based on the questionnaire findings, three key people from the case company were selected for short interviews with three open-ended questions.

The research process of this thesis took place from research subject selection in September 2022 to approximately the end of Q1 of 2023. Figure 5 presents an overview of the research process plan. As described in the earlier paragraph, the research was conducted in the form of a literature review, a questionnaire, and interviews. The literature review was conducted from late Q4 of 2022 to early Q1 of 2023 and revisited as needed later, depending on whether the case findings required more theory research. Following, the questionnaire was conducted online for the case company, and interviews were conducted face-to-face shortly after that. The interviews were conducted in person, Teams video call interview was a backup plan. The data analysis and the final thesis were executed for review and feedback by the end of Q1.

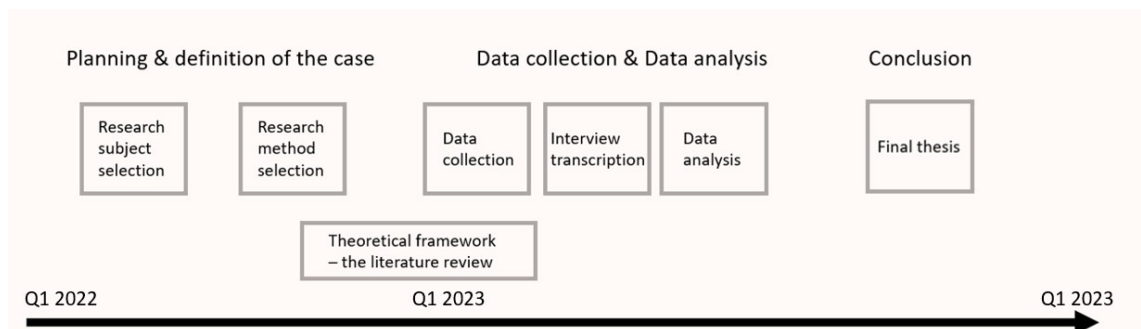


Figure 5. Research process plan of this thesis.

3.4 Case selection and description

The case company was a high-tech enterprise with approximately 10 employees. It concentrated on research and development (R&D) and delivered products for business-to-business customers, as well as research institute partners. The case company deals in specific technologies and processes that are not commonly found in Finland or Europe. It was working with multiple industrial partners to gain insight from the industry side. The final industrial section, to which the specific technology can be applied was still in motion at the time of writing this thesis due to the dynamic and multi-sided nature of the technology for several applications. The case study in this thesis was framed as follows. The case study considered the knowledge management in the case company by identification, diffusion level, transfer efficiency, and documentation of critical company knowledge. A questionnaire and three interviews were executed at the case company. The literature review supported the study so that the data gathered at the case company could be compared to external points of view for additional insights.

3.5 Data analysis

The practical research in this thesis was performed as a qualitative case study with a mostly interpretive point of view. Three out of five analytical techniques for case studies, as presented by Yin (2018), were used in analysing the data. These were pattern matching, explanation building, and logic modelling. The goal of this thesis was to provide improvement suggestions for knowledge management in the case company. As such, the cause-effect patterns in the data (logic modelling) were of the greatest interest. Gillham (2000, 13) points out that when analysing data gathered with different methods, one can observe whether they agree or disagree with their results. Should the methods give contradicting findings, one should re-assess the validity of the research methods and pay attention to the contradictions when making conclusions. According to Gillham (2000, 32), the gathered data could still be valid, but the case has proved more complex than anticipated. Additionally, Gillham (2000, 32) proposed that it can be beneficial to check the case environment's views on the case study analysis before drawing conclusions.

3.6 Reliability and validity of the collected data

A case study cannot be performed in a void, as the process itself might already have influenced the company. Gillham (2000, 7) mentioned that in a case study, the researcher is a part of the study and that they must recognize their part in the research. The researcher inevitably forms their preconceptions of the company and the interviewed people. In this thesis, the questionnaire answers are collected anonymously to minimize connecting a certain person with a particular answer set. However, the interviews might have been affected by this human bias. Furthermore, the research might bring improvements or changes in a company simply because someone took up the role of asking questions and gathering data. (Gillham 2000, 7) Therefore the research process itself might have influenced the results of the research.

As discussed by Yin (2015, 8–9) the data collected in a case study is always bound to its specific context. This thesis research did not attempt to find generalizable KM solutions. The goal was to observe knowledge management from the point of view of the case company. Four common tests for the validity of an empirical study were used in this thesis: construct validity, internal validity, external validity, and reliability (Yin 2018). Construct validity was considered in the use of multiple data-gathering methods from different sources. Internal validity was considered by pattern matching, explanation building, and logic modelling of the data in the analysis stage. Competing explanations and conclusions were considered. External validity was considered in the literature review part of this thesis. Reliability was achieved through research protocols. All data and inscriptions of the interviews were collected into a database. The conclusions and participants in the informal discussions with the case company management or interviewees were recorded in the database.

According to Gillham (2000, 13), a common inconsistency in the data can be observed in people's words versus deeds. Additionally, people might be honest in an interview, but they simply do not know themselves well enough to give consistent results. In the interviews performed at the case company, the anonymity of the answers could not be completely guaranteed within the case company. This was due to the case company being a micro-enterprise with less

than 10 full-time employees at the time of this thesis research. In addition, some of the employees knew each other well. Participants had to be made aware of this dilemma, and as such their answers could have been affected by the pressure of who has access to the data. In the questionnaire, answer sets were collected anonymously and could not be connected to a particular employee.

4 FINDINGS

In this chapter, the research findings are presented. The employees of Company X were asked to fill out a questionnaire and a small subset of the employees were interviewed to shed light on the status of and approach towards KM in company X. They were asked to identify and evaluate some KM parameters. The questionnaire referred to here can be found in its entirety in Appendix 1 and the interview script can be found in Appendix 2. To begin with, the questionnaire results are presented in a clear and organized manner, using tables, figures, or graphs to illustrate key findings. Additionally, this chapter lays out the findings from the short interviews. In both the questionnaire and interview findings, specific technical terms that are unique to Company X are replaced by generalized terms such as “*specific technology of company X*” and “*applied Company X technology*”. The results are interpreted considering the original research questions. As a continuation, a limited version of Boisot's (1999, 41-69) style knowledge mapping on Company X is presented. After that, the reliability and validity of the research results are assessed. Furthermore, the research questions of this thesis set in Subchapter 1.3 are answered and research findings are connected to the theory of SME KM collected in Chapter 2. Finally, based on these thesis research findings, recommendations to Company X regarding knowledge management are provided.

4.1 Questionnaire findings

As stated in Subchapter 3.3, the questionnaire was targeted to all existing Company X employees who were active at the time of this thesis research (Company X questionnaire 2023). The roles of the employees ranged from management to process scientists. These findings are based on the seven questionnaire responses received from the case company (out of a total of ten questionnaires that were sent out). To begin with, awareness of knowledge management in Company X, employee activity in knowledge management, and possible indications towards emergent KM are probed. Findings are presented in Figure 6 and Figure 7.



Figure 6. Awareness of KM among the Company X employees as per results of the questionnaire (Company X questionnaire 2023).

The first questions, presented in Figures 6 and 7, are designed to probe the knowledge management awareness and activity in Company X employees of all levels. Question 1 on KM awareness and its results are summarized in Figure 6. Out of seven respondents, two were actively involved in Company X's knowledge management activities. On the other hand, three out of seven managed their knowledge while not being fully aware of how knowledge was managed in Company X in general. Two respondents identified as not being actively involved in KM of Company X. Still, one of them was aware of how KM in Company X is conducted in general. On the whole, 3 out of 7 respondents were aware of KM in Company X, while 4 out of 7 declared themselves as being unaware. (Company X questionnaire 2023) However, the three employees who were unaware of KM in Company X but identified with managing their knowledge were potential sources of emergent KM (Zieba et al. 2016) which was described in subsection 2.2.7. These 3 people could be involved in KM activities of their own, while not being aware of the overall KM strategy of Company X or, possibly, even KM as a concept. (Company X questionnaire 2023)



Figure 7. Engagement in KM among the Company X employees as per results of the questionnaire (Company X questionnaire 2023).

The second question examines the overall engagement in KM activities in the small Company X and the results are summarized in Figure 7. Two out of seven respondents had given active KM suggestions (or overseen it). Three out of seven had offered suggestions, but needed to be made aware of the definition of KM. Two out of seven respondents were neither aware nor had made suggestions. Altogether, five out of seven responders were showing activity in Company X knowledge management. The case company was quite small with 10 employees (and less than 10 full-time employees) at the time of this thesis research. Therefore, this can be seen as a notable level of active engagement with KM improvement. (Company X questionnaire 2023)

As a follow-up, the respondents were asked to evaluate the knowledge intensity level of Company X on a scale from 1 to 10. The definition of a knowledge-intensive company by Nunes et al. (2006) and Joe et al. (2013) was given to help with the evaluation. The responders gave Company X an average of 9.3 in knowledge intensiveness, as shown in Figure 8. This fits the theoretical notion that a science-based R&D company, such as Company X, usually is knowledge-intensive. Furthermore, the result shows that the respondents saw knowledge as an intrinsic part of their work and Company X functions. (Company X questionnaire 2023)



Figure 8. The knowledge intensiveness of Company X was evaluated by the employees to be 9 out of ten, meaning the company is perceived as highly knowledge-intensive (Company X questionnaire 2023).

Next, the knowledge-sharing avenue type and re-usability of created knowledge were evaluated by the respondents. As previously stated in subsection 2.1.3, Hansen et al (1999) presented two KM strategy options, codification, and personalization, where one key difference is in knowledge sharing. It can happen mainly via a knowledge storage system or social interactions between employees. Generally, knowledge storage fits reusable solutions while the social avenue is best suited for customized case-by-case solutions. Table 2 presents the findings of Company X respondents' views on knowledge sharing. Table 3 compiles the evaluations on the re-usability of Company X knowledge. (Company X questionnaire 2023)

Table 2. Comparing knowledge-sharing habits in Company X between knowledge storage and social actions (Company X questionnaire 2023).

