Improving knowledge sharing in a Chinese IT company

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March 2018

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Xiaodong Ming: Improving knowledge sharing in a Chinese IT company
M.Sc. thesis, 63 pages, 3 index and appendix pages
March 2018

Abstract

In modern organizations, knowledge is a crucial resource which provides a sustainable competence advantage in business and has a positive effect on project success. Organizations can obtain knowledge from different sources including the daily practices. Knowledge sharing is a complicated process where individual initiatives, organizational social ecology, technologies and knowledge management cycle should be inclusive. The author had worked in a Chinese IT company and observed the scenarios and challenges in the company's routine work due to the lack of practice on knowledge sharing or poor quality of the shared knowledge. Accordingly, this thesis discusses the knowledge sharing practice in this company by drawing on the collected scenarios.

This thesis reviews the research on knowledge management, knowledge sharing and project success papers to establish a systematic and comprehensive understanding. A case study which includes observation and interviews is conducted, and a model is proposed to analyze the knowledge sharing problems in the case company.

The proposed model includes both a knowledge management cycle model and the extrinsic factors which affect knowledge sharing initiative and the quality of the shared knowledge. Furthermore, organizational strategies need to be linked with knowledge sharing as well. This is a comprehensive and holistic model where the relationship between extrinsic factors and three knowledge management cycle stages is specific explained.

Key words: organizational social ecology, knowledge management, knowledge sharing, project success

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1. Introduction

In recent years, many information technology (IT) companies have been established in China. They are growing rapidly with the breakthrough of hardware and deep learning. However, not all the IT companies survived. Most of contemporary companies are project-oriented. Many factors such as top management support, technology and collaboration can facilitate the success of a project [Davis 2014; Jugdev and Müller 2005; Lim and Mohamed 1999; Pinto and SleviSn 1987]. Therefore, the success or failure of projects have a big influence on the development of companies. Being a successful IT company, it shall continuously improve its working processes, methods and tools to deliver products effectively and efficiently. It is necessary for the IT companies to tackle different challenges to seek for a sustainable competitive advantage.

Being an intern in a Chinese IT company, the author observed that many projects could not complete smoothly because of insufficient and ineffective knowledge management. The most common two problems are lack of knowledge sharing and low quality of the shared knowledge. In view of this, this thesis aims to solve the knowledge sharing problems in this Chinese IT company.

Lee et al. [2016] summarized "knowledge as a mixture of information, experience, value standards and norms, which by this definition could be evidenced in documentation, information, technical reports, professionalism and know-how." Compared with traditional economies, contemporary economy has seen knowledge as a competitive asset rather than tangible assets [Beijerse 1999]. Nonaka and Takeuchi [1995] mentioned that Japanese companies have been successful in automotive and electronics industries because of organizational knowledge creation and dissemination. As organizational assets, it is important to transfer knowledge from source to people who need to know [Hinds et al. 2001]. Consequently, it is necessary for a company to properly manage its knowledge and to share it in a right way.

1.1. Research objectives

Many researchers have addressed the importance of knowledge sharing in organizations. They have studied knowledge sharing from different aspects such as the extrinsic motivators [Bock et al. 2005], the top-management support [Lee et al. 2016], organizational culture [Lee et al. 2016], or virtual community context [Chiu et al. 2006]. However, some of previous studies discussed knowledge sharing in general, and the research was conducted in a universal

condition rather than in a specific industry and country [e.g., Rubenstein-Montano et al. 2001; Safa, & Von Solms 2016]. On the other hand, some of them studied knowledge sharing under a specific industry in a typical country. Hasan and Crawford [2003] investigated the interaction between technology and knowledge sharing based on two Australian universities. Suppiah and Singh-Sandhu [2011] studied how did organizational culture influence the knowledge sharing based on seven Malaysia organizations. So far, there is no unifying and comprehensive knowledge management model accepted by majority researchers and enterprises. Because different organizations might have their own unique social ecology such as organizational culture, structure, information system and reward system [Gupta and Govindarajan 2000], which causes the variants of knowledge management models.

This thesis studies on knowledge sharing related practices in a Chinese IT company, and the research question of this study is presented below:

- What kind of scenarios are related to knowledge sharing in the case study company? If knowledge sharing problems exist in the scenarios, can they be solved with one of the available knowledge management models? If not, how can we improve it to fit the situation?

1.2. Research methods

Knowledge sharing positively contributes to project success. Meanwhile, there are many extrinsic factors which affect knowledge sharing initiative and the quality of shared knowledge. Therefore, the first step of this research is to undertake a qualitative examination of the relationship among organizational social ecology, knowledge sharing and project success based on the available research achievements through literature review to build a holistic and systematic understanding on them. Additionally, the overall goal of this research is to improve knowledge sharing in the case Chinese IT company. Therefore, it is necessary to have insights into the real knowledge sharing situation in the company. The author observed the work activities related to knowledge sharing in the case Chinese IT company's big data center to identify what kind of problems they had. To avoid the subjective perception of the author, several interviews were designed to collect information about knowledge sharing practices in the case company from other person's perspective. Based on the previous researches, a specific and comprehensive solution model was proposed to improve the work processes which were affected by insufficient and ineffective knowledge sharing, and the availability of the solution model was also evaluated by several interviewees.

1.3. Thesis structure

The thesis consists of seven chapters. Chapter 2 introduces the concept of knowledge and knowledge management, the knowledge taxonomy, a prescriptive model of knowledge management. Chapter 3 discusses the relationship between each organizational social ecology determinants and knowledge sharing, followed by the introduction of a knowledge management model proposal. Chapter 4 reviews the project success factors in a chronological order, and discusses why knowledge sharing has positive effect on project success. Chapter 5 contains the introduction of the case company, the procedure of the case study as well as the target data, the explanation of observation and interview method which are used in the case study, and ethical consideration of this research. Chapter 6 analyzes and discusses the data collected from the case company, and feedbacks on the solution model is presented, followed by the contributions, limitations and future work. Finally, Chapter 7 draws the conclusion of this thesis.

2. Knowledge and knowledge sharing

This chapter starts with the definition of knowledge, where there is a comparison of data, information and knowledge. Explicit knowledge and tacit knowledge are briefly discussed, as well as the categories of knowledge assets in an organization. Next, the definition of knowledge management (KM) and one knowledge management cycle model are introduced as well as the importance of knowledge management in a company.

2.1. What is knowledge?

There is a slight variation among the definitions of knowledge. The traditional definition of knowledge was first proposed by Plato [1953; cited in Kakabadse et al. 2003] as "justified true belief". Accompanied with debate from different schools of philosophy, this definition had dominated Western philosophy for a long time [Nonaka and Takeuchi 1995; cited in Kakabadse et al. 2003]. It is not always satisfying. Nonaka et al. [2000, p. 7] indicated that "this view fails to address the relative, dynamic and humanistic dimensions of knowledge".

Besides, Gammelgaard and Ritter [2000; cited in Al-Alawi et al. 2007, p. 24] defined knowledge as:

> A fluid mix of framed experience, values, contextual information, and expert insight that provide a framework for evaluating and incorporating new experiences and information. Knowledge originates and prospers in the minds of experts. In organizations, it often becomes embedded not only in documents of repositories but also in organizational routine, process, practices, and norms.

Lee et al. [2016, p. 464] articulated that "knowledge is considered as a mixture of information, experience, value standards and norms, which by this definition could be evidenced in documentation, information, technical reports, professionalism and know-how."

In addition, researchers on knowledge management have a consensus that knowledge should be distinct from data and information. There is a pyramid hierarchy (see Figure 1) where data is at the lowest level, with information in the middle, and knowledge at the highest level [Barclay and Murray 1997; Kakabadse et al. 2003; Becerra-Fernandez and Leidner 2008]. Data emphasizes on the original and raw facts or statistics which can be easily captured, stored and communicated. Information extends from data, and organizes data into meaningful content. Finally, knowledge is information interpretation based on one's experience, understanding and

intuitions, or information leading to actions and decisions. Although there is difference between information and knowledge, many researcher use the terms ‘information’ and ‘knowledge’ interchangeably when discussing knowledge sharing area without clearly distinguishing them [Barclay and Murray 1997].

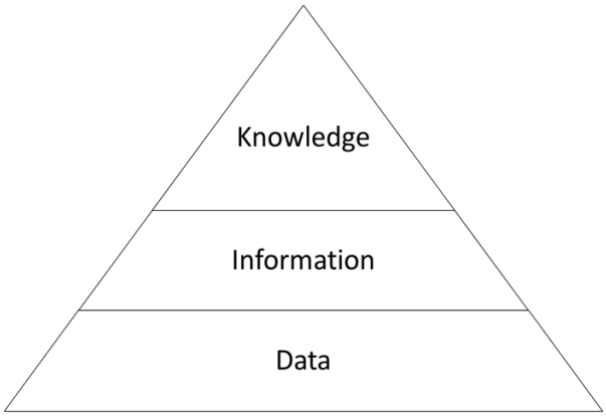

Figure 1. DIK hierarchy – developed from [Rowley 2007, p. 163].

Moreover, “recent perspective treats knowledge as a transformation process, enabling the conversion of data into information or information into decisions” [Becerra-Fernandez and Leidner 2008, p. 5]. For example, Figure 2 shows an example of the transformation from data to knowledge. It is a fragment of log file. The original captured data is meaningless for non-IT workers. With a little network knowledge, the data can be interpreted as continuous request records which contain an IP (Internet Protocol) address, a request time, a request context, status and size. This meaningful data is information. Finally, developers who have sufficient knowledge in this area can use the information to do some analysis or prediction to improve their products or provide some concrete statistics which might help the leaders have a clear understanding of current situation and design the future. For example, summing over the total request per hour can monitor the user activities or predict the possible trend.

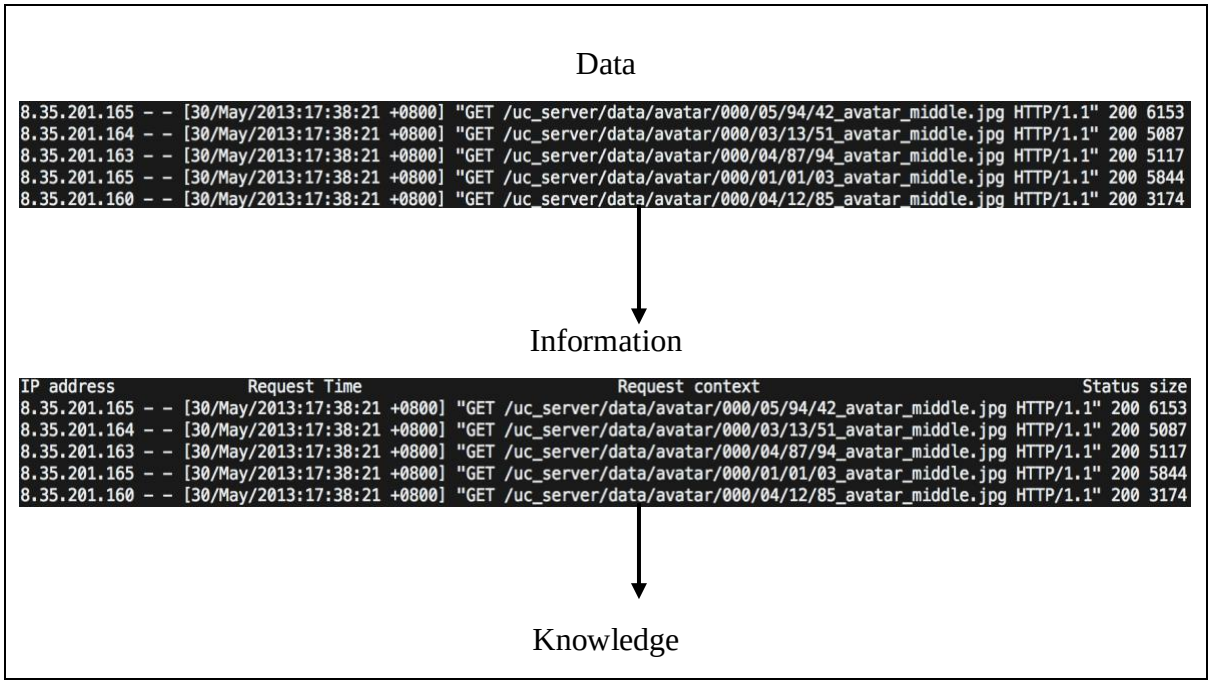

Figure 2. Example of transformation among data, information and knowledge.

In this thesis, knowledge is considered as a mixture of information, experience, value standards and norms which leads to a further decision and actions based on one's personal experience, judgement, attitude, intuition and belief [Lee et al. 2016].

According to the above definition, the following four knowledge examples can be seen as the representation of information, experience, value standards and norms in an IT company respectively:

- Information is explicit knowledge and easy to understand. Information such as project schedule, the running status of a system can help employees better plan what to do next.
- Experience is the hands-on knowledge which gains from practices. An experienced employee can help others cope with bugs he or she has fixed.
- Value standards refer to what is appreciated within an organization. Customer-oriented, collaboration and innovation are the examples of value standards in an organization.
- As a definition in the dictionary, norm is an expected pattern of behavior and belief. Technical norms in an organization help new employees build their understanding of routines such as the coding style, the process of releasing a new version of a product, etc.

