OPTIMIZING KNOWLEDGE REUSE WITHIN FIRMS:

FRAMEWORKS, STRATEGIES AND EMERGING TOOLS

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Declaration

I hereby declare that this thesis is my original work and it has been written by me in its entirety.

I have duly acknowledged all the sources of information which have been used in the thesis.

This thesis has not been submitted for any degree in any university previously.

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Summary

Optimizing knowledge reuse within firms is critical for firms to sustain competitive advantage. However, there exists a problem of how knowledge should be moved from the employees who created the knowledge to those who need the knowledge in an effective and efficient way. As every firm is different, firms should make decisions according to their specific context. This thesis, comprising three studies, seeks to shed some light on how to make decisions for optimizing knowledge reuse within firms.

The first study (Chapter 2) explores an integrative framework for understanding knowledge reuse within firms. Although numerous studies have been conducted to understand knowledge reuse and its influencing factors from different perspectives, few are concerned with a holistic picture of organizing these factors and their interactions. This impedes existing findings to be applied effectively in practice. Against this backdrop, the first study proposes an integrative framework. The proposed framework provides a starting point for optimizing knowledge reuse within firms. It also enables researchers to place existing/future studies on the management of knowledge reuse in a holistic picture.

The second study (Chapter 3) explores how to develop strategies for optimizing knowledge reuse. Knowledge management strategies are classified as codification and personalization, which imply different costs and benefits for a firm. The optimum strategy usually requires a mix of codification and personalization according to organizational context. However, there are few theories that guide firms on decision-making of the optimum mix. Therefore, the

second study develops a formal approach by introducing a Markov Decision Process model for knowledge reuse. This approach allows firms to determine optimum mix based on the analysis of benefits and costs in their specific context.

The third study (Chapter 4) addresses how firms should deal with emerging technologies that provide alternative tools for implementing knowledge management strategies. At present, social media is such a phenomenon. According to the proposed framework, social media influences knowledge reuse not only through changes in organizational cost of investment, but also through changes in individual behaviors. The third study provides some insights on integrating social media for knowledge reuse purposes by understanding whether and how the use of social media influences knowledge reuse at the individual level. The survey results show that firms should recognize the different needs of employees as knowledge producers and knowledge consumers at different stages of the knowledge reuse process. In addition to the direct investment cost of implementing social media, these individual level concerns must be addressed for successful application.

In sum, this thesis contributes to decision-making for optimizing knowledge reuse within firms in three different but related aspects: i) an integrative framework that serves as a starting point for firms to analyze the problem of knowledge reuse; ii) a formal approach for developing the optimum knowledge management strategy; and iii) some insights on integrating emerging technologies (social media in particular) for optimizing knowledge reuse within firms.

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Chapter 1 Introduction

1.1 Motivation of the Study

"Knowledge has become the key economic resource and the dominant — and perhaps even the only — source of competitive advantage"

---Peter F. Drucker, The Post Capitalist Society, 1993

Firms today compete in a knowledge-based economy where economics is not only about scarce natural resources but, more importantly, about how to effectively and efficiently leverage abundant information and knowledge generated along with the development of technology and globalization. Jerry Junkins, former chairman and CEO of Texas Instruments, once lamented that "If TI only knew what TI knows", which was echoed by Lew Platt of Hewlett-Packard who said "I wish we knew what we know at HP". Many managers began to realize that there is substantial untapped knowledge within their firms and, if exploited, huge gains could be achieved (Carla and Grayson, 1998, p.156). According to the Foresight 2020 survey conducted in late 2005 by the Economist Intelligence Unit of 1656 executives from 100 countries around the world, knowledge management (KM) is believed to offer the greatest potential for productivity gains.

With increasing awareness of the importance of KM, many firms have invested heavily in various KM projects. As a result, some firms have enjoyed significant success. According to the 2003 report "Measuring the Impact of Knowledge Management" by APQC (American Productivity & Quality Center),

Ford claims that KM delivered about one billion dollars in hard documented value from 1995 to 2002 from annual investment of 500 thousand dollars. Caterpillar also reported cost savings of 75 million dollars attributed to communities of practice from 2003 to 2008 (Milton, 2014). However, a notably large number of firms are still struggling with low returns on their KM investments (Swan et al., 2000; Chua and Lam, 2005; Rao, 2012).

One of the biggest reasons for low returns can be ascribed to reuse problems (Dixon, 2000; Majchrzak et al., 2013). For example, many firms invest heavily in building KM systems, but few documents stored in their electronic repository undergo a second use (i.e., reuse). If there is no reuse, firms are unlikely to reap the value from KM investment. Successful knowledge reuse includes not only the effectiveness of knowledge sharing by its producers, but also the utilization of knowledge at the recipients' side (Goh, 2002). However, in the literature, focus has been put on encouraging employees to share knowledge, though some research states that knowledge absorption/application by recipients is a criterion of successful knowledge sharing or knowledge transfer (Minbaeva et al., 2003; Siemsen et al., 2008). Therefore, a better understanding of knowledge reuse within firms is needed for improving returns on KM investment.

Furthermore, every firm is unique and success cases cannot be copied easily (Porter, 1991). This is further compounded by the ever-changing environment in which firms operate. As a Chinese saying goes, "Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a life-time". The ability to make wise decisions is crucial to the success of knowledge

reuse. Therefore, this thesis seeks to shed some light on how to make decisions for optimizing knowledge reuse within firms.

One very important KM decision that a firm needs to make is about strategies for managing knowledge. Broadly, there are two types of KM strategies: codification and personalization (Hansen et al., 1999). The codification strategy focuses on codifying knowledge into explicit forms that employees can reuse independently of one another, whereas the personalization strategy emphasizes on facilitating interactions among employees through networks and the knowledge may remain tacit. There are different costs and benefits associated with codification and personalization. These differences originate from aspects such as the organizational investment of implementing codification/personalization and the costs and benefits to individual employees to share and/or reuse under different strategies. Developing the optimum KM strategy is a challenging issue for firms, especially when firms grow large.

Another important decision that firms make about KM is how they should evolve their management of knowledge reuse over time along with emerging technologies and business needs (Porter, 1991; Scheepers et al., 2004). Emerging technologies may provide alternative tools for implementing KM strategies. One phenomenon that cannot be ignored today is the use of social media. The proliferation of social media, such as Facebook, Twitter, and LinkedIn, has substantially changed people's behavior especially the young generation (Jue et al., 2009). Due to its many overlapping principles, such as sharing and collaboration, social media is increasingly viewed as an informal KM tool (Von

Krogh, 2012). However, in practice, it seems to run independently of traditional KM tools and techniques. This isolation may confuse employees about where to share and seek knowledge. The existing studies call for more research to better understand the relationship between social media and KM and how to integrate them accordingly (e.g., Kaplan and Haenlein, 2010; Von Krogh, 2012).

Given the importance and complexity of KM, it has been studied by researchers in many different disciplines including information systems, strategic management, organization studies, human resource management, and psychology (Wang and Noe, 2010). As a result of this diversity, various definitions of knowledge and its management have been developed and adopted in the literature. In order to avoid confusion, working definitions of the key terms used in this thesis are clarified in the following section.

1.2 Working Definitions

1.2.1 Knowledge

Knowledge is a multi-faceted concept. Some studies view it as a justified true belief at a given point of time (e.g., Nonaka and Takeuchi, 1995), while other studies consider knowledge to be at a higher level than information and data (e.g., Davenport and Pruzak, 1998). A review of the various definitions of knowledge, such as a state of mind, object, process, access to information, or capability, can be found in the existing literature (Alavi and Leidner, 2001; Tan et al., 2010). This thesis follows the view that knowledge is "a justified belief that increases the entity's capacity for taking effective action" (Alavi and Leidner, 2001, p.109). It

assumes interpretation and contextualization of information and is closely tied to action (Davenport and Pruzak, 1998; Tsoukas and Vladimirou, 2001; Nissen, 2006).

Knowledge includes both explicit and tacit components along a continuum (Polyani, 1966; Tsoukas, 2005; Nonaka and Von Krogh, 2009). The explicit part is easy to articulate and transfer, whereas the tacit part is deeply rooted in individual's minds (Campos and Sánchez, 2003). Some of the tacit part can be converted to explicit with a cost (Leonard and Sensiper, 1998; Jasimuddin and Zhang, 2009; Nonaka and Von Krogh, 2009).

1.2.2 Knowledge Reuse and Knowledge Management

Knowledge reuse is defined herein as the totality of knowledge re-applied within an organization over a certain time period (Chai and Nebus, 2012). It is constructed as an organizational level concept that relates closely to economic concerns. Knowledge reuse includes individual-level knowledge sharing by knowledge producers, individual-level knowledge seeking and reuse by other employees who act as knowledge consumers, and the transfer of knowledge from knowledge producers to knowledge consumers. The movement of knowledge within a firm is viewed as being in a quasi-market where the currency of transaction is not limited to money (Davenport and Pruzak, 1998; Kankanhalli et al., 2005). Knowledge producers and knowledge consumers are two types of roles that employees play when they engage in the quasi-market of knowledge within

their organization. An individual who is a knowledge producer may sometimes become a knowledge consumer, and vice versa.

Knowledge management is "a systematic process of creating, maintaining and nurturing an organization to make the best use of its individual and collective knowledge to achieve the corporate vision, broadly viewed as sustainable competitive advantage or achieving high-performance" and the objective is to "become aware of its knowledge, individually and collectively, and to shape itself so that it makes the most effective and efficient use of the knowledge it has or can obtain" (Bemret and Bennetz, 2003, p.440). From this definition, we can see that knowledge reuse is critical to achieving the objective of KM. That being said, we acknowledge the importance of knowledge creation as the source of knowledge reuse and innovation. The existing theories of knowledge creation, such as the well-known SECI (Socialization – Externalization – Combination - Internalization) model by Nonaka and Takeuchi (1995), have laid a solid foundation for many studies about knowledge. However, this thesis is interested in how to make decisions about managing extant knowledge within firms (e.g., whether and to what extent to codify knowledge) so that knowledge can be effectively and efficiently reused to reap the maximal value. As such, knowledge reuse is adopted as much as possible in this thesis.

1.2.3 Knowledge Reuse and Knowledge Sharing/Knowledge Transfer

In a broad sense, knowledge reuse, knowledge sharing, and knowledge transfer refer to the same process of knowledge movement, only with different emphasis.

Studies of knowledge sharing generally take a supply-side point of view with an emphasis on encouraging knowledge producers to contribute or document knowledge (e.g., Bartol and Srivastava, 2002; Gray and Meister, 2004). Studies of knowledge transfer focus on the efficacy of moving knowledge from a sender unit to a recipient unit with the assumption that this knowledge is valuable to the recipient and that both the sender unit and recipient unit are predetermined (e.g., Szulanski, 1996; Argote, 1999). In contrast, studies of "knowledge reuse" emphasize more on the demand for knowledge at the consumer's side (e.g., Markus, 2001; Majchrzak et al., 2004; Chai and Nebus, 2012).

As discussed in the previous section, lack of reuse is a major cause of low returns on KM investment. In this thesis we treat optimizing knowledge reuse as critical for reaping the value of KM. Therefore, we prefer to use knowledge reuse as the key term throughout this thesis. That said, in order to be comprehensive, we include knowledge sharing, knowledge transfer, and knowledge management in the literature review. We may also use these terms for the sake of respecting the work of other researchers.

1.3 Objectives of the Thesis

In the first section we discussed two important decisions about optimizing knowledge reuse: how to develop the optimum KM strategy and how to deal with emerging technologies. Before making any decisions about optimizing knowledge reuse, firms need to understand the problem of knowledge reuse in a comprehensive manner. According to Porter (1991, p.98), "A framework can help

the analyst to better think through the problem by understanding the firm and its environment and defining and selecting among the strategic alternatives available, no matter what the industry and starting position". As such, there are three objectives that this thesis aims to achieve and they are described as follows.

The first objective is to develop an integrative framework for understanding the problem of knowledge reuse within firms. Due to the importance and difficulties of managing knowledge within firms, numerous studies have been conducted to understand this issue and its influencing factors from different perspectives (Wang and Noe, 2010). For example, some studies have focused on the process of knowledge transfer (e.g., Szulanski, 1996), and some studies have investigated motivations for the sharing behavior of knowledge producers through electronic repositories (e.g., Kankanhalli et al., 2005). Although useful, these findings are only valid in a certain context. If not enough attention is paid to the assumptions of these studies, the findings may confuse managers in terms of decision-making for optimum knowledge reuse. An integrative view at a higher level is needed to facilitate the understanding of knowledge reuse within firms.

The second objective is to develop a formal approach for decision-making about the optimum KM strategy. As mentioned in the first section, KM strategies can be categorized as codification or personalization. These strategies imply very different costs and benefits for an organization. The optimum strategy usually requires a mix of codification and personalization according to organizational context. However, to the best of our knowledge, the extant KM literature only

suggests that firms should make decisions according to the properties of products or knowledge needs (Hansen et al., 1999; Scheepers et al., 2004; Choi et al., 2008), and few theories about how to decide the optimum mix (Chai and Nebus, 2012). Therefore, the second study aims to address this research void from a novel perspective.

The third objective is to shed some light on how firms should make decisions regarding emerging technologies to sustain the success of knowledge reuse over time. These technologies may provide alternative tools for implementing KM strategies. As a result, the costs and benefits related to codification and personalization may change. Social media is one such phenomenon at present. Unlike traditional information technologies, social media has been widely adopted in the daily life of individuals (Cao et al., 2012). For the purpose of organizational decision-making on how to use social media for optimizing knowledge reuse, it is necessary to understand whether and how the use of social media impacts knowledge reuse performance at the individual level. Grounded in the work performance theory of Motivation-Ability-Opportunity, we provide insights for managers on integrating social media for knowledge reuse at the organizational level.

1.4 Thesis Structure

This thesis consists of five chapters and Figure 1-1 presents an overview of its structure. Chapter 1 presents our motivation and research objectives. Due to the diversity of research perspectives, working definitions of the key terms are also

clarified. Chapter 2 (Study 1) addresses the first objective by developing an integrative framework. This framework provides a clear and holistic picture for understanding knowledge reuse within firms. Chapter 3 (Study 2) addresses the second research objective by proposing a formal Markov Decision Process model for balancing codification and personalization strategies. This model enables firms develop the optimum mix of codification and personalization based on analysis of the benefits and costs for managing knowledge reuse in specific contexts. Chapter 4 (Study 3) addresses the third research objective by investigating the relationship between the use of social media and knowledge reuse performance at the individual level and providing insights for organizational decision-making on integrating social media. Chapter 5 summarizes all three studies and concludes with the theoretical contributions and managerial implications as well as suggestions for future research.

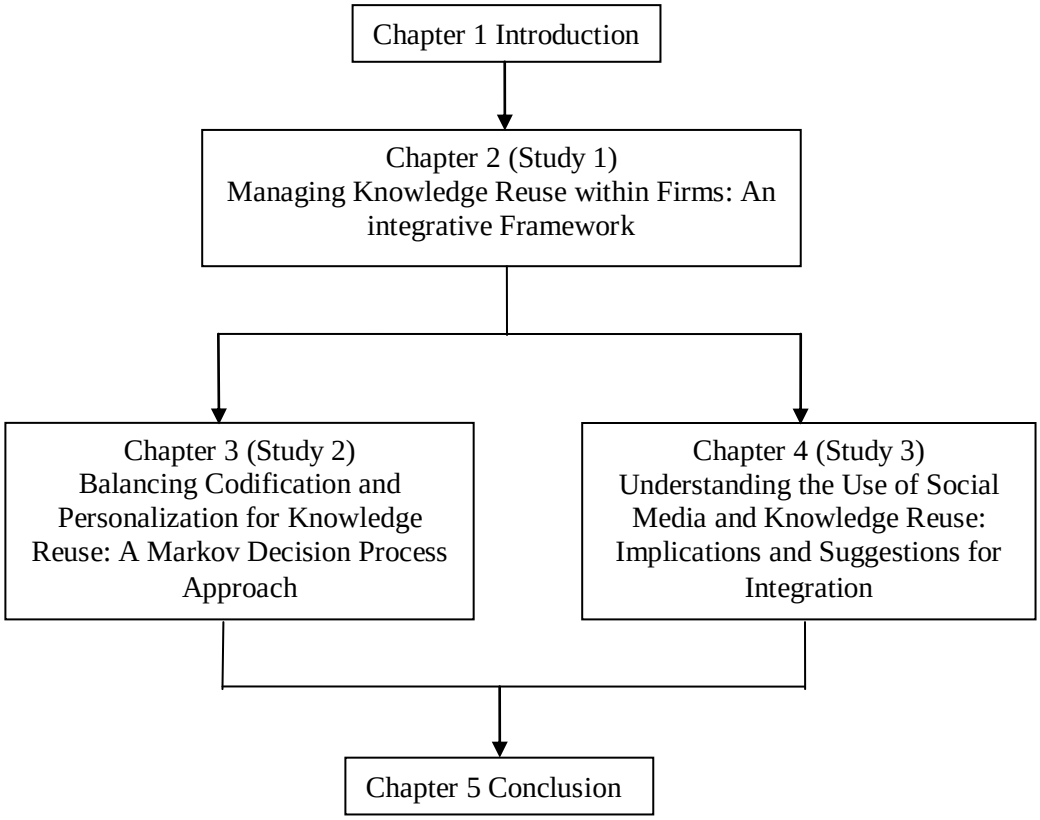

Figure 1-1 Overview of the thesis structure

Chapter 2 Managing Knowledge Reuse within Firms: An Integrative Framework

2.1 Introduction

As mentioned in Chapter 1, firms today compete on a knowledge basis. Many strategic management studies have revealed the importance of knowledge for a firm to sustain competitive advantage (e.g., Grant, 1996; Murray, 2002; Teece, 2007). For this to occur, knowledge within a firm must be utilized in an effective and efficient way (Grant, 1996; Teece, 2000; Armistead and Meakins, 2002; Wang and Noe, 2010). However, this is not easy. As firms grow larger, employees may not be aware of what their colleagues know. This may result in lost business due to a lack of awareness of others' knowledge, or wasting resources in re-inventing the wheel where a solution already exists. Therefore, how to manage knowledge so it can be reused effectively and efficiently is crucial for firms to reap the maximum value from knowledge management (KM) investment.