Please evaluate the percentage (out of 100%) of knowledge, you share/receive via knowledge storage.	Please evaluate the percentage (out of 100%) of knowledge you share/receive via social actions with colleagues.
25 %	75 %
30 %	70 %
33 %	67 %
33 %	67 %
40 %	60 %
50 %	50 %
50 %	50 %
Average: 37 %	Average: 63 %

The results presented in Table 2 indicated a proclivity towards social actions of knowledge sharing in an average ratio of 60-40. However, as seen in Table 2, there was variation between the respondents. There were several estimations of an approximately 70-30 ratio, favouring the social action side. However,

some respondents gave a 50-50 ratio of equal importance for both knowledge-sharing types. Of course, in the questionnaire, it was assumed that most knowledge is transferred either via social avenues or knowledge storage bases. There might be additional knowledge transfer types in Company X, not addressed here. In essence, the importance of social actions of knowledge sharing between Company X colleagues could be observed here. (Company X questionnaire 2023) Therefore, it could be concluded that team building and knowledge-sharing culture incentives would be useful for Company X knowledge transfer. These topics are discussed in more detail in Subchapters 4.3 and 4.7.

Table 3. Evaluating the re-usability of Company X solutions for different applications (Company X questionnaire 2023).

Please evaluate the percentage (out of 100%) of Company X solutions that can be re-applied.	Please evaluate the percentage (out of 100%) of Company X solutions that need to be customized from case to case.
30 %	70 %
30 %	70 %
40 %	60 %
50 %	50 %
50 %	50 %
58 %	42 %
58 %	42 %
Average: 45 %	Average: 55 %

In the results displayed in Table 3, one can notice a 45-55 percentage ratio for the evaluated re-usability of knowledge vs customized case-to-case solution ratio. Keeping in mind this evaluation was done by Company X employees of all levels, it describes how the knowledge usage strategy of Company X was perceived. The actual existing strategic focus of Company X management was not addressed here. Again, variation in the results presented in Table 3 can be observed. Out of the seven respondents, two saw 60 % of the knowledge as reusable, for two others it was a 50-50 case, and three respondents saw less than 50 % of the solutions as reusable. It would take more research to find out the reason behind the differing assessments. For the purposes of this thesis, it can be deduced that in the case of Company X, it is not yet fully clear which solution type dominates: the re-usable or customized solutions. (Company X questionnaire 2023) The results in Table 3 were also related to the codification

vs personification of knowledge strategy theory by Hansen et al (1999), presented in subsection 2.1.3, and this is discussed in more detail in Subchapter 4.3.

4.2 Interview findings

The questionnaire was targeted at the entire staff of Company X, whereas the interviews were conducted with selected three key people of Company X. The key people were selected based on their expertise and experience in certain crucial areas or based on their key position in the company. The interview script can be found in Appendix 2. Essentially, the interviews were kept short and efficient, approximately 15 minutes, to value the interviewees' time constraints. The interviews revolved around three main question topics on Company X knowledge management. In the following three subsections the interview findings are presented (Company X interviews 2023).

4.2.1 The current Company X knowledge management practices and strategies

One of the interviewees in a key management position noted that one crucial aspects of KM is transforming knowledge into explicit form as data, reports, pictures, drawings, and plans. Then all this data should be stored. The objective was that knowledge would not be left as merely verbal information. Additionally, from a risk management perspective, one had to keep enough people involved in the critical skill areas, so that each skill would have a sufficient population. These were the current main focuses of KM.

Out of the example list of KM tools and practices (Cerchione & Esposito 2017) provided to the interviewees, the practices that they recognized as regularly used were brainstorming, ideas (& discussion of them), competition, case-based reasoning, and benchmarking. It was noted that for example benchmarking was limited by resources such as time and access to publication databases and relevant publications. Brainstorming was considered a powerful tool, sometimes even too much so that some filtering might be needed. Putting

the ideas into practice was considered to usually work as a good filter. It was concluded by one of the interviewees that at the time of writing this thesis research, there was a lot to learn from others. Knowledge came from both the customers and cooperation projects where experienced and knowledgeable experts were included. This knowledge was collected, filtered, and used to solve Company X's problems or to compare and analyse the capabilities of competitors. (Company X interviews 2023)

It was recognized that often knowledge is largely saved inside the people, and social networking inside the company is one main knowledge transfer avenue. Consequently, it was noted by one of the interviewees that this presented the risk of losing some of the knowledge if a key personnel member left the company. In that sense, the knowledge might not be safely stored. In addition, it was noted by the interviewee that everyone brought in their own expertise and knowledge background, to begin with, and then they acted as the knowledge deposit for those things. Not all that know-how is inherently transferable, and it moves with the people. According to the interviewee for example weekly meetings and case-based reasoning were good knowledge transfer avenues for socialized knowledge. The interviewee commented that while the company has a clear IP strategy, at the internal level it is difficult to pinpoint the KM strategy. A small company, they continued, does not need an extensive KM strategy but it has been discussed that knowledge should flow freely between the people. However, they concluded, a large portion of the knowledge was in people's heads and during knowledge transfer, the receiving party might forget something or not fully master all the transferred knowledge. (Company X interviews 2023)

4.2.2 The most crucial Company X knowledge and its management

One of the interviewees described the most essential Company X knowledge as knowledge baskets: producing starting materials for production, the specific production technology of the company, and sample testing in the product application. There should always be enough expertise in each basket, they continued. However, it was discussed that it can be difficult in a small company of about 10 people to foresee or prevent all KM-related risks. They counted that there were about 3 people in the first two baskets, while the third one was understaffed in expertise. The interviewee added that in the case of personnel changes, they kept an eye out for potential people that could be brought into the company as replacements. They considered that a short-term replacement might not be of an equal quality or experience but in those cases, the expertise could be acquired later or patched up with external help. Overall, they noted that Company X was interested in what expertise should be kept in-house and what could be outsourced to externals. For example, they continued, in some cases, the external service provider might be on the top of their field and impossible to acquire into the company otherwise. One such example, they mentioned, is process automation, where there was some expertise inside the company but there were also external people doing that as their full-time profession. It was not feasible to hire this type of person who does only automation if that skill is not needed all the time. They noted it would be better to cultivate a relationship with an external company or an entrepreneur who could learn the company's specific needs and be subcontracted as needed. In summation, it was recognized by the interviewee that while there were many functions crucial to the company, they would not alone increase the company evaluation or attract investors, as that was determined by the big picture. (Company X interviews 2023)

Another interviewee saw internal R&D knowledge as the most crucial company asset. This was because the company worked on multiple innovations that had not been tried before and therefore there was no existing previous knowledge of those applications. The R&D knowledge encompassed, according to the interviewee, how things were done, what was their outcome, and the systematic examination of the collected data. In addition, the interviewee commented,

compared to the publicly available knowledge such as scientific publications or patents, the self-produced company knowledge was fully understood in its origins. At the time of this research, the interviewee considered, this crucial knowledge was managed occasionally as there were no organized habits for KM. Knowledge was shared mostly via emails and conversations. Documenting was used in certain cases and there was the company cloud service, but it could be used more sensibly to make knowledge storage better and more efficient. (Company X interviews 2023)

Another interviewee described the crucial company knowledge to include the specific company technology-related knowledge, material management knowledge, production recipes, and side technologies needed in the main processes. An understanding was needed, they continued, concerning the application components, material choices, processing of the materials, and putting all that in a feedback loop. Overall, the interviewee added, it was important to keep up with the industry development regarding the final technology application of Company X products. There were many companies, the interviewee considered, working in that technology application area but the specific manufacturing technology of Company X was unique, making the details of that technology confidential, and one of the company's most crucial assets. The crucial assets, they considered, were managed by maintaining patents. The internal KM, the interviewee continued, was not very systematic, and the knowledge tended to personify. Company X, they concluded, was a small team located in two cities and the knowledge management came up with some duties occasionally here and there. (Company X interviews 2023)

4.2.3 Future of KM development plans and investment possibilities

On the topic of future KM investments, one of the interviewees commented that knowledge management-related investing was in a way happening all the time by over-resourcing and overtraining people in certain key roles. For example, they specified, if two people were needed for a certain action, the knowledge should be held by at least three people in case of sick leaves, holidays, or even personnel changes. In addition, the interviewee considered, the core knowledge

of a certain person might not be needed all the time, so overtraining and over-recruiting were, in a way, unavoidable, and sometimes one had to adapt by keeping certain roles in-house and outsourcing certain things. The most difficult case, according to the interviewee, would happen if there were only one expert in a certain area with whom the customers or investors were accustomed to dealing and that expert would leave the company. Fortunately, they continued, Company X has not encountered this type of risk, but these scenarios were important to consider in case they affected company evaluation. Essentially, the interviewee summarized, the risk management point of view explained why over-resourcing was needed as well as keeping up relations with possible subcontractors. Additionally, the interviewee pointed out, over-resourcing also meant being ready for company growth, at which point even more additional resources would be needed. In addition, the interviewee commented, it was important to consider how to attain staff commitment for lessened HR risks: for some people it was the salary, company shares, or other benefits. In small companies, they added, there could be additional work pressures, making it important for people to take care of their physical and mental well-being. They were not considered small things by the interviewee as they directly affected work performance or could cause surprises. (Company X interviews 2023)

Another interviewee noted that knowledge was collected, and it did not therefore just vanish out of the company. However, they saw a different type of risk in the collected knowledge not being utilized: the collected knowledge was safe, but it was not in optimal use. At the time of this research, they considered, there was probably a lot of useful knowledge somewhere but without proper tools to handle and manage the knowledge it could not be used. A possible action, they proposed, would be to organize the knowledge better and inform people of the existing knowledge more efficiently. For example, they continued, the Teams platform had been a powerful tool for sharing knowledge and working together in cooperation projects with external partners. However, the interviewee stated, the most pressing constraint for investing in better organization of company knowledge was time. (Company X interviews 2023)

Another interviewee also pointed out that the lack of time was affecting the clarity of the internal KM strategy. There was no time, they continued, to search

for a perfect solution for days, one had to just move on with something. This being the case, the interviewee considered, KM was easily lost when no documentation had been made and only the person who came up with a certain solution might know about that option. According to the interviewee, peer-to-peer sharing was the most crucial KM tool. Possibly, they continued, targeted knowledge-sharing meetings could work, but they were not sure if that concept was the most effective one. *“There is a cloud system, but it is a box full of unorganized knowledge, which is almost the same as having an empty box”*, the interviewee commented. On the other hand, they continued, if reports of every action were being made, that would take time from other work. The optimal solution would be to hire someone to take care of it, the interviewee considered. In addition, they noted that there was a lot of data that was created and might be useful if collected by methods other than incoherent paper notes or personal memory. (Company X interviews 2023)

The same interviewee concluded that KM habits should be created in every direction, but that was unavoidably something for later when there would be time. They commented that while the production parameters were logged, the material properties and characterization knowledge were not connected to it. Therefore, they continued, finding all the necessary information for process parameter planning took time and required *“data mining”*. Having everything in one library, the interviewee suggested, would improve the efficiency of process planning immensely. Still, they continued, whether or when resources could be allocated for this type of work, was the question. For example, the interviewee considered, in their previous role this type of process library, documented on physical papers and filed, was born half by accident and proved to be an extremely practical solution as a KM tool. (Company X interviews 2023)

4.3 Comparing the findings to the theory review

This subchapter draws together the practical research findings and the main theoretical frameworks connected to them. It is beneficial to compare the results to the Chapter 2 theory review of existing literature to determine the extent to which the findings support or contradict the established theories. The theoretical foundation has helped to guide the research questions and hypotheses, and it provides a basis for interpreting the findings. On the other hand, the process of comparing the findings to the theory review can help to better understand the implications of the results and to contribute to the ongoing development of the field.