Knowledge is an important organizational asset, which can be reused and provide competitive advantages in the market and lead to success [Barclay and Murray 1997; Wang and Noe 2010]. For instance, customer involvement helps companies learn what the customers want, and customer feedback provides an outside view to promote product improvement [Riege 2005]. However, unlike tangible assets, the characteristics of knowledge is unique as it cannot be imitated or substituted after creating [Al-Alawi et al. 2007]; contextualized as it depends on a specific situation, domain knowledge or experience [Nonaka et al. 2000]; volatile as it not always remains the same and needs to be updated. Those characteristics make knowledge difficult to manage. That is why many researchers have attempted to build a systematical and effective knowledge management model and system to help organizations exploit knowledge in good use.

2.2. Explicit and tacit knowledge

Knowledge can be classified as either tacit or explicit [Polanyi 1962]. Nonaka et al. [2000, p. 7] described tacit knowledge and explicit knowledge as follow:

> "Explicit knowledge can be expressed in formal and systematic language and shared in the form of data, scientific formulas, specifications, manuals and such like. It can be processed, transmitted and stored relatively easily. In contrast, tacit knowledge is highly personal and hard to formalize. Subjective insights, intuitions and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in action, procedures, routines, commitment, ideals, values and emotions."

Smith [2001, p. 315] has referred explicit knowledge can be "technical data, academic data or information that is described in a formal language, like manuals, mathematical expressions, copyright and patents". It is logical and expressive. A people-to-documents approach [Smith 2001] can be used to record, transfer and reuse explicit knowledge. It means knowledge holders make records of their knowledge through documentation, audio, video or other methods, then store in a repository or a knowledge management system for the recipients. For example, Stackoverflow (https://stackoverflow.com/) is a developer community where developers can share their knowledge. A developer can post a problem he or she faced, and the others who know how to tackle this problem can write some advices or tips to provide help. Moreover, it also helps other developers come across the same problem for later use.

Tacit knowledge is more abstract than explicit knowledge. It is rooted in personal experience, cognition, attitude and behavior [Lee and Yang 2000]. Because of this, it cannot be easily documented for sharing like explicit knowledge. For example, it is easy to teach someone the action and pose when he or she rides a bike. But how to keep balance is too complicated to describe, and he or she can only gain this skill through practices.

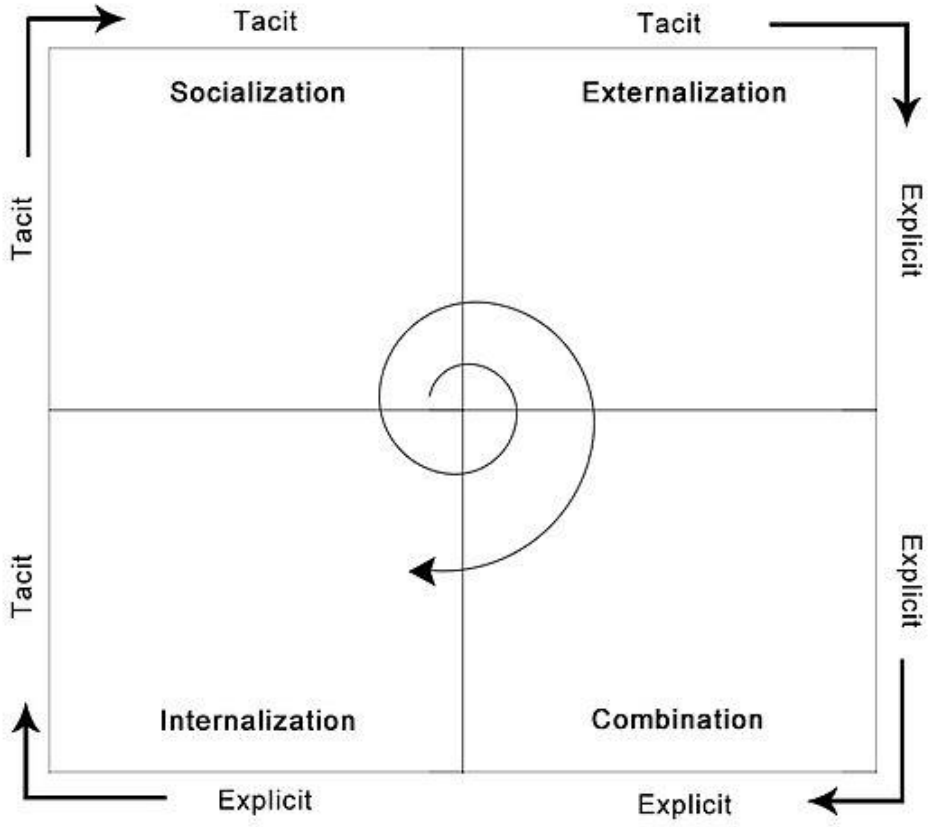

Figure 3. The SECI model adapted from Nonaka [1994].

As shown in Figure 3, Nonaka [1994] proposed a SECI (the abbreviation of socialization, externalization, combination and internalization) model. The model indicated that tacit knowledge can be converted to explicit knowledge through externalization or to tacit knowledge through socialization from one person to another. Externalization is the process of articulating tacit knowledge into explicit knowledge by sequentially sensible use metaphor, analogy and model [Nonaka et al. 2000]. Socialization is the process of transferring source side tacit knowledge to destination side based on common experiences [Nonaka et al. 2000]. In addition, combination is the process of collecting and synthesizing explicit knowledge into more intricate and systematic explicit knowledge sets, and internalization is the process of

embodying explicit knowledge into tacit knowledge such as learning by doing [Nonaka et al. 2000].

Because of the conversion from tacit knowledge to explicit knowledge, tacit knowledge can be shared among individuals, groups or organizations. The key to learn and understand tacit knowledge is simultaneous processing where self-involved activities such as observation and practice play a critical role. Smith [2001, p. 314] has addressed some methods of sharing tacit knowledge such as "altruistic sharing, networking, face-to-face contact, videoconferencing, chatting, storytelling, personalize knowledge" where all of them are the example of people-to-people approach.

2.3. Knowledge assets in an organization

One challenge of knowledge management is how to manage the knowledge assets in an effective way because of the tacit nature of knowledge and different characteristics of different knowledge. Therefore, Nonaka et al. [2000] proposed an adequate accounting system (see Figure 4) which classifies organizational knowledge into experiential knowledge assets, conceptual knowledge assets, routine knowledge assets and systemic knowledge assets. Consequently, it helps organizations create and store their knowledge in a structured and logical manner.

Experiential Knowledge Assets	**Conceptual Knowledge Assets**
Tacit knowledge shared through common experiences • Skills and know-how of individuals • Care, love, trust, and security • Energy, passion, and tension	Explicit knowledge articulated through images, symbols, and language • Product concepts • Design • Brand equity
Routine Knowledge Assets	**Systemic Knowledge Assets**
Tacit knowledge routinised and embedded in actions and practices • Know-how in daily operations • Organisational routines • Organisational culture	Systemised and packaged explicit knowledge • Documents, specifications, manuals • Database • Patents and licenses

Figure 4. Four categories of knowledge assets [Nonaka et al. 2000].

Experiential knowledge assets involve hands-on tacit knowledge which is produced in a contextual situation among the employees in an organization or between the members of the

organization and other stakeholders [Nonaka et al. 2000]. The skills and experience generated from a problem-solving process are instances of experiential knowledge assets. They are the core assets which provide a sustainable competitive advantage to an organization. However, due to the nature of tacit knowledge, experiential knowledge assets are hard to capture, store and transfer [Nonaka et al. 2000].

Conceptual knowledge assets involve articulate explicit knowledge presented by images, symbols and language such as products concept, design and brand equity [Nonaka et al. 2000]. They are bonded with the customers' and employees' conception. It is difficult to learn the perception of each stakeholder, but conceptual knowledge is easier to manage than experiential knowledge.

Routine knowledge assets are tacit knowledge which is embedded in the organizational practices and behaviors [Nonaka et al. 2000]. For example, a certain pattern of thinking style and behaviors are shaped, enhanced and shared between employees after successive practice.

Systemic knowledge assets consist of systematized and structured explicit knowledge such as "explicitly stated technologies, product specifications, manuals, licenses, patterns, and documented and packaged information about customers and suppliers" [Nonaka et al. 2000, p. 21]. Due to the characteristic of explicit knowledge, systemic knowledge assets are easy to capture, store and transfer. Therefore, companies pay more attention on managing and using the systemic knowledge assets.

2.4. Knowledge management

Knowledge management has been studied by many researchers for more than 30 years [Girard and Girard 2015], but there is no consensus on the definition of knowledge management. Because it varies from different disciplines and even varies in the same discipline due to different research perspectives. Generally, Girard and Girard [2015, p. 2] summarized the most two accepted and cited definitions of knowledge management as below:

> Knowledge Management is a conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that strive to improve organizational performance. [O'Dell and Grayson 1998]

> Knowledge Management draws from existing resources that your organization may already have in place-good information systems management, organizational change management, and human resources management practices. [Davenport and Prusak 1998, p. 163]

These definitions describe knowledge management from different perspectives. This first definition demonstrates that the goal of knowledge management is aiming to improve organizational performance with the three essential activities which include right knowledge, right people and right time. The second one addresses knowledge management from management perspective, and focuses on the existing knowledge in the organization, which combines resources from several management directions such as information system management and human resources management. In an organization, knowledge originates in daily practice, sometimes organizational knowledge needs to be spread within the scope of the organization, which means the right knowledge is perceived by the right person at a right time.

Davenport's team published another paper in 1998. The authors claimed that there are four types of projects objectives during knowledge management – to create knowledge repositories, to improve knowledge access, to enhance the knowledge environment and to manage knowledge as an asset [Davenport et al. 1998; Rowley 1999]. To embrace those four project objectives, Rowley [1999, p. 418] defined knowledge management as:

> Knowledge management is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives. The knowledge to be managed includes both explicit, documented knowledge, and tacit, subjective knowledge. Management entails all of those processes associated with the identification, sharing and creation of knowledge. This requires systems for the creation and maintenance of knowledge repositories, and to cultivate and facilitate the sharing of knowledge and organizational learning. Organizations that succeed in knowledge management are likely to view knowledge as an asset and to develop organizational norms and values, which support the creation, and sharing of knowledge.

As a summary, knowledge management is a process including at least creation, storage, sharing and reusing both explicit and tacit knowledge to further the organization's development and improve the performance.

Realizing the benefits of knowledge and knowledge management, an increasing number of researchers [e.g., Bukowitz and Williams 2000; Dalkir 2005; Meyer and Zack 1996] have contributed to design a useful knowledge management cycle model based on the requirements of knowledge management. In this thesis, the final solution is built on the knowledge management cycle (KMC) model (see Figure 5) suggested by Evans et al. [2015]. This is a holistic, integrated, practical and comprehensive prescriptive knowledge management model proposed by them based on critical analyzing and summarizing available knowledge management cycle models proposed by others [Bukowitz and Williams 2000; Dalkir 2005; Evans and Ali 2013; McElroy 2003; Meyer and Zack 1996; Wiig 1993].

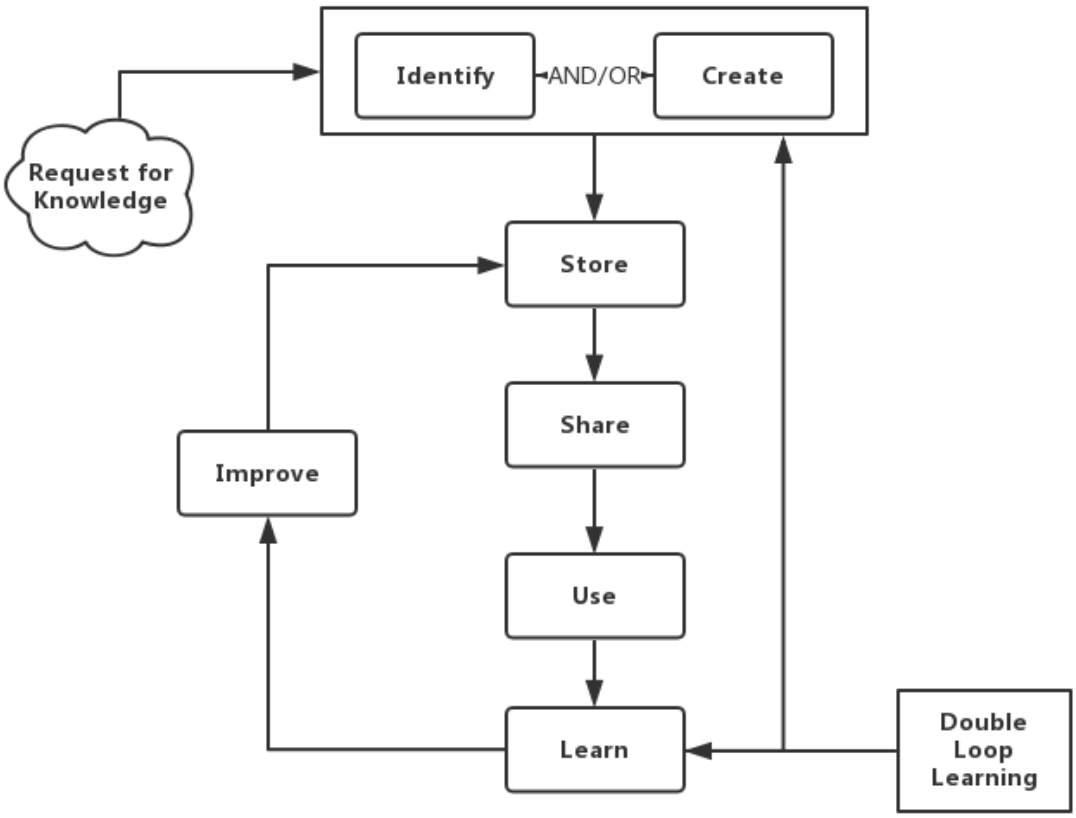

Figure 5. The Knowledge Management Cycle (KMC) Model [Evans et al. 2015].