Companies such as Xerox, Siemens, and Infosys are widely cited as success cases of knowledge reuse (Garud and Kumaraswamy, 2005; Milton, 2014). As early as 2001, Xerox estimated their KM system Eureka had prevented at least 300,000 redundant solutions. One classic story showing the value of knowledge reuse is as follows: A Brazilian engineer ran into an equipment problem. It seemed the only option was to replace the customer's color copy machine — a $40,000 cost. But, before the engineer submitted the equipment

order, he decided to check Eureka one more time. A Canadian colleague had entered the solution to his problem into Eureka a few hours earlier, so the potential $40,000 copier replacement became a $0.90 part replacement (Mottl, 2001). On the other hand, there are also many companies reporting that their KM systems have failed (Chua and Lam, 2005). Thus, there is a need to better understand knowledge reuse within firms.

In general, knowledge reuse involves two types of roles —knowledge producers who create and share knowledge with others, and knowledge consumers who seek and reuse the shared knowledge— and the transfer of knowledge from knowledge producers to knowledge consumers (in explicit form or tacit form). For knowledge reuse to be successful, the way of knowledge shared by its producers has to be matched with the way of interpretation by knowledge consumers. However, most of the extant literature has focused on some part of knowledge reuse, for example, the behavior of sharing knowledge through electronic repository by knowledge producers (e.g., Kankanhalli et al., 2005; Bock et al., 2006; He and Wei, 2009), the process of knowledge transfer (e.g., Szulanski, 1996; Hansen et al., 2005), and the behavior of reusing knowledge by knowledge consumers (e.g., Markus, 2001; Chai and Nebus, 2012).

These studies provide detailed insights of knowledge reuse in certain contexts. However, these insights should be interpreted carefully as they are valid only in certain contexts (Porter, 1991; Foss, 2007). For example, monetary reward proved very effective for knowledge sharing through electronic repository at Siemens, whereas the application at Infosys did not work well and the company

changed the incentive scheme to emphasize the "joy of sharing" (MacCormack and School, 2002; Garud and Kumaraswamy, 2005). When it comes to decision-making on optimizing knowledge reuse in a specific company, these fragmented insights should be interpreted together with other factors about that specific company. However, to the best of our knowledge, in the literature there is few framework providing a holistic view of knowledge reuse within firms (Argote et al., 2003).

The need for an integrative framework is further evidenced by emerging knowledge governance studies that "…attempt to uncover how knowledge transactions —which differ in their characteristics— and governance mechanisms —which differ with respect to how they handle transactional problems— are matched, using economic efficiency as the explanatory principle" (Foss, 2007, p.29-30). In the same paper, Foss (2007) also points out that traditional KM studies have focused on knowledge sharing and/or seeking at the level of individual employees while almost universally ignoring organizational costs. In contrast, strategic management and human resource management studies have focused on knowledge as capabilities at the organizational level (e.g., Teece, 2000; Foss et al., 2010; Chang et al., 2012).

It is noteworthy that concerns at the organizational level differ from those at the individual level (Garud and Kumaraswamy, 2005; Martin, 2008; Foss et al., 2010; Minbaeva et al., 2012). From an organizational perspective, the purpose of a firm is to maximize value through the optimum utilization of existing resources and capabilities (Grant, 1996). Organizations care about whether knowledge

really creates value for their business; in contrast, for individuals, whether they participate in knowledge reuse depends on their perceived benefit over cost for their task performance (Kankanhalli et al., 2005). These different concerns should be taken into account for effective management of knowledge reuse within firms.

In the literature, frameworks for managing knowledge generally include two dimensions —process outcomes and influencing factors— and do not consider the different levels of factors/concerns explicitly (Szulanski, 1996; Argote et al., 2003). As discussed above, the analysis/communication of different levels is another important dimension for managing knowledge reuse. Moreover, from a systems thinking perspective, the external environment (emerging technologies in particular) plays a role in the success of optimizing knowledge reuse within firms over time (Porter, 1991; Rubenstein-Montano et al., 2001). All of these aspects should be taken into account for decision-making on optimizing knowledge reuse within firms. This chapter aims to develop such an integrative framework.

The remainder of this chapter is organized as follows. Section 2 categorizes and reviews the various factors influencing knowledge reuse. Section 3 addresses a complete view of knowledge reuse process. Section 4 presents the proposed integrative framework. Section 5 illustrates how this framework might be applied in practice. Section 6 concludes this chapter.

2.2 Factors Influencing Knowledge Reuse

As introduced before, knowledge reuse involves knowledge producers and knowledge consumers as well as the transfer of knowledge from knowledge producers to knowledge consumers. Accordingly, factors influencing knowledge reuse can be categorized into four groups: characteristics of the knowledge, characteristics of the knowledge producer, characteristics of the (potential) knowledge consumer, and characteristics of the context in which the transfer takes place (Szulanski, 1996).

2.2.1 Characteristics of Knowledge

Given the diversity of studies on knowledge, various descriptive terms have been used by researchers from different disciplines. For instance, to characterize the extent of knowledge that can be articulated, many studies use the term "tacitness", whereas others use "codifiability" or "teachability" (Zander and Kogut, 1995; Hansen, 2002; Chai et al., 2003; Reagans and McEvily, 2003). As clarified in the first chapter, this thesis views tacitness as a continuum. The process of turning tacit knowledge into explicit knowledge can be viewed as a kind of externalization in the classic SECI model of knowledge creation (Nonaka and Takeuchi, 1995). However, firms may prefer knowledge remains in a tacit form due to cost concerns (Chai and Yap, 2004; Jasimuddin and Zhang, 2009).

Along the continuum of knowledge from tacit to explicit, Bohn (1994) proposed a multi-stage model of technological knowledge in firms ranging from total ignorance to complete understanding (as shown in Table 2-1). Stage 1 and

stage 8 represent extreme cases where one either knows nothing or knows everything about the subject knowledge. Awareness means that one knows of the existence of the subject knowledge and, if interested, can start to investigate it. One's level of understanding about the subject knowledge increases along with the progress of stages. In many later studies, the level of understanding is defined as the depth of knowledge or expertise level (e.g., Szulanski et al., 2004; Majchrzak et al., 2013). This model is useful for describing the different needs of knowledge consumers at different stages of the knowledge reuse process.

Table 2-1 A stage model of knowledge (reproduced from Bohn 1994, p.63)

Stage	Name	Comment	Typical form of knowledge
1	Complete ignorance	-	Nowhere
2	Awareness	Pure art	Tacit
3	Measure	Pre-technological	Written
4	Control of mean	Scientific method feasible	Written and embodied in hardware
5	Process capability	Local recipe	Hardware and operating manual
6	Process characterization	Trade-offs to reduce costs	Empirical equations (numerical)
7	Know why	Science	Scientific formulas and algorithms
8	Complete knowledge	Nirvana	-

Embeddedness is another important characteristic that reflects the context-dependency of knowledge (Doz and Santos, 1997; Chai and Yap, 2004). Knowledge transfer might fail if attention is not paid to the context, since people tend to take background knowledge for granted (Taylor, 1993). Causal ambiguity is a closely related concept that is discussed in many other representative works

(e.g., Szulanski, 1996; Gottschalg and Zollo, 2007). When making decisions about knowledge reuse, managers are advised to take into account the differences about the context where the knowledge was produced and the context where the knowledge will be applied.

2.2.2 Characteristics of Knowledge Producers

Knowledge producer is a role that employees take when they have knowledge to share with others. According to work performance theory, an individual's knowledge sharing performance can be explained by the well-established framework of motivation, ability, and opportunity (Baldwin and Ford, 1988; Argote et al., 2003; Minbaeva et al., 2003; Siemsen et al., 2008). In brief, motivation refers to one's willingness to act; ability refers to one's knowledge base and skills related to the action; and opportunity refers to the environmental context (Siemsen et al., 2008). Against this backdrop, distinguishing the characteristics of knowledge producers as motivation-related or ability-related can help managers identify effective approaches for improving knowledge sharing.

Motivation-related factors for contributing knowledge to an electronic repository have been studied extensively in the information systems discipline (e.g., Bartol and Srivastava, 2002; Kankanhalli et al., 2005; King and Marks Jr, 2008). By reviewing relevant journals such as *MIS Quarterly*, *Organization Science*, *Journal of Management Information Systems* and many others, He and Wei (2009) created a summary of individual-level motivators including extrinsic reward, reputation, reciprocity, and enjoyment in helping others. These are

directly related to the perceived benefits for an individual to make decisions on knowledge sharing. Furthermore, required time and effort, evaluation apprehension, and fear of power loss are common de-motivators that impede employees from sharing knowledge (Kankanhalli et al., 2005; Bordia et al., 2006; Lee and Ahn, 2007).

Compared to motivation-related factors, ability-related factors have received less research attention because knowledge sharing is more like a cost for knowledge producers. However, ability-related factors cannot be ignored. Employees can only share knowledge that they know they have (Drew, 1999). Existing research has revealed that sometimes employees do not share knowledge because they do not know what knowledge others need (Garud and Kumaraswamy, 2005; Xu et al., 2010). More often than not, knowledge producers will share knowledge when they encounter knowledge seeking questions proposed directly by their colleagues (Bordia et al., 2006).

In addition, ability-related factors play a critical role in the quality of shared knowledge and the perceived cost of sharing (Minbaeva, 2013). These factors have two main dimensions: expertise (i.e., depth of knowledge) and experience (i.e., breadth of knowledge). Expertise is a determining factor for the quality of shared knowledge, while experience helps knowledge producers convey knowledge in a more understandable way (Haas and Hansen, 2007; Minbaeva, 2013). Self-efficacy, or confidence in one's own knowledge, which refers to the belief in oneself of having the ability to share, is another important factor

influencing knowledge sharing (Siemsen et al., 2009; Wang and Noe, 2010). It is also reinforced by one's experience with knowledge sharing.

2.2.3 Characteristics of Knowledge Consumers

Knowledge consumer is a role that employees take when they attempt to seek and reuse knowledge from others or elsewhere in the company. Like the factors influencing the sharing performance of knowledge producers, the factors influencing the seeking and reuse performance of knowledge consumers can be classified as motivation-related or ability-related. Interestingly, in contrast to knowledge sharing performance, it is the ability-related factors, not the motivation-related factors, that are more likely to impede knowledge reuse within firms (Szulanski, 1996).

Ability-related factors play an important role in how much benefit knowledge consumers can obtain from knowledge reuse, especially reuse through an electronic repository, because some background knowledge is needed to exploit the current knowledge (e.g., Cohendet and Meyer-Krahmer, 2001; Haas and Hansen, 2007; Teece, 2007). In general, ability-related factors include absorptive capacity and retentive capacity (Szulanski, 1996; Carla and Grayson, 1998; Haas and Hansen, 2007). Absorptive capacity refers to the ability to understand other's knowledge, while retentive capacity refers to the ability to institutionalize the utilization of new knowledge (Szulanski, 1996). Perceived ease of use of the repository is another factor that may prevent employees from using it to seek knowledge (Markus, 2001; Kankanhalli et al., 2005).

Although, theoretically, knowledge reuse will benefit knowledge consumers, they may still resist knowledge seeking/reuse from others. For instance, some employees do not seek knowledge from others as they perceive themselves as experts and seeking knowledge elsewhere would be a sign of incompetence (Garud and Kumaraswamy, 2005). Some employees may not seek knowledge from others because of "Not-Invented-Here" syndrome and future obligations (e.g., Eisenberger et al., 2004; Hansen and Nohria, 2004; Bock et al., 2006). Other motivation-related factors include incentive conditions, perceived usefulness, and trust in the quality of the knowledge source (Szulanski, 1996; Borgatti and Cross, 2003; Kankanhalli et al., 2005; He and Wei, 2009; Agarwal et al., 2011). Firms can change knowledge consumers' lack of motivation through positive management. For example, in order to improve knowledge reuse within firms, Infosys encourages the formation of rich social networks among employees by approaches such as offering tea breaks and online social networking tools. As a result, employees no longer have a fear of seeking knowledge from others (Garud and Kumaraswamy, 2005).

2.2.4 Characteristics of Context

Context is a broad concept. It includes both the specific inter-personal context between knowledge producers and knowledge consumers as well as the general organizational context such as culture and norms (Wang and Noe, 2010). The strength of ties is an important characteristic of inter-personal context and its influence varies across different stages of the knowledge reuse process (e.g.,

Hansen, 1999). From an organizational perspective, it is impossible to detect every inter-personal context for knowledge reuse. However, firms can influence inter-personal context via organizational context. As such, this research mainly focuses on organizational context.

Existing studies have revealed the different effects of organizational factors, such as organizational reward systems and norms, on knowledge reuse within firms through codification (e.g., electronic repository) and personalization (e.g., interaction networks) (e.g., Bartol and Srivastava, 2002; Haas and Hansen, 2007; Lee and Ahn, 2007). For instance, monetary reward is more effective for knowledge sharing through codification, whereas fairness and merit pay are more crucial in knowledge sharing through personalization (Bartol and Srivastava, 2002). Strong organizational ownership norms can give employees more utility by sharing the same amount of knowledge (Lee and Ahn, 2007). Strong norms of reciprocity can motivate knowledge producers to share their knowledge, but also exert more pressure on consumers to contribute in future (Kankanhalli et al., 2005; Watson and Hewett, 2006). However, these differences are not systematically accounted for in the decision-making about KM strategies. This is largely due to the lack of a clear picture depicting how these organizational factors interact with others to influence knowledge reuse.

2.3 A Complete View of Knowledge Reuse Process

Many stage models of knowledge reuse/transfer have been proposed in the literature. For instance, taking a project management perspective, Szulanski (1996)

identified four stages of knowledge transfer: i) Initiation, where both a need and the knowledge to meet that need are identified; ii) Implementation, where resources flow between the two parties; iii) Ramp-up, where knowledge is reused at the recipient's side; and iv) Integration, which starts with the satisfactory results of the transferred knowledge and continues until it becomes a part of the organizational routine. This view focuses on a certain piece of knowledge transfer and manages it as a project with a definite start and end. However, for the purpose of optimizing knowledge reuse, this model is not suitable because it doesn't look into the needs of knowledge producers and knowledge consumers along the reuse process.

Taking a knowledge recipient's perspective, Markus (2001) divided the process of knowledge reuse through an electronic repository into four phases: defining the search question; searching for and locating experts or expertise; selecting an appropriate expert or expert advice; and applying the knowledge. Similarly, Hansen *et al.* (2005) considered three stages of knowledge transfer through networks: deciding to seek knowledge; searching for knowledge; and transferring knowledge. These two models assume implicitly that employees know what knowledge to search. Whereas in practice, employees may not know what knowledge they need until they encounter it.

Employees can reuse knowledge only when they know the knowledge exists. Therefore, the first important step is to get employees aware of what knowledge exists within their organization. A complete view of knowledge reuse process should include explicitly this step as a stage. Therefore, we advocate the

recently proposed marketing view of knowledge reuse by Chai and Nebus (2012). That is, a knowledge reuse process consists of five stages— Awareness; Interest; Evaluation; Trial; and Adoption. Briefly, Awareness refers to the process of getting to know the existence of the knowledge; Interest refers to the process of finding out more about the knowledge; Evaluation refers to the process of justifying whether the knowledge is useful in the context of one's task; Trial refers to the process of running a pilot project to see whether it works; and Adoption refers to the process of integrating the knowledge fully into one's task performance. This view explains how individual actors (knowledge consumers in particular) become aware of, interested in, and ultimately adopt the target knowledge.

This research further develops the marketing view of knowledge reuse stages. From an organizational perspective, the analysis of the five stages (Awareness, Interest, Evaluation, Trial and Adoption) should include not only knowledge consumers, but also knowledge producers. This is especially important for the first stage— Awareness, because many times knowledge producers do not share knowledge as they do not know the knowledge need of others (Xu et al., 2010). How to get knowledge producers aware of knowledge needs by others should also be taken into account.

2.4 The Proposed Integrative Framework

As discussed before, the proposed framework is to provide a holistic view for organizational decision-making on optimizing knowledge reuse within firms.

With this purpose, this framework, as shown by Figure 2-1, is a higher level overarching framework. It includes concerns at organizational level and individual level (i.e., Block A and Block E are at organizational level in Figure 2-1). Although additional levels, such as team and department levels, have been studied in the literature, we follow Foss (2010) in terms of not including more levels because, fundamentally, knowledge reuse performance can always be traced back to the behavior of individual employees. Moreover, there is a need to keep the framework concise.