4.3.1 KM awareness and emergent KM in Company X

Among the questionnaire respondents, a clear interest to give KM-related suggestions was observed at the time of this research. Furthermore, the respondents unanimously evaluated Company X as a mostly knowledge-intensive company. The overall clear awareness of the concept of KM and company KM strategy was at the level of 43 % (3 out of seven respondents). However, another 43 % (3 out of seven respondents) identified as not fully aware of general KM but managing their work-related knowledge. (Company X questionnaire 2023) As already mentioned in Subchapter 4.1, this indicated the possibility of emergent style KM being underway at Company X. Emergent KM is defined as knowledge sharing and KM practices that “*emerge*” from the practical needs of day-to-day business activities in a bottom-up manner and oftentimes are not officially notified as KM (Zieba et al. 2016). Moreover, Zieba et al. (2016) found that in small case enterprises it was often certain key employees who were best aware of what knowledge should be collected and organized to answer better to the day-to-day challenges. Company X's staff consisted mostly of scientifically trained people and science education prepares for handling data and knowledge in one's research. Therefore, useful emergent knowledge management practices that might already be happening at Company X could be included in the official KM strategy if recognized. This could be one way to develop KM without putting in extra resources. Also, Zieba et al. (2016)

advocated for awareness towards the emergent practices by the management of SMEs so that good practices could be noted and developed, or even officialised as routine processes by the companies. On the other hand, if the company already had KM practices that it would like everyone to use unanimously, the awareness of the staff concerning these practices could be improved.

4.3.2 Knowledge transfer strategies

According to the interview comments, there was a need to develop the availability, organization, and transfer of knowledge (Company X interviews 2023). These things were needed both internally and when engaging with external consultants. Managing the knowledge needed for one's work efficiently does not automatically mean that the communication of that knowledge is taken care of. According to the questionnaire findings, the knowledge sharing was primarily done via social actions, and partially via knowledge storage, in an approximately 60% to 40% ratio (Company X questionnaire 2023). This highlighted the importance of social actions in knowledge sharing at Company X. Additionally, peer-to-peer sharing, and meetings were mentioned in the interviews as important knowledge transfer avenues (Company X interviews 2023). On the other hand, the knowledge storage (cloud) was referred to in the interviews as an underutilized knowledge-sharing platform and a disorganized knowledge storage system (Company X interviews 2023). Thereby, it was also possible that if the knowledge storage and its usage were not optimal, social avenues were simply seen as easier ways to share knowledge and were thus preferred. It was interesting that the observation of social actions being the prevalent knowledge transfer practice conflicted with the general KM aim of Company X in translating knowledge into explicit form (Company X interviews 2023). From this point of view, developing the existing knowledge storage strategy might be beneficial. Still, the prevalence of knowledge sharing via social actions was logically in agreement with the notions made in Chapter 2 about knowledge often being people-tied in the case of small companies (Cerchione & Esposito 2017; Joe et al. 2013; Nunes et al. 2006; Zieba et al.

2016). Similar comments on personified knowledge in the small team were made in one of the interviews (Company X interviews 2023).

According to Hansen et al (1999), both social knowledge sharing and well-developed knowledge storage are relevant strategic options and it is more about choosing the right strategy for the set purpose of the company. As presented in subsection 2.1.3, personification (social actions as primary) and codification (knowledge storage as primary) are two different KM strategies often found in the knowledge-intensive consultancy industry (Hansen et al. 1999). Furthermore, Hansen et al (1999) recommended choosing one of those approaches as the primary knowledge strategy, with approximately 80% to 20% ratio between the two. The question then stood, what was the most suitable strategic approach for Company X in the framework of this KM theory? There might be other factors for Company X KM that this theoretical framework does not address. However, it could provide a useful mirror to play with different KM strategy options.

4.3.3 Monetization of the knowledge and KM strategy

Hansen et al. (1999) advise choosing the main KM strategy based on the types of knowledge the company produces, how they are monetized, and the company's business model. Figure 9 presents the codification vs personalization strategies as first displayed in subsection 2.1.3. In the questionnaire research, the overall views on re-usability of the Company X knowledge were addressed. As explained in subsection 2.1.3, one main aspect in choosing the knowledge strategy is whether the company focuses on producing reusable knowledge or customized knowledge (Hansen et al. 1999). And this again depends on Company X's customer's needs.

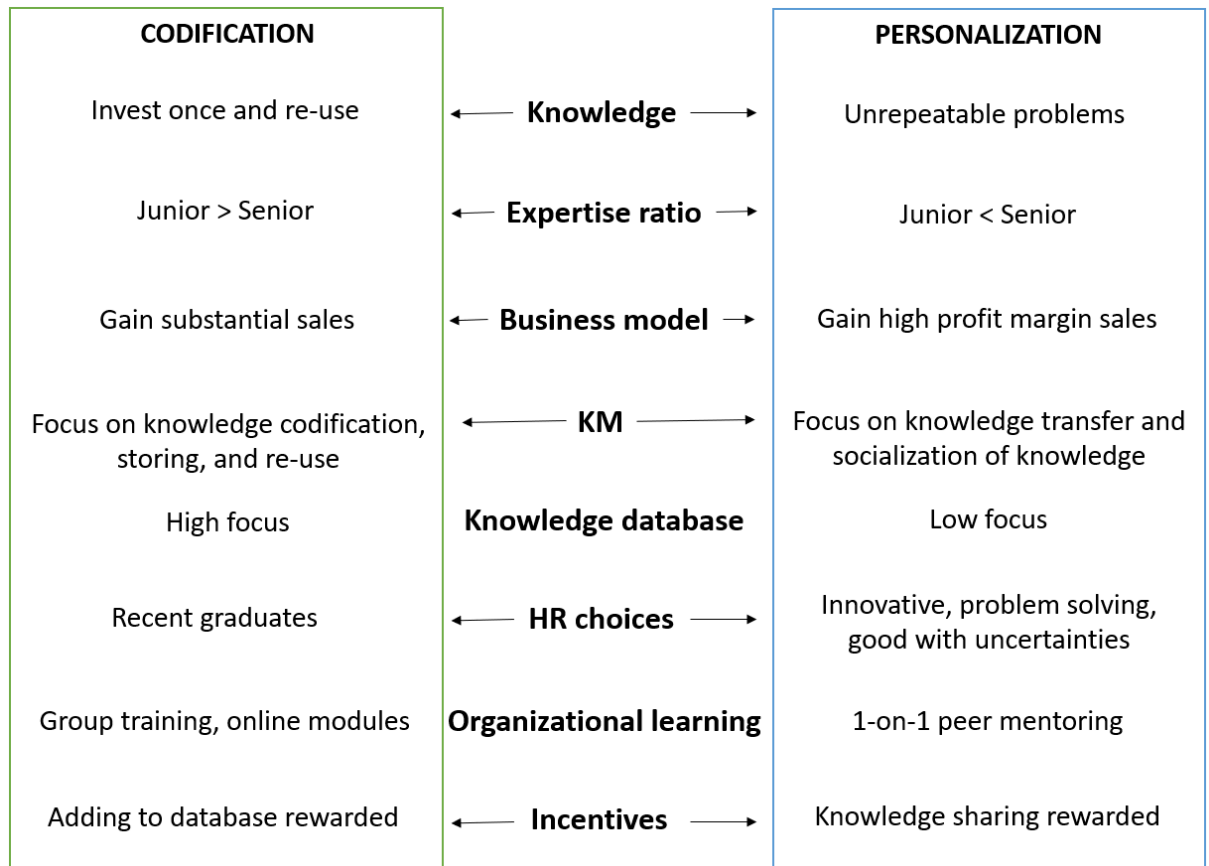


Figure 9. Knowledge strategies modelled after Hansen et al. (1999)

In the questionnaire, it was evaluated that 45% of the company solutions were reusable and 55% were customized case-by-case. Again, this evaluation was made by Company X employees of all levels. There was a notable variance in the answers, with some respondents evaluating that 70% of the solutions were customized case by case, others that 50%, and some that 42%. (Company X questionnaire 2023) The variance could be caused by different people dealing with different types of knowledge or the company KM not being clear. However, finding the answer to this would require more research at the case company. Essentially, if Company X found this theory framework useful this could be one KM strategy point to clarify. Furthermore, as mentioned by Hansen et al. (1999) the main strategy might also change during the company's development. For Company X in the growth phase, the optimal strategy choice at the time of this research might not be the final KM strategy aimed for. This is also discussed in Subchapter 4.7.

4.3.4 Optimizing the knowledge processes

Another consideration is looking into potential improvement points in the overall knowledge flow processes in Company X. Figure 10 represents again the theory on knowledge processes, as first explained in subsection 2.1.3. In knowledge production, according to the interview findings, both R&D knowledge creation and external procurement were found essential (Company X interviews 2023). Knowledge storing was referred to as an unorganized and underutilized process (Company X interviews 2023). It was found important by Company X management, this is one clear improvement point. In the knowledge flow, social processes were preferred according to the questionnaire and interview findings (Company X questionnaire 2023; Company X interviews 2023). The SECI cycle (Nonaka 1991) is one representation of how company knowledge travels between the tacit and explicit realms while being transferred from peer to peer. Socialization is the act of transferring tacit knowledge, often via an extended mentor-mentee relationship. This could be a helpful framework in transferring person-tied knowledge that includes a tacit side. In subsection 2.2.5, the role of organizational learning in knowledge sharing was discussed further.