In an organization, there are many reasons such as for solving a problem, making decisions, improving product quality or innovation can trigger a knowledge request. After knowledge request, the knowledge might go through seven stages which include identify and/or create, store, share, use learn and improve. This thesis mainly focuses on identify and / or create, store and share stage.

Identify and/or Create: The user must identify if suitable knowledge has been in the repository. If the knowledge is not in the repository but the knowledge is valuable and can be used in the future or if the existing knowledge cannot fully satisfy the needs, new knowledge assets need to be created [Evans et al. 2015]. Moreover, organizations should have some criteria which link to organizational strategies and objectives to analyze and assess the value of the new knowledge to avoid low quality knowledge and instant knowledge, and the criteria can teach employees what kind of knowledge should be archived and share to others as well.

Store: Argote et al. [1997] found that people also forget or lose track of what they have created and learned. Thus, store stage is indispensable for knowledge management. Evans et al. [2015] stated knowledge as an organizational asset must be classified and saved in a structured way in order to effectively maintain, retrieve and reuse in the future. Therefore, there should be some instructions to lead employees using a right tool and a uniform standard to save different knowledge such as image, audio, video, text, etc.

Share: "Knowledge sharing is basically the act of making knowledge available to others within the organization" [Ipe 2003, p. 341]. McDermott [1999] indicated that knowledge sharing starts after one person realizing others who need help, what challenges they are facing, what thinking style they used to have, what degree of detail they need. He or she tries to utilize his or her knowledge and insights to give others a better understanding of their own situation and guide them to a right movement. Knowledge sharing is an important process to timely disseminate knowledge to where it is needed. It is a process from source unit to receiving unit. Consequently, successful knowledge sharing is highly depending on the ability to perceive knowledge, motivation to dispose knowledge, efficiency and various channels to transfer knowledge, motivation to acquire knowledge and the ability to absorb knowledge [Gupta and Govindarajan 2000a].

As presented in section 2.3, experiential, conceptual, routine and systemic knowledge assets are all valuable resources for an organization. Knowledge can be shared both synchronously and asynchronously. When knowledge seekers ask for some knowledge, if the required knowledge has been in the repository, this is asynchronous sharing. Otherwise, the required knowledge is not in the repository, which means the knowledge holder needs to transfer it to the knowledge seeker simultaneously, this is synchronous sharing. The preceding section has mentioned that knowledge can be categorized into explicit knowledge and tacit knowledge,

due to their nature, it is usual to share explicit knowledge through people-to-document approach and tacit knowledge through externalization or socialization approach.

Use: Once shared, the knowledge can be used to make decisions, solve problems, improve efficiency within an organization [Evans et al. 2015]. Explicit knowledge is easy to understand thus can be directly used. But tacit knowledge is hard to apply well. Therefore, Evans et al. [2015] suggested that the intervention of a mentor may be helpful for correctly and efficiently applying the knowledge. The use stage is also important for internalizing and socializing the tacit knowledge.

Learn: Some knowledge is volatile, and they can be used to trigger off new knowledge or refresh the existing knowledge to keep them up to date. Therefore, the learn stage can proceed to both improve stage and create stage in the KMC model based on different situations. If the knowledge is insufficient to help the knowledge searcher, the learn stage will be redirect to the identify and/or create stage where new knowledge is produced to fix the gaps [Evans et al. 2015]. If the knowledge is out-of-data, the learn stage can be proceeded to the improve stage [Evans et al. 2015]. These two loops in knowledge management cycle model so called double loop learning.

Improve: During the learning stage, if the existence knowledge needs to be refined, an improve stage is used to update the foundation knowledge. This is an updating loop in the knowledge management cycle model.

The drawback of this KMC model is that it is a prescriptive model which only focuses on the knowledge cycle flow while external organizational factors are exclusive. Rubenstein-Montano et al. [2001] conducted a research where they reviewed the existing conceptual and practical knowledge management models and summarized knowledge management models into three categories which are prescriptive, descriptive and hybrid models. Prescriptive models are task-base and only focus on the knowledge life cycle without linking other factors which might influence the knowledge flow to them. In contrast, descriptive models take environment factors (e.g. organizational culture, structure, technology, individuals) into consideration while ignoring the knowledge life cycle. Therefore, a hybrid model includes both prescriptive and descriptive components is more comprehensive and holistic.

Therefore, Rubenstein-Montano et al. [2001, p. 13] concluded that a good knowledge management model should fulfill the following rules:

1. the model should be both prescriptive and descriptive;
2. cultural aspects of an organization must be recognized and knowledge management must occur in a manner compatible with the culture of the organization;
3. knowledge management is an evolutionary, iterative process directed by feedback loops and learning.
4. the organizational strategies and goals must be linked to knowledge management

The KMC model [Evans et al. 2015] is not fully consistent with the above rules. It only focuses on the knowledge circle and neglect the outside factors which might have effects on those processes. This thesis focuses on knowledge sharing practices in an organization rather than all activities in knowledge management processes, so the relationship between different organizational factors and knowledge sharing is further studied in Chapter 3.

2.5. Summary

Knowledge is a mixture of experience and information which leads to further decisions and actions based on one's personal experience, judgement, attitude, intuition and belief. Knowledge can be classified into tacit knowledge and explicit knowledge. Within an organization, knowledge assets include experiential, conceptual, routine and systemic knowledge assets. It is an important resource for companies to keep a sustainable advantage in the market. Furthermore, knowledge management, a process including at least knowledge creation, storage, sharing and reusing for both explicit and tacit knowledge to further the organization's development and improve the performance, is used to provide an effective, logical, sustainable way to manage knowledge. A good knowledge management model should consider the knowledge management cycle as well as the external factors which have an effect of knowledge sharing. As a part of knowledge management, knowledge sharing is crucial for successful knowledge management.

3. Knowledge sharing within an organization

Since knowledge sharing takes a pivotal role in an organization's knowledge management process, it is necessary for an organization to investigate how to build an efficient knowledge management system. Section 2.4 has addressed that a knowledge management model should be both prescriptive and descriptive. Including the knowledge management cycle (KMC) model, it is also important to consider the environmental factors which might have an impact on individual knowledge sharing initiative and the quality of shared knowledge.

Riege [2005] summarized individual barriers, organizational barriers and technology barriers are three key domains of knowledge sharing barriers. They need to be considered when building a comprehensive and robust knowledge management model and system. He also claimed that even though the three barriers are discussed separately, they are intertwined in most situations. For example, motivation to share knowledge depends on the individual characteristics. However, individual motivation might be affected by organization culture or reward system. This chapter discusses how organizational context influences knowledge sharing from the individual level, organizational level and technology level respectively.

3.1. Individual and knowledge sharing

It is mentioned in most knowledge management books that one of the biggest challenge in knowledge sharing is passing on the right knowledge from a right person to a right person at a right time [Riege 2005]. Therefore, individual ability, attitude, intuition and behavior influence the knowledge sharing result.

Basically, knowledge sharing originates from individuals, thus knowledge is intimately and inextricably bound with people's egos and position [Davenport and Prusak 1998]. Additionally, knowledge sharing in an organization is a team-based collaborative process. So, many researchers have contributed to investigate how do individual factors influence knowledge sharing in a team setting.

Personal motivation is one of factors related to employee sharing behaviors. The motivation involves the intrinsic motivation such as altruism and extrinsic ones such as economic reward and reputation feedback [Hung et al. 2011]. Hung et al. [2011] conducted a laboratory experiment with 140 participants from a university and suggested the following results:

- Economic reward and altruism had a significantly positive relationship between the satisfaction in a meeting but could not improve the quantity and quality of knowledge contribution.
- Reputation feedback had a significantly positive effect on the quantity and quality of knowledge sharing but did not have a notable effect on perceivers' satisfaction.

The conclusions are consistent with other research results. Bock et al. [2005] showed that people's attitude toward knowledge sharing would not increase by offering an economic reward. Without a sense of personal commitment, extrinsic reward is only a short-term reinforcement, which makes employees actively participating knowledge sharing practices. Kankanhalli et al. [2005] implied that organizational reward could increase knowledge contribution if the contributors had a feeling of organizational identification. However, the experiment conducted by Hung et al. [2011] was temporary, which made it hard to establish group identification in a limited period for the testers. That might be the reason why in their research economic reward showed no effect on improving the quantity and quality of knowledge contribution. Reputation feedback makes individuals know that their knowledge distribution help others, which increases their sense of honor and peer recognition [Hung et al. 2011]. Although altruistic motivation showed no sufficient effect on knowledge sharing, Taylar [2006] claimed that a combination of high levels of altruism and knowledge of the subject might be necessary to aid knowledge sharing.

Moreover, knowledge sharing is not all about communication but related to it. Both theoretical studies and empirical studies have noted that the communication skills of the employees are the foremost factor where knowledge sharing relies on. Riege [2005, p. 24] summarized that "effective communication is fundamental to effective knowledge sharing." He indicated that verbal and written were the special case of people-to-people approach and people-to-document approach respectively. Baron and Markman [2000] demonstrated that the social network skill is important for knowledge sharing. For example, the ability to read accurately if others need help, and how to be persuasive to make others accept advice with pleasure. Moreover, Al-Alawi et al. [2007] confirmed that the interaction such as communication between staff could facilitate knowledge sharing in an organization.

O'Dell and Grayson [1998] argued that lack of time was another knowledge sharing barrier because sharing knowledge is a time-consuming and effort-consuming process. Some managers might clearly realize that knowledge sharing is beneficial to the organization, but the

limited time stops the possibility to implement it. On the other hand, some managers hold a perception that "if people are not constantly busy doing something, they are not working productively" [Riege 2005, p. 25]. Consequently, people prefer to hoard their knowledge rather than spend time on sharing with others. Instead, people are willing to do some tasks whose achievement can be distinctly seen by the leaders [Michailova and Husted 2003].

Differences in experience, education or position level and lack of job security can have influences on knowledge sharing too. For example, people naturally have a mentality that others who have a higher education level or have more experience must know what they know. Thus, people tend to believe there is no need to share knowledge with people who are better than themselves. Furthermore, they fear to share knowledge with higher level people such as managers. Because some managers are not open-minded, they are not willing to learn from their subordinates and they are not tolerant towards mistakes made by employees [Michailova and Husted 2003]. Thus, lower level employees often intentionally hoard their knowledge just in case not to lose their jobs.

Other factors such as personal attitude and interpersonal trust are also related to knowledge sharing. Bock et al. [2005] proved that a favorable attitude toward knowledge sharing made people intentionally to share. It is similar with Cabrera et al. [2006] who found openness to experience was positive to self-driven knowledge sharing. Al-Alawi et al. [2007] examined trust and knowledge sharing and proved that knowledge sharing could benefit from interpersonal trust among coworkers. Further, Bakker et al. [2006] shown that people were willing to share more when "they thought other team members were honest fair and integrity".

In addition, shared goals in an organization [Chow and Chan 2008], extensive social network [Chow and Chan 2008; Kankanhalli et al. 2005], higher level and longer work experience [Constant et al. 1994] all positively impact on knowledge sharing.

3.2. Organization and knowledge sharing

Besides individual factors, organizational content also affects the employee's knowledge sharing initiative and the quality of the shared knowledge. This thesis mainly reviews the influences of organizational culture, organizational structure, reward system and leadership on knowledge sharing.

The culture of the work place or the culture of the subunit dominates the effective knowledge sharing [Ipe 2003]. Organizational culture shapes concept about what need to do and which

knowledge is important [Ipe 2003]. Kim and Lee [2006] proved that employees were much more willing to share their knowledge after clearly understanding the vision and objectives of the company. Similarly, Delong and Fahey [2000] argued that employees would share their experience and skills with others if the organization advocated specific value orientations such as collaboration and innovation. Their viewpoint had been proved by Lin [2008] and Chen and Huang [2007] both of who demonstrated that high degree of innovative and cooperative organizational culture had a significant positive effect on social interaction and subsequently facilitated knowledge sharing process among employees while bureaucratic culture showed no significant influence on it. It indicates that making collaboration spirit as a clear objective and regulation can motivate employees' enthusiasm to participate in knowledge sharing practices. However, a strong sense of competitiveness within departments or subsidiaries results in lack of cross-department and inter-organizational sharing across subsidiaries [O'Dell and Grayson 1998]. They treat their unique knowledge as secret which brings them profits or innovation ideas. Therefore, they intentionally withhold knowledge to keep competitive edge.