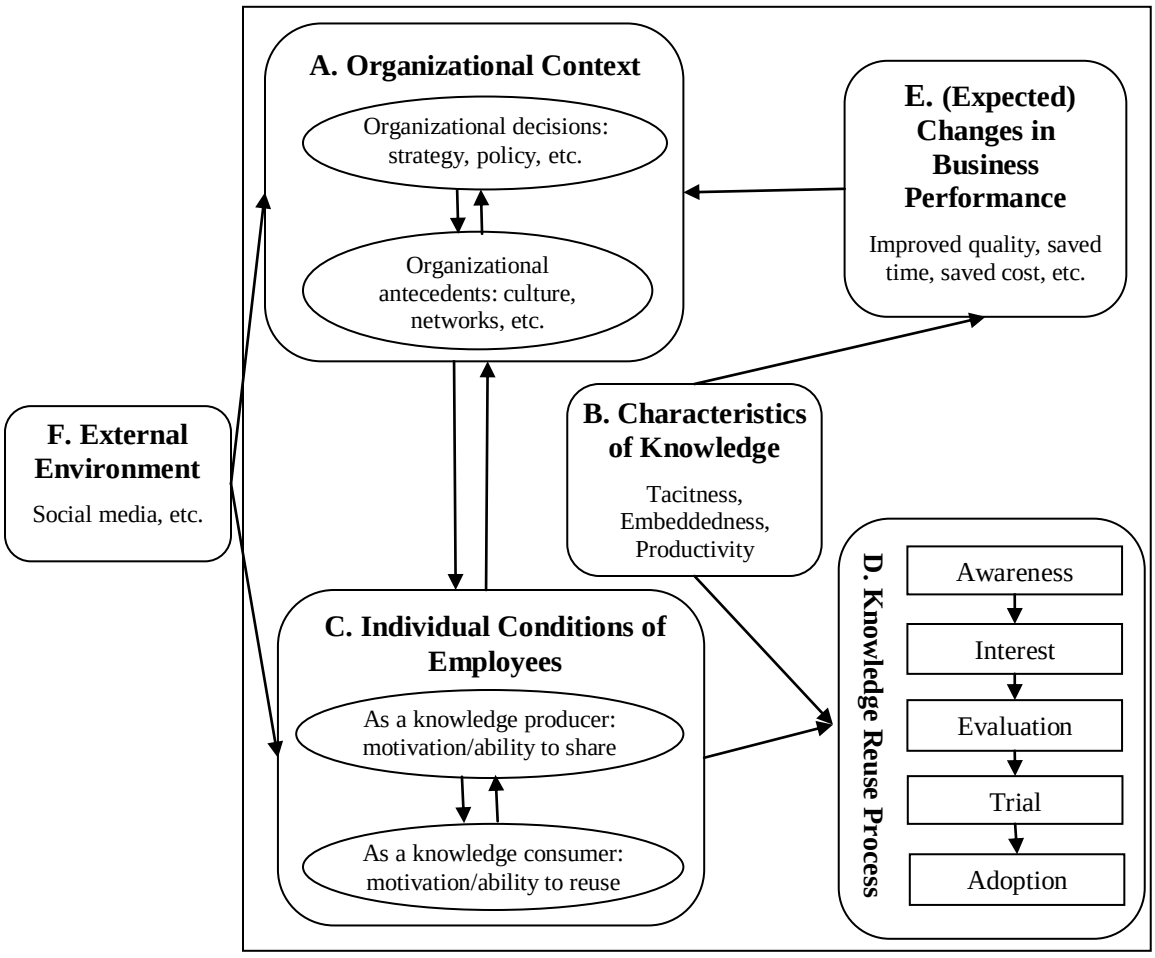

Figure 2-1 An integrative framework of managing knowledge reuse

This framework categorizes factors into six blocks: Block A organizes the organizational context factors, which are classified as organizational decisions and antecedents; Block B considers the characteristics of knowledge; Block C refers to individual conditions of employees as a knowledge producer or a knowledge consumer; Block D refers to knowledge reuse process; Block E records changes (actual or expected) in business performance related to knowledge reuse; and Block F describes the external environment, which may influence the optimization of knowledge reuse. In the following we provide an explanation of each block and its relationship with others.

A. Organizational Context

Organizational context includes organizational decisions and organizational antecedents. Organizational decisions refer to factors that can be manipulated by managers, for example, strategies, policies, incentive schemes, and job design. They are critical concerns to the optimization of knowledge reuse within firms. Organizational antecedents refer to status quo factors that influence knowledge reuse such as organizational culture and norms. Organizational decision will influence antecedents once the decision is implemented within the firm.

Organizational decision should be made on a comprehensive evaluation of factors in the framework. That is, not only factors of organizational antecedents, but also that of the expected changes in business performance, as well as the individual conditions of employees in the specific company. Taking Infosys as an example, the company decided to encourage knowledge sharing by a monetary

incentive scheme called the "Knowledge Currency Unit" implemented in 2001, and this initiative indeed motivated many contributions into the electronic repository known as Kshop. However, it did not improve the performance of knowledge reuse because the excessive number of contributions increased the search cost for other employees and many of the contributions were of low quality. Therefore, a prompt action was taken in 2002 to counteract this adverse effect and improve knowledge reuse within the firm as a whole (Garud and Kumaraswamy, 2005).

B. Characteristics of Knowledge

As discussed in the previous section, tacitness and embeddedness are two widely-studied characteristics of knowledge. Generally, the higher level of tacitness or embeddedness, the higher cost will be incurred for a knowledge producer to articulate his knowledge to others and for a knowledge consumer to understand and reuse the shared knowledge. Based on the knowledge model shown in Table 2-1, knowledge producers do not have to fully master the knowledge for sharing it with others in early stages of knowledge reuse process, especially the Awareness stage. In addition, for the purpose of optimizing knowledge reuse, the value of the knowledge to other task performance, namely productivity, should also be estimated and taken into account.

C. Individual Conditions of Employees

Employees can act as a knowledge producer or a knowledge consumer in the process of knowledge reuse. As analyzed in the previous section, the factors influencing knowledge producers and consumers can be classified as motivation-related or ability-related. Therefore, the individual conditions refer to levels of motivation and ability. For the purpose of optimizing knowledge reuse, the conditions of (potential) knowledge consumer's motivation and ability must be taken into account simultaneously when firms make decisions to encourage knowledge producers to share knowledge in a certain way. In the case of Infosys, the failed incentive scheme was due to the lack of ability of some knowledge producers contributing to Kshop.

According to a presentation by Tata Chemicals at *KM Asia 2013*[1], the company is doing well in this aspect. Tata Chemicals has developed a listener program to capture knowledge from front-line workers who are not able to codify their knowledge in a structured way. Listeners are employees from the corresponding business unit, rather than from a general KM team, who volunteer for the role. As a result, the listener is not only motivated, but also has the background knowledge to understand front-line workers. It should be noted that the conditions of motivation and ability are not static but constantly changing together with other factors, especially those in Block A such as organizational incentives and training schemes (Siemsen et al., 2008; Foss et al., 2010).

[1] This is the most famous conference in Asia for KM practitioners. I attended this conference on November 12-14, Orchard Hotel, Singapore.

D. Knowledge Reuse Process

Knowledge Reuse Process includes five stages: Awareness, Interest, Evaluation, Trial, and Adoption. Awareness is the first stage of a knowledge reuse process. The purpose of this stage is to make potential consumers aware of the reusable knowledge within firms and knowledge producers aware of knowledge needs from others. When interested parties begin to seek more details about this knowledge, this is defined as the Interest stage. After gathering enough information, consumers may enter the Evaluation stage. During this stage, consumers cognitively assess the knowledge in their own context. They have to fully understand their own context and the particular knowledge. Some consumers might quit if the knowledge does not fit into their context. At the Trial stage, consumers try the knowledge in their own context on a small scale (i.e., a pilot study) and then decide the possibility of full application which leads to the final stage— Adoption. They might adapt or integrate the knowledge according to their own context. They may also give feedback about the knowledge.

Their benefits and costs of participation are influenced not only by the stage of knowledge reuse process, but also by the characteristics of knowledge per se. In addition, difficulties resulting from tacitness and embeddedness vary along the process of knowledge reuse. For example, generally speaking, tacitness is not a problem in the Awareness stage, but becomes problematic later on (Hansen, 1999). Firms may take different initiatives to satisfy different needs. For example, Tata Chemicals has a knowledge fair to increase awareness of what knowledge is available within the company and an organizational repository, as well as many

communities of practice to support knowledge transfer. There may be many knowledge reuse processes going on for different projects in a firm at the same time (Szymczak and Walker, 2003; Chai and Nebus, 2012). Therefore, it is very important for knowledge managers to analyze the volume of knowledge reuse within their firm when they make decisions about knowledge reuse optimization.

E. (Expected) Changes in Business Performance

Block E records the changes (expected or actual) in business performance related to knowledge reuse. The expected changes serve as objectives for managing knowledge reuse and the actual changes serve as outcomes of the management strategy. In strategic management studies, this is referred to as organizational capability or competence (Teece, 2007; Foss et al., 2010) and is reflected mainly by three aspects — improved quality, saved time, and saved costs (Haas and Hansen, 2007). New knowledge creation can also be a result of knowledge reuse within firms (Majchrzak et al., 2004; Watson and Hewett, 2006).

Business performance is a construct at the organizational level that aggregates the performance of individual employees. These employees may play the role of knowledge producer and/or knowledge consumer. For example, the total effect of knowledge reuse on business performance is contingent on improved performance at the knowledge consumer's side minus organizational cost and the cost of the time and effort at the knowledge producer's side. If the extent of improvement at consumer's side is less than the cost at knowledge

producer's side, firms cannot reap value. As a result, the firm may seek ways to reduce the cost of sharing by knowledge producers.

F. External Environment

As a pioneer of strategy theory, Porter stated that "…strategy is the act of aligning a company and its environment. That environment, as well as the firm's own capabilities, are subject to change. Thus, the task of strategy is to maintain a dynamic, not a static balance." (Porter, 1991, p.97). For decision-making about optimizing knowledge reuse within firms, the most important environmental factor is emerging technologies that support the management of knowledge reuse. The past two decades have witnessed a proliferation of technologies, social media in particular, to support communication (Treem and Leonardi, 2012). As a result, the organizational cost of implementing both codification and personalization strategy has, to some extent, been reduced. In addition, it has shaped people's behavior of sharing and reuse.

These six blocks work together to the performance of knowledge reuse within firms. In addition to direct effect on organizational decisions, organizational antecedents influence the individual conditions of employees, especially the motivation to share as a knowledge producer and the motivation to reuse as a knowledge consumer. When it comes to the external environment, especially the emerging technologies such as social media, the influence is not only on organizational cost of implementing the strategic alternatives, but also on the individual conditions of employees. For benefits and costs of knowledge reuse

at the individual level, the magnitudes are contingent on the individual conditions of employees, the stage of knowledge reuse process, and the characteristics of knowledge. Furthermore, these benefits and costs aggregate to the changes in organizational business performance. Optimization of knowledge reuse cannot be achieved unless all the six blocks are taken into account.

2. 5 An Illustrative Example

The proposed framework serves as a general guideline and first step for optimizing knowledge reuse within firms. This framework can be applied to most organizations. By taking company X as an example, this section illustrates how this framework might be applied in practice.

Company X is a leading ICT solutions provider. Its telecom network equipment, IT products, and smart devices provide solutions in more than 170 countries and regions worldwide. Reusable knowledge includes marketing solution topic, sales guide, lessons learnt in projects, and so forth. As the competition of the ICT market becomes increasingly fierce, company X invests a lot in KM including learning from well-known KM consultants and success cases world-wide, deploying KM systems, connecting the sharing of knowledge (e.g., writing case studies of their projects) with career advancement, and so forth. Although some of the practices are widely accepted, many problems emerge due to a lack of comprehensive consideration.

One of the biggest issues is about the KM system. At first, the decision-making of deploying the system is a result of learning from the success case at

IBM. After many years of operation, employees increasingly complain about the difficulty in finding valuable knowledge through the system, whereas the platform still works well at IBM. By comparison we can see that IBM has a strong ability of information architecture and technological abilities of upgrading the system to emerging business needs. However, company X does not possess the ability to do so. In addition, as company X ties knowledge sharing (writing case studies in particular) with career advancement, there are many documents of low quality in the system, which further increases the difficulty in finding valuable knowledge.

Organizational decision on the deployment of the KM system would be different if company X had applied the proposed framework. At first, the expected business change is to gain more projects and the KM system can help front-line employees find relevant knowledge such as marketing materials, solutions and best practices quickly. Second, only reusable knowledge needs to be shared in the system and company X may have different policies regarding its three project types —A, B and C. Type A, important and novel projects, has great potential of reuse for other projects. The capture and sharing of the type A project experience needs much time and effort; Type B refers to important projects and the project team may review project experience on their own; Type C refers to routine projects and it is up to project teams whether they have something to share with others. Third, company X would see that the capabilities of employees differ from those at IBM and take the predicted consequences into account. Fourth, to optimize knowledge reuse, the documented knowledge should be provided as a series based on the stages of knowledge reuse. For example, one-page summary

of project is provided for the first stage of knowledge reuse Awareness, and sales guide for latter stages such as Interest, Evaluation and Trial.

In addition, according to this framework, knowledge consumers proceed to next stage of knowledge reuse only when the perceived benefit is greater than their cost. Therefore, a good start is crucial and managers are suggested to pay sufficient attention to the first stage of knowledge reuse—Awareness. On top of the motivations and abilities to share and reuse knowledge, the perceived benefit and cost are also influenced by organizational antecedents and the characteristics of knowledge. In order to reduce the cost of individual employees becoming aware, company X may start a series of activities informing front-line employees what knowledge (i.e., key messages of different projects, sales guide for different scenarios, etc.) exists in what place, who the experts are, and the progress of projects in a certain field. Finally, knowledge reuse can be increased to a large extent because currently many employees do not know what is going on at other places. As a result, the company can achieve the objective of more projects.

Applying this framework provides a clear start to assess completely what problems exist within the firm in terms of knowledge reuse optimization. Without this, biased decision is likely to take place, which results in bad performance. Once the problems are identified, firms can take various initiatives to solve these problems. For example, in order to make KM strategies based on the comprehensive evaluation of all the relevant factors, firms may use the approach proposed in the next chapter. In addition, for the purpose of sustaining the success of knowledge reuse over time, firms may periodically assess the external

environment, which may change the organizational cost of investment and/or the individual conditions of employees to share and seek knowledge.

2.6 Conclusion

Managing knowledge reuse within firms is important for reaping the value of KM investment. Numerous studies on managing knowledge have been conducted from various perspectives and, although they help us understand knowledge reuse in some sense, they are insufficient to support organizational decision-making for optimizing knowledge reuse within firms. An integrative framework is needed to better understand this problem. Therefore, this study has developed such an integrative framework.

This framework provides knowledge managers with a starting point for knowledge reuse optimization. It helps managers comprehensively understand the problem of knowledge reuse within the firm and develop an unbiased decision. In addition, this framework contributes to the literature by providing a structured way to organize various influencing factors that have been studied separately by different researchers. It also enables researchers to place existing/future research on the management of knowledge reuse within firms in a holistic picture. As a result, contributions can be interpreted in a more accurate way.

As the integrative framework is a first attempt, there is not enough feedback from managers about it yet. Case studies may be conducted to understand the effect of applying it in practice. From an information technology

perspective, researchers may also consider how to develop a user-friendly tool that managers can use in the implementation of this framework.

Chapter 3 Balancing Codification and Personalization for Knowledge Reuse: A Markov Decision Process Approach[2]

3.1 Introduction

As discussed in the previous chapter, knowledge reuse is critical for reaping the maximal value from knowledge management (KM) investment. Firms which are able to reuse their knowledge reap millions of dollars of cost savings (MacCormack and School, 2002; Koene, 2006; Milton, 2014). However, many firms are still struggling with the problem of knowledge reuse (Chua and Lam, 2005). In addition, recent research shows that encouraging knowledge producers to document as much knowledge as possible may not help, and even hurt an organization's performance (Garud and Kumaraswamy, 2005; Haas and Hansen, 2007; Lee and Van den Steen, 2010). The management of knowledge reuse should be planned strategically.

Broadly, strategies for KM can be classified as codification and personalization (Hansen et al., 1999). Codification is a "people-to-document" approach where knowledge is extracted and stored, usually in some electronic repository, so that potential consumers can seek knowledge from the repository without necessarily knowing the knowledge producer. For example, engineers reuse worldwide solutions from their corporate repository (e.g., ShareNet of Siemens, Eureka of Xerox, and Knowledge OnLine of Fluor). In contrast,

[2] This chapter is adapted from Hongmei Liu, Kah-Hin Chai, James F. Nebus, (2013) "Balancing codification and personalization for knowledge reuse: a Markov decision process approach", Journal of Knowledge Management, Vol. 17 No: 5, pp.755 – 772.

personalization is a "people-to-people" approach where there are direct interactions between knowledge producers and knowledge consumers. Peer Assist is a typical form of personalization used by firms like BP and NASA where peers are invited face-to-face or virtually to address the challenge faced by the team who sent out the request (Greenes, 2001).

Codification and personalization imply very different costs and benefits for an organization. Earlier studies have separately explored codification and personalization for knowledge reuse (e.g., Hansen et al., 1999; Zack, 1999; Earl, 2001). In recent years many studies have revealed that firms should adopt a mixed strategy of codification and personalization (e.g., Scheepers et al., 2004; Greiner et al., 2007; Kumar and Ganesh, 2011). However, they have been inconclusive about the ideal mix ratio (e.g., 80-20, 50-50) and there are few formal theories that can guide firms on decision-making about the optimum mix (Chai and Nebus, 2012). Therefore, this study aims to develop a formal approach for decision-making about the optimum mix of codification and personalization.

Knowledge reuse is a complex process that consists of five stages from Awareness, Interest, Evaluation, to Trial and Adoption. Employees go through these five stages as time progresses. Whether an employee proceeds to next stage of knowledge reuse or quits depends on his/her perceived benefit over cost. From an organizational perspective, the KM strategy is to support as many knowledge consumers as possible to go through the five stages of knowledge reuse. In addition, there are many knowledge reuse processes going on at the same time. Therefore, the decision-making of KM strategy should base on the volume of

reusable knowledge and how many potential consumers will pass through each stage. How many consumers will be at next stage of knowledge reuse mainly depends on the number of consumers at current stage and whether codification or personalization is implemented to support the current stage. This characteristic meets the Markov property. Therefore, Markov Decision Process (MDP) provides a nice and concise structure for analyzing costs and benefits factors related to knowledge reuse optimization.

Therefore, we propose an MDP model to balance codification and personalization along the stages of knowledge reuse process. To apply this model, organizations first need to assess the costs and benefits of implementing codification and/or personalization taking into account all the relevant factors as proposed in the previous framework. In addition, it is noteworthy that reusable knowledge discussed in this study is characterized by a certain degree of complexity and productivity (Chai et al., 2003). Complexity is a function of tacitness and embeddedness. Complex knowledge refers that the knowledge is tacit to a large extent and successful knowledge reuse requires input of time and effort from both its producers and potential consumers. Productivity refers to the value of that knowledge to other task performance. This kind of knowledge includes engineering solutions, process innovations, engineering know-how and so forth.

The remainder of this chapter is organized as follows. Section 2 provides a theoretical foundation by summarizing existing studies on codification and personalization, perceived costs and benefits of knowledge reuse for knowledge

producers and consumers, as well as extant applications of MDP models. Section 3 presents the model for optimizing knowledge reuse by balancing codification and personalization. Taking a typical knowledge reuse scenario as example, Section 4 analyzes the optimality and provides a series of analytical implications. Section 5 provides a numerical example and compares this model with previous studies. Section 6 concludes this chapter.

3.2 Theoretical Foundation

This section presents the relevant literature that forms the foundation of the theoretical framework. The first subsection presents the implications of following a codification or personalization strategy. The second subsection outlines the costs and benefits associated with knowledge reuse, and the third subsection points out parallels with other applications of MDP model.