Procuring external knowledge assets	Identification of key knowledge	Knowledge sharing & transfer
Internal creation of knowledge, innovation	Knowledge codification	Used and applied knowledge
Producing knowledge	Storing knowledge	Knowledge flow

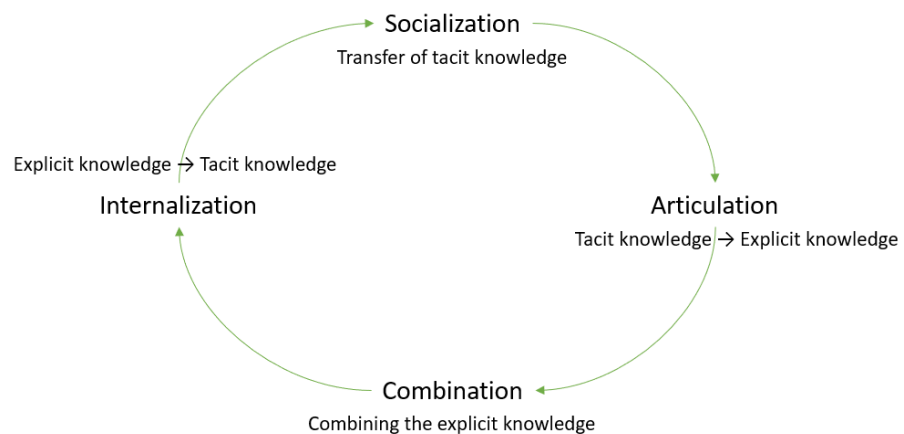


Figure 10. Knowledge processes and phases pictured after Obeso et al. (2020) and Nonaka (1991).

4.3.5 KM and risk management

From the interview findings, the risk of person-tied knowledge being lost due to personnel changes were recognized in Company X (Company X interviews 2023) and in the theory review subsection 2.2.2. In addition, in one of the interviews, it was commented that it would create a difficult situation if there was only one expert in a certain area, whom the customers or investors were accustomed to contacting, and that expert would leave the company (Company X interviews 2023). This is also mentioned by Joe et al. (2013): the name and authority of a single person might have an important role inside the company or in the customer interface, making losing them a big risk. Fortunately, Company X has not encountered this specific risk, but it was recognized as something a small company should be aware of (Company X interviews 2023). Overall, referring to the interview findings, Company X's KM risk management strategy included keeping a talent pool that was slightly bigger than the existing personnel need (Company X interviews 2023). Consequently, critical knowledge was learned by multiple people. In addition, Company X considered outsourcing some tasks to external consultants. (Company X interviews 2023). In subsection 2.2.2 lack of resources, especially time, was recognized as the biggest challenge in SME KM (Nunes et al. 2006). Externalizing some expertise would be one way to optimize time resource usage within the case company. Another key challenge in SME KM mentioned in subsection 2.2.2 is that the short-term is always considered over the long term due to the challenging business environment of an SME (Nunes et al. 2006). Still, based on the interview comments Company X seemed quite well prepared on the risk management front (Company X interviews 2023).

4.4 Knowledge mapping

The knowledge mapping procedure started by organizing the knowledge categories based on the interview findings on the most crucial company knowledge. After this, the knowledge mapping lists gained from the questionnaire were categorized and complemented by interview findings. The knowledge mapping list is presented in Table 4. The underlined items in Table 4 represent knowledge that was possessed by only 1–2 people in Company X, as found by the questionnaire respondents. The rarity of the knowledge items was estimated by company employees of all levels. Therefore, the knowledge items named as rare in Table 4 could also potentially be knowledge that was available in principle but not easy to access or find. If this was the case, the items perceived as rare in Table 4 (but not as rare as deemed there) could serve as possible starting points for knowledge-sharing initiatives. (Company X interviews 2023; Company X questionnaire 2023)

Table 4. Knowledge taxonomy of Company X where the underlined items were rare knowledge inside Company X (Company X interviews 2023; Company X questionnaire 2023).

Internal R&D creation of new knowledge that does not exist yet		
Procedures	R&D silent knowledge	Materials handling
Know-how	IP creation	
Results	Deep understanding of key technologies	
Production of starting materials		
Materials	Processes	Results
Production process & technology		
Process control	Physics	Quality control of samples
Process parameters	Mathematics	<u>Characterization techniques</u> <u>Modelling of the physical process</u>
Process know-how <u>Details of the process system</u> <u>Recipes</u>	Coding <u>Process automation</u> Machine maintenance Mechanical engineering <u>Optical setup & photonics</u>	Interaction of power & matter
Building process units	Vacuum technology	
Designing process units <u>Product creation knowledge</u> <u>Trial and error history</u> Comprehensive process library	Production equipment Power source technology	
Application testing		
Mathematics	Characterization Next generation materials	<u>Application testing procedures</u>
Specific branch of chemistry Performance affecting factors	Application materials & their properties	<u>Performance test results</u>
Business management		
Customer collaboration	Project management	IP creation & strategy
Customer negotiations	Networking	IP management
Customer management	Funding of advanced R&D technology	
People management		
Team building	People management	Teamwork Knowing other people's strengths
Operation management	People engagement	
Other		
Laboratory working practices	English	Dangerous goods logistics
Chemical safety	Chemical handling	Sample logistics

For the knowledge mapping, both the questionnaire data, as well as the interview data were considered. This allowed the questionnaire estimates regarding knowledge diffusion or structure level to be supplemented with a Company X management view. Therefore, in the final knowledge map, the

defined rarity of a knowledge item came from different perspectives, making it more accurate. On the other hand, the management level might not have been aware of all practical issues affecting the knowledge flow on the floor level. Application testing knowledge was recognized as rare unanimously, which makes sense as it was a relatively new area for Company X. Process automation was perceived unanimously as a rare internal skill. However, it was considered in one of the interviews that this skill could and possibly should be externalized. Production process technology was considered by the management side as a solid company skill. There was a lot of company history and personal experience behind that knowledge category. However, it was considered as partially rare knowledge by the questionnaire respondents in items “*details of the processing system*”, “*recipes*”, “*product creation knowledge*”, and “*trial and error history*”. The comments made in the interviews might shed light on this. One respondent felt that not having easy access to the process history (collected over a span of a decade) was slowing them down in process development. Another interviewee commented that there was a lot of data and knowledge that was unorganized and therefore not optimally exploited. Considering these comments, production process technology could be suffering from a knowledge flow issue. (Company X interviews 2023; Company X questionnaire 2023) This is discussed further in Subchapter 4.7 with the KM development suggestions to Company X.

In the next steps, a Boisot (1999, 41–69) knowledge map as styled by Ihrig & MacMillan (2015) was drawn based on the knowledge item list presented in Table 4 combined with interview insights. The knowledge map is of a limited depth, for the scope of this thesis, because a more extensive map would require more research. Additionally, it must be borne in mind that this map tool was designed with larger organizations in mind. However, here it is used for knowledge mapping in a small company with for example no separate departments. The definitions for knowledge map and its axes, as first explained in subsection 2.1.4, are presented in Figure 11 and repeated below for reader comfort.

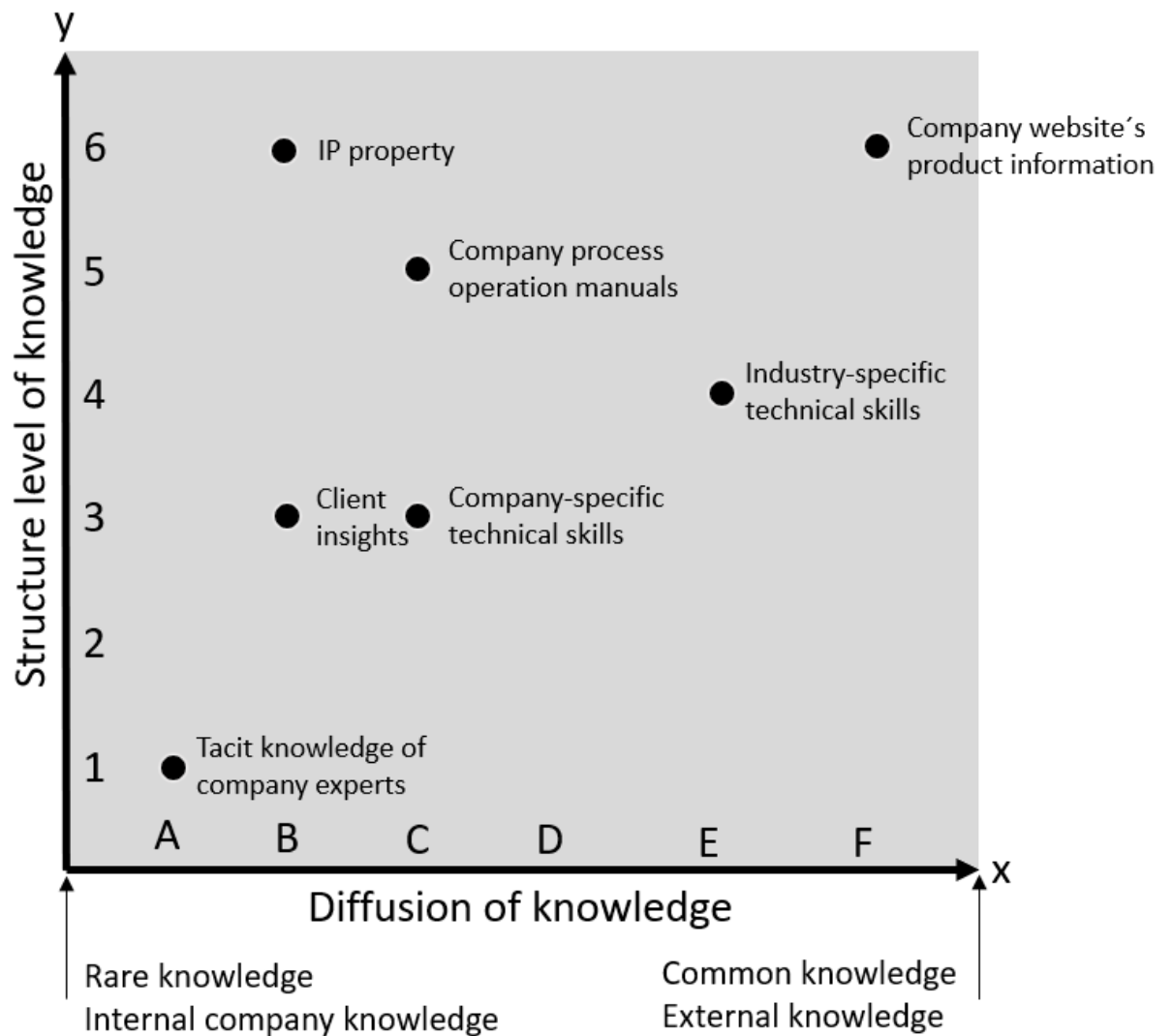


Figure 11. Knowledge map after Ihrig & MacMillan (2015) article and based on Boisot (1999, 41–69) model of information space. Examples of knowledge placement in the information space are given.