Apart from organizational culture, organizational structure also has influence on knowledge sharing. Formalization, centralization and integration are three dimensions of an organizational structure [Kim and Lee 2006; Lin 2008]. Many researchers have proved that less formalized, less centralized and more integrated organizational structure is positive to the knowledge sharing [Chen and Huang 2007; Kim and Lee 2006; Lin 2008; Zhang et al. 2010]. Formalization refers to the degree of imposing the standardized organizational regulations, rules, procedures and other guidance on employees [Lin 2008]. Employees working in a high formalization organization are less likely to discuss with others, as the standardized norms can lead employees do their jobs in a right way. In contrast, employees have more freedom and flexible to do their tasks within a low formalization organization. Consequently, people are more likely to interact with each other in a less formalized working environment. Centralization refer to the degree of decision-making power and authority within an organization at a higher level [Kim and Lee 2006]. If the right of decision-making is owned by one or two people in an organization, the others might lose a sense of involvement where they can express themselves and share their knowledge to others. Thus, a decentralized organization structure can increase the rate of knowledge sharing practices. Integration means the degree of several subunits of an organization working interrelated [Chen and Huang 2007]. Integrative organization structure gives chances for employees to learn from others. They can exchange useful experiences and relevant knowledge while working together [Chen and Huang 2007]. Other researchers argued

that an open and flexible organizational structure supported the sharing of knowledge best [e.g. De Long et al. 2000; Nonaka and Takeuchi 1995; cited in Riege 2005]. Regardless of the hierarchical organizations structure, a top-down communication flow direction inhibits the knowledge sharing practices [Riege 2005] for it is hard to share knowledge from ordinary employees to the board.

In addition, a reward system which aims to encourage employees to achieve organizational objectives is also likely to affect knowledge sharing practices among organizational members [Šajeva 2014]. Many researchers have engaged themselves in finding out the relationship between a reward system and the knowledge sharing. However, there is no consensus on it, for the reward systems vary in different organizations. Extrinsic reward and intrinsic reward are two main reward types. Extrinsic reward refers to tangible reward such as monetary – bonuses and non-monetary – promotion or job security [Šajeva 2014]. Bock et al. [2005] found that there was a negative relationship between monetary rewards and knowledge sharing. Others [Huysman and de Wit 2002; cited in Šajeva 2014] suggested that monetary rewards only had a short-term positive effect. One possible explanation might be that employees are stimulated to share their knowledge while they are pursuing the reward during the initial phase. Gradually, this might form a high competitiveness culture because everyone tries to get the reward. Consequently, individuals might intentionally hoard their knowledge, which has a negatively effect on knowledge sharing [Wiewiora et al. 2013]. As for intrinsic reward, reputation feedback [Hung et al. 2011] and a sense of pleasure while helping others [Lin 2008] were proved to facilitate knowledge sharing. Moreover, a reward system can be designed with a focus on individual performance or team performance. Wang and Noe [2010] concluded that group-based incentives had more positive results than individual-based incentive while Lee and Ahn [2007] found a converse result that group-based reward was less efficient than individual-based reward [Šajeva 2014]. As a summary, a well-designed reward system aligned with organizational strategy and goals might have positive effect on knowledge sharing.

Another factor obstructs knowledge sharing can be caused by the leadership of the company who might be unaware of the importance of knowledge sharing. Even if the managers and leaders pay their attentions to knowledge sharing, knowledge sharing practices might also be insufficient. Because different leadership styles have different effects on knowledge sharing. According to Yang [2007], transactional and transformational leadership are two types of leadership styles. He described that transactional leaders stimulated subordinates through rewards exchange while transformational leaders involved themselves with subordinates to

interact and collaborate with followers. Bradshaw et al. [2015] took an empirical research and proved that transformational leadership style significantly contributed to knowledge sharing. Additionally, Yang [2007] investigated the correlation between knowledge sharing and different leadership roles. He summarized eight leadership roles which were monitors, coordinators, producers, directors, innovators, brokers, facilitators and mentors. His findings revealed that the facilitator, mentor and innovator roles were positively influencing knowledge sharing while a monitor role negatively. The explanation of this result is that facilitators focus on fostering relationship between employees to make a harmonious working atmosphere and encouraging employees collaborating with each other while facing problems [Yang 2007]. Mentors guide followers to improve job-related skills where people-to-people approach is used to share knowledge. Innovators capture and collect useful knowledge to achieve organizational goals. Finally, delegating enough power to the leaders improves knowledge sharing practices as well [Srivastava 2006].

Additionally, there should be some policies in the company to remind employees to collaborate with others. Furthermore, knowledge sharing should be integrated into the performance evaluation criteria, which stipulate people capture valuable knowledge, store it, transfer it, use it when they need to and maintain it. Finally, the size of the organization, deficiency of infrastructure and resources and physical work environment can also affect people on participating knowledge sharing practices [Riege 2005].

3.3. Technology and knowledge sharing

There is little doubt that information and communication technology (ICT) has made work and life easier for most people. ICT tools are crucial tools for organizations to improve their daily routine efficiency which includes knowledge sharing. For example, imagine there is a large-scale company with several branches located all over the world. ICT tools such as e-mail, instant messaging and telephone can overcome the temporal and physical barriers, and provide convenient and nimble knowledge sharing service for employees. However, there is no omnipotent technology which can satisfy all the demands of companies. They need to customize their systems based on their own needs, especially the individual and organizational factors. Riege [2005] summarized the following knowledge sharing barriers caused by technology:

- lack of integration of ICT systems and processes impedes on the way people do things;

- lack of technical support (internal or external) and immediate maintenance of integrated ICT systems obstructs work routines and communication flows;
- unrealistic expectations of employees as to what technology can do and cannot do;
- lack of compatibility between diverse ICT systems and processes;
- mismatch between individuals' need requirements and integrated ICT systems and processes restricts sharing practices;
- reluctance to use ICT systems due to lack of familiarity and experience with them;
- lack of training regarding employee familiarization of new ICT systems and processes;
- lack of communication and demonstration of all advantages of any new systems over existing ones.

Many ICTs can be used to support knowledge sharing. For example, if one ever has to answer the same question over and over again, it might be a good idea to turn it into digital archives where other employees can access it. According to Yuan et al. [2013, p. 1663], those ICTs can be classified into three categories:

- Communication tools such as e-mail, instant messaging, telephone, and video conferencing;
- Long-standing tools such as databases and team digital archives;
- Social media such as wikis, forums, profiles, blogs, social networking sites, online communities, and micro-blogging tools, hosted by the organization behind its firewall.

Although ICT infrastructure is recognized as an indispensable part in contemporary enterprise, it is still confusing how to best apply it on knowledge management. There are two aspects of ICT tools that are related to knowledge sharing, one of them is the utilization rate of ICT tools, the other one is the end-user focus [Kim and Lee 2006]. Kim and Lee [2006] demonstrated that employee usage of ICT tools and user-friendly ICT systems positively contributes to knowledge sharing in organizations. ICTs are tools for employees working smoothly, thus it is more important to design a system correctly matching the requirements of the goals and considering the usage habits of employees in order to increase their utilization rate. However, it is hard to implement a system which fulfills all stakeholders' usage convention. Furthermore,

a higher robust and more stable system is appreciated as everyone wants to work with a trouble-free application.

In addition, diversity of repositories and channels should be used to store and transfer knowledge in an organization. Previous section has mentioned there are at least four types of knowledge assets which are experiential, conceptual, routine and systemic in organizations. The characteristics of those knowledge might be explicit or tacit, structured or unstructured, temporary or permanent. It is necessary for organizations to wisely design a series of methods to store and transfer knowledge based on those features. For example, communication tools such e-mail, instant messaging, telephone and video conferencing support synchronous and asynchronous communication among employees [Yuan et al. 2013]. Other tools such as wikis, forums, blogs, database and team-based digital archives can be used to save various types of long-standing knowledge which provides organization sustainable competence and leads to improve business or technical solutions [Yuan et al. 2013].

3.4. Knowledge management model proposal

As a summary, a comprehensive knowledge management model should include a knowledge management cycle model and take the external individual, organizational and technical factors into consideration. Figure 6 is a knowledge management model proposal which is built on the previous discussion.

One goal of knowledge sharing is transferring the right knowledge from one to another, which means the processes include at least identify and / or create stage, store stage and share stage. Therefore, this thesis focuses more on those three stages. First, the identify and / or create stage can be affected by reputation feedback, personal openness to experience, interpersonal trust, organizational vision and goals, innovation and collaboration culture, time, reward system, and leadership style. For example, reputation feedback makes employees know that their knowledge distribution helps others, which increases their sense of honor and peer recognition [Hung et al. 2011], thus they are more likely to identify and create knowledge on their own initiative. Organizational vision and goals assists employees knowing better what kind of knowledge is valuable and needs to be identified and created. Second, the store stage is closely related to organizational vision and goals, time and ICT tools. Organization vision and goals can guide the employees what kind of knowledge should be encapsulated, how to store different knowledge in a structured way for better manipulating, maintaining and retrieval where all of them affect the quality of the shared knowledge. Besides, various ICT tools provide

the possibility to store different data types such as videos, audios, images, text, etc. Third, the share stage can be influenced by reputation feedback, interpersonal trust, communication, innovation and collaboration culture, integrated organizational structure and ICT tools. For example, good communication skills can help others learn the knowledge in a persuasive and pleasure way. A high integrated organizational structure makes it more convenience to communicate with employees from different subunits.

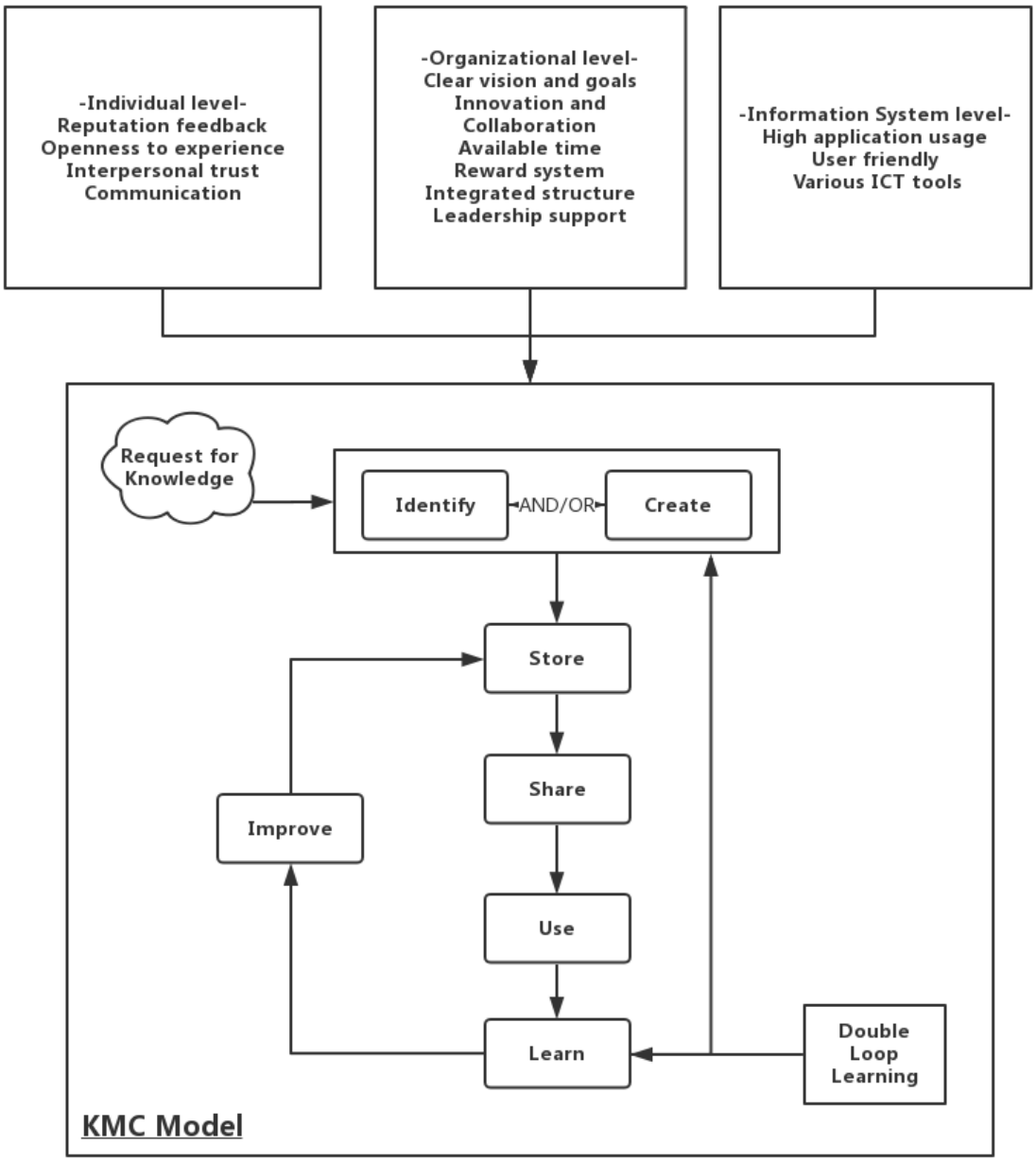

Figure 6. Knowledge management model proposal.

The case study in this thesis is based on the model proposal aligned with concrete methods for improving knowledge sharing practices.

3.5. Summary

Many factors in the organization might have effect on knowledge sharing. On the individual level, I1) reputation feedback; I2) openness to experience; I3) interpersonal trust among employees; I4) communication skills and social network and I5) altruism have been proved positively affecting knowledge sharing. Organizations who embrace knowledge sharing should O1) have a clear vision and goals and link knowledge sharing strategy to them; O2) advocate innovation and collaboration; O3) remain available time for knowledge sharing; O4) design an effective reward system which focusing on non-monetary and team-based incentives; O5) adapt less formalized, less centralized and more integrated organizational structure; O6) empower leadership and choose a suitable leadership role. Next, as a driver of contemporary enterprises, ICT systems should consider users' usage habits (T1), match users' requirements (T2), and various ICT tools are needed (T3). Finally, a comprehensive model is proposed on the basis of previous discussions. Note that those notations (I1-I5, O1-O6, T1-T3) will be used in the late chapter.