3.2.1 Codification and Personalization

Codification and personalization can be characterized by five tenets from the existing literature. Firstly, codification requires firms to invest in electronic repositories and knowledge producers must codify their knowledge before reuse takes place. In contrast, costs of personalization are incurred mostly at the time reuse happens, and this cost is proportional to the number of knowledge consumers (Chai and Nebus, 2012). Secondly, extrinsic incentives (e.g., monetary rewards, recognition/promotion) are more effective for codification, whereas intrinsic incentives (e.g., enjoying helping others, gratification of developing

professional relationships) are more effective for personalization (Bartol and Srivastava, 2002; Lee and Ahn, 2007). Thirdly, codification can simultaneously reach a large number of people who access the standardized repository, whereas personalization can convey rich information but is limited by the number of people that can be reached (Chai et al., 2003). Fourthly, codification can only transfer explicit knowledge, while personalization can transfer both explicit and tacit knowledge (Hahn and Mukherjee, 2007). The cost of codification increases dramatically as the tacitness of knowledge increases. Finally, people can retrieve knowledge from a repository whenever needed since its creation. However, whether consumers can obtain knowledge from its producer is contingent on the availability of that person (Lee and Van den Steen, 2010).

In their pioneering work proposing the classification of codification and personalization, Hansen *et al.* (1999) suggested that firms choose one strategy based on characteristics of their product and employees' working needs, and warned firms not to employ both. Koenig (2001) acknowledged that firms should choose strategies which align with their business operations and goals, but his studies showed that a 50-50 split between personalization and codification can be desirable in certain industries like pharmaceuticals. Scheepers *et al.* (2004) indicated that firms may need to evolve their strategy by adjusting the proportion of codification and personalization to align with the nature of the knowledge process. Later, many empirical studies reported firms benefiting from a mixed strategy (e.g., MacCormack and School, 2002; Umemoto et al., 2004; Kumar and Ganesh, 2011).

When it comes to decision-making on the mix of codification and personalization, empirical studies can only suggest that KM strategy should be aligned with the nature of the knowledge reuse process. From an Operations Research perspective, Jasimuddin and Zhang (2009) proposed a preliminary framework of mixed strategy based on the cost and effort to transfer explicit and tacit knowledge. From a marketing perspective, Chai and Nebus (2012) proposed a stage model to analyze costs/benefits of knowledge reuse and thereby optimize knowledge reuse efficiency. Although interesting, this theoretical model is quite primitive analytically. Against this backdrop, this research advances this literature stream by proposing a more refined framework for firms to analyze knowledge reuse processes and a more scientific model that can provide detailed insights by running models with different organizational reuse contexts.

3.2.2 Perceived Costs/Benefits of Knowledge Reuse

In addition to time and effort of sharing and seeking/reusing knowledge, producers may consider sharing knowledge as losing power. Furthermore, producers may be apprehensive about their advice being evaluated, especially under codification strategy (Bordia et al., 2006; Lee and Ahn, 2007), and potential consumers may want to avoid implied future obligations to reciprocate with knowledge producers under a personalization strategy (Eisenberger et al., 2004). Associated with costs are various benefits. Benefits to knowledge producers include enjoyment, developed trust, reputation and reciprocity as well as monetary reward (Lee and Ahn, 2007); Benefits to knowledge consumers include

increased competence of improving performance quality and saved time to perform more tasks (Haas and Hansen, 2007). As discussed in the previous chapter, the magnitudes of costs and benefits are not only directly related to the strength of motivation, but also indirectly contingent on the characteristics of knowledge, context factors, and ability-related factors. These factors also affect the number of consumers that go through stages of the knowledge reuse process.

This strand of literature provides relevant perspectives for managers to assess knowledge reuse in their firms, such as knowledge producers' and consumers' costs and benefits for participating in knowledge reuse and their alignments with the organization's interest. This research complements this literature by suggesting a way to systematically leverage these findings in organizational decision-making for KM strategies.

3.2.3 Applications of MDP Models

MDP models have been widely applied in various fields such as population harvesting, agriculture, queues, finance, and investment (White, 1993; Maddah et al., 2010; Wu and Chuang, 2010). The closest application related to this study is Markov analysis in human resources management field (e.g.,Heneman and Sandver, 1977; Barrick and Alexander, 1991). These researchers showed the applicability of Markov process to analyze employee movement. They used empirical data to assess the probability of employee movement in an organization from one state (position) to any other state over a specified time period. Therefore, it is appropriate to extend Markov analysis to knowledge reuse processes. This

research extends the application of MDP to a new field, which might inspire opportunities to advance research in both fields.

3.3 The Model

This section develops a model to balance codification and personalization for optimizing knowledge reuse within firms. The first subsection presents the stage model of knowledge reuse process, and illustrates the applicability of an MDP model. The second subsection analyzes the corresponding costs/benefits under codification and personalization strategies, and the mapping of them from individual level to organizational level. The third subsection details the proposed MDP model for decision-making. Finally the fourth subsection discusses how to set parameter values in practice.

3.3.1 The Five-Stage Model of Knowledge Reuse Processes

As reviewed in Chapter 2, knowledge reuse process is viewed differently in the literature according to research purposes. As suggested by the proposed integrative framework, we follow the marketing view of knowledge reuse. This section provides a detailed explanation about the five-stage model of knowledge reuse process — Awareness, Interest, Evaluation, Trial, and Adoption.

Awareness is the first stage of a knowledge reuse process. The purpose is to make potential consumers aware of the knowledge that is intended for reuse. During this stage, firms identify knowledge items of great reuse potential. Then an overview of the knowledge (i.e., what the knowledge is and where it can be

useful) is delivered to potential consumers via codification or personalization. If the process is initiated by a consumer asking for a solution, this stage means making knowledge producers aware of potential reuse of their knowledge in different contexts. When interested parties begin to seek more details about this knowledge, this is defined as the Interest stage. After gathering enough information, consumers may enter the Evaluation stage. During this stage, potential consumers cognitively assess the knowledge in their own context. They have to fully understand their own context and the particular knowledge. Some consumers might quit if the knowledge does not fit into their context. At the Trial stage, potential consumers try the knowledge in their own context on a small scale (i.e., a pilot study) and then decide the possibility of full application. In Adoption, the final stage, potential consumers become final consumers. They might adapt or integrate the knowledge according to their own context. They may also give feedback about the knowledge.

In general knowledge reuse activities can be classified into these five stages, and potential consumers go through these stages as time progresses. Although consumers may backtrack to a previous stage, they will proceed to later stages or stop at current stage. Therefore the sequential property holds. For example, the Adoption stage must come after all other stages and Evaluation cannot happen before Awareness. However, there is an assumption here: time is not an important factor in reuse. In other words, the management of knowledge reuse is not for solving a problem immediately but increasing competence continuously. Therefore, how long it takes to pass each stage matters little as long

as the reuse process finishes. Based on this argument, from an organizational perspective, it is appropriate to view the general five stages as sequential and aggregate the many on-going knowledge reuse processes within an organization.

3.3.2 Cost/benefit Analysis under Codification and Personalization

The strength of costs and benefits is contingent on many aspects. According to the integrative framework proposed in the previous chapter, firms should assess the costs and benefits based on individual conditions. It is noteworthy that different amount and depth-level of knowledge are required to meet the individual needs at different stages of the knowledge reuse process (Bohn, 1994). This section presents the cost-benefit analysis qualitatively through Table 3-1 and Table 3-2. Values of costs/benefits for each stage and their mapping from individual level to organizational level are analyzed in the following paragraphs.

For individual knowledge producers, their costs and benefits are incurred only once under codification strategy. In general, firms have many on-going knowledge reuse processes, and not all consumers go through every stage to final adoption. Their costs and benefits are also contingent on their absorptive capacity and effort when passing each stage. The magnitudes of these values have to be determined in a specific context.

Table 3-1 Costs/benefits per stage under codification strategy

Under codification strategy	Knowledge producer		Knowledge consumer		Organization	
	Benefits	**Costs**	**Benefits**	**Costs**	**Benefits**	**Costs**
Awareness	Recognition, signal of competence	Time to codify necessary knowledge, evaluation apprehension	Potential of increasing competence	Time and effort	Potential of improving performance	Infrastructure cost (repository, etc.), motivation cost, opportunity cost from producers, management cost
Interest			Inspiration, increased knowledge	Time and effort	Increased knowledge	Opportunity cost from knowledge consumers, management cost
Evaluation			Increased knowledge	Time and effort	Increased knowledge	Opportunity cost from knowledge consumers, management cost
Trial			Increased knowledge	Time and effort	Increased knowledge	Opportunity cost from knowledge consumers, management cost
Adoption			Increased competence	Time and effort	Improved performance	Management cost

Table 3-2 Costs/benefits per stage under personalization strategy

Under personalization strategy	Knowledge producer		Knowledge consumer		Organization	
	Benefits	**Costs**	**Benefits**	**Costs**	**Benefits**	**Costs**
Awareness	Recognition, signal of competence	Time and effort to report their success	Potential of increasing competence	Time and effort	Potential of improving performance	Infrastructure cost for communication, management cost, Opportunity cost from knowledge producers and consumers
Interest	Perceived reciprocity, enjoyment	Time and effort to answer questions from potential consumers	Inspiration, increased knowledge	Time and effort, future obligation	Increased knowledge	Opportunity cost from knowledge producers and consumers, management cost
Evaluation	Perceived reciprocity, Increased knowledge via interaction with consumers	Time and effort to answer questions from potential consumers	Increased knowledge	Time and effort, future obligation	Increased knowledge	Opportunity cost from knowledge producers and consumers, management cost
Trial	Perceived reciprocity, Increased knowledge via interaction with consumers	Time and effort to address problems from potential consumers	Increased knowledge	Time and effort, future obligation	Increased knowledge	Opportunity cost from knowledge producers and consumers, management cost
Adoption	Perceived reciprocity, Increased knowledge via interaction with consumers	Time and effort to address problems from potential consumers	Increased competence	Time and effort, future obligation	Improved performance	Opportunity cost from knowledge producers, Management cost

From an organizational perspective, the benefits to knowledge producers do not necessarily result in benefits to the organization. For example, monetary rewards for knowledge sharing are benefits to knowledge producers but are actually costs to the organization; enjoyment for knowledge producers is only beneficial for the organization if they become more productive. There are two types of knowledge reuse costs for an organization. One is organizational cost for facilitating knowledge reuse, including infrastructure cost, motivation cost, and management cost. The other is opportunity cost, which results from employees participating in knowledge reuse instead of performing tasks. Since employees have to spend time and effort performing tasks regardless of knowledge reuse, costs to knowledge consumers are not fully attributed to costs to the organization. In addition, under personalization strategy, perceived reciprocity to knowledge producers and future obligation of knowledge consumers only exist at the individual level. To sum up, costs of an organization on knowledge reuse mainly come from organizational cost and opportunity cost of knowledge producers. Benefits for an organization on knowledge reuse mainly result from increased competence of potential consumers. The mapping of costs/benefits from individuals to the organization is modeled by the following equations.

*Organization's costs = β*consumers' costs + producers' costs + organizational cost;*

*Organization's benefits = consumers' benefits + α*producers' benefits;*

Organization's net payoff = Organization's benefits - Organization's costs.

Benefits to consumers and costs to producers are attributed fully to the organization, so the coefficients are set to 1. Benefits to knowledge producers and costs to knowledge consumers are partially attributed to the organization, and values of α and β ($0 < \alpha, \beta < 1$) indicate this interest alignment from individuals to the organization.

3.3.3 Proposed MDP Model for Optimizing Knowledge Reuse

There are four main assumptions of the proposed model: First, The management of knowledge reuse is not for solving a problem immediately but increasing competence continuously. Therefore, how long it takes to pass each stage is not a major concern as long as the reuse process finishes. In practice, most reuse process finishes in one year, and a few may last for two years. Second, the number of knowledge producers equals to the number of reusable knowledge items and the number of potential consumers equals to the number of reuse rate. Third, the perceived benefits and costs for each stage of knowledge reuse are independent to each other. Finally, different levels of codification and personalization are not taken into account, and this research, as a first attempt, focuses on the extreme cases, i.e., organizational decisions includes only two options: codification and personalization.

Based on the analysis of previous two sections, the elements (i.e., decision epochs, action set, state space, reward function, transition probability, and decision rule) of the proposed MDP model are defined as follows.

- Decision epochs

$T = \{1, 2, ..., 6\}$, where *t = 1* to *5* represent stages of knowledge reuse from Awareness to Adoption accordingly and a decision is made for each stage of knowledge reuse; and *t = 6* is the final stage of knowledge reuse where no decision is needed.

- Action set

$A = \{P, C\}$, where *P* represents personalization and *C* represents codification. Both *P* and *C* are feasible choices for the decision at each stage of knowledge reuse.

- State space

$S = \{1, 2, ..., M\} \times \{1, 2, ..., N\} \times \{P, C\}$, the first element *M* represents the estimated number of reusable knowledge items, which also imply the number of knowledge producers[3]. The second element *N* is the reuse rate and the third element represents the strategy (*P* for personalization, *C* for codification) in use, that is, the decision of the previous stage of knowledge reuse. Therefore, the state of knowledge reuse stage *t* is described as $s_t = (m, n_t, a_{t-1})$. For the first decision at knowledge reuse stage *t = 1*, this study assumes $a_0 = P$, which means initially firms do not have any specific preparations for knowledge reuse.

[3]We assume the number of knowledge items to be reused is equal to the number of knowledge producers. It is reasonable because knowledge producer is defined as a role that employees play in knowledge reuse. Numbers of producers or users are not physical numbers of employees, but the number of that role.

- Reward function

Since the model is proposed for an organization to make decisions on codification and personalization strategies so as to optimize knowledge reuse, reward is defined as organization's net pay-off. We use BP_{it} represents benefit of producer from sharing knowledge i at knowledge reuse stage t, CP_{it} represents cost of producer for sharing knowledge i at knowledge reuse stage t, BU_{nit} represents benefit to consumer n for reusing knowledge i at knowledge reuse stage t, CU_{nit} represents cost to consumer n for reusing knowledge i at knowledge reuse stage t, and I_t represents organizational cost at knowledge reuse stage t. Therefore, the reward function is written as

For $t = 1,...,5$,

$$r_t(s_t, a_t) = \sum_{i=1}^{M} \alpha_i \cdot BP_{it}(a_t \mid a_{t-1}) + \sum_{i=1}^{M} \sum_{n=1}^{N_{it}} BU_{nit}(a_t) - \sum_{i=1}^{M} CP_{it}(a_t \mid a_{t-1}) - \sum_{i=1}^{M} \sum_{n=1}^{N_{it}} \beta_n \cdot CU_{it}(a_t) - I_t(a_t \mid a_{t-1})$$

and when $t = 6$,

$$r_t(s_t) = SV(a_{t-1})$$

The final reward depends only on the previous stage. As stated earlier that codification yields a salvage value for the organization, so $SV(a_5 = C) = SV$ and $SV(a_5 = P) = 0$. The assumption is that only codification used at the Adoption stage can yield a salvage value. Because Adoption is the only stage that demonstrates the value of that particular knowledge item being stored in organizational repository.

The notations for the proposed model are summarized in Table 3-3.

Table 3-3 Notations for the proposed MDP model

Notation	Explanation
i	Index of knowledge item to be reused, up to M.
n	Index of reuse rate, up to N_{it} which stands for reuse rate of knowledge i at stage t
BP_{it}	Benefit of Producer from sharing knowledge i at knowledge reuse stage t
CP_{it}	Cost of Producer for sharing knowledge i at knowledge reuse stage t
BU_{nit}	Benefit to Consumer n for reusing knowledge i at knowledge reuse stage t
CU_{nit}	Cost to Consumer n for reusing knowledge i at knowledge reuse stage t
I_t	Organizational cost at knowledge reuse stage t
α_i	A discount factor that shows the degree of knowledge producer i's interest alignment with the organization
β_n	A discount factor that shows the degree of knowledge consumer n's cost alignment with the organization

- Transition probability

This describes the likelihood of what the next state will be given the current state and decision. The uncertainty regarding the number of reusable knowledge items is analyzed through running the model with various *m*. For a certain number of reusable knowledge items, uncertainty lies in the change of reuse rate at each stage. Since the reuse rate at next stage depends only on the current reuse rate and is independent of previous ones, it satisfies the Markovian property. For a certain knowledge item, the reuse rate is non-increasing from the Awareness to Adoption stage because every consumer has to enter the reuse process at the first stage but may quit at any stage. Hence, $P(s_{t+1}|s_t, a_t) = P(n_{t+1} \mid n_t, a_t)$.

- Decision rule

The decision rule prescribes a procedure for action selection in each state at a specified stage. We choose a deterministic Markovian decision rule because the characteristic of a knowledge reuse process satisfies the Markovian property—the transition probability and reward function depend on the past only through the current state of the system and the action selected by the decision maker in that state. Policy π is a sequence of decision rules providing the decision maker with a prescription for action selection under any possible future system state.

Based on the above definitions, for the finite horizon MDP problem, the objective is to solve

$$V^*(s_1) = \max_{\pi \in \Pi} E[\sum_{t=1}^{T-1} \gamma^{t-1} r_t(s_t, a_t) + \gamma^{T-1} r_T(s_T) \mid s_1]$$

Where γ is a discount factor regarding future reward to the present, $V^*(s_1)$ is an expected value of rewards from all stages. Since the state and action space are finite, the existence of a deterministic Markovian policy is guaranteed (Puterman, 1994). Therefore, Bellman's equation can be used to solve this problem as follows.

$$V_t(s_t) = \max_{a_t} \{r_t(s_t, a_t) + \gamma \cdot E[V_{t+1}(s_{t+1} \mid s_t, a_t)]\}$$

$$\text{where } s_{t+1} = s_{t+1}(s_t, a_t),\ E[V_{t+1}(s_{t+1} \mid s_t, a_t)] = \sum_{j \in S} p_t(j \mid s_t, a_t) V_{t+1}(j)$$

Finally a backward induction algorithm is implemented to obtain optimal policy.

3.3.4 Value-setting of Parameters in the Model

Parameters in the model can come from audit and metrics of knowledge reuse activities. A general knowledge audit includes the business needs assessment, cultural assessment, and an examination of what knowledge is needed, available, missing, applied, and contained (Liebowitz et al., 2000). Burnett *et al* (2013) developed a procedure of knowledge audit as follows: First of all, identify organizational enablers and KM processes which employees carry out. Second, develop snapshot of current knowledge assets. Third, produce pictorial representation of current knowledge assets. Fourth, determine current knowledge needs. Finally, create pictorial representation of current knowledge needs.