Figure 11 presents an “*information space*” knowledge map (Boisot 1999, 41–69). In the map, the structure level of knowledge (y-axis) describes to what extent the cause-and-effect relationships in that knowledge are known and how well they can be controlled. As a set of examples relating to Figure 11, at level 1 an expert uses their tacit knowledge to produce results, but the process is intangible and hard to explain. At level 2 two experts can work together and exchange their tacit knowledge while doing so. Level 3 is where a task can be performed by a non-expert but requires rounds of trials and errors. At level 4 the relationship between the actions and their results is becoming clearer, and at

level 5 it can be documented. Level 6 signifies precise knowledge that leads to the desired result every time. These are usually patented solutions. Knowledge diffusion measures how rare a certain piece of knowledge is, and it is presented in the x-axis of Figure 11. As a set of examples relating to Figure 11, at point A only one expert in the company has the tacit knowledge inside their head. At level B a minority (the experts) in the company has the knowledge and they can discuss it among themselves. Level C signifies knowledge held by multiple people within a specific sector of the company. Level D is awareness held by people in all sectors of the company. Level E stands for knowledge that is generally held by all companies in a certain industry field. At level F, the knowledge is familiar to a large population, including those outside that specific industry. (Ihrig & MacMillan 2015)

To begin, the knowledge items presented in Table 4 were divided into six categories as per the structure level of the knowledge. The knowledge categories for the items are given in Table 5. The underlined items in Table 5 were found rare by the questionnaire respondents. Additionally, the questionnaire findings as well as interview comments were used to define the rarity of a knowledge item internally (Company X interviews 2023; Company X questionnaire 2023). In addition, some items might have been rare internally but available externally as services or consultancy assignments. These evaluations are compiled in Table 6.

Table 5. Dividing the knowledge taxonomy for Company X into six knowledge structure level categories. The underlined items are found by the respondents to be rare knowledge inside Company X (Company X interviews 2023; Company X questionnaire 2023).

Subject expert tacit knowledge	Subject expert explicit knowledge	Trial & error task performance
1	2	3
Internal R&D creation of new knowledge that does not exist yet		
R&D silent knowledge Deep understanding of key technologies	IP creation Know-how	
Production of starting materials		
	Materials	Processes Results
Production process & technology		
<u>Details of the process system</u> <u>Product creation knowledge</u>	Process know-how Designing process units Physics Coding <u>Process automation</u> <u>Optical setup & photonics</u> <u>Modelling of the physical process</u>	Interaction of power & matter Mechanical engineering
Application testing		
	Specific branch of chemistry Performance affecting factors <u>Performance test results</u>	<u>Application testing procedures</u>
Business management		
Customer negotiations Networking	Customer management Funding of advanced R&D technology IP creation & strategy	
People management		
People management People engagement		Knowing other people's strengths Teamwork
Other		
	Laboratory working practices Chemical safety	

Table 5. continued Dividing the knowledge taxonomy for Company X into six knowledge structure level categories. The underlined items are found by the respondents to be rare knowledge inside Company X (Company X interviews 2023; Company X questionnaire 2023).

Rules of thumb found	General principles clear	IP level - causalities fully clear
4	5	6
Internal R&D creation of new knowledge that does not exist yet		
Materials handling	Procedures Results	
Production of starting materials		
	Processes Results	
Production process & technology		
Process parameters	Process control	Building process units
<u>Trial and error history</u>	Process parameters	Comprehensive process library
Machine maintenance	<u>Recipes</u>	
Power source technology	Vacuum technology	
Quality control of samples	Production equipment	
	<u>Characterization techniques</u>	
	Mathematics	
Application testing		
	Mathematics	
	Application materials & their properties	
	Next generation materials	
	Characterization	
Business management		
	Customer collaboration	
	Project management	
People management		
	Team building	
	Operation management	
Other		
Chemical handling	Dangerous goods logistics	English
	Sample logistics	

Table 6. Dividing the knowledge taxonomy for Company X into six knowledge diffusion categories. The underlined items are found by the respondents to be rare knowledge inside Company X (Company X interviews 2023; Company X questionnaire 2023).

One key person A	Few people in the company B	Many people in a team C
Internal R&D creation of new knowledge that does not exist yet		
Know-how of a certain thing	IP creation Procedures Deep understanding of key technologies	R&D silent knowledge
Production of starting materials		
	Processes	Materials
Production process & technology		
Process control	Process know-how	Process parameters
<u>Details of the process system</u>	<u>Trial and error history</u>	<u>Recipes</u>
<u>Product creation knowledge</u>	Comprehensive process library	Quality control of samples
<u>Modelling of the physical process</u>	Production equipment Interaction of power & matter	<u>Characterization techniques</u>
Application testing		
<u>Application testing procedures</u>	Performance affecting factors	Characterization
<u>Performance test results</u>	Application materials & their properties	
Business management		
Customer negotiations	Customer collaboration & management	
Customer management	Project management	
Networking	IP creation & strategy & management	
Funding of advanced R&D technology		
People management		
People management	Team building	Teamwork
People engagement	Operation management	
Other		

Table 6. continued Dividing the knowledge taxonomy for Company X into six knowledge diffusion categories. The underlined items are found by the respondents to be rare knowledge inside Company X (Company X interviews 2023; Company X questionnaire 2023).

Many people in the company	Many people in the industry	Large population held knowledge
D	E	F
Internal R&D creation of new knowledge that does not exist yet		
Results	Materials handling	
Production of starting materials		
Results		
Production process & technology		
Machine maintenance	Building process units Designing process units Physics Mathematics Coding <u>Process automation</u> Mechanical engineering <u>Optical setup & photonics</u> Vacuum technology Power source technology	
Application testing		
	Mathematics Specific branch of chemistry Next generation materials	
Business management		
People management		
Knowing other people's strengths		
Other		
	Laboratory working practices Chemical safety Chemical handling Dangerous goods logistics Sample logistics	English

Finally, the definitions of Table 5 and Table 6 were put together into the visual presentation of a knowledge map. The knowledge map is presented in Figure 12. Organizing the collected data on company knowledge on a map could help with the KM strategizing process. For example, in the knowledge map, there were four bigger clusters of knowledge items. Also, we can see clearly what knowledge was available externally and what knowledge is held internally, and how that knowledge was diffused.

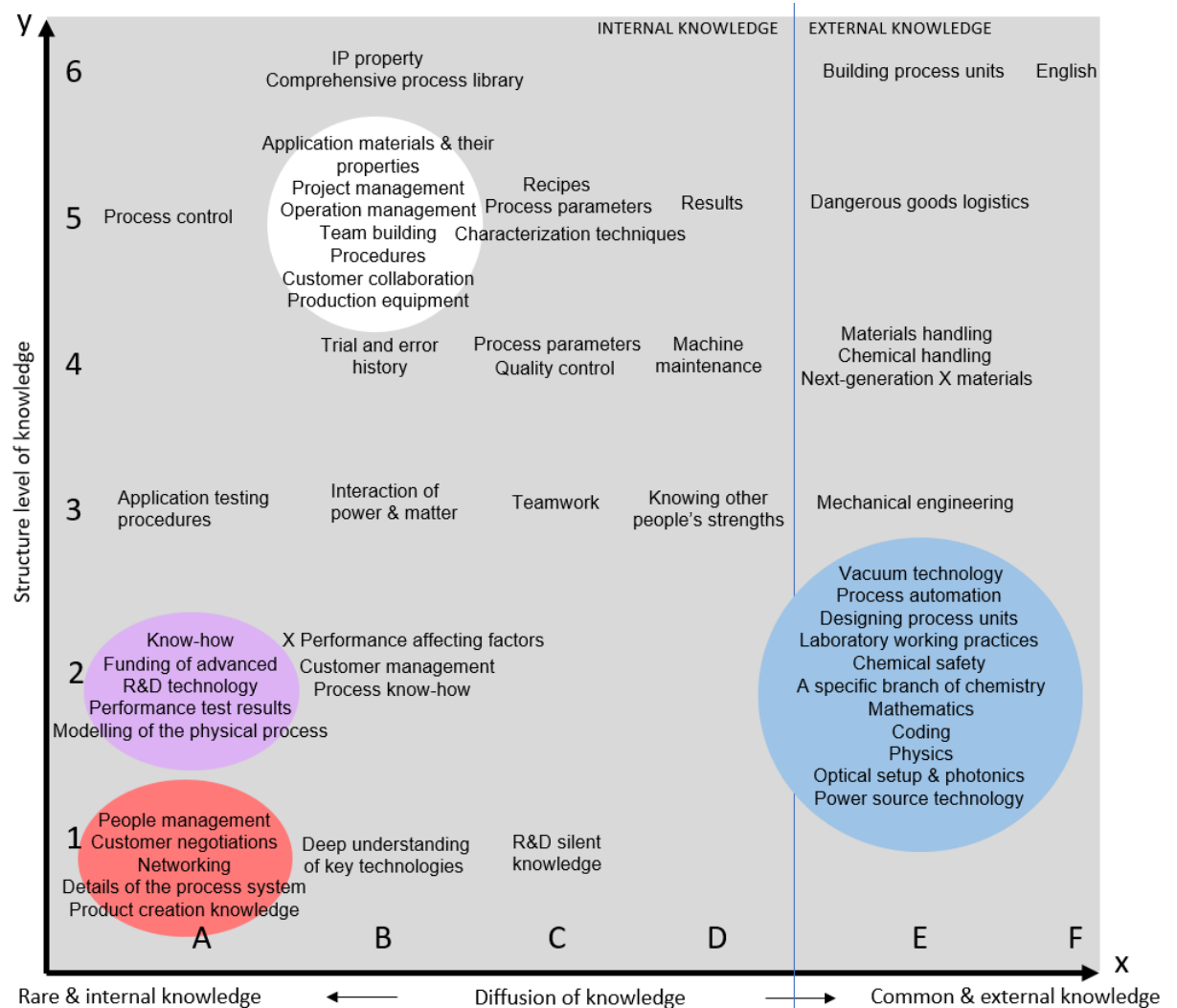


Figure 12. Knowledge mapping of Company X from inputs gathered in the questionnaire and interviews (Company X interviews 2023; Company X questionnaire 2023), mapping was done as explained by Boisot (1999, 41–69) and Ihrig & MacMillan (2015).