4. Project success and knowledge sharing

Many contemporary companies are project-oriented. A product might be divided into several projects and those projects might combine with several sub-projects [Whitaker 2009]. Consequently, it is important to ensure the project success while pursuing a good quality product.

First, it is necessary to differentiate between project success criteria and project success factors [Collins and Baccarini 2004; Lim and Mohamed 1999]. Project success criteria is a set of standards to evaluate whether a project is success or not after the project closure [Belassi and Tukel 1996]. Differently, project success factors mean something that facilitates the project processes or results such as technology, experience, financial, motivation [Lim and Mohamed 1999]. However, some researchers [e.g., Clarke 1999; Kerzner 1987; Morris and Hough 1987] regard project success as a combination of project process success and final product success. This study focuses on project success factors rather than project success criteria.

This chapter firstly discusses the project success factors, then explains the reasons behind their positive effect on project success and their importance for a successful project.

4.1. Project success factors

Project success is an ambiguous description:

- It varies from stakeholder to stakeholder [Freeman and Beale 1992].
- There might be different results when measuring it in a short-term perspective and long-term perspective [Jugdev and Müller 2005].
- The measurements might be different in various industries [Belassi and Tukel 1996].

Therefore, an objective, comprehensive, acceptable framework is needed to evaluate project success. However, views on project success factors have changed over time and vary in different literature. The next few sections will introduce several viewpoints about project success raised by previous researchers in a chronological order.

4.1.1. Before the 1980s

Before the 1980s, researchers used an iron triangle (time, cost, quality) as the basic standard to evaluate project success, focusing on the implementation and handover stages, and omitting initiation and planning stages [Atkinson 1999; Cooke-Davies 1990]. Customers were not

involved in this model. Their satisfaction was collected through surveys or complaints [Pinto and Slevin 1988] rather than through communication during the project. However, in this period, literature was mostly based on theory due to lack of empirical work [Belassi and Tukel 1996].

4.1.2. 1980s-1990s

From the 1980s-1990s, due to the common awareness to service and satisfaction, many sets of critical success factors (CSFs) emerged [Kerzner 1987]. Those factors included not only time, cost, quality but also the satisfaction of various stakeholders such as team, clients and end users [Jugdev and Müller 2005]. Consequently, customers became more demanding [Munns and Bjeirmi 1996]. The unclear meaning of stakeholders sparked controversy among various stakeholders' groups because there was no shared knowledge on success [Davis 2014]. Another problem in this period was that most CSFs intuitively summarized by project managers were based on a single case study [Davis 2014; Jugdev and Müller 2005]. Thus, one project might have been assessed as success using one list of CSFs and failure using another list of CSFs. The third drawback is that those factors were disordered without common subject to group them well [Davis 2014].

At the same time, a new viewpoint was formulated by Lim and Mohamed [1999]. They suggested that a combination of micro viewpoint and macro viewpoint should be conducted to evaluate project success. The micro viewpoint would check the achievement after the development phase but before the handover to the client or users, and it should meet the standards from all parties [Lim and Mohamed 1999]. The macro viewpoint involves a long-term perspective to measure user' feedback [Lim and Mohamed 1999]. Similarly, Turner et al. [2009] pointed out that in a complex project, it is more convincing to use multiple perspectives to assess project success at different times.

Pinto and Slevin [1987] proposed ten critical success factors (see Table 1), which were highly recognized during this period. However, these CSFs still narrowly described project success as well completed and with appreciate project management [Jugdev and Müller 2005].

Jugdev and Müller [2005] concluded that the CSFs in this period did not consider the organizational effectiveness, change management and the compatibility between project management and strategic management.

Success factor	Description
Project mission	Clearly defined goals and direction
Top management support	Resources, authority and power for implementation
Schedule and plans	Detailed specification of implementation process
Client consultation	Communication with and consultation of all stakeholders
Personal	Recruitment, selection and training of competent personnel
Technical tasks	Ability of the required technology and expertise
Client acceptance	Selling of the final product to the end users
Monitoring and feedback	Timely and comprehensive control
Communication	Provision of timely data to key players
Trouble-shooting	Ability to handle unexpected problems

Table 1. Ten success factors list [Pinto and SleviSn 1987, p. 26].

4.1.3. 1990s-2000s

In the 1990s, many categorized CSF frameworks appeared with a great deal of stress on internal and external stakeholders when referring to project success frameworks [Lester 1998]. Freeman and Beale [1992] concluded the factors which contribute to project success as including technical performance, efficiency of project execution, managerial and organizational implications, personal growth, project termination, technical innovativeness, manufacturability and business performance. After that, Belassi and Tukel [1996, p. 143] proposed a new framework for determining project success. Their literature review summarized success factors into four categories: "1) factors related to the project; 2) factors related to the project manager and the team members; 3) factors related to the organization and 4) factors related to the external environment." During the same time, Shrnhur et al. [1997] mentioned that success varies between long-term and short-term perspective.

4.1.4. 21st Century

Over the past 40 years, several common understandings have been reached on the topic of project success. Project success is a complex question, which is affected by various factors

such as top management support, strategy and technology. Meanwhile, it is also important to strengthen the competencies and innovation abilities of organizations for their future [Jugdev and Müller 2005]. Continuously, stakeholder's perspective is recognized as the core basis for evaluating project success. Müller [2003] believed that an owner who is actively involved throughout the project and communicates well with the team and manager contributes a successful project.

Inspired by Wateridge [1998] and Müller [2003], Turner [2004, p. 350] mentioned four conditions which are all necessary but do not guarantee project success: 1) Stakeholders should reach a common measuring criteria before a project begins, and repeatedly adjust it at review meetings throughout the project life cycle; 2) There should be a collaborative attitude among stakeholders as well as viewing the project as partnership, especially between the project sponsor and project manager; 3) The autonomy of decision-making should be given to the project manager while facing unforeseen circumstances with the instructions from the sponsor on how they want the project to accomplish; 4) The sponsor should actively participate into the project.

This view reinforces the consensus that project manager is not the only one who takes responsibility for a project, but also other stakeholders involved in the project, especially the project owner [Davis 2014; Jugdev and Müller 2005]. However, Turner et al. [2009] found that previous standards of success were mostly conducted from a single perception of stakeholders at a specific point rather than multiple stakeholders over several time frames. They thought "inappropriate evaluation of the success criteria of an existing project could misdirect the project's decision making, demotivate employees and establish an unproductive organizational culture".

4.2. Project success and knowledge sharing

Knowledge sharing plays an important role to make a step forward to project success. As discussed in the second chapter, "Knowledge sharing is basically the act of making knowledge available to others within the organization" [Ipe 2003, p. 341]. How can knowledge be exchanged among individuals? There are two modes. The first one is people-to-people approach, which is directly communicated between the sender and the recipient in real time such as a dialogue or mentoring new staff. The other one is people-to-documents approach where the senders make records of their knowledge by documentation, audio, video or other methods in a repository or a knowledge management system. Then, the recipients will access

the knowledge repository or system when needed. For example, writing research papers, leaving an audio message and teaching online courses are all typical examples of indirect knowledge sharing.

Both of the approaches have pros and cons. The people-to-people approach is instant but non-recorded. The sender and the recipient can talk in turn until the recipient fully understands the knowledge the sender wants to share, which means the recipient is able to get a prompt response while having understanding difficulties. Conversely, the reusability is weak because this mode does not keep a record of the knowledge. If another person needs to know the same information, it is necessary to repeat the same process one more time. Compared with people-to-people approach, people-to-documents approach usually has a delay but it is persistent. For instance, Coursera (https://www.coursera.org/) is an online course website. Teachers upload their courses on the platform in advance, then students can access them at any time they want. Sometimes, it is not convenient for students who come across confusions after watching the given videos and materials because they cannot question the teacher like in the traditional class. As a supplement, there is a discussion area where teachers and students can communicate with each other for further knowledge sharing. Some students might have the same questions, if one asked before, the others can quickly find the answer. Therefore, it is much more reusable than people-to-people approach.

Many previous researchers indirectly mentioned that knowledge sharing is essential for project success. The previous section mentioned that time, cost and quality were used to rate the project success before the 1980s. Without a doubt, there should be a knowledge sharing stage before the time, cost and quality are decided. Imagine there is a commercial corporation between investors and a team. First, investors propose how much money they can offer for the project, when they want project closure and their expectation on the results. Next, based on the proposal, team members should evaluate the feasibility (e.g. technical difficulty, human resources, schedule and risks) as per holistic system thinking. After that, they should give feedback to the investor on why it is possible or not. They should repeatedly exchange their ideas until reaching a consensus.

Pinto and Slevin [1987]	Project mission; schedule and plans; client consultation; personnel; client acceptance; communication
Morris and Hough [1987]	Project objectives; technical uncertainty innovation; community involvement
Bounds [1998]	Staff training and education; concurrent development of individual, team and organization
Clarke [1999]	Effective communication; clear objectives and scope
Cooke-Davies [2002]	Adequacy Education; adequacy risk plan
Turner [2004]	Collaboration with stakeholders; project review; investor participation
Davis [2014]	Cooperation, consultation, communication; agreeing mission; cost

Table 2. Examples of knowledge sharing related critical success factors developed in the literature.

After the 1980s (see Table 2), most of the CSF lists and frameworks contain provisions related to knowledge sharing. Project mission, schedule and plans, client consultation, personnel, client acceptance, communication are considered to be a part of success factors [Pinto and Slevin 1987]. Bounds [1998] indicated that staff training and education as well as strong leadership and management should be involved in a successful project. Clarke [1999; cited in Jugdev and Müller 2005] demonstrated that success factors should include "effective communication, clear objectives and scope, dividing the project into manageable components, and using project plans as living documents". Kerzner [1987] recommended all stakeholders should have a corporate project understanding. In summary, apart from time, cost and quality, collaboration (e.g. client consultation and project review meeting) and communication skills are considered to be the most important CSFs. During collaboration or communication, knowledge is transferred among individuals. That knowledge helps each person to have a better understanding of the present situation, leading them to a right direction.

4.3. Summary

The understanding of project success factors is changing all the time. There is no absolutely convincing standard to evaluate project success, because different stakeholders have different expectations in a project, and it is inherently subjective. Meanwhile, it also varies from short term viewpoint to long term viewpoint and it can be evaluated differently in different industries.

It is nevertheless true that there has been a trend on the topic of project success during the past decades. Before the 1980s, iron triangle (time, cost, quality) was used to evaluate project success only in implementation and handover stage [Atkinson 1999; Cooke-Davies 1990]. Then, many non-classified CSFs lists emerged during the 1980s-1990s, and those lists considered not only iron triangle but also satisfaction of clients and end users. After that, researchers began to contrast the inherent relationship and similarity of each CSFs in order to categorize them into groups. In addition to including external stakeholders (client, investor, end user), the perspective of internal stakeholders (project manager, team member, organization) is also encompassed. During the same period, some researchers [Lim and Mohamed 1999; Shrnhur et al. 1997] suggested that project success should be evaluated by a combination of micro viewpoint (short term perspective) and macro viewpoint (long term perspective). More recently (21st century), built on the existing theory, it is suggested that success criteria should be agreed on with stakeholders before the project and milestone have to be set to review and adjust the criteria throughout the project. Next, a collaborative working relationship among stakeholders can make a positive effect on project success. Therefore, the ability to deal with the potential risks is also a crucial factor contributing to project success.

Although few researchers specifically and directly mentioned knowledge sharing as a crucial success factor, many other factors are actually knowledge sharing, such as collaboration, all parties' participation and communication. Therefore, knowledge sharing contributes to project success.

5. Knowledge sharing practices in a case company

The motivation of this thesis comes from my work experience. I had worked in the case company as an intern where I found the work efficiency was poor because of insufficient or none knowledge sharing. For example, my first task was taking over a fraud-prediction project left by a previous colleague. The leader only sent me 5 persistent model without any helpful scripts, instructions and background information. I had to contact the leaving colleague to figure out all the puzzles. However, I noticed many similar scenarios happening in the company from time to time. Therefore, it is necessary to find out a right way to improve the work efficiency caused by poor knowledge sharing. This thesis aims to help the IT company improve their work efficiency which was affected by knowledge sharing. A qualitative examination based on empirical evidences was undertook in this research.

This chapter begins with a brief introduction of the case study Chinese IT company, followed by research procedure in the second section. In the third section, two research methods (observation and interview) used in this research are introduced. Finally, research ethics is explained.

5.1. Introduction of the case company

The case company is a crowdsourcing platform with more than 5000 employees. It provides services such as creative design, website building, copywriting etc. to individuals or organizations. There are two forms of the services. One is self-operated business, and the other one is third-party business. For example, if ones are good at website building, they can register as employers and post their skills on the crowdsourcing platform, others who need to build a website can contact them and buy their services.

There are three major levels in the case company's organizational structure, which are the board, departments and different functional groups in the departments. In this research, the observer and interviewees served in the data engineering group under big data center department which includes data engineering group, analysis group, algorithm and search group and data science group. This group help other departments process massive amounts of data and information, then send back the results to them.