Organizational cost can be assessed at the first step by analyzing the organizational enablers which include strategic vision, infrastructure, structure and environment, as well as culture and behavior. The volume of reusable knowledge, i.e., number of reusable knowledge, can be estimated at the second step. The fourth step helps identify the volume of potential consumers. The frequency of usage (high, medium and low) was also included in the illustrative example by Burnett *et al* (2013). For the interpreted benefits and costs in participating knowledge reuse as a knowledge producer and/or a knowledge consumer, questions regarding the value can be added into surveys and interviews alike in the process of knowledge audit.

The specific instruments of carrying out knowledge audit include existing record, questionnaire surveys, interviews, and so forth. For instance, one of the famous consulting firms EY conducts knowledge survey twice per year in its

global units for measuring the value of knowledge resources since 2009 (Callahan and Usher, 2013). Nebus (2012) conducted interviews and surveys together to ask employees for their data of benefits and costs in the process of knowledge reuse.

3.4 Optimality Analysis of a Typical Reuse Scenario

Taking a typical reuse scenario presented in the literature (Chai and Nebus, 2012) as example, this section shows the optimality analysis and provides insights for a general situation of knowledge reuse. The first subsection illustrates the typical reuse scenario and the simplified model, and the second subsection presents the optimality analysis.

3.4.1 A Typical Reuse Scenario and the Simplified Model

Although costs/benefits for each stage are context-specific depending on characteristics of the knowledge to be reused, of consumers' absorptive capacity and so forth, most knowledge reuse processes follow a general trend (Haas and Hansen, 2007; Chai and Nebus, 2012). In the following paragraphs, we describe this typical scenario and explore optimality based on that.

For knowledge producers, the costs/benefits under codification incurred only once. The cost per reuse under personalization first increases and then decreases whereas benefits per reuse under personalization do not vary much over the five stages. For consumers, the costs per stage follow a somewhat U-shape distribution along the reuse stages and the benefits per stage follow a non-decreasing distribution.

It is intuitive to understand non-decreasing benefits for knowledge consumers. We argue that a U-shaped cost is reasonable because when people consider a new knowledge item, they must spend more effort acquiring the basic concept; the middle stages are not that costly because they have learnt the fundamentals. However, when it comes to trial and adoption, some problems may emerge. By personalization, costs of knowledge producers will first increase as help is needed by knowledge consumers to comprehensively understand the knowledge. Once consumers have a better understanding, the one-period cost of knowledge producers in that stage will decrease. In addition, the pay-off differences of codification and personalization from knowledge producers and consumers are insignificant compared to organizational cost of facilitating knowledge reuse.

To examine effects of interesting factors like the number of reusable knowledge items and reuse patterns (i.e., a vector of reuse rates along five stages), this study assumes that reuses of different knowledge items yield the same set of costs/benefits values to the organization (i.e., heterogeneity of reusable knowledge is not taken into account). This assumption is made to keep the formulation simple enough to perform an analytical analysis of its optimality structure. As a result, the one-period reward function of the simplified model can be rewritten as

$$r_t(s_t, a_t) = m \cdot [\alpha \cdot BP_t(a_t \mid a_{t-1}) - CP_t(a_t \mid a_{t-1})] + m \cdot n_t \cdot [BU_t(a_t) - \beta \cdot CU_t(a_t)] - I_t(a_t \mid a_{t-1}).$$

The first term is the pay-off derived from knowledge producers' sharing behavior. The second term is pay-off from consumers' reuse behavior. The third

part is organizational cost. Modeling knowledge reuse processes this way offers a systematic framework for analyzing relevant factors to optimal decision-making on KM strategies. Next section presents insights as a result of this modeling methodology.

3.4.2 Optimality Analysis

For the aforementioned general reuse problem, decision for stage *t* (a_t) is either *P* or *C*, so let BUP_t (CUP_t) denote benefit (cost) for consumer under *P* at stage *t*, BUC_t (CUC_t) denote benefit (cost) for consumer under *C* at stage *t*, *BPC* (*CPC*) denote benefit (cost) for producer under *C*, and BPP_t (CPP_t) denote benefit (cost) for producer per reuse under *P* at stage *t*. In addition, IP_t denotes organizational cost under *P* for stage *t*, and *IC* denotes organizational cost under *C*. As a result, $r_t(s_t, a_t)$ can be categorized into four cases.

- *Case 1*: $a_{t-1} = P$ and $a_t = P$,

$$r_t(s_t, a_t) = m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t) + m \cdot n_t \cdot (BUP_t - \beta \cdot CUP_t) - m \cdot IP_t$$

- *Case 2*: $a_{t-1} = P$ and $a_t = C$,

$$r_t(s_t, a_t) = m \cdot (\alpha \cdot BPC - CPC) + m \cdot n_t \cdot (BUC_t - \beta \cdot CUC_t) - IC$$

- *Case 3*: $a_{t-1} = C$ and $a_t = C$,

$$r_t(s_t, a_t) = m \cdot n_t \cdot (BUC_t - \beta \cdot CUC_t)$$

- *Case 4*: $a_{t-1} = C$ and $a_t = P$,

$$r_t(s_t, a_t) = m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t) + m \cdot n_t \cdot (BUP_t - \beta \cdot CUP_t) - m \cdot IP_t$$

Case 1 and *Case 4* share the same formula as under personalization the cost-benefit will be incurred regardless of the decision in previous stage. However, the magnitude of them may be different due to the reach and richness of the previous decision (Chai et al., 2003). According to the cost-benefit analysis and the typical scenario in previous sections, following insights are obtained.

- Legacy effect on optimal policy

Proposition 1: Decision for the current stage affects the one-period reward of next stage, and therefore the optimal policy for the whole knowledge reuse process.

Justification: It follows directly from the one-period reward of the above four cases. Suppose the current decision is *P*, and then the one-period reward at next stage will be either *Case 1* or *Case 2*. Similarly, if the current decision is *C*, the ensuing stage reward will be *Case 3* or *Case 4*. No doubt that *Case 1* differs from *Case 2* and *Case 3* differs from *Case 4*. Even if the decision at the next stage is *P* (i.e., *Case 1* and *Case 4*), their values are different because *P* and *C* may lead to different reuse rates. Therefore, firms need to consider this effect when they make a reuse strategy based on stage models.

- Scale effect on optimal policy

Proposition 2: Personalization is optimal for firms with a small number of reusable knowledge items, whereas codification is optimal for firms with a large number of reusable knowledge items.

Justification: Comparing *Case 1* and *Case 2*, when *m* is small, firms cannot get payback from a huge investment (i.e., *IC*). Along with increasing *m*, organizational cost of personalization (i.e., $m \cdot IP_t$) increases, so it will be optimal to use codification when *m* reaches a certain level. That is, codification has a strong scale effect and firms should consider codification only when their reuse demand is large enough. The specific value of *m* for considering codification is contingent on organizational reuse context.

- Switching considerations

Proposition 3: It is optimal to start codification earlier if it will be adopted for knowledge reuse in the period of concern. In other words, it is irrational to switch from personalization to codification.

Justification: Due to large *IC*, the one-period reward of *Case 2* is negative in most reuses. Since it is only incurred once, early adoption will amortize this cost over a longer period. Although personalization may yield some extra benefits to knowledge producers and consumers in the latter stages, *Case 3* indicates that firms do not invest much and continuously receive benefits, which also drives firms to adopt codification early.

Proposition 4: Once codification is in use, it is optimal to switch to personalization in latter stages if the extra pay-off that would result from personalization is big enough.

Justification: Once codification is in use, comparing *Case 3* and *Case 4*, the extra pay-off resulting from *P* can be represented by $\Delta 1 = m \cdot n_t \cdot (BUP_t - \beta \cdot CUP_t) - m \cdot n_t \cdot (BUC_t - \beta \cdot CUC_t)$, and the total difference under *C* and *P* for the organization is $\Delta = \Delta 1 + m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t) - m \cdot IP_t$. Note that $m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t) - m \cdot IP_t$ is negative, so firms have to consider the trade-off between $\Delta 1$ and $m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t) - m \cdot IP_t$. The optimal decision is to switch to personalization when the trade-off results in $\Delta > 0$. This model provides a way of making the trade-off quantitatively.

- Reuse pattern effect on optimal policy

Proposition 5: The reuse pattern has a significant influence on an organization's optimal policy.

Justification: From the reward function of the restricted model, it is easy to see that reuse rate n_t has a significant effect on an organization's pay-off from consumers' reuse behavior. Since the benefits from knowledge consumers increase faster than costs along reuse stages, and costs/benefits for knowledge producers do not change much in latter stages, the organization's pay-off is dominated by the sum of consumers' pay-off. Therefore, if reuse rate n_t is higher at the latter stage, the organization's pay-off will increase significantly. Therefore,

a point is reached where the reuse pattern has a significant influence on an organization's optimal policy.

- Interest alignment effect on optimal policy

Proposition 6: When the volume of reusable knowledge is high, interest alignment factors α and β have a salient influence on an organization's optimal policy.

Justification: By observing one-period reward functions, α has an effect on the ultimate value via $m \cdot n_t \cdot (\alpha \cdot BPP_t - CPP_t)$ and $m \cdot (\alpha \cdot BPC - CPC)$, β has an effect via $m \cdot n_t \cdot (BUP_t - \beta \cdot CUP_t)$ and $m \cdot n_t \cdot (BUC_t - \beta \cdot CUC_t)$. According to the costs/benefits described for the restricted model, the effects of α and β are salient when the volume of reusable knowledge ($m \cdot n_t$) is high.

3.5 Numerical Examples and Comparative Analysis

The purpose of this section is to illustrate how this model might be applied in practice and what the effect might look like. Parameters (see Table 3-4) are set by referring to existing literature (Chen and Edgington, 2005; Chai and Nebus, 2012). Some adaptations are made based on the cost-benefit analysis and documented case studies (MacCormack and School, 2002; Umemoto et al., 2004).

Table 3-4 Parameter settings for numerical examples

Stage *t*	1.Awareness	2.Interest	3.Evaluation	4.Trial	5.Adoption	**BPC**	100
BPP(t)	10	10	10	10	15	**CPC**	200
CPP(t)	25	75	100	75	25	**IC**	50000
BUP(t)	25	25	75	450	4050	**SV**	100
CUP(t)	125	50	50	50	50	**α**	0.5
BUC(t)	25	25	75	400	4000	**β**	0.4
CUC(t)	75	50	60	70	70	**γ**	1
IP(t)	20	70	90	70	10		

3.5.1 An Illustrative Example

In this example, uncertainties of reuse rates are considered. Reuse rates are classified into three levels at each stage: high, medium, and low. Specific reuse rates for each stage in practice should be estimated according to properties of the organization's reusable knowledge, of its producers and potential consumers.

Suppose a reuse rate scenario as shown by Figure 3-1. Transition probabilities are set as follows: *PhP = 0.5*, representing the probability of leading to a high reuse rate in the next stage given the current decision is personalization, similarly *PmP = 0.3* and *PlP = 0.2*; *PhC = 0.3*, representing the probability of leading to a high reuse rate in the next stage given the current decision is codification, and *PmC = 0.4* and *PlC = 0.3*. If the current magnitude of reuse rate is smaller than a certain level at the next stage, the corresponding probability is set to zero and its weight is allocated evenly to other possibilities. We use '1' to represent personalization and '2' to represent codification in the decision matrix. When *m = 100*, for a reuse rate scenario shown by Figure 1, the decision matrix

(i.e., the optimal decision at a certain state) and value matrix (i.e., the expected value from then on) are given by Figure 3-2 and Figure 3-3 respectively.

	high	medium	low
1	10	9	8
2	9	6	5
3	7	4	2
4	5	3	1
5	3	2	1

Figure 3-1 A reuse rate scenario for the illustrative example

	hP	mP	lP	hC	mC	lC
1	2	2	2	2	2	2
2	2	2	2	2	2	2
3	2	2	2	2	2	2
4	1	1	1	1	1	2
5	1	1	1	1	1	1

Figure 3-2 Decision matrix of the illustrative example

	hP	mP	lP	hC	mC	lC
	1.0e+006 *					
1	0.8073	0.8073	0.7997	-Inf	-Inf	-Inf
2	0.8325	0.8309	0.8304	0.8975	0.8689	0.8684
3	0.8907	0.8055	0.6028	0.9557	0.8705	0.8603
4	1.0656	1.0076	0.4293	1.0656	1.0076	0.6576
5	1.2008	0.8005	0.4002	1.2008	0.8005	0.4002

Figure 3-3 Value matrix of the illustrative example

Here is the approach to find the optimal policy when different reuse rates realize. For reuse pattern (10, 6, 4, 3, 1), for $t = 1$, the reuse rate is at a high level, as assumed that the previous decision is personalization. The optimal decision (i.e., 2) and expected value (i.e., 807300) are given in the decision matrix and value matrix respectively at row 1, column "hP". Then, for $t = 2$, the reuse level is medium and the previous optimal action is codification. The optimal decision (i.e.,

2) is given at row 2, column "mC". Likewise, the optimal policy (2, 2, 2, 1, 1) is obtained, that is, implementing codification for the first three stages and then personalization for the following two stages.

There are three points to note for the illustrative example. First, the above paragraph shows the way of finding the optimal policy for a given reuse scenario, but it does not mean firms determine their optimal policy by running the model once. Many possible scenarios must be examined for decision-making. Second, firms are rarely sure of the number of reusable knowledge items (*m*), so together with the first point, firms have to run the model many times and conduct what-if analysis according to the evaluation of their reuse context. Finally, expected values of earlier stages might be smaller than those of later stages because costs are usually larger than benefits at earlier stages. This implies that firms can enjoy greater pay-off if they help more potential consumers go further along a reuse process.

3.5.2 Comparative Analysis

This section fixes reuse patterns as shown by Table 3-5. Optimal policies under three reuse patterns [4] with and without interest alignment consideration are presented by Figure 3-4 and Figure 3-5 respectively.

[4] In companies like Siemens, the conservative reuse rate of adoption in ShareNet project is assumed to be 1/10 according to MacCormack, A. D. and H. B. School (2002). Siemens ShareNet: Building a Knowledge Network, Harvard Business School Publishing.We construct three scenarios to illustrate the optimistic, average, and conservative situations.

Table 3-5 Example reuse patterns

Stage *t*	1.Awareness	2.Interest	3.Evaluation	4.Trial	5.Adoption
Optimistic	10	9	8	8	8
Average	10	6	5	4	4
Conservative	10	3	2	1	1

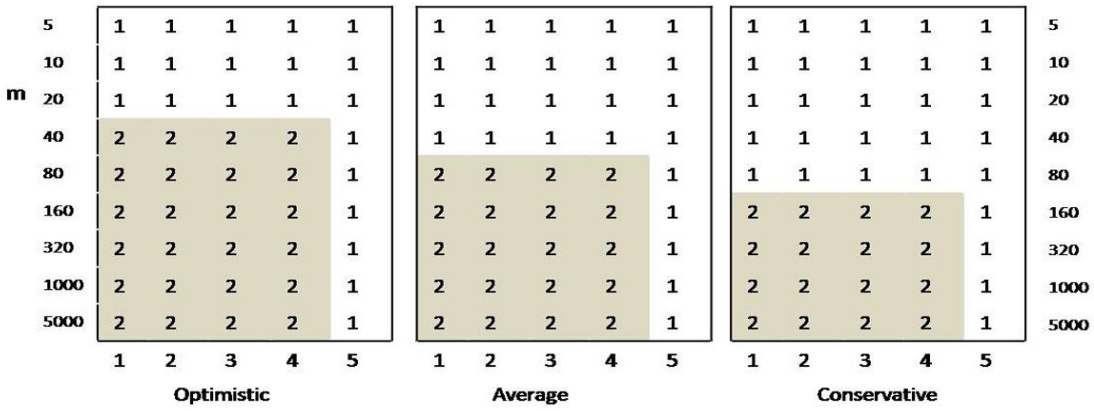

Figure 3-4 Optimal policies with interest alignment consideration

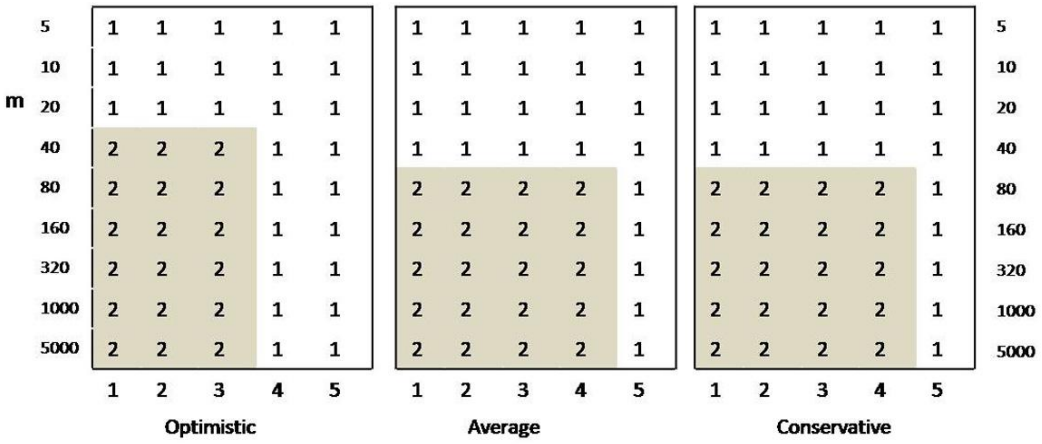

Figure 3-5 Optimal policies without interest alignment consideration

By observing Figure 3-4 and Figure 3-5, it is clear that when *m* is small (i.e., no greater than 20 in this case), it is optimal to use personalization. When *m*

increases, the reuse pattern has a salient effect on optimal policies regardless of interest alignment consideration.

If there is no difference between the benefits of personalization and codification as assumed in the previous paper (Chai and Nebus, 2012) (i.e., *BUP(t) = BUC(t)*, *BPP(5) = BPP(4) =10*), the optimal policies with and without interest alignment considerations are shown as Figure 3-6 and Figure 3-7 respectively.