Furthermore, the four knowledge clusters circled in Figure 12, could give us vital KM planning advice. The red and purple clusters in Figure 12 represent the rare expertise knowledge of Company X. Knowledge items included in these groups

could be potential future IP material if they are made more structured, essentially moved up the y-axis. For example, “*details of the process system*”, “*product creation knowledge*”, “*know-how*”, and “*performance test results*” (material performance in the final application of the technology) are potential knowledge monetization targets for Company X. In the blue cluster we can see knowledge items that are expert knowledge which is generally available externally. This cluster represents the knowledge that Company X could potentially externalize. In addition, these are skills that Company X could generally look for in their new employee candidates, as they would be useful. The white cluster represents Company X’s middle management (and project manager) responsibilities and knowledge. In conclusion, the knowledge map can give us a lot of useful information to plan KM in Company X. Such knowledge mapping would ideally be an iterative process executed in cooperation with the target company (Ihrig & MacMillan 2015). Therefore, the knowledge mapping presented here could serve as a starting point for more detailed mapping processes in Company X in the future should the need arise.

The knowledge map findings on critical company knowledge feature similar touchpoints with the theory presented in subsection 2.2.1. on critical SME organizational knowledge. Joe et al. (2013) presented five key categories of knowledge: subject expertise, business connections and networking, organizational memory, business knowledge of processes & company value expansion, and governance-related knowledge. Subject expertise on science is available externally, but it is still an expertise-level knowledge group. Business connections and networking are in the red cluster of Figure 12, sparsely diffused partially tacit knowledge. Organizational memory is presented in multiple places in the knowledge map in Figure 12, for example, in the “*trial and error history*”. Business knowledge of processes & company value expansion is featured also in the red and purple clusters, as well as governance knowledge. This is logical as these knowledge items are generally not held by many.

4.5 Assessing the reliability and validity of the research findings

To begin, the advice of Gillham (2000, 13) was followed and the findings from two different data collection methods, the questionnaire, and the interview, were compared for the unity of logic. As already addressed in Subchapter 4.1, the questionnaire was targeted to all levels of employees, while the interviews featured management side or more experienced employees. Therefore, the questionnaire provided data on how the KM of Company X was generally perceived, while the interviews searched for data on the existing KM strategies of Company X. The logical disparities between these two methods were desirable research material for conclusions on the KM status and possible development points. These were analysed and addressed in Subchapter 4.3.

Additionally, as stated in Subchapter 3.6, three techniques advised by Yin (2018) are addressed. These were pattern matching, explanation building, and logic modelling. Pattern matching could be done based on research assumptions made in Subchapter 1.3. There it was assumed that person-tied knowledge and unevolved organizational memory could expose an SME to the vulnerability of knowledge loss. This was addressed in the interviews as a legitimate concern in the case company. However, in the interviews, another unforeseen risk was found in unutilized knowledge due to it being stored in an unorganized manner. Also, knowledge mapping showed that a lot of the expertise knowledge was available also externally or could be acquired by the company. The risk of knowledge loss might therefore have been greatest specifically at the rare internal knowledge items. Knowledge mapping was presented in Subchapter 4.4. Pattern matching showed that the research question framing, made based on SME KM theory and research preconceptions pointed to a promising direction but the specific case of Company X held more details than what was anticipated. Logic modelling and explanation building were used in Subchapter 4.3 where the questionnaire and interview findings were compared to the theory to find possible explanations.

Finally, reliability and validity concerns expressed in Subchapter 3.6 are commented on. While the anonymity of all participants could be guaranteed externally, the interviews might not have been fully anonymous for the

Company X audience. This might have affected the reliability of the interview results in some ways. People might have said what they wanted to be true or what they thought others would like to hear. Additionally, some valuable data analysis on how KM was seen from the perspective of different roles could not be included in this research since a certain answer could not be connected to a certain role without compromising the anonymity of the respondent internally within the case company. However, in general, the interviewees were open and relaxed about being interviewed and nonchalant about the others possibly being aware of this. They were themselves openly referring to being interviewed in normal workplace discussions. As for the research process affecting the company KM already, it was possible but unlikely, due to the lack of time resources available for KM at Company X.

4.6 Answering the research questions

The objective of this Thesis, as first presented in Subchapter 1.3, was to research possibilities to use KM as a tool to alleviate the vulnerabilities to knowledge loss in small high-tech enterprises. The research question revolved around identification, diffusion level, transfer efficiency, and documentation of critical knowledge of Company X. Finally, the purpose of charting the current KM status of Company X and making an extensive theory review on SME KM was to answer the following key question: how knowledge should be managed during the growth phase of a small company to alleviate the risk of losing critical knowledge tied to key personnel. In this subchapter, these research questions are answered based on the research findings presented in Subchapters 4.1 to 4.4. Overall, this thesis provided a comprehensive look into KM at the case company.

The identification and diffusion level of critical Company X knowledge culminated in the knowledge mapping presented in Subchapter 4.4. The knowledge map combined Company X knowledge items recognized as critical by employees and management and organized them into a map based on the diffusion level and structure degree of the items. In the map, the internal Company X knowledge and externally available know-how important for

Company X could be distinguished. According to the knowledge mapping results, internal key operational knowledge items were “*details of the process system*”, “*product creation knowledge*”, “*know-how*”, and “*performance test results*” (material performance in the final application of the technology). Key company management knowledge items included “*funding of advanced R&D technology*”, “*customer negotiations*”, “*networking*”, and “*people management*”. Essentially, these were the rare key internal knowledge items that should be guarded against knowledge loss risks.

Knowledge transfer efficiency was researched in both the questionnaire and interviews. It was analysed and discussed in detail in subsection 4.3.2. At the time of this thesis research, an average of 60% of the transferred knowledge was evaluated to be transferred by social actions, as considered by Company X employees of all levels (Company X questionnaire 2023). The current knowledge storage system of Company X was found both underutilized and unorganized (Company X Interviews 2023). It was not found to be, in its current form, optimal for efficient knowledge transfer. This gave Company X options. It could focus on social knowledge-sharing avenues or develop an improved knowledge storage system for ease of finding the needed knowledge. Documentation of critical knowledge was addressed in the interviews. It was found important for Company X to eventually translate the key knowledge into explicit forms of documentation. On one hand, documentation was found lacking due to time pressures and the complicated knowledge being heavily person-tied. On the other hand, knowledge was documented but it could still sometimes “*disappear*”, in the sense that it was not efficiently put to re-use. (Company X interviews 2023; Company X questionnaire 2023)

Finally, the question of how knowledge should be managed during the growth phase of a small company to alleviate the risk of losing critical knowledge tied to key personnel is addressed. In the interviews it was commented that not all KM-related risks can be foreseen, despite risk management planning and that the greatest impediments to KM improvement in the case company were time constraints. Therefore, KM improvements should be chosen with care and integrated into existing processes as far as possible. All KM recommendations

for Company X were compiled in Subchapter 4.7. It was acknowledged that not all the risks in SME KM could be controlled. Still, Company X had a solid risk management plan. Based on this thesis case study, it would be recommended that the rare key knowledge items, as mentioned earlier in this chapter, should as a priority be retained in the company. Additionally, as the company grows, improving the knowledge storage would likely become important to avoid spending resources on re-creating already existing knowledge. Alternatively, focusing on team building and designated interfaces for social knowledge sharing could be beneficial.

4.7 Recommendations for Company X KM development

As many of the recommendations for Company X were based on knowledge mapping, the knowledge map compiled in Subchapter 4.4 is presented again in Figure 13 for reader comfort. Firstly, in an interview, there was an expressed interest in what Company X should keep in-house and what could be attained as external services (Company X interviews 2023). In short, items in Figure 13 on the external knowledge diffusion side, have the potential to be externalized for consultants working in the scientific industries. However, these knowledge items also include general skills needed in scientific R&D work and not everything can be externalized. Still, knowledge items in the far right of the knowledge map in Figure 13 could be easily considered for acquisition as external services when internal knowledge resources on a topic are lacking or otherwise occupied.

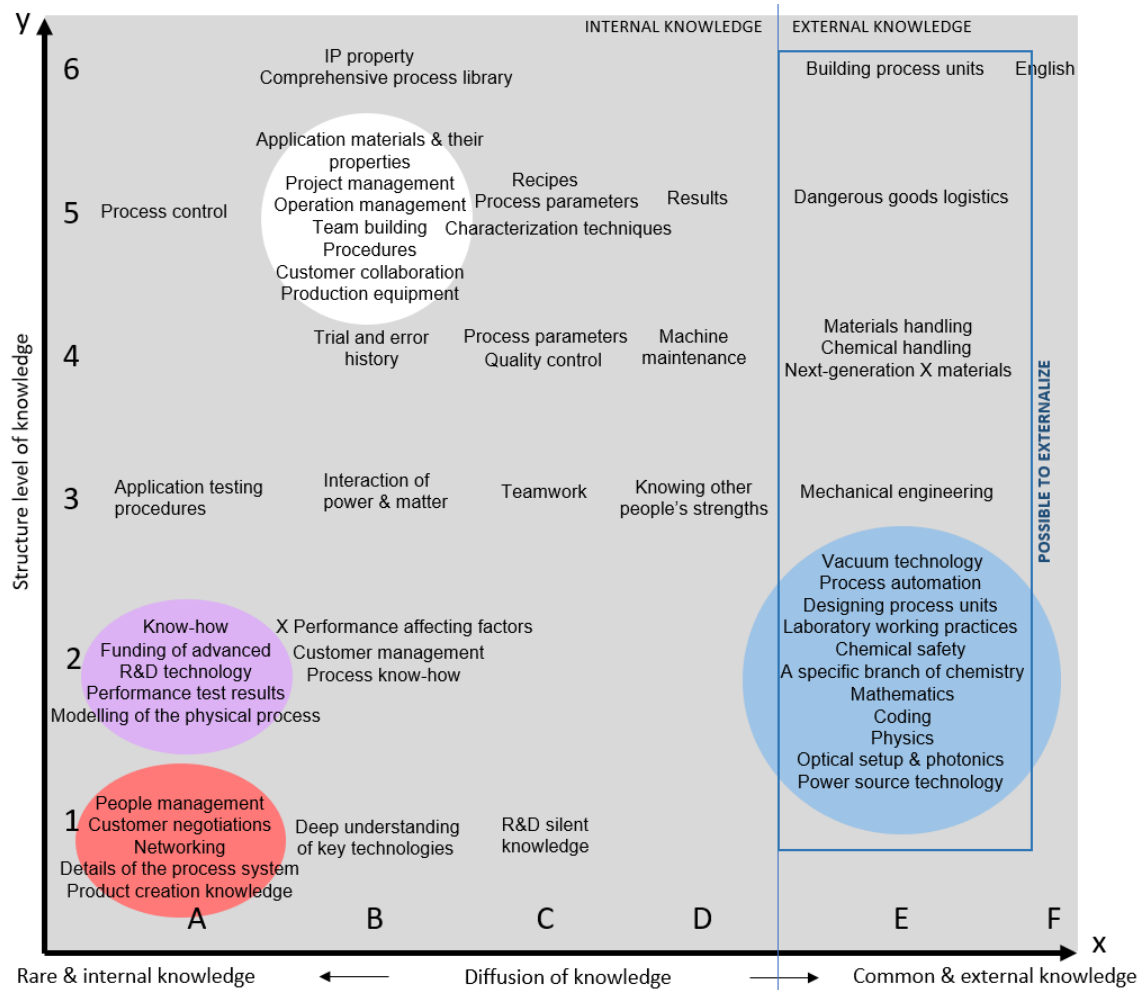


Figure 13. Knowledge mapping Company X from inputs gathered in the questionnaire and interviews, mapping is done as explained by Boisot (1999, 41–69) and Ihrig & MacMillan (2015).