General interaction and cooperation among functional groups and departments are shown in the Figure 7. There are three major components in this chart, which represent big data center, operation and maintenance center and other departments. The bidirectional arrow means there

might be some cooperation and communication between the departments or functional groups. Other departments represent a set of departments who need to collaborate with big data center, and operation and maintenance center. Those departments usually have their own products and technical groups, but they do not have the ability to compute massive data on their platforms. If they need some statistics data which requires complex manipulating and analysis, they must ask big data center for help. Firstly, they need to contact the product manager of the data engineering group, then the product manager will arrange the task to one analyst in analysis group. The analyst will discuss the calculation standard along with the feasibility analysis with them. Next, the analysis group will write a template SQL (Structured Query Language) code and deliver it to the data engineering group. The data engineering group will convert the SQL code into HiveQL code following the architecture of the data warehouse and test it on the real-time system. Finally, it will be published on the real-time platform and send back the data to their database.

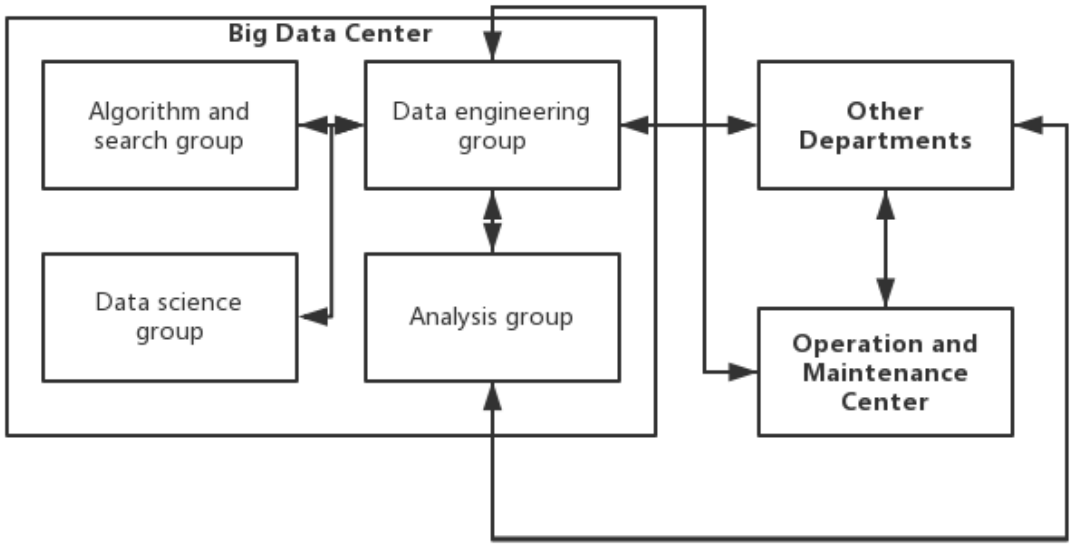

Figure 7. Work relation chart.

Due to the reason of security and privacy, the manipulation right to the database of big data center and other departments are limited. Operation and maintenance center plays as an administrator who holds all the access right in the case company. For example, data engineering group only has read access to all the database in the company. Therefore, they must submit

request to operation and maintenance center when they need to create or modify a table in the database.

Additionally, ICTs tools used for knowledge sharing in the case company have communication tools such as e-mail, enterprise-based instant messaging, personal smart phone, long-standing tools such as gitLab (https://about.gitlab.com/) and organizational digital archives and social media such as wiki.

5.2. Procedure of the case study

It has been mentioned in the previous section that this thesis aims to help the company improve their work efficiency which was affected by knowledge sharing. Therefore, it is necessary to learn the practices of knowledge sharing in the case company. Based on the collected information, we can analyze its advantages and disadvantages on the knowledge sharing practices to find a suitable solution to improve knowledge sharing in the company.

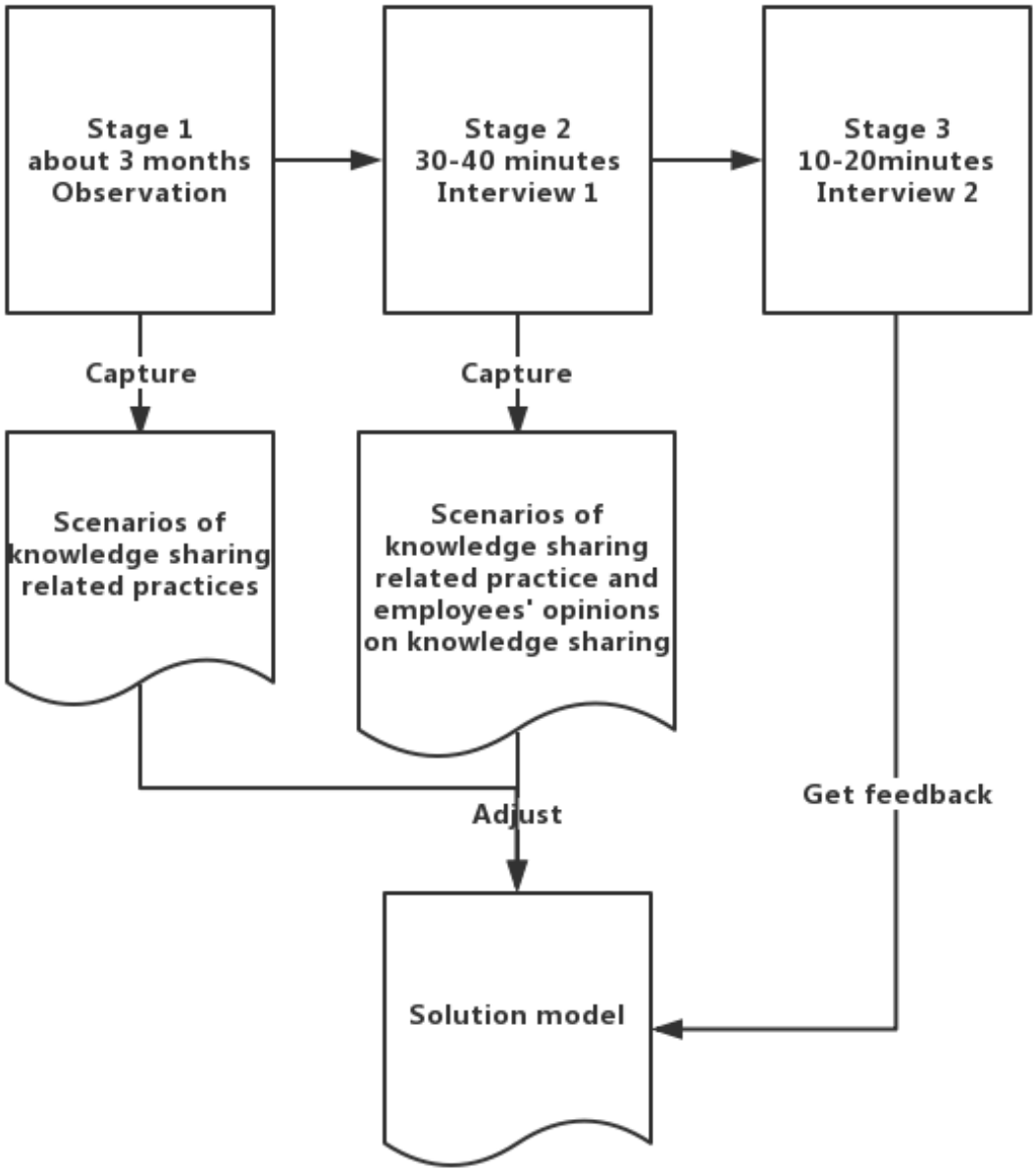

Figure 8. Research processes.

The research was divided into three stages (see Figure 8). In the first stage, the author worked in the case company as a big data developer for almost three months. During this period, the author observed some knowledge sharing related scenarios. In the second stage, three interviewees with different positions (technical leader, developer and product manager) participated in the interviews. Before the interview, the author informed them the basic information about this interview and signed a consent form (see Appendix 1) with them. Next,

the author integrated the available research results on knowledge sharing with the practical conditions in the case company and highlighted several key points to improve its knowledge sharing issues through a holistic and comprehensive analysis. Finally, the author explained the proposed model to the same interviewees and asked their feedbacks about the model.

Two types of information were gathered. Frist, knowledge sharing related scenarios and activities were captured. There were good practices which enable employees to actively share knowledge with other colleagues, or policies which guides employees documenting and commenting what they have done and pre-designed knowledge sharing workshops. In contrast, some working processes might get stuck because of low quality knowledge sharing, which corresponds to the store stage and share stage in the KMC model. Here low quality knowledge sharing refers to the poor quality of the shared knowledge rather than the share stage in the KMC model. In other word, the knowledge searcher cannot easily get a good understanding of the knowledge while finding them. More worsely, some working process cannot move forward because of lacking knowledge sharing, which corresponds to the identify and / or create stage in the KMC model. It means some knowledge has already existed, but the knowledge holder intentionally or unintentionally hoard the knowledge, thus others who need this knowledge cannot access it. In summary, good knowledge sharing practices, low quality knowledge sharing scenarios and lack of knowledge sharing scenarios were collected.

Position	Years in IT industry	Gender	Main jobs
Product Manager	6	Female	Product planning, Product management, Coordination
Technical Leader	11	Male	Extract-Transform-Load (ETL), Data operation
Developer	9	Male	ETL, Dashboard, Scraping

Table 3. Summary of interviewees' background information.

To avoid the subjective perception of the author, three interviews were designed to collect information about knowledge sharing situation in the case company from other person's perspective. Three employees (see Table 3) participated in a two-phase online audio interview. In the first phase, the interviewees were asked a few pre-designed questions (see Table 4) where they can answer freely based on their experience and intuition. Meanwhile, the author might question closely based on their answers. The purpose of those questions was to know their

personal attitude and experience of knowledge sharing, their perceptions and observation of present knowledge sharing practices in the case company. Therefore, Q1 to Q6 was designed to collect individual information and their experiences and familiarity of knowledge sharing. Q7 to Q11 aimed to learn the insights of knowledge sharing practices in the case company from interviewees' view. The interview questions (see Appendix 2) are attached at the end of the thesis.

No.	Questions
Q1	How many years have you worked in IT industry?
Q2	What are the most important tasks in your position?
Q3	Do you share documents, files, codes, experience, ideas in your work?
Q4	Do you have documents, files, codes, experience, ideas which cannot be shared with others because of privacy and difficult? If yes, what are they?
Q5	Do you meet the situation in which the resources owned by others shall be shared for effective collaboration, but are not accessible?
Q6	How familiar are you with knowledge sharing (knowledge management)? How do you think of it?
Q7	What is the present situation of knowledge sharing in your company or department? Give some examples.
Q8	Is there any policy in your company or department requires you share your knowledge or collaborate with others? If yes, what are they? If no, why the company or department does not take it seriously?
Q9	If 8 yes, do you think employees execute it well? If 8 no, do you think it is necessary for a company to design the policy for knowledge sharing?
Q10	Do you have a common place (physical or virtual) where you can save, share and maintain documents, files, codes, experience and ideas in your company? If yes, do you think it is helpful or not? If no, do you think there should have one?
Q11	Which ones do you think might influence knowledge sharing in a company? People (a1. Motivation, a2. Communication skill, a3. Trust); Reward system; Performance evaluation; Leadership; Processes; Organizational structure; Organizational culture; Information systems

Table 4. Interview questions.

In the second phase, the author showed the solution model and explained to the interviewees and asked their opinions about it. Two questions were asked. One was that did they think it is reasonable and workable to improve the knowledge sharing problems, while the other one was that what were the difficulties if an organization wants to put this model into practices. They were also freely allowed to provide the author some suggestions to improve the solution model.

Note that all the interviews were conducted in Chinese. The audio and the transcripts are available upon request.

5.3. Observation and Interview

Observation and interview methods were used in this research. The following sections introduce those two technique and their advantages and disadvantages.

5.3.1. Observation

Researchers can collect data about people, processes and cultures in various disciplines through observation [Kawulich 2005]. One type of observation is participant observation which is a "process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the researcher setting" [Schensul et al. 1999, p. 91]. In this study, the author used participant observation method working inside the case company as a normal employee for observing some processes or activities related to knowledge sharing.

Participant observation makes it possible to access the "backstage culture" of an organization as well as unscheduled events. It provides a naturally full sense feeling of person's behaviors, intentions, situations [De Munck and Sobo 1998]. On the other aspects, it allows researchers to get some information which informants are unable or unwilling to share or there might be some distortions and inaccuracies in the description of informants [Marshall and Rossman 2014]. For example, in this study, if the interviewees have a sense of self-preservation, they may provide less bad knowledge sharing practices in order to maintain a good image of the case company. Therefore, participant observation gives the researcher an opportunity to know the real situation.

There are two significant drawbacks of participant observation. The first one is that participant observation is a time-consuming process. The other one is that participant observation is a subjective process where researchers may gain different understanding even under the same environment. Therefore, DeWalt and DeWalt [2002] suggested that observation accompanying

with additional strategies such as interviews, surveys and other quantitative methods can increase the validity of the research.

5.3.2. Interview

In order to analyze the knowledge sharing problem in the case company, the perceptions of the employees are also important. As a complement to participant observation, interview was used to gather employees' perceptions of knowledge sharing practices in their daily routine work.

In this study, the author used online audio interviews to gather employees' perceptions. One of the advantages of online audio interview is that it can extend access to interviewees even though the interviewer and interviewee are not physically at the same space. Another advantage is that it also saves money and time [Opdenakker 2006]. However, asynchronous of place makes it impossible to observe the informant's expression, body language and thoughtless details. Further, compared with questionnaire, it builds a better interaction with interviewees. Especially when they have doubt about the questions, they can get a quick response. Hence, they are able to understand what exactly the interviewer want to know.