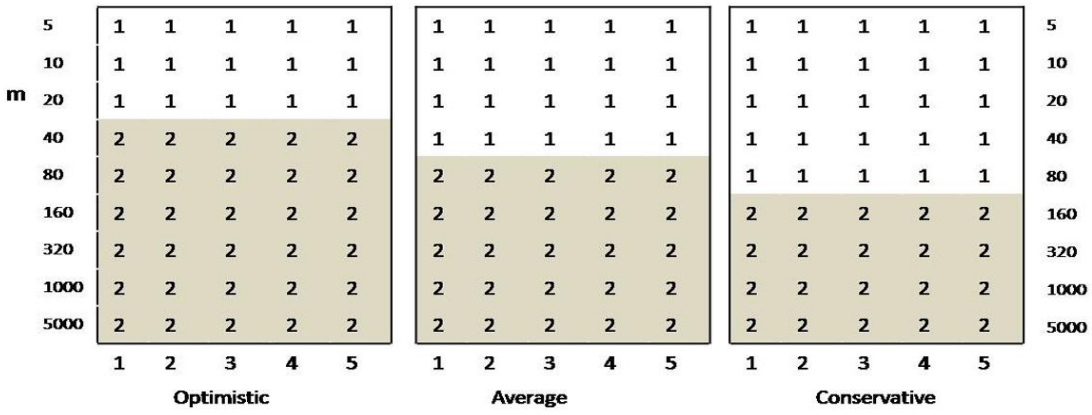

Figure 3-6 Optimal policies with interest alignment and same benefit of consumers under *C* and *P*

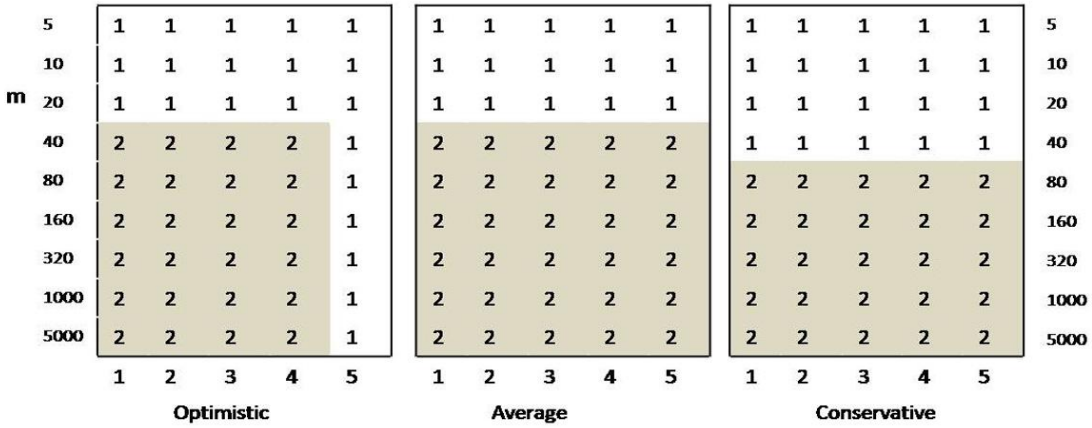

Figure 3-7 Optimal policies without interest alignment and same benefit of consumers under *C* and *P*

Comparing optimal policies in Figure 3-4 and Figure 3-5 as well as in Figure 3-6 and Figure 3-7, interest alignment consideration (i.e., α and β) increases the starting *m* for adopting codification. Moreover, comparing Figure 3-4 (5) with Figure 3-6 (7) shows that magnitudes of costs/benefits have a significant effect (i.e., extra pay-off accelerates the switch from *C* to *P* with the same *m* in this case) on optimal policies for knowledge reuse, especially when the number of reusable knowledge items is large.

In general, for firms with a small number of reusable knowledge items, personalization is always their best policy. However, for firms with a larger number of reusable knowledge items, it is better to consider interest alignment and reuse patterns when making decisions about knowledge reuse as they are critical to whether they should switch from codification to personalization and when to execute the switch. In other words, it is more important for firms with higher reuse demands to plan knowledge reuse strategically. As to the standard of "large", it is not an absolute concept, and it is contingent on the costs/benefits levels of their employees.

3.6 Conclusion

This study has addressed the decision-making of KM strategies for optimizing knowledge reuse within firms. By adopting theories from different fields, we propose a formal approach for the optimum mix of codification and personalization according to the analysis of costs and benefits in specific context. In this way, firms can first analyze their reuse context (costs/benefits, number of

reusable knowledge items, reuse pattern, etc.) and then systematically integrate these considerations into their decision-making with the proposed MDP model.

This study contributes to two streams of literature. On one hand, this study contributes to the KM literature by developing a flexible model which can provide guidelines for determining optimum KM strategy tailored to the characteristics of a particular firm. This is important because firms highlighted in KM success stories may not match the context of the focal firm in terms of the nature of their knowledge or their volume of reusable knowledge. The proposed approach offers an opportunity for firms to gain insights by setting the model's parameters according to their own reuse contexts and conducting what-if analysis. On the other hand, this study contributes to literature about MDP applications by extending it to KM field. It is our hope that combining MDP with knowledge reuse theory will enable firms to increase KM returns on investment, and avoid the disappointments that followed from the broken promises made by the field of KM in previous decades.

As discussed in the introduction chapter, the focus of this paper is to provide insights on how firms should make decisions for optimizing knowledge reuse. In other words, we attempt to teach firms how to fish. An illustrative example is provided to show how this model might be applied. However, this example should not be taken as specific prescriptions for deciding the mix of codification and personalization in a KM strategy. The validity and reliability of decision-making for the optimum KM strategy depends on the accuracy of the framework's parameter values. For future research, applications of this

framework to various firms are needed to support its generalizability. Sensitivity analysis can also be performed to show the robustness of optimal policies suggested for these contexts.

In addition, future research may extend this model for the situation when the benefits and costs of each stage may be dependent of each other. It is also possible for future research to include different levels of codification and personalization in the action space. Then, interesting findings might be released by comparing the results.

Chapter 4 Understanding the Use of Social Media and Knowledge Reuse: Implications and Suggestions for Integration

4.1 Introduction

As discussed in Chapter 2, emerging technologies external to firms may provide new considerations for implementing knowledge management (KM) strategies. The proliferation of social media, such as Facebook, Twitter, and LinkedIn, is one such phenomenon that cannot be ignored. The adoption of social media within firms is increasing rapidly (Treem and Leonardi, 2012). However, in most cases, it runs independently of traditional KM systems. This isolation may confuse employees about which systems they should use for knowledge sharing and seeking/reuse. According to anecdotal feedback from *KM Asia 2013*[5], KM managers are currently grappling with the problem of whether and how to integrate social media with traditional KM tools and techniques.

Social media is a group of internet-based applications that build on the ideological and technological foundations of Web 2.0, which allows the creation and exchange of user-generated content (Kaplan and Haenlein, 2010, p.61). Typical social media applications include blogs, wikis, social network sites (SNS), micro-blogs, social tagging, and podcasts (Jue et al., 2009). This study mainly focuses on SNS. SNS is defined as a web-based platform that allows individuals to construct a public or semi-public profile within a bounded system and articulate a list of others with whom they share a connection, as well as share updates and

[5] This is the most famous conference in Asia for KM practitioners. I attended this 13th annual conference on November 12-14, Orchard Hotel Singapore.

links with their connections (Boyd and Ellison, 2007; Wu et al., 2010). Compared with traditional media, the unique characteristic of SNS is that the above-mentioned activities are recorded and available to view at any time thereafter (Leonardi et al., 2013).

From the perspective of implementing KM strategy, SNS provides a natural mix of codification (i.e., people-to-document) and personalization (i.e., people-to-people) that might help overcome barriers to knowledge reuse through traditional mechanisms such as formal KM systems and transfer of people (Hansen et al., 1999; Chai et al., 2003; Chai and Nebus, 2012). However, the use of SNS is voluntary and the content is often a mix of work and social life (Brzozowski, 2009; Wu et al., 2010; Zhang et al., 2010; Hoong et al., 2012). There are many debates going on whether the use of SNS improves productivity at work (Skeels and Grudin, 2009; Archambault and Grudin, 2012; Majchrzak et al., 2013).

In addition, unlike the adoption of traditional information systems, SNSs have been accepted widely in personal lives (Cao et al., 2012). Traditional factors of technology adoption, such as ease of use, may no longer be problematic. The new problem for firms is how to direct the use of SNS toward the purpose of knowledge sharing and seeking. According to the integrative framework proposed in Chapter 2, the integration should take into account an understanding of how the use of SNS is associated with knowledge reuse performance at the individual level. Therefore, this study aims to provide insights for integration through

understanding the association between the use of SNS and knowledge reuse performance at work.

To understand the problem better, we rely on the Motivation-Ability-opportunity (MAO) theory of work performance (Argote et al., 2003; Siemsen et al., 2008; Reinholt et al., 2011; Minbaeva, 2013). Of these three dimensions, motivation (i.e., willingness) and ability (i.e., one's cognitive capacity) are personal factors, and opportunity is an environmental factor (Blumberg and Pringle, 1982). Whether individuals will seize the opportunities offered by SNS to improve knowledge sharing/seeking is contingent on their motivation and ability to do so (Anderson, 2008; Reinholt et al., 2011; Minbaeva, 2013).

When it comes to the stages of knowledge reuse, although one single study may not be able to cover the outcomes of all five stages as dependent variables contingent on the factors of interest, it is important to distinguish two stages (namely search and transfer) according to the existing empirical studies (Hansen, 1999; Hansen et al., 2005; Jensen, 2010; Yuan et al., 2013). To be consistent with the marketing view of the knowledge reuse stages — Awareness, Interest, Evaluation, Trial, and Adoption — we use Awareness and Transfer for the knowledge reuse stages where Transfer includes the latter four stages (i.e., Interest, Evaluation, Trial, and Adoption). More details will be provided in the next section.

To summarize, our research questions are: When does the use of SNS influence knowledge reuse, at the Awareness stage or the Transfer stage? Does the effect vary across knowledge producers and consumers? Is the effect

contingent on individual heterogeneity (i.e., motivation and ability)? By answering these questions, we hope to better understand the relationship between the use of SNS and knowledge reuse performance at the individual level so that more pertinent insights can be provided for organizational decision-making to integrate social media for knowledge reuse purposes.

The remainder of this chapter is organized as follows. Section 2 reviews the relevant literature to provide a theoretical foundation. Section 3 presents our hypotheses from the perspective of knowledge producers and knowledge consumers. Section 4 describes the methodology, including the data collection procedure and measurement of constructs. Section 5 presents the results of the measurement model and structural model. Section 6 discusses the findings and implications of integrating social media for knowledge reuse purposes. Section 7 concludes this chapter.

4.2 Theoretical Foundation

This section presents an overview of the theoretical framework of MAO theory and summarizes the current understanding of the use of social media in workplaces, as well as the Awareness and Transfer stages of knowledge reuse.

4.2.1 Motivation-Ability-Opportunity Theory of Work Performance

The Motivation-Ability-Opportunity theory has been applied widely in the literature to explain work performance. Briefly put, motivation refers to one's willingness to act, ability refers to one's knowledge base and skills related to the

action, and opportunity refers to the environmental or contextual mechanisms that enable action (Siemsen et al., 2008). In the early days, this theory was employed to explain consumer behavior related to information processing (e.g., Maclnnis and Jaworski, 1989; de Heer and Poiesz, 1998) and organizational performance (e.g., Wu et al., 2004; Clark et al., 2005). In recent years, researchers have started to adopt this framework to explain individual behavior related to knowledge sharing (Argote et al., 2003; Siemsen et al., 2008; Reinholt et al., 2011; Minbaeva, 2013).

The existing literature recognizes that motivation, ability and opportunity affect individual behavior. However, it is far from conclusive how they interact to achieve a certain level of performance (Reinholt et al., 2011). Argote *et al.* (2003) pointed out that motivation, ability, and opportunity are complementary to each other in improving KM performance. Siemsen *et al.* (2008) proposed a constraining-factor model that shows the constraining factor among motivation, ability, and opportunity determines the level of knowledge sharing. In addition, they suggest that motivation, ability, and opportunity should not be addressed alone, but rather in a dynamic and coordinated way. Having a different research focus, some studies view ability and opportunity as moderators of the relationship between motivation and individual performance (e.g., Maclnnis and Jaworski, 1989; Hughes, 2007), while others view motivation and ability as moderators of the relationship between opportunity and individual performance (e.g., Reinholt et al., 2011). As the focus of this study is to understand the influence of SNS use on

knowledge reuse performance at work, we follow the view that motivation and ability serve as moderators.

4.2.2 Use of Social Media in the Workplace

Social media has revolutionized people's communication behavior. Compared to traditional media, social media provides at least four affordances: visibility, persistence, editability, and association (Treem and Leonardi, 2012; Luo et al., 2013). Visibility refers to an individual's behavior and knowledge becoming visible to others without much effort. This visibility is provided not only by directly using a certain social medium, but complemented by knowledge sharing across different social media platforms and groups of people. Persistence, also known as "reviewability" or "recordability", enables users to better understand knowledge by reviewing a communication in its original form at any time thereafter (Jackson et al., 2007). Editability refers to the fact that content can be edited both before and after a communicative act. It might free users from evaluation apprehension (Bordia et al., 2006). Association shows the connection between employees, and between employees and content. Knowledge producers and potential consumers are no longer isolated, and they can exchange knowledge in a more effective and efficient way (Seebach, 2012). Although some traditional media may provide some of these affordances, only social media affords all of them simultaneously at high levels and with the lowest cost (Treem and Leonardi, 2012). SNS is a typical application that affords these characteristics (Treem and

Leonardi, 2012). As such, theoretically, the use of social media — SNS in particular — can improve knowledge reuse processes within an organization.

There are two primary ways that firms can use of social media: the first is to communicate with external customers, vendors, and the public; the second is for employees to communicate and interact with colleagues in the same organization (Leonardi et al., 2013). The first way has been well studied in the literature (e.g., Hanna et al., 2011; Sepp et al., 2011; Luo et al., 2013). The second way is being paid increasing attention, along with the success of the first way of social media use (Leonardi et al., 2013). For the deployment of social media, some firms use public SNS such as Facebook, LinkedIn, and Twitter. In contrast, some firms prefer the adoption of open source or proprietary software, and software firms tend to develop in-house proprietary prototypes that later become incorporated into commercial software products (Leonardi et al., 2013).

In practice, except for large technology firms such as Microsoft and IBM, most firms still hesitate to allow employees use public SNS due to concerns about employees' productivity and organizational information security (Rooksby and Sommerville, 2012). Studies of public social media at large technology firms have revealed trends in social media adoption by individuals (DiMicco and Millen, 2007; Skeels and Grudin, 2009; Archambault and Grudin, 2012). Having seen the irreversible trend of social media, these technology firms have developed new software products with SNS features. Many firms have started to implement internal social media, especially SNS, to increase connections among employees.

Another stream of relevant research focuses on analyzing the motivations that drive the use of social media. In most cases, social media behavior is voluntary. Studies on blogging have shown that enjoying helping, sharing culture, and usefulness are strongly linked to one's blogging behavior (Hsu and Lin, 2008; Yu et al., 2010). In addition, employees are found to contribute more if they receive feedback from co-workers as posted comments (Brzozowski et al., 2009). Few employees are motivated to use social media for external reward. Rather, they are motivated to build social capital such as connecting with weak ties on a personal level, advancing career with the company, and campaigning for their projects (DiMicco et al., 2008).

When it comes to the relationship between the use of social media and knowledge reuse performance, most studies focus on analyzing the content of certain types of social media tools within a specific company (Cao et al., 2012; Hoong et al., 2012; Seebach, 2012). Cao *et al.* (2012) proposed that social media promotes work performance by improving the relationship (i.e., trust) among employees. Hoong *et al.* (2012) explored the use of internal micro-blogging for project knowledge sharing by text-mining and predicted that social media has the potential to improve traditional KM systems. Seebach (2012) revealed that weak ties enabled by social media provide more valuable opinions and recommendations. To our best knowledge, no prior studies have examined whether and/or how the use of social media influences knowledge reuse performance. By revealing the relationship between them, this study hopes to

provide insights on organizational decision-making for integrating social media for knowledge reuse improvement.

4.2.3 Knowledge Awareness and Transfer

As discussed in the introduction, Awareness and Transfer are two distinguished stages of knowledge reuse. For instance, weak ties between employees are helpful for spreading awareness of new opportunities for knowledge reuse, but they impede transfer of complex knowledge (Hansen, 1999). For knowledge producers, Awareness is a process to achieve awareness of what knowledge to share and Transfer is a process to document their knowledge or share their knowledge directly with knowledge consumers. For knowledge consumers, Awareness is a process to achieve awareness of reusable knowledge within their company through active and/or passive search and Transfer is the remaining process to learn and apply the reusable knowledge to improve their own task performance.

As mentioned in Chapter 2, knowledge producers and consumers have different needs during the process of knowledge reuse (He and Wei, 2009; Yan and Davison, 2013). Table 4-1 presents an overview of the needs and outcomes at the Awareness and Transfer stages. Based on the above discussions, the analysis of SNS use hereafter will be performed according to the view of knowledge producers and consumers.

Table 4-1 Needs and outcome of knowledge reuse at Awareness and Transfer stage

Stage	Role	Potential needs	Outcome
Awareness	Knowledge producer	Promote what knowledge one has, and get to know what knowledge others need	Awareness of what knowledge to share
	Knowledge consumer	Active and passive search to know what knowledge exists in their firm	Awareness of reusable knowledge
Transfer	Knowledge producer	Provide knowledge to others through codification or personalization	Knowledge provision
	Knowledge consumer	Acquire, absorb and institutionalize the reusable knowledge	Knowledge acquisition

4.3 Hypothesis Development

As mentioned before, knowledge producers and consumers have different needs at the Awareness and Transfer stages. For this reason, the proposed research framework includes two parts as shown by Figure 4-1 and Figure 4-2. The justifications are presented after the figures.