As already mentioned earlier, time constraints were affecting the KM possibilities at the case company and in the small enterprise sector in general. Therefore, putting resources into KM development must be done with careful consideration and with the best possible return on investment in mind. One potential development point suggested by this thesis was knowledge transfer and storage. These KM activities are important internally as well as when working with external contractors. If done right, KM improvement here could save time and resources for the employees and externals in the long term. If gone wrong, the developments could add a layer of bureaucracy that creates no extra value.

This thesis work provided the case company with two alternative suggestions on knowledge transfer & storage. Firstly, investing time into a knowledge storage system. This was also discussed at the end of one interview as an all-

encompassing process library (Company X interviews 2023). Ideally, all data created in R&D: material handling, process parameters, characterization data, testing results, etc. should be found without excessive data mining. This could be solved with one safe internal knowledge storage system to which all the big data, old and new, would be uploaded. Data should be labelled with certain search words for example sample number. In that case, Company would have a type of internal wiki hosted for example on network-attached storage (NAS) which makes it possible to add and access data both from inside the company premises as well as remotely. Artificial intelligence (AI) based big data mining algorithms could be used to analyse this raw data and provide structured useful information on demand. This layer of AI-based programming could be used by any user to produce for example on-demand ready-made reports that include for example all data on a certain sample set. This type of data handling would take resources to set up but would provide a return on investment if the company used a lot of reusable solutions in the future.

Secondly, as an alternative option, the company could focus on utilizing social actions as the main knowledge transfer method. Now it was evaluated by the employees that on average 60% of the knowledge transfer happened via social avenues (Company X questionnaire 2023). But, in this case, Company X should optimize these social actions. To begin with, the importance of team building and knowledge-sharing & learning incentives should be recognized. Organizational learning and knowledge-sharing incentives were discussed in more detail in subsection 2.2.5. As the risk management of Company X included having multiple people skilled in critical tasks, most likely mentoring is needed. This process of passing on tacit expertise knowledge is well described by the SECI cycle (Nonaka 1991), latest displayed in subsection 4.3.4. All in all, if the social action-founded knowledge transfer was chosen, those processes should be valued and encouraged. This strategy could provide the best return on investment if the company needs versatile employees who can produce customized solutions. In essence, both social actions and functional knowledge storage are essential, but the main questions are, in what ratio and at what stage of the company's growth.

5 CONCLUSIONS

This final chapter concludes this thesis work. To begin, the main results of the case study research are summarized. Additionally, the theoretical and practical implications of this thesis study are discussed. After that, the reliability, validity, and limitations of this research work are evaluated. Finally, conclusions of this thesis work are given, and future research prospects based on this thesis are considered.

5.1 Summary of the results

The highlight of the results was the emergence of distinct knowledge clusters in the knowledge map. Each cluster was a unique representation of a key knowledge dimension of Company X: the rare internal tacit knowledge cluster which is expert-centric, operation-based knowledge cluster which is middle management and project manager centric, and the cluster of commonly existing industry knowledge which is again expert-centric. According to the knowledge mapping results, internal key operational knowledge items were “*details of the process system*”, “*product creation knowledge*”, “*know-how*”, and “*performance test results*” (material performance in the final application of the technology). Key company management knowledge items include “*funding of advanced R&D technology*”, “*customer negotiations*”, “*networking*”, and “*people management*”. Overall, these were the rare key internal knowledge items that should be guarded against knowledge loss risks.

Moreover, based on the questionnaire, the case company was found to be perceived as highly knowledge intensive. A clear interest among questionnaire respondents to give KM-related suggestions was observed although the minority of the personnel in the company was fully aware of knowledge management. Interestingly, a fraction of the employees had been, possibly unaware, managing their knowledge relating to their responsibilities. Furthermore, it was evident from the questionnaire that much of the knowledge transfer in the case company took place via social interaction. (Company X questionnaire 2023) Based on the interviews this could partially have been due

to the company knowledge storage being unorganized and underutilized. Finally, it was observed that the risk management relating to knowledge loss was conducted by training multiple employees on the key tasks, rather than comprehensively documenting the procedures and protocols in a knowledge storage system. (Company X interviews 2023)

5.2 Theoretical and practical implications

In this thesis work, emergent knowledge management theory and its appearance in the SME sector are discussed as presented by Zieba et al. (2016). Emergent KM is defined by KM practices that “*emerge*” from the practical needs in a bottom-up manner (Zieba et al 2016). There were implications in the questionnaire findings that emergent knowledge management could be undergoing in the case company (Company X questionnaire 2023). Moreover, it was pointed out in the interviews that some knowledge of the case company was tied to individual employees (Company X interviews 2023). This is a commonly found phenomenon in the SME sector according to the SME KM literature (Cerchione & Esposito 2017; Joe et al. 2013; Nunes et al. 2006; Zieba et al. 2016). All things considered, SMEs and especially small enterprises face distinctive challenges in KM implication from lack of resources and a myopic focus caused by their challenging business environments (Durst & Edvardsson 2012; Nunes et al. 2006). This was also evident in the interviews with the case company that the lack of time, in particular, was acknowledged as an impediment to KM. Additionally, it is pointed out that not all KM risks could be predicted as there were several unknown variables. (Company X interviews 2023) Furthermore, the case company was unanimously perceived as knowledge-intensive by the questionnaire respondents (Company X questionnaire 2023). Knowledge-intensive enterprise is defined by its significant basis in problem-solving and creativity, usually working on a new application or technology, and generally possessing a highly educated workforce (Nunes et al. 2006; Joe et al. 2013).

On top of that, knowledge transfer in Company X was slightly dominated by social actions over knowledge base usage (Company X questionnaire 2023).

The interviews revealed that the current knowledge base was underutilized, possibly due to its disorganized structure and non-clear usage protocol (Company X interviews 2023). From the theoretical perspective, this might imply that the company was using the social-avenue-based personalization approach as described by Hansen et al. (1999). On the other hand, the codification strategy that relies on a centralized knowledge base (Hansen et al. 1999) might bring another type of value for the Company when it expands and should therefore be also considered. Together this strategy model or personalization versus codification provided a comprehensive framework for considering the KM options for Company X.

Finally, this thesis provided a Boisot (1999, 41–69) style knowledge mapping as described by Ihrig & MacMillan (2015) for Company X knowledge that was acknowledged as critical by the employees and the management. The data gathered from the questionnaire responses and the interviews when put into a Boisot (1999, 41–69) knowledge map, formed clusters of key knowledge. The main aim of knowledge mapping was to reveal the knowledge environment of the research subject and to potentially point out their key knowledge. In the case of Company X, it revealed two clusters with rare internal expert knowledge of Company X, which might carry future IP potential. Additionally, another cluster represented the expert knowledge which is generally available externally. This is the knowledge that Company X could potentially externalize or optionally look for in new hire candidates. The final cluster collected the general middle management and project management tasks related to Company X. The emergent knowledge map findings mostly agreed with the findings on critical SME organizational knowledge by Joe et al (2013). On the whole, knowledge mapping turned out to be a valuable tool for this thesis research because organizing and visualizing the company knowledge answered the research questions on critical knowledge identification and its diffusion.

5.3 Evaluation of the results: Validity, reliability, and limitations

To ensure the validity and reliability of the research results presented in this thesis different data collection methods, a questionnaire, and interviews in this

case, were used as advised by Gillham (2000, 13) for case study research. Both views from all Company X employees and management were ensured a voice in the results. Explanation building and logic modelling, as explained by Yin (2018), were the two dominant techniques for analysing the results. Additionally, pattern matching (Yin 2018) was used to confirm the risk of personnel-tied knowledge loss. However, the risk of unutilized but existing knowledge emerged during the interview stage (Company X interviews 2023), unpredicted. Therefore, while the SME KM theory-based research question framing pointed to a promising direction, the specific case of Company X held more details than what was anticipated. All in all, this complied with the nature of the case study method, which is always highly context-related (Gillham 2000, 1).

Limitations to this case study research arose from the small size of the case company. The interview and questionnaire replies could not be connected to the exact role of the respondent in the case company without compromising the anonymity of their replies internally at Company X. Due to this, some valuable data analysis on how KM was seen from the perspective of different roles could not be included in this research. Even with these precautions, while the overall anonymity of all participants could be guaranteed externally, the interviews might not have been fully anonymous for the Company X audience. This might have affected the reliability of the interview results. However, the interviewees seemed open and relaxed about being interviewed and were by themselves openly referring to being interviewed in this research in their normal workplace discussion.

5.4 Conclusions and recommendations for future research

In conclusion, this thesis provided an overview of KM in the small high-tech enterprise case company X. In the scope of this thesis, knowledge management in small enterprises was researched in a case study conducted in a small Finnish case company. The objective of this thesis was to research the possibilities of using KM as a tool to alleviate the vulnerabilities to knowledge loss in small enterprises. Research data was collected through a questionnaire

targeted at the whole case company team, and three short interviews with key people in the case company. The research questions revolved around charting identification, diffusion level, transfer efficiency, and documentation of critical knowledge of Company X.

Finally, the purpose of charting the current KM status of Company X and making an extensive theory review on SME KM was to answer the following key question: how knowledge should be managed during the growth phase of a small company to alleviate the risk of losing critical knowledge tied to key personnel. The greatest impediment to KM improvement in the case company was the time constraint. Therefore, it was essential to choose KM improvement points with care. While Company X saw risk management as a part of its KM, all the risks could not be controlled. Based on the case study conducted in this thesis, it was recommended that the knowledge map could be used in Company X KM planning. Especially the rare key knowledge items emergent in the map should be protected against knowledge losses. Moreover, as the company grows, clearing up the knowledge transfer strategy could be beneficial. Company X could improve the current knowledge storage and adjacent protocols to avoid spending resources on re-creating already existing knowledge. Alternatively, Company X could focus on team building and designated interfaces for social knowledge sharing to optimize the knowledge transfer between colleagues.