5.4. Ethics

This research was approved by the leader of data engineering group in the case study company. Furthermore, all the interviewees were provided and signed a consent form before the interviews. I explained the propose and procedure of this research, the privacy was protected, and I informed them I would record the conversion for transcribing.

6. Findings, analysis and discussion

This chapter begins with presenting the knowledge sharing related scenarios which were collected through observation and interviews in the first two stages. Next, there is a comprehensive analyzing and discussing based on those knowledge sharing scenarios in the company, the answers from interviews and the available research results. Several concrete methods are suggested for the specific scenarios. Finally, the solution model is evaluated by the interviewees, followed by the discussion of contributions, limitations and future work.

6.1. Knowledge sharing scenarios

6.1.1. Scenarios collected in the observation

The author found the following scenarios related to knowledge sharing. They were grouped by happening within the data engineering group, between different functional groups within the big data center and between big data center and others:

N1) Everyone in the data engineering group needed to write a weekly report about what they had done in the last week and what they planned to do in the next week on each Thursday. People who did not submit it on time or with poor quality would be punished by treating others snacks.

N2) There was a weekly meeting where everyone in the data engineering group need summarize what they had done in the last week and what would they do in the next week on each Friday. There should be some discussions if something is unclear. However, the meeting might be cancelled if the group leader cannot participant.

N3) Data engineering group established a new platform thus some scripts running on the old platform needed to be migrated to the new one. My leader assigned me several scripts and asked me to run them on the new platform. I found the architecture of those two platforms was different as well as some slight variations in coding rules. There was no documents to help me learn those differences.

N4) In data engineering group, it was required that staff needs hand over the portfolio to another colleague if he or she was leaving, but there was no clear guidance to describe what degree of quality the portfolio should be. Therefore, some of the portfolio leaving by previous staff were ambiguous and abstract, which made it hard for the others to get started quickly. For example, my first task was taking over a fraud-prediction

project leaving by a previous colleague. The leader only sent me 5 persistent models without any helpful scripts and instructions. Another thing is that I asked my leader do I need to add some comments and systematically sort out my files when I leave. To my surprise, my leader said just compressing them and sent to him was enough.

N5) I found there was an intranet wiki website having many disordered knowledge assets. Some of them were useful, but the others were hard to understand. They were more like a person wants to show what he had done rather than teaches others how can they achieve what he had done. Moreover, it was voluntary to edit a wiki page, and the maintenance was poor.

N6) I usually participated several projects at the same time. But there was no project management tool used in the company to help us track the progress of those projects. Only the product manager maintained a simple worksheet file and it was not available for other stakeholders.

N7) The most common stages of knowledge sharing in the company is communication (share) and application (use). Other stages such as store, learn and improve are omitted. There was one time, one of my colleagues updated his scripts, which leaded some meaning of fundamental fields changed. After that, he told and reminded us that he modified his bottom level scripts, be careful if our scripts had dependency on it. I asked him why did not he write a document about the change. He said IT companies were moving fast, there was no time to do it.

N8) I faced a challenging bug which most of my colleagues could not help me until I found a colleague who had the same problem before.

N9) There was one time I did not fully understand the purpose of one snippet SQL code. I asked the corresponding analyst for help, but he did not assist me right away. Instead, he came to explain for me after finishing his job.

N10) Similar with the situation in N3), it was a time-consuming project to migrate hundreds of scripts, which involved modifying code, adding dependency, running and verifying the new results. To reduce the burden on the developers and put more human resources into other important projects, the technical leader called the supervisors of each projects whose scripts were still running on the old platform to learn about the usage rate. Their response made the technical leader very angry because some of the

projects were abandoned by other departments without informing the data engineering group, which means useless efforts and more hardware-consuming.

N11) All the new employees were required to attend an orientation training hold by the company, but there was no training when I worked in the data engineering group.

N12) Data engineering group organized some lectures to taught colleagues from other departments about the architecture of the data warehouse, the mechanism of the new platform and the cooperation rules if they want data engineering group help them manipulate massive data. But they still asked the same questions again and again when co-work with data engineering group.

N13) There was a time I participated in one project where one analyst (A) from analysis group, one developer (B) from other department, one product manager (C) and developer (D) from algorithms and search group, and me worked together. After the first meeting where all of us showed up, all the communication was narrowed to two persons. For example, if I had a question, I would contact C. If C cannot handle it, C would contact D, then C deliver D's message to me.

N14) Sometimes the whole program flow might stop because the data cannot insert into the database. Most of the reasons were that the field type of the destination table was changed by the recipient without informing data engineering group, which causing the type inconsistency between source side and recipient side.

6.1.2. Interview

In addition, other scenarios related to knowledge sharing mentioned by the interviewees are listed below:

N15) Some experiences were formed into courses which were used to train and share with others [Product manager].

N16) Top leaders organized once brainstorm where employees were allowed to freely speak on how to build the department well [Product manager].

N17) There was a weekly workshop in the data engineering group, and a monthly workshop in the whole big data center. However, there was no strict regulation. Sometimes, the workshop might be cancelled if most of us were busy on other things [Technical leader].

N18) Most of the projects in my team adapted agile development method. The scrum master strictly followed the wiki process and documented key points during each sprint [Developer].

No.	Short description	Knowledge type	Knowledge asset type	Participants
N1	Weekly report	Explicit	R, S	Data engineering group
N2	Weekly meeting	Explicit, tacit	E, R	Data engineering group
N3	No clear documents about new platform	Explicit, tacit	E, R, S	Developers
N4	Poor working transition	Explicit, tacit	E, C, R, S	Developers
N5	Disordered, unclear and delayed wiki site	Explicit, tacit	E, C, R, S	Developers
N6	Project progress untraceable	Explicit	R, S	Data engineering group
N7	Lack of time	Explicit, tacit	E, C, R, S	Developers
N8	Hoarding useful knowledge	Tacit	E	Developers
N9	Neutral attitude	Explicit, tacit	E, C, R, S	Developers, analysts
N10	No notification of closing projects	Explicit	R	Data engineering group, other departments
N11	Orientation training	Explicit, tacit	E, C, R, S	All employees
N12	Low efficiency training lecture	Explicit, tacit	E, C, R, S	Product manager, other departments
N13	Low efficiency communication	Explicit, tacit	E, C, R, S	Product manager, developer, other departments
N14	No notification of changing	Explicit	C, R	Developers, other departments
N15	Experience to course	Explicit, tacit	E, R, S	Data engineering group, analysis group, other departments
N16	Brainstorm	Explicit, tacit	E, C	Big data center
N17	Unstable workshops	Explicit, tacit	E, C	Data engineering group / Big data center
N18	Planned documenting	Explicit, tacit	C, R, S	Developers

Note. E indicates experiential; C, conceptual; R, routine, S, systemic.

Table 5. Summary of knowledge sharing related scenarios.

Table 5 is a summary of those knowledge sharing scenarios (N1-N18). To be consistent with the previous chapter, the potential knowledge type and knowledge assets type in an organization are summarized based on the scenarios as well as the participants of each scenario.

6.2. Analysis and discussion

As shown in Table 5, those scenarios can be classified into pre-planned knowledge sharing, lack of knowledge sharing and low quality of the shard knowledge. N1, N2, N11, N12, N15, N16, N17 and N18 were regular activities which were pre-planned to sharing knowledge among stakeholders. Some of them worked well while others not. For example, members of data engineering group should update their current working progress and next week's plan on an intranet wiki page where everyone was available to see other colleague's state on Thursday (e.g., N1). Based on the weekly report, data engineering group held a weekly meeting where some issues were discussed, and the product manager made notes of some key points as a record (e.g., N2). Those two scenarios made everyone in the data engineering group up to date, which might help them plan their future work better. In contrast, other pre-planned scenarios existed some drawbacks where the shared knowledge quality was very poor. There was no mentor to guide me and no instructions to follow when I worked there, thus it took me large time to get started with my job (e.g., N11). There were some lectures (e.g., N12, N15) organized by big data center to teach developers form other departments about the architecture of the data warehouse, the mechanism of the platform and the cooperation rules if other departments want big data center help them process massive data, but those developers still asked the same questions again and again. It indicated that the quality of those lectures was very poor and the materials were not shared with them for reviewing. N3, N4, N5, N6, N7, N8, N9, N10, N12, N13 and N14 showed some badly scenarios caused by lack of knowledge sharing (e.g., N3, N7, N8, N10, N14) or low quality knowledge sharing (e.g., N4, N5, N6, N9, N12, N13). Table 6 is a summary of pre-planned knowledge sharing, low quality knowledge sharing and lack of knowledge sharing. It shows that the pre-planned knowledge sharing might be shared with poor quality (e.g., N12, N13).

Scenario categories	Scenario number
Pre-planned knowledge sharing	N1, N2, N4, N11, N12, N15, N16, N17, N18
Low quality knowledge sharing	N4, N5, N6, N9, N12, N13
Lack of knowledge sharing	N3, N7, N8, N10, N14

Table 6. Three categories of knowledge sharing scenarios.

To be consistent with previous sections, this section discusses the knowledge sharing practices from the perspectives of individual, organizational and technical level. Note that although this section discusses them separately, there might be some interaction and correlation among each level.

6.2.1. Individual perspective

All the three interviewees claimed the necessity for an organization to manage knowledge to improve working efficiency. However, at majority of time, they shared their knowledge with others only when they were asked to. The developer said he did not want to recklessly show off himself when he was not sure about whether others needed his help or not. As a consequence, some employees might hoard their knowledge which was valuable to others (e.g., N8). This is similar with one kind of knowledge sharing barrier mentioned by Riege [2005], which is that informants were not aware of the value and benefit of their knowledge to others. As the developer said,

> "There might be many times that I struggled to solve a problem which has been finished by other colleagues. But they did not directly share their experiences on intranet wiki. Instead, they would like to teach me when I asked for help." [Developer]

There might exist a paradox where the informants hoard the useful knowledge and the knowledge searchers cannot realize the right person who can help them. Therefore, there should be a knowledge management strategy at organization level.

Al-Alawi et al. [2007] has shown that interpersonal trust was positively related to knowledge sharing. However, all the three interviewees expressed that except classified knowledge, they would like to share knowledge with others within their privilege. They thought that as long as other colleagues had a justifiable reason, they can share acquired knowledge with those

colleagues even if they were not familiar with each other. The technical leader also mentioned that most of the techniques in big data area were open-source software, thus developers were encouraged to share the latest news. Consistent with earlier research [Huang 2011], product manager said that people counted on to improve their personal skills and reputation after knowledge sharing.

N9 is an example where the reputation feedback plays an important role when sharing knowledge. The employee chose to do other assignments which are directly related to the reward system and performance evaluation criteria rather than sharing the required knowledge requested by others. N13 is an example of low efficiency communication. Therefore, it is necessary to organize some training sessions to improve employees' communication skills.

As a summary, the above discussion indicates that most of the employees knows the importance of knowledge sharing and hold an open attitude to share knowledge. The interpersonal trust is not that important while sharing knowledge with others from the interviewees' perspective. Furthermore, N9 and N13 implies that organizational strategies must be aligned with knowledge management and the communication skills of the employees needs improve.

6.2.2. Organization perspective

Rubenstein-Montano et al. [2001] indicated that knowledge management should be aligned with the organizational strategies and goals. However, in the case study company, there was no macrocosmic layout to lead each departments' members what kind of knowledge was needed to be store and share, and how to do that. One of the reasons why top management did not pay attention to knowledge sharing was that the value of knowledge is hard to assess. As the product manager said,

> "Top management think knowledge sharing cannot directly take back the profits." [Product manager]

Since there were no distinct policy and rules in the company, departments or employees had autonomy on knowledge sharing issues. Usually, because of the lazy nature of human beings, employees prefer to passively share with others rather than actively archive knowledge assets. As a result, the working efficiency was quite low, people used extra time to seek for duplication or existence knowledge (e.g., N3, N8, N10, N14). The technical leader and the developer pointed out,

> "There is no official requirements on knowledge sharing in this company. Sometimes, employees might have some communication in private. Furthermore, it mostly depends on the characteristics of each departments. A technical-driven department is more likely to pay much attention to knowledge sharing and collaboration than other departments. In addition, top management awareness, organizational culture and technical infrastructure are also important." [Technical leader]

> "There might be some small requirements where one employee could accomplish them in a short time. Whether they documented the details or not mainly depends on the self-awareness and individual habits." [Developer]

Therefore, the company should have some detailed rules of the valuable knowledge which is useful for other employees. In this way, employees can identify the important knowledge and intentionally store it in the right ICT tool. Except scenario N16, all the other pre-planned knowledge sharing scenarios (N1, N2, N4, N11, N12, N15, N17, N18) were executed because there is some clear policy requiring employees participate in the weekly meeting, training session and write the documents. Additionally, the leadership participation plays a leading role when designing the policy.

Besides the above factors, the case company is profit-oriented and customer-oriented where there might be some defects of innovation and collaboration. That is why the technical leader repetitively emphasized that innovation is very important. Furthermore, as showed in Figure 10, several subunits worked in the big data center, but the degree of integration is not so high, which means the interaction among each subunit is inactive. The reason might be the deficiency of reward system and performance evaluation criteria. For example, one person has a knowledge sharing task and three other tasks at the same time, the three tasks are all linked with performance evaluation and rewards, thus it stimulates this person give priority to those three tasks rather than knowledge sharing task (e.g., N9).