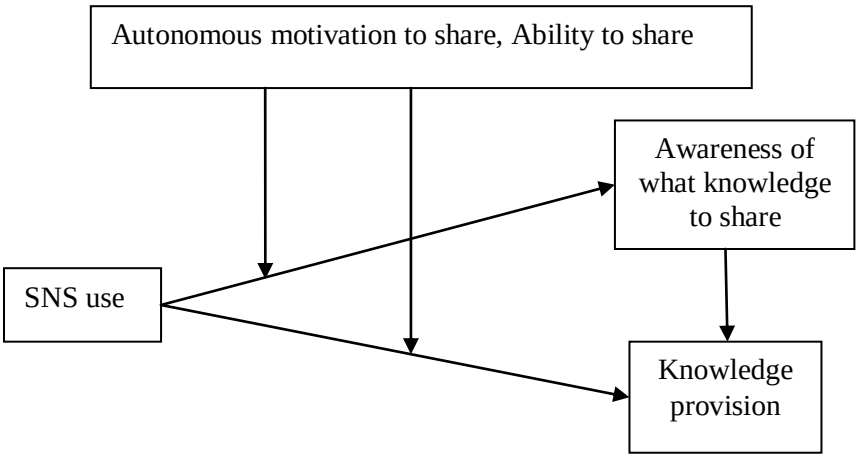

Figure 4-1 Knowledge producer's perspective

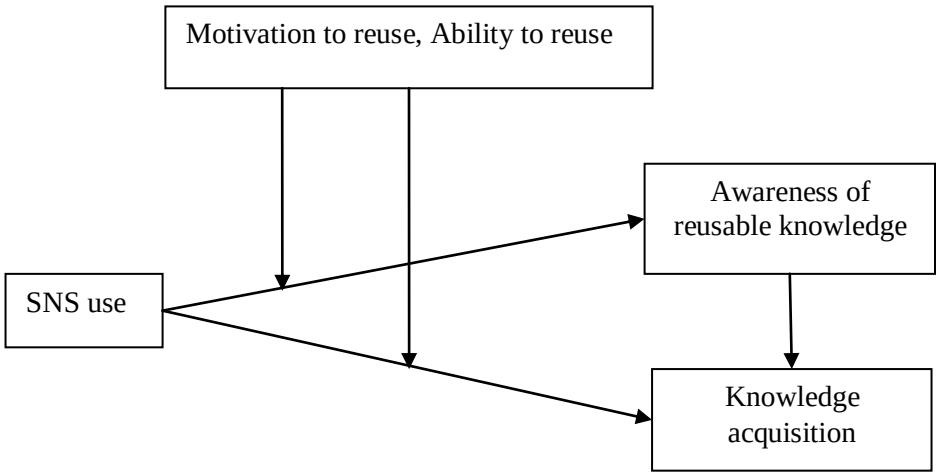

Figure 4-2 Knowledge consumer's perspective

4.3.1 Knowledge Producer's Perspective

4.3.1.1 Outcomes of Knowledge Sharing

According to the Awareness and Transfer stage model of knowledge reuse, from the knowledge producer's perspective we define the outcome of the first stage as awareness of what knowledge to share and the outcome of the second stage as knowledge provision.

- *Awareness of what knowledge to share*

Knowledge producers are supposed to attempt to know what knowledge to share at the first stage. There are two dimensions for awareness of what knowledge to share: awareness of what knowledge others need and awareness of what knowledge one has as a knowledge producer. Sometimes knowledge producers are not aware of what knowledge to share because they do not know the knowledge needs/questions of others (Xu et al., 2010). Knowledge producers are

advised to have some reuse context in mind when they think of sharing (Minbaeva, 2013). Awareness of what knowledge others need helps knowledge producers share knowledge in an easy-to-understand way for potential consumers. On the other hand, knowledge producers can only share the knowledge they know they have (Drew, 1999). If knowledge producers do not know what knowledge they have, they cannot be aware of what knowledge to share. In addition, being aware of what knowledge others need will inspire employees to search their internal "knowledge base" and become aware of what knowledge to share. Therefore, we hypothesize:

H1a: Awareness of what knowledge others need is positively associated with one's awareness of what knowledge to share.

H1b: Awareness of what knowledge one has is positively associated with one's awareness of what knowledge to share.

H1c: Awareness of what knowledge others need has a positive effect on the awareness of what knowledge one has.

- *Knowledge provision*

As a result of the Transfer stage, knowledge producers provide their knowledge to others. The extent that a knowledge producer has offered his or her knowledge to others is defined as knowledge provision (Reinholt et al., 2011). Transfer of knowledge is more complex and time-consuming than the prior stage (i.e., Awareness). Under the codification strategy, knowledge producers have to write down all the necessary information for potential consumers. Under the

personalization strategy, knowledge is transferred through intense interactions between producers and consumers. Taking this into account, knowledge producers may not provide much knowledge if they are not highly aware of the value of their knowledge to others, that is, awareness of what knowledge to share. Therefore, we hypothesize:

H2: Awareness of what knowledge to share is positively associated with knowledge provision.

4.3.1.2 SNS Use and Outcomes of Knowledge Sharing

SNS use is defined as the extent that an individual spends time and effort in posting and/or browsing updates on SNS through which he or she is connected with colleagues. By sharing profiles and updates with connections, SNS makes the previously unknown background knowledge of knowledge producers known to other employees (Leonardi et al., 2013). In addition, SNS enables employees to post questions and receive feedback more efficiently than traditional media. Through participation in SNS, knowledge producers may become aware of what knowledge others need via questions posted by colleagues (Treem and Leonardi, 2012). In addition, these activity streams are available to be viewed or reviewed by employees at their convenience. Browsing these activities may also increase one's awareness of what knowledge he or she has. Therefore, we hypothesize:

H3a: SNS use is positively associated with awareness of what knowledge others need.

H3b: SNS use is positively associated with awareness of what knowledge one has.

As mentioned previously, knowledge transfer is a more complex process than becoming aware of what knowledge to share. The relationship between knowledge producers and consumers plays a critical role in the extent of knowledge provision (Levin and Cross, 2004). SNS use for connecting employees within a company will increase social bonds and build trust (Cao et al., 2012; Seebach, 2012). Through social media use, knowledge producers can codify knowledge gradually instead of all at once and also with the help of relevant experts through their comments. In addition, interaction information tracked on SNS can reduce consumers' time-demand from knowledge producers at the Transfer stage. Therefore, we hypothesize:

H3c: SNS use is positively associated with knowledge provision.

4.3.1.3 The Moderating Role of Motivation to Share Knowledge

Motivation refers to the willingness of an action (Blumberg and Pringle, 1982). According to self-determination theory, different types of motivation vary in their effect on individual behavior (Gagné and Deci, 2005). Autonomous motivation (i.e., intrinsic, integrated, or identified motivation), consistent with individuals' interests and values, results in volitional knowledge sharing; in contrast, controlled motivation pressures individuals to share knowledge by offering reward or punishment (Gagné, 2009; Minbaeva, 2013). Since participation in SNS

is voluntary, autonomous motivation is more pertinent to our research objective. Therefore, we focus on autonomous motivation to share knowledge in this study.

When an individual is highly autonomously motivated, he or she will proactively leverage opportunities offered by social media to understand others' work activities and promote his or her own knowledge. Therefore, he or she is more likely to be aware of knowledge sharing opportunities, i.e., awareness of what knowledge others need/one has. As a result, they are more likely to provide more knowledge to others. On the contrary, some individuals may not pay attention to discussions on SNS and think about whether they can contribute knowledge. Therefore, we hypothesize:

H4a: Motivation to share knowledge will strengthen the positive association between SNS use and awareness of what knowledge others need.

H4b: Motivation to share knowledge will strengthen the positive association between SNS use and awareness of what knowledge one has.

H4c: Motivation to share knowledge will strengthen the positive association between SNS use and knowledge provision.

4.3.1.4 The Moderating Role of Ability to Share Knowledge

Ability to share knowledge is defined as the extent of skills and knowledge required to articulate knowledge to others (Siemsen et al., 2008). It is largely reliant on one's existing knowledge base (Szulanski, 1996; Siemsen et al., 2008). The expertise level of the knowledge producer is very important to the accuracy and comprehensiveness of the knowledge he/she can provide (Minbaeva, 2013).

Experts are able to share knowledge with a higher quality (Haas and Hansen, 2007). They can also articulate more components of knowledge that might be tacit for others (Jasimuddin and Zhang, 2009). Knowledge producers may not share their knowledge with others if they perceive their ability to share as insufficient or that is too time-consuming to meet the high standards of documenting knowledge into an organizational repository. However, they may share their knowledge by participating in discussions initiated by others on SNS. In other words, SNS use reduces barriers to sharing. Therefore, we hypothesize:

H5a: When the knowledge producer's ability to share is low, SNS use is more helpful for him/her to gain awareness of what knowledge others need.

H5b: When the knowledge producer's ability to share is low, SNS use is more helpful for him/her to gain awareness of what knowledge he/she has.

H5c: When the knowledge producer's ability to share is low, SNS use is more strongly related to his/her knowledge provision.

4.3.2 Knowledge Consumer's Perspective

4.3.2.1 Outcomes of Knowledge Seeking

Similar to the previous section, we follow the Awareness and Transfer stage model of knowledge reuse. For knowledge consumers, the outcome of the first stage (Awareness) is defined as awareness of reusable knowledge and the outcome of the second stage (Transfer) is defined as knowledge acquisition.

- *Awareness of reusable knowledge*

For potential consumers, the objective at this stage is to become aware of useful knowledge from other people or places for task performance. To achieve this objective, employees must be clear about their knowledge need (i.e., awareness of what knowledge one needs) and the existence of knowledge in their organization (i.e., awareness of what knowledge others have) (Szulanski, 1996; Faraj and Sproull, 2000). Awareness of what knowledge one needs enables employees to understand the value of knowledge from others, that is, reusable knowledge. Except for knowledge reuse instructed by managers (Chai et al., 2004), employees must become aware of what knowledge others possess in order to be aware of reusable knowledge. In addition, awareness of what knowledge one needs will promote employees to actively search for what knowledge others have. Therefore, we hypothesize:

H6a: Awareness of what knowledge one needs is positively associated with awareness of reusable knowledge.

H6b: Awareness of what knowledge others have is positively associated with awareness of reusable knowledge.

H6c: Awareness of what knowledge one needs has a positive effect on awareness of what knowledge others have.

- *Knowledge acquisition*

Once potential consumers have identified the source of knowledge for reuse, the transfer begins. As a result, knowledge consumers acquire knowledge from others.

The extent that a knowledge consumer has acquired the knowledge is defined as knowledge acquisition. It is contingent on many factors such as time availability and the ability to reuse the knowledge. Furthermore, there may be many similar knowledge pieces/instances in an organizational repository or held by employees with different abilities to share. High awareness of reusable knowledge within an organization helps employees choose the most pertinent knowledge piece or knowledge holder for one's task performance. Therefore, we hypothesize:

H7: Awareness of reusable knowledge is positively associated with knowledge acquisition.

4.3.2.2 SNS Use and Outcomes of Knowledge Seeking

Employees may become aware of what knowledge they need by actively analyzing the problem at hand or by passively being informed by others that they need certain knowledge. Awareness of what knowledge others have within an organization can be achieved by active search or serendipity (De Bruijn and Spence, 2001). Through SNS use, employees receive updates about others' work and thoughts. They can also post updates and knowledge needs. The high visibility of social media reduces ignorance among employees about who is doing what.

According to Szulanski(1996), a lack of source credibility is a significant barrier to identifying valuable knowledge. In order to make correct evaluations about the reuse potential of knowledge, employees usually refer to previous success cases or check the provider's profile. Social media makes this easy by

associating employees with documents. Various social tagging/marking tools can enable individuals to manage relevant information for later reuse. In addition, the persistence of the content on SNS ensures that employees can reconstruct the context of knowledge exchange over time and allows more time for individuals to digest the knowledge transferred from producers. Therefore, we hypothesize:

H8a: SNS use is positively associated with awareness of what knowledge one needs.

H8b: SNS use is positively associated with awareness of what knowledge others have.

H8c: SNS use is positively associated with knowledge acquisition.

4.3.2.3 The Moderating Role of Motivation to Reuse Knowledge

Motivation to reuse knowledge refers to the extent of an employee's willingness to seek knowledge from others. Unlike motivation to share knowledge, motivation to reuse knowledge, such as for information needs or knowledge growth, usually exists as a type of autonomous motivation (Gagné and Deci, 2005; Phang et al., 2009). Exceptions may exist when employees are required by managers to reuse certain practices (Chai et al., 2004). Consequently, consumers gain knowledge growth, which can be viewed as a form of autonomous motivation (Phang et al., 2009). Highly motivated individuals are proactive about improving their task performance by keeping aware of what knowledge they need and what knowledge others have. They are not afraid of posting questions/knowledge needs on SNS. In contrast, less motivated consumers may not give knowledge reuse high priority

and report mindlessly that the knowledge is not useful in their context (Chai et al., 2004). When facing difficulties in knowledge transfer, employees may give up on acquiring knowledge if their motivation is not high enough. On the contrary, highly motivated employees will seek help through SNS use in order to increase knowledge acquisition. Therefore, we hypothesize:

H9a: Motivation to reuse knowledge will strengthen the positive association between SNS use and awareness of what knowledge one needs.

H9b: Motivation to reuse knowledge will strengthen the positive association between SNS use and awareness of what knowledge others have.

H9c: Motivation to reuse knowledge will strengthen the positive association between SNS use and knowledge acquisition.

4.3.2.4 The Moderating Role of Ability to Reuse Knowledge

Ability to reuse knowledge is defined as one's cognitive traits for understanding other's knowledge and using it to improve task performance (Cohen and Levinthal, 1990; Siemsen et al., 2008; Minbaeva, 2013). When the ability to reuse knowledge is high, employees can better interpret the knowledge activities online. Browsing knowledge requests and sharing activities not only enable employees to become aware of what knowledge others have, but may also inspire individuals to think about whether they need that kind of knowledge when they encounter it online. However, employees may not see the value of certain knowledge if they lack the experience or relative knowledge (Demian, 2004). If the ability to reuse is low, they may give up on reusing other's knowledge. As a result, knowledge

acquisition is low, even though their awareness level is high. Therefore, we hypothesize:

H10a: When the ability to reuse knowledge is high, SNS use is more likely to increase the awareness of what knowledge one needs.

H10b: When the ability to reuse knowledge is high, SNS use is more likely to increase the awareness of what knowledge others have.

H10c: When the ability to reuse knowledge is high, SNS use is more likely to increase knowledge acquisition.

4.4 Methodology

4.4.1 Sampling and Data Collection

This study aims to explore the relationship between the use of SNS and knowledge reuse performance at work. The young generation is more active in the use of SNS, so we follow a convenience sampling method and survey engineers, who are currently enrolled in a part-time master's program at the National University of Singapore. At work, these engineers are usually involved in the extensive use of technical knowledge.

We use a survey method to collect self-reported data. It is appropriate for the purpose of this study as perceptual processes, not objective properties, affect one's behavior (Szulanski, 1996). In the questionnaire, we ask separate questions regarding close colleagues who are in the same department or project team as the respondent and distant colleagues otherwise (Reinholt et al., 2011). The

definitions of close colleagues and distant colleagues are provided at the beginning of the questionnaire.

The survey questionnaire was developed in two stages. After the questionnaire was drafted, we invited three postgraduates from the engineering faculty and six working professionals from different industries to check for content validity. Some items were re-worded based on their feedback. For the formal test, questionnaires were distributed prior to or during the break in evening classes attended by these engineers. In total, 186 completed questionnaires out of 225 (82.7%) were received. 71 copies were excluded due to inconsistent answers and consequently the effective response rate was 51.1%. The majority of the participants (92.1%) are less than 35 years old. Most of them work in the engineering field (70.4%) with bachelor's degree (59.1%) or master's degree (38.3%). The majority (49.6%) have worked in their current position for one to three years.

In addition, we used two questions to exclude samples if they chose the options "I don't use any SNS to connect with close colleagues" or "I don't use any SNS to connect with distant colleagues". As a result, we have 104 responses and 91 responses that are eligible for further analysis regarding close colleagues and distant colleagues, respectively.

4.4.2 Measurement

Employees may behave differently when they consider sharing knowledge with or seeking knowledge from close colleagues and distant colleagues (Borgatti and

Cross, 2003; Bordia et al., 2006; Reinholt et al., 2011). Therefore, when necessary, we used separate abbreviations of constructs in relation to close colleagues and distant colleagues (as shown in Table 4-2). We identified 13 important constructs from Section 3. All of them are measured by multiple reflective items based on the literature review. In order to keep the questionnaire concise, we used three items to measure each construct as required for structural equation modeling (Baumgartner and Homburg, 1996; Velicer and Fava, 1998; Siemsen et al., 2008).

Table 4-2 Overview of constructs

Construct	Definition	Abbreviation*	References
Awareness of what to share	The extent to which one understands the value of one's knowledge for others (close colleagues and distant colleagues respectively).	AwWSC; AwWSD	(Schmidt, 2002; Engelmann et al., 2009)
Awareness of reusable knowledge	The extent to which one understands the reuse potential of existing knowledge (of close colleagues and distant colleagues respectively).	AwRKC; AwRKD	(Schmidt, 2002; Engelmann et al., 2009)
Awareness of what knowledge one has	The extent to which one understands what knowledge he/she has.	AwIH	(Schmidt, 2002; Engelmann et al., 2009)
Awareness of what knowledge others need	The extent to which one understands what knowledge is needed by others (close colleagues and distant colleagues respectively) to solve work-related problems.	AwCCN; AwDCN	(Schmidt, 2002; Engelmann et al., 2009)
Awareness of what knowledge one needs	The extent to which one understands what knowledge he/she needs to solve a problem at hand.	AwIN	(Schmidt, 2002; Engelmann et al., 2009)
Awareness of what knowledge others have	The extent to which one understands what knowledge others have within the company (close colleagues and distant colleagues respectively).	AwCCH; AwDCH	(Schmidt, 2002; Engelmann et al., 2009)
Knowledge provision	The extent to which one has provided knowledge to others (close colleagues and distant colleagues respectively).	KPC; KPD	(Reinholt et al., 2011; Minbaeva et al., 2012)
Knowledge acquisition	The extent to which one has reused knowledge of others within the organization (close colleagues and distant colleagues respectively).	KAC; KAD	(Reinholt et al., 2011; Minbaeva et al., 2012)
SNS use	The extent to which one spends time and effort on SNS through which they are connected with others (close colleagues and distant colleagues respectively).	SNS use_C; SNS use_D;	(Kankanhalli et al., 2005; Pagani et al., 2011; Junco, 2012)
Autonomous motivation to share	When an individual is autonomously motivated, the sharing behavior is self-endorsed and congruent with his interests/values.	AMSC; AMSD	(Minbaeva, 2013)
Ability to share	When considering sharing knowledge with others(close colleagues and distant colleagues respectively), the extent to which one can articulate it to others.	ASC; ASD	(Siemsen et al., 2008)
Ability to reuse knowledge	The extent to which one can understand and absorb the new knowledge from others for his or her own task.	ARKC; ARKD	(Szulanski, 1996)
Motivation to reuse knowledge	The extent to which one is willing to reuse knowledge from others.	MRKC; MRKD	(Gagn éand Deci, 2005)

*where there are two abbreviations in one cell, the first one refers to the construct regarding close colleagues and the second refers to the construct regarding distant colleagues.

4.5 Result Analysis

Structural Equation Modeling (SEM), a class of multivariate techniques that combine aspects of factor analysis and regression, is employed for this study. It is one of the most prominent statistical analysis techniques for understanding latent phenomena such as individual perceptions, motivations, and their influence on performance (Hair et al., 2013). When applying SEM, researchers must choose one of the two types: covariance-based techniques (i.e., CB-SEM) or variance-based partial least squares (i.e., PLS-SEM).

CB-SEM is mainly used to test existing theories by determining how well a proposed theoretical model can estimate the covariance matrix for a sample data set; whereas PLS-SEM is primarily implemented to develop theories in exploratory research by focusing on explaining the variance (Chin, 2010; Hair et al., 2013). In addition, PLS-SEM accounts for measurement error and provides more accurate estimates of interaction effects (Chin et al., 2003). Because there is limited existing knowledge on the relationship between SNS use and knowledge reuse performance at work and our main purpose is to explain/predict this relationship, we employed PLS-SEM for this study (Gefen et al., 2011). Specifically, we used SmartPLS2.0 M3 with bootstrapping for the measurement model and structural model analysis.

4.5.1 Descriptive Results

Figures 4-3 and 4-4 show a summary of the SNS platforms used by participants to connect with close colleagues and distant colleagues, respectively. For connecting with close colleagues, 90.4% of respondents use some kind of SNS and about 26% of respondents use internal SNS. For connecting with distant colleagues, the percentage of

SNS use decreases to about 80% for any SNS and 14.8% for internal SNS. Regardless of whether it is for connecting with close colleagues or distant colleagues, Facebook is the most popular SNS in use.

SNS for Close Colleagues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Facebook	45	39.1	39.1	39.1
	LinkedIn	3	2.6	2.6	41.7
	Twitter	1	.9	.9	42.6
	Internal SNS	15	13.0	13.0	55.7
	Other	10	8.7	8.7	64.3
	Don't use	11	9.6	9.6	73.9
	Use more than one types, including internal SNS	15	13.0	13.0	87.0
	Use more than one types, not including internal SNS	15	13.0	13.0	100.0
	Total	115	100.0	100.0	

Figure 4-3 Overview of SNS use for connecting close colleagues

SNS for Distant Colleagues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Facebook	40	34.8	34.8	34.8
	LinkedIn	7	6.1	6.1	40.9
	Internal SNS	11	9.6	9.6	50.4
	Other	11	9.6	9.6	60.0
	Don't use	24	20.9	20.9	80.9
	Use more than one types, including internal SNS	6	5.2	5.2	86.1
	Use more than one types, not including internal SNS	16	13.9	13.9	100.0
	Total	115	100.0	100.0	

Figure 4-4 Overview of SNS use for connecting distant colleagues

When asked about their last experience of knowledge sharing, 68.7% chose to tell colleagues first, 17.2% chose to document first, and 10.4% chose to broadcast on SNS first. When it came to their last experience of knowledge seeking, 52.6% chose to directly ask another colleague for help, 32.5% chose to search an organizational

repository, and 10.4% chose to ask a question on SNS (as shown in Figure 4-5 and 4-6). The results show that SNS is not yet a popular way to share or seek new knowledge related to work which implies that conventional KM tools still hold crucial roles in work places. However, much work can be done to improve the use of SNS for both knowledge sharing and knowledge seeking.

First way to share knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Broadcasted it first on SNS	12	10.4	10.6	10.6
	Documented it first into organizational repository	20	17.4	17.7	28.3
	Told colleagues first through direct conversation	79	68.7	69.9	98.2
	Others	2	1.7	1.8	100.0
	Total	113	98.3	100.0	
Missing	Unknown	2	1.7		
Total		115	100.0		

Figure 4-5 Overview of first way to share knowledge

First way to seek knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Asked a question through SNS	12	10.4	10.5	10.5
	Asked another colleague first for help	60	52.2	52.6	63.2
	Searched organizational repository first	37	32.2	32.5	95.6
	Others	5	4.3	4.4	100.0
	Total	114	99.1	100.0	
Missing	Unknown	1	.9		
Total		115	100.0		

Figure 4-6 Overview of first way to seek knowledge

4.5.2 Measurement Model Assessment

4.5.2.1 Assessment Criteria

All of the latent variables for structural models are reflective and measured through seven-point Likert scales, so the evaluation criteria of measurement models include construct reliability and validity. Construct reliability shows whether the indicators assigned to the same construct reveal a strong mutual association (Götz et al., 2010). Based on the inter-correlations of the observed indicator variables, Cronbach's alpha provides an estimate of the reliability assuming all indicators are equally reliable. It is often used as a conservative measure of internal consistency reliability. Complementarily, composite reliability takes into account different outer loadings of indicator variables. When it comes to construct validity, two types are normally considered: convergent validity and discriminant validity. Convergent validity, the extent to which a measure correlates positively with alternative measures of the same construct, is usually measured by the average variance extracted (AVE). AVE is defined as the grand mean value of the squared loadings of the indicators associated with the construct. Discriminant validity refers to the extent to which a construct is truly distinct from other constructs by empirical standards. It is often examined by the Fornell-Larcker criterion which compares the square root of AVE values with the latent variable correlations (Hair et al., 2013). For more details on how these indicators are calculated, readers can refer to Appendix B.

As a rule of thumb, for construct reliability Cronbach's alpha should be greater than 0.70 and the composite reliability should fall into the interval between 0.70 and 0.95. For construct validity, AVE values should be greater than 0.50 and the square root of

each construct's AVE should be greater than its highest correlation with any other construct. Weaker loadings of measurement items on constructs, especially on newly developed scales, are often encountered by researchers in the social studies. Researchers are advised to remove the indicators when loadings are below 0.4, examine the indicators when loadings are between 0.4 and 0.7, and delete them only when doing so leads to an increase in the composite reliability or AVE above the suggested threshold (Hair et al., 2013).

Common method variance (CMV), the variance that is attributable to the measurement method, is a potential threat to research done using self-report surveys in a single setting (Spector, 2006). In order to reduce the effects of potential causes of CMV (Podsakoff et al., 2003), we ensured strict anonymity by stating on the questionnaire that "Your participation is voluntary. This survey is anonymous and no personal identifiers will be collected. You are free to not answer any questions you do not wish to". Moreover, we used pre-tests to check the clarity of items and re-worded them when necessary. In order to reduce item ambiguity, important definitions were also provided at the beginning of the questionnaire, such as close colleagues, distant colleagues, SNS, knowledge, and repository. Lastly, Harman's single factor test will be performed in the following subsections to assess the severity of the common method bias. In Harman's single factor test, all measurement items are subject to exploratory factor analysis (EFA). CMV is assumed to exist if a single factor emerges from the unrotated factor solutions (Malhotra et al., 2006). When the indicator of Harman's single factor test is high, a common factor method is used to further examine the effect of common method variance versus substantive indicator variance (Liang et al., 2007).

4.5.2.2 Measures of Knowledge Sharing with Close Colleagues

First, we examined the loadings of indicators on their associated constructs. The measurement item AwIH3 was removed from further analysis because its loading is below the threshold value of 0.40. Table 4-3 shows a summary of the measurement items and their loadings related to knowledge sharing with close colleagues. Table 4-4 is an overview of the reliability and validity values regarding knowledge sharing with close colleagues. We can see that all of the Cronbach's alpha values are above the threshold value of 0.70 and the composite reliability values are between 0.70 and 0.95, suggesting that all of the measurements are fairly reliable (Hair, Hult et al. 2013). In addition, all of the AVE values are well above 0.50 and their square roots are greater than any construct correlations. Therefore, the convergent validity and discriminant validity criterion are well met.

Table 4-3 Overview of measures related to knowledge sharing with close colleagues

Construct	Measurement item	loading
SNS use_C	USECC1: I use SNS a lot through which I am connected with **close colleagues**.	0.95***
	USECC2: I am a heavy user of SNS through which I am connected with **close colleagues**.	0.87***
ASC	ASC1: I am an expert of the knowledge which I share with **close colleagues**.	0.78***
	ASC2: I am capable of articulating the knowledge which I share with **close colleagues**.	0.82***
	ASC3: I know very well of the knowledge which I share with **close colleagues**.	0.86***
AMSC	AMSC1: I share knowledge with **close colleagues** because I enjoy it.	0.86***
	AMSC2: I share knowledge with **close colleagues** because I find it personally satisfying.	0.86***
	AMSC3: I share knowledge with **close colleagues** because it is part of my job.	0.71***
AwIH	AwIH1: I am aware of what knowledge I have.	0.95***
	AwIH2: I know what I am good at for work.	0.95***
AwCCN	AwCCN1: I am informed about what knowledge **close colleagues** need.	0.86***
	AwCCN2: **Close colleagues** often ask me work-related questions.	0.84***
	AwCCN3: I don't know what knowledge **close colleagues** need. (reverse-coded item)	0.70***
AwWSC	AwWSC1: I understand the value of my knowledge to **close colleagues**.	0.91***
	AwWSC2: I am aware of the usefulness of my knowledge to **close colleagues**.	0.90***
	AwWSC3: I don't know the value of my knowledge to **close colleagues**.	0.82***
KPC	KPC1: I have provided my knowledge to **close colleagues**.	0.86***
	KPC2:I have documented my knowledge and shared the documents with **close colleagues**.	0.70***
	KPC3: I have spent time teaching **close colleagues** with my knowledge.	0.89***
	KPC4: **Close colleagues** have reused my knowledge.	0.72***

***p<0.001 (two-tailed t-test)

Table 4-4 Overview of reliability and validity of constructs regarding knowledge sharing with close colleagues

Construct	Cronbach Alpha	Composite reliability	AVE	SNS use_C	ASC	AMSC	AwIH	AwCCN	AwWSC	KPC
SNS use_C	0.81	0.91	0.83	**0.91**						
ASC	0.76	0.86	0.68	-0.01	**0.82**					
AMSC	0.74	0.86	0.66	0.17	0.48	**0.82**				
AwIH	0.89	0.95	0.90	0.18	0.40	0.35	**0.95**			
AwCCN	0.73	0.85	0.65	0.03	0.49	0.41	0.28	**0.81**		
AwWSC	0.85	0.91	0.77	-0.07	0.56	0.27	0.53	0.63	**0.88**	
KPC	0.81	0.87	0.63	-0.12	0.41	0.29	0.32	0.34	0.43	**0.80**

Note: Diagonal elements are square roots of corresponding AVE (Average Variance Extracted).

We also performed Harman's single factor test. The single factor accounts for a maximum of 29.4% of the total variance regarding knowledge sharing with close colleagues. This indicates that CMV is not a major problem.

4.5.2.3 Measures of Knowledge Sharing with Distant Colleagues

For the same reason as in the previous subsection, measurement item AwIH3 was removed because of outer loadings below 0.4. The loading of AwDCN3 on AwDCN is 0.41. Although the loading is low, AwDCN3 is kept based on the results of comparing the values of composite reliability and AVE before and after deletion. Table 4-5 shows a summary of the measurement items and their loadings related to knowledge sharing with distant colleagues. Table 4-6 shows that the Cronbach's alpha values range from 0.70 to 0.90 and the composite reliability ranges from 0.81 to 0.95. As a result, we can claim that all of the constructs are measured with high reliability. In addition, convergent validity and discriminant validity are established as all of the AVEs are greater than 0.5 and all their square roots are greater than the construct correlations.

Table 4-5 Overview of measures related to knowledge sharing with distant colleagues

Construct	Measurement item	loading
SNS use_D	USEDC1: I use SNS a lot through which I am connected with **distant colleagues**.	0.95***
	USEDC2: I am a heavy user of SNS through which I am connected with **distant colleagues**.	0.82***
ASD	ASD1: I am an expert of the knowledge which I share with **distant colleagues**.	0.86***
	ASD2: I am capable of articulating the knowledge which I share with **distant colleagues**.	0.88***
	ASD3: I know very well of the knowledge which I share with **distant colleagues**.	0.90***
AMSD	AMSD1: I share knowledge with **distant colleagues** because I enjoy it.	0.90***
	AMSD2: I share knowledge with **distant colleagues** because I find it personally satisfying.	0.88***
	AMSD3: I share knowledge with **distant colleagues** because it is part of my job.	0.73***
AwIH	AwIH1: I am aware of what knowledge I have.	0.94***
	AwIH2: I know what I am good at for work.	0.96***
AwDCN	AwDCN1: I am informed about what knowledge **distant colleagues** need.	0.88***
	AwDCN2: **Distant colleagues** often ask me work-related questions.	0.94***
	AwDCN3: I don't know what knowledge **distant colleagues** need. (reverse-coded item)	0.41**
AwWSD	AwWSD1: I understand the value of my knowledge to **distant colleagues**.	0.95***
	AwWSD2: I am aware of the usefulness of my knowledge to **distant colleagues**.	0.95***
	AwWSD3: I don't know the value of my knowledge to **distant colleagues**.	0.53***
KPD	KPD1: I have provided my knowledge to **distant colleagues**.	0.90***
	KPD2: I have documented my knowledge and shared the documents with **distant colleagues**.	0.89***
	KPD3: I have spent time teaching **distant colleagues** with my knowledge.	0.86***
	KPD4: **Distant colleagues** have reused my knowledge.	0.83***

***p<0.001 (two-tailed t-test)
**p<0.05 (two-tailed t-test)

Table 4-6 Overview of reliability and validity of constructs regarding knowledge sharing with distant colleagues

Construct	Cronbach Alpha	Composite reliability	AVE	SNS use_D	ASD	AMSD	AwIH	AwDCN	AwWSD	KPD
SNS use_D	0.75	0.88	0.79	**0.89**						
ASD	0.85	0.91	0.77	0.05	**0.88**					
AMSD	0.78	0.87	0.70	0.04	0.54	**0.84**				
AwIH	0.89	0.95	0.90	0.08	0.39	0.38	**0.95**			
AwDCN	0.70	0.81	0.61	0.23	0.28	0.39	0.12	**0.78**		
AwWSD	0.77	0.86	0.69	0.08	0.56	0.41	0.27	0.54	**0.83**	
KPD	0.90	0.93	0.76	0.08	0.40	0.36	0.14	0.62	0.51	**0.87**

Note: Diagonal elements are square roots of corresponding AVE (Average Variance Extracted).

For this set of constructs, Harman's single factor test shows that a maximum of 30.37% of the total variance regarding knowledge sharing with distant colleagues can be explained by a single factor. Therefore, CMV is unlikely to be a serious problem for this set of measures.

4.5.2.4 Measures of Knowledge Seeking from Close Colleagues

After examining the loadings of measurements on constructs, AwIN3 was removed from further analysis as its loading on AwIN is below 0.40. AwCCH3 is retained although its loading is only 0.49 because the composite reliability (0.84) and AVE (0.65) of the construct AwCCH are above the threshold value. Table 4-7 shows a summary of measures related to knowledge seeking from close colleagues. Table 4-8 presents the reliability and validity indicators of constructs regarding knowledge seeking from close colleagues.

According to Table 4-8, all of the relevant constructs in this section show good reliability as the Cronbach's alpha values range from 0.70 to 0.90 and the composite reliability from 0.84 to 0.93. The validity test criteria are also satisfied because the AVE values are above 0.64 and their square roots are greater than any construct correlations.

Table 4-7 Overview of measures related to knowledge seeking from close colleagues

Construct	Measurement item	loading
SNS use_C	USECC1: I use SNS a lot through which I am connected with **close colleagues**.	0.92***
	USECC2: I am a heavy user of SNS through which I am connected with **close colleagues**.	0.912***
ARKC	ARKC1: I am capable of understanding **close colleagues'** knowledge.	0.89***
	ARKC2: I have the competence to absorb **close colleagues'** knowledge.	0.89***
	ARKC3: I am good at integrating **close colleagues'** knowledge for my task performance.	0.88***
MRKC	MRKC1: I think it is right to seek **close colleagues'** knowledge rather than reinvention.	0.80***
	MRKC2: I like to ask **close colleagues** for help when I encounter a problem at work.	0.89***
	MRKC3: I am motivated to seek **close colleagues'** help first when I encounter a work-related problem.	0.86***
AwIN	AwIN1: When I encounter a problem at work, I normally know what knowledge is needed to solve it.	0.87***
	AwIN2: When I encounter a problem at work, in general I can understand the problem clearly.	0.92***
AwCCH	AwCCH1: I am aware of **close colleagues'** expertise.	0.93***
	AwCCH2: I know what **close colleagues** are good at.	0.92***
	AwCCH3: I know what knowledge has been documented by **close colleagues** in the repository.	0.49***
AwRKC	AwRKC1: I understand the value of **close colleagues'** knowledge to my task performance.	0.85***
	AwRKC2: I know whether **close colleagues** have relevant expertise regarding my work.	0.93***
	AwRKC3: I know whom of **close colleagues** I shall turn to for help when I encounter a work-related problem.	0.85***
KAC	KAC1: I have gained knowledge from **close colleagues**.	0.94***
	KAC2: I have used knowledge documented by **close colleagues**.	0.86***
	KAC3: **Close colleagues** have helped me with their knowledge.	0.92***

***p<0.001 (two-tailed t-test)

Table 4-8 Overview of reliability and validity of constructs regarding knowledge seeking from close colleagues

Construct	Cronbach Alpha	Composite reliability	AVE	SNS use_C	ARKC	MRKC	AwIN	AwCCH	AwRKC	KAC
SNS use_C	0.81	0.91	0.84	**0.92**						
ARKC	0.87	0.92	0.79	0.03	**0.89**					
MRKC	0.817	0.89	0.73	0.09	0.55	**0.85**				
AwIN	0.75	0.89	0.80	0.23	0.57	0.26	**0.89**			
AwCCH