Finally, this thesis holds potential for further research at the case company or by including a larger number of research-based small enterprises. One possibility would be to continue research on knowledge transfer at the case company to optimize the company KM strategy in this aspect. Another future research path could be addressing how to turn the key Company X knowledge into a competitive advantage with KM. Furthermore, one could investigate the monetization opportunities for case company knowledge, and the possible business models to build around them. This would be a valuable report for Company X in its growth phase. Other research possibilities could include researching a larger sampling of small knowledge-intensive high-tech enterprises for their KM strategies and statuses, including investigating the

potential existence of emergent knowledge management in more detail. As emergent KM in SMEs is still a relatively understudied concept (Zieba et al. 2016), especially in Finland, this would provide interesting data to add to the literature on SME KM. In conclusion, the base research provided in this thesis could be continued in multiple directions to add to the understanding of KM at the case company or small enterprise sector in general.

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APPENDICES

APPENDIX 1: Questionnaire form

Please read questions 1–2 and choose from the below options what describes you best.

1. Are you aware of how knowledge management is implemented in Company X?
 - YES, I am actively involved in Company X knowledge management.
 - YES, but I am not actively involved in Company X knowledge management.
 - NO, I am not involved in Company X knowledge management.
 - NO, but I manage my own knowledge as needed for my tasks and responsibilities.

2. Have you recently given suggestions/ provided ideas for Company X knowledge management?
 - YES, I think my personal knowledge management system/habit might benefit the whole company if implemented.
 - YES, I think so, but I am not sure of the definition of knowledge management.
 - NO, I have not seen any need so far.
 - NO, I am not sure of the definition of knowledge management.

A knowledge-intensive enterprise is defined by a notable need for creativity and problem-solving, usually on an uncommon application(s). Most employees are of high educational and experiential backgrounds, the work is greatly independent. (Nunes et al., 2006). Enterprise sectors generally regarded as knowledge-intensive include for example scientific, engineering, consulting, law, and architecture (Joe et al., 2013).

3. How knowledge-intensive do you see Company X on a scale from 1–10 where 1 stands for “highly labour-based # and 10 stands for “*highly knowledge-based*”?

Knowledge mapping is a tool for identifying and classifying company knowledge. In Boisot's (1999) information space tool, presented in Figure 1, knowledge is mapped by its diffusion rate (sparse vs. common knowledge) and structural level (tacit expertise vs ready IP). Knowledge is often dealt with in two dimensions: explicit and tacit. Explicit knowledge is easy to express in writing or spoken words, for example, workplace instructions. Tacit knowledge is not easy to put into words, it includes experience, persona, and cognitive input. (Weed-Schertzer, 2020, 12 - 14)

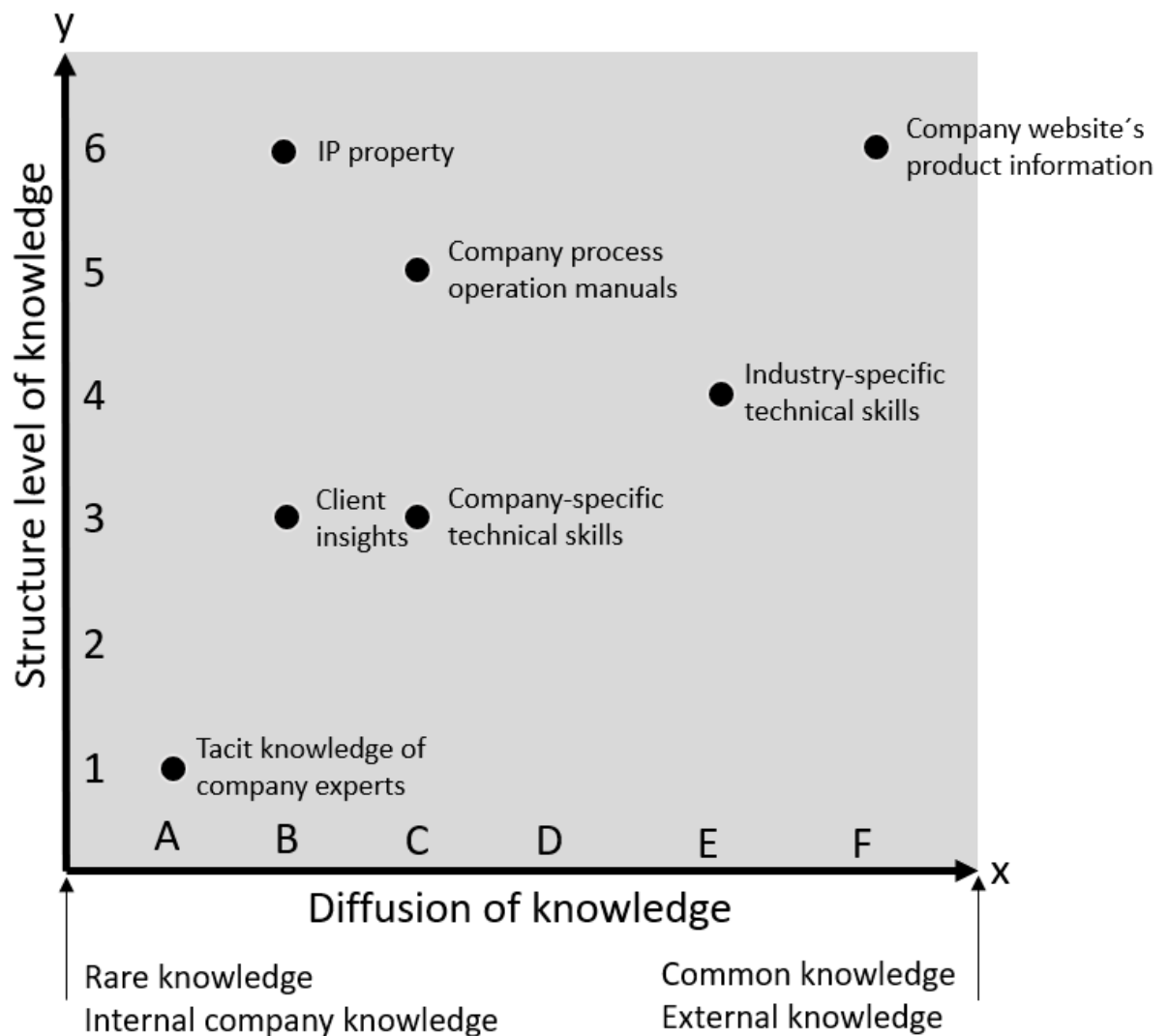


Figure 1. Knowledge map after Ihrig & MacMillan (2015) article and based on Boisot (1999, 41–69) model of information space. Examples of knowledge placement in the information space are given.

The answers to questions 4–6 will be used for knowledge mapping of Company X. Answers will be used as an overall source pool of knowledge types. They will

be neither identified as coming from a certain respondent nor connected with your other answers.

The provided knowledge types will be grouped into generalized categories by the researcher and the researcher will make sure no explicit company technology, material, etc. is named in the final published thesis.

4. Write in types of knowledge you see as crucial to the core functions of Company X, please. These can include both your own areas of expertise/responsibility and other knowledge areas you see as crucial to the overall functions.
5. Please identify, in your perception, the five (5) most crucial knowledge categories in Company X.
6. Is there, in your perception, some rare knowledge that is crucial for the company? This means knowledge that is not easy to acquire externally AND is possessed by only 1–2 people in Company X.

Knowledge sharing between colleagues can happen via knowledge storage (cloud, internal system, etc.), in which case, knowledge is translated into an explicit written/numeral format. Alternatively, knowledge sharing can happen via social actions, where the shared knowledge can be a mix of explicit and tacit knowledge (see question sets 2–3 for the definition of tacit knowledge).

7. Please evaluate the percentage (out of 100%) of knowledge you share/receive via knowledge storage.
8. Please evaluate the percentage (out of 100%) of knowledge you share/receive via social actions with colleagues.

New knowledge is created in Company X to create value for the company and solve encountered problems. In some cases, knowledge creation is invested in once, and then the knowledge can be re-used. In the case of unique challenges with mostly unrepeatable problems, customized solutions need to be created.

9. Please evaluate the percentage (out of 100%) of Company X solutions that can be reused.

10. Please evaluate the percentage (out of 100%) of Company X solutions that need to be customized from case to case.

APPENDIX 2: Interview script form

1. What knowledge management practices or strategies exist in Company X?
2. What knowledge is most crucial for Company X and how is that knowledge managed?
3. Do you see that investing (time/money) in KM practices/tools could help to alleviate risks of knowledge loss? Would that be a worthwhile investment to Company X, why/why not?

Included a taxonomy of KM practices & tools in the SME sector by Cerchione and Esposito (2017).

Table 1. An extensive taxonomy of KM tools and practices used by SMEs is collected after Cerchione and Esposito (2017).

KM process	KM tools in SMEs	KM practices in SMEs
Knowledge Creation	Data Mining	Brainstorming
	Data Visualization	Ideas
	Expert Systems	Competition
	Social Data Mining	Knowledge Elicitation
	Text Mining	Interview
	Collaborative filtering	Benchmarking
	Crowdsourcing Systems	Knowledge Filtering
	Mash-up	Rating
	Prediction and Idea Markets	
	Syndication Systems	
Knowledge Storing	Trust and Reputation Systems	
	Business Process Management	Casual Mapping
	Configuration Management Systems	Knowledge Mapping
	Content Management Systems	Knowledge Modelling
	Product Data Management Systems	Problem-Solving
	Product Lifecycle Management	Process Mapping
	ERP Systems	Social Network Analysis
	Databases and Data Warehouse	After Action Review
	Data Management Systems	Balance Scorecard
	Document Management Systems	Best Practices
Decision Support Systems	Contextual inquiry	
Knowledge Transfer		Knowledge Office
		Lesson Learned
	Cloud Computing	Case-Based Reasoning
	Learning Management Systems	Coaching/Mentoring
	Peer-to-peer Resource Sharing	Practice Communities
	Podcasting/Videocasting	Communities of Sharing
	Social Media	Focus Groups
	Wiki	Job Rotation
	Audio/Video Conference	Learning By Doing
	Blogs	Work Groups
Chat	Facilitated Discussion	
Conversational Technologies	Meeting/Task Force	
E-mail	Informal Networks	
	Knowledge Cafes	
	Seminars	
	Storytelling	