Riege [2005] also mentioned that lack of time might be a barrier of knowledge sharing. For example, writing documents is a task for scrum master in an agile development project, which means there is a specific process used to complement it (e.g., N18). On the other hand, if there is no pre-design process to store and share knowledge, the employees might neglect to manage their knowledge (e.g., N7). Therefore, it is better to reserve a regular time slot for the employees to share knowledge.

6.2.3. Technology perspective

Previous section has introduced the ICTs used for knowledge sharing in the case company, where the instant messaging and smart phone were used for informal discussions because they were very informative, effective and up-to-date [Yuan et al. 2013]. E-mail was used for formal discussions which provided evidence and traceability such as work progress, product concepts and design. Besides, all the scripts of released projects needed to be uploaded to gitLab as a backup. However, the digital archives and intranet wiki were not in good use. Digital archives were more likely an abandoned virtual storage with jumbled and outdated materials. Compared with digital archives, the intranet wiki was more up-to-date and well-organized, but sometimes wiki was lack of contextual information of knowledge which impeded the knowledge seekers to effectively, quickly and fully grasp the sharing content. As the developer said,

> "Sometimes, it is hard to understand another developer' wiki because I did not come across the same situation as they did." [Developer]

Furthermore, the diversity of the ICT tools is not sufficient. For example, scenario N6 showed that the project progress is untraceable for stakeholders. One reason is that there were no project management tools used in the case company.

To improve the quality of shared knowledge, there should be an instruction manual to lead employees writing structured and understandable documents. For example, if writing a document after solving a bug, the key elements should involve the background of the problem, system environment, solutions in steps with text and figures together. As the product manager said,

> "There should be a specific guidance to rule which elements should be included in different types of document. Besides, a unifying common language is beneficial for sharing knowledge among employees from different positions such as developers, analysts and designer." [Product manager]

Additionally, consistent with previous research [Kim and Lee 2006], the interviewees thought ICTs should be user-friendly and match the usage of employees.

6.3. Solution

The knowledge management model (see Figure 6) proposed in section 3.4 can be used as a guidance to improve the issues identified in the knowledge sharing related practices. This model is built on the KMC model proposed by Evans et al. [2015], following knowledge management model criteria published by Rubenstein-Montano et al. [2001, p. 13], and integrating factors which have been empirically proved existing a positive influence on knowledge sharing initiative and quality. The KMC model as well as knowledge management model criteria has been discussed in section 2.4 and the relationship between each factors and knowledge sharing has been discussed in Chapter 3. Additionally, the author highlights some key points in this section based on the constructive opinions from interviewees and previous researches.

Firstly, it is important to convince top management that knowledge is a critical resource which empowers organization with sustainable competence [Wang and Noe 2010]. Because the implementation of knowledge management system needs capital support, top management will agree on building a knowledge management system only when they realized its profits and value. Secondly, knowledge management should be aligned with the organizational strategies and goals, especially a detailed description of what kind of knowledge is valuable and reusable. Thirdly, innovation and collaboration organizational culture is necessary, for it fosters relationship among employees and cultivates employees sharing consciousness. Fourthly, a well-designed reward system and performance evaluation criteria should be linked with knowledge sharing. Meanwhile, the reward system should not just consist monetary or financial rewards, because they only have a short-term positive effect on knowledge sharing [Šajeva 2014]. Finally, there should be an overall plan on how to use various ICTs such as communication tools, long-standing tools and social media based on the characteristics of knowledge assets and an instructive template of good knowledge document. For example, it would be better to use telephone or instant messaging in urgent situation rather than e-mail, and it is more reasonable to record contextual knowledge through blog.

No.	Short description	Factors	Improvement
N1	Weekly report	O1, O6	/
N2	Weekly meeting	O1, O6	/
N3	No clear documents about new platform	O1, O3	M1, M2
N4	Poor working transition	O1	M1
N5	Disordered, unclear and delayed wiki site	O1, O3	M1, M2
N6	Project progress untraceable	T3	M3
N7	Lack of time	O3	M2
N8	Hoarding useful knowledge	O1	M1
N9	Neutral attitude	I1, O2, O4	M4, M5
N10	No notification of closing projects	O1	M1
N11	Orientation training	O1	M1
N12	Low efficiency training lecture	O1, O4	M1
N13	Low efficiency communication	I4	M6
N14	No notification of changing	O1	M1
N15	Experience to course	I1, I2, O1, O6	/
N16	Brainstorm	O6	/
N17	Unstable workshops	O1, O3	M1, M2
N18	Planned documenting	O1, T3	/

Table 7. Improvement methods of each knowledge sharing scenarios.

Specifically, Table 7 shows the factors related to each knowledge sharing scenario and the possible methods to improve the bad practices of them. According to the summary in Chapter 3, extrinsic factors which influence knowledge sharing can be classified into individual (I1-I5), organizational (O1-O6) and technical (T1-T3) factors. In the case company, two of the universal knowledge sharing issues are lack of knowledge sharing which corresponds to the identify and / or create stage, and poor quality of the shared knowledge which corresponds to the store and share stage in the case company. Section 3.4 has mentioned the relationship between each extrinsic factor and identify and / or create stage, store stage and share stage respectively. Actually, the author considered most of the bad practices of knowledge sharing (N3, N4, N5, N8, N10, N12, N14) in the case company are directly caused by lack of clear

vision and goals which linked with knowledge sharing strategies (O1). If there were no such strategies, employees would not know what kind of knowledge needs to be identified and created to share. Even when some employees voluntarily shared knowledge and store it, they would finish it in their own way without following a unified standard. Therefore, organizational strategies and objectives need to be aligned with knowledge sharing, which should specifically define the valuable and the reusable knowledge and design a unified standard to store different knowledge (M1). Another potential factor caused bad knowledge sharing practices in the case company was limited time (N3, N5, N7). There are two workable methods to improve the time limited situations. The company can organize some training sessions to teach employees how to manage their time efficiency, or hire extra employees whose main responsibility are knowledge sharing related tasks (M2). As for N6, the project progress was untraceable since there was no project management software used in the company. Therefore, the company can apply some project management software such as jira (https://www.atlassian.com/software/jira) to solve this problem (M3). N9 indicated that employees held a neutral attitude towards knowledge sharing because the reward system is not directly linked with knowledge sharing. The company can organize employee training sessions on the value of knowledge sharing to encourage them actively participate in it (M4). Meanwhile, designing a reward system aligned knowledge sharing is also helpful (M5). Finally, the company can organize employee training on communication skills as well to solve the problem caused by low efficiency communication (M6).

6.4. Model feedback

From theoretical perspective, this is a comprehensive model which involves both knowledge management cycle and environment factors. The knowledge management cycle is dynamic where there are an updating loop and a recreating loop. On top of that, organizational culture is recognized and organizational strategies and objectives are aligned with knowledge sharing. Therefore, it totally fulfills the rules suggested by Rubenstein-Montano et al. [2001, p. 13].

From interviewees' point of views, they all thought it is a well-designed model especially the knowledge cycle flow. The product manager praised the classification of the external factors of this model and the developer indicated that the model includes most important aspects of knowledge sharing.

However, all of them pointed out that it was impractical to conduct this model into practice, because there might be some gap between theory and practice. The challenges of promoting the implementation of this model were mentioned as follow,

> "To implement this model into practice is a process from the abstract to the concrete, thus it is necessary to find a capable person or team to design a specific scheme based on the actual conditions in the company." [Product manager]

> "The knowledge management cycle is perfect. However, the final practical solution must be consistent with the background and development stage of the company. The difficulty is that the organizational business system is changing so fast, which means a well-working solution might be out-of-data after a period of time." [Technical leader]

> "Basically, IT companies are result-oriented. The company that is in pioneering stages needs an explosive process … knowledge sharing is needed only when the company survival, which means knowledge sharing is important but not urgent." [Developer]

Taken together, there are three challenges. First, applying theory to practice is difficult. Second, the model might not be flexible enough to match fast changeable business system. Third, the priorities of an organization shift from various stages. For example, according to the capability maturity model integration (CMMI), there is a five-level hierarchy used to measure the quality processes of an organization [Brown 2009]. Brown [2009, p. 319] described CMMI in his book as follow:

> "1) Ad-hoc level: processes are typically undocumented, often chaotic, and reactionary. There is virtually no predictability possible; 2) Repeatable level: some processes are repeatable with somewhat successful, consistent results. There is still risk of exceeding costs and time estimates; 3) Defined level: defined and documented standard processes with an emphasis on successfully attaining objectives. This is great standard to aim for. Most software companies are not even close to this level; 4) Managed level: using quantitative and other measurements techniques, measure performance, fix gaps, and make the process work for you by becoming predictable and

> controllable; 5) Optimized: an organization that relies on innovation, quantitative measurements to not only deliver as planned but also to advance with continuous improvement."

Binding the opinion from the developer with CMMI, it seems meaningless that a startup consumes time and resources to share unpredictable and unrepeatable knowledge.

6.5. Contribution, limitation and future work

The study proposes a knowledge management model in a more holistic way, and links the extrinsic factors with the stages in the KMC model. Practically speaking, the study gives concrete suggestions for the deficiencies in knowledge sharing scenarios in the case company to improve its knowledge sharing issues.

However, this study exists a few limitations. First, the proposed model was based on observation and interviews from a single IT company, which means it might not be directly generalized for other companies or even other IT companies. Second, the observer worked only in one department as a developer, thus he just observed the knowledge sharing scenarios within his department and other departments who had directly cooperate with his. The observer could not observe knowledge sharing scenarios in other departments and interaction among those departments. Third, the number of interviews was limited for gathering more information, which might omit other employees' insights into knowledge sharing. Fourth, this research was conducted in China, which might be difficult to generalize to other cultural companies.

For future work, it is necessary to investigate how much contribution a specification knowledge management model make regarding to different company scale or company maturity degree. For example, a start-up with less than 5 people, it might be better to directly follow up with each other rather than build a knowledge management system. Additionally, it might be a good attempt to break through the limitation of traditional knowledge sharing research. For example, applying gamification on knowledge sharing might incite employees' desire to actively participate in knowledge sharing practice.

7. Conclusion

The goal of this thesis research is to improve the bad practices of knowledge sharing in a Chinese IT company. The research question is what kind of scenarios are related to knowledge sharing in the case study company? If knowledge sharing problems exist in the company, can those problems be solved with one of the available knowledge management models? If not, how can we improve it to fit the situation?

To solve the research questions, the author proposed a customized knowledge management model with specific methods to improve knowledge sharing issues for the case company based on reviewing the available knowledge management, knowledge sharing and project success publications to establish a logical relationship among organizational social ecology, knowledge sharing and project success, and a case study which included an observation period in the Chinese IT company and three interviews. The solution model was recognized a well-designed solution from theoretical and interviewees' perspective while there are some defects as well. It can be used as a reference if the case study IT company or companies with similar characteristics want to improve knowledge sharing problem.

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Appendix 1: Interview consent form

Interview consent form

Please read and sign this form.

You have been invited to participate in an interview which is part of my master thesis work at University of Tampere. By participating in the interview, you will help to evaluate and improve the knowledge sharing framework which is used to enhance the working efficiency in a company.

In this interview, you will be asked several questions and the audio will be recorded.

Participation in this interview is voluntary. All information will remain strictly confidential. The findings might be used to analyze, the knowledge sharing motivation of employees, present situation of knowledge sharing in the company and improve the knowledge sharing process framework. However, at no time will your name or any other identification be used. Company data will remain classified as well. By participating the experiment, you can get a meal as a compensation.

You can withdraw your consent to the interview and stop participation at any time. If you have any questions, please contact Xiaodong Ming at ming.xiaodong.x@student.uta.fi.

I have read and understood the information on this form and had all of my questions answered.

Data and Place: _____ Signature: _____

Thank you!

Appendix 2: Interview Questions

1. How many years have you worked in IT industry?
2. What are the most important tasks in your position?
3. Do you share documents, files, codes, experience, ideas in your work?
4. Do you have documents, files, codes, experience, ideas which cannot be shared with others because of privacy and difficult? If yes, what are they?
5. Do you meet the situation in which the resources owned by others shall be shared for effective collaboration, but are not accessible?
6. How familiar are you with knowledge sharing (knowledge management)? How do you think of it?
    a. I have never heard of it.
    b. I have heard of it, but I think it is useless
    c. I have heard of it, and share my knowledge when someone asked (negatively)
    d. I have heard of it, and regularly share my knowledge with others (positively)
7. What is the present situation of knowledge sharing in your company or department? Give some examples.
8. Is there any policy in your company or department requires you share your knowledge or collaborate with others? If yes, what are they? If no, why the company or department does not take it seriously?
9. If 8 yes, do you think employees execute it well? If 8 no, do you think it is necessary for a company to design the policy for knowledge sharing?
10. Do you have a common place (physical or virtual) where you can save, share and maintain documents, files, codes, experience and ideas in your company? If yes, do you think it is helpful or not? If no, do you think there should have one?
11. Which ones do you think might influence knowledge sharing in a company?
    a. People (a1. Motivation, a2. Communication skill, a3. Trust)
    b. Reward system

c. Performance evaluation

d. Leadership

e. Processes

f. Organizational structure

g. Organizational culture

h. Information systems

i. Others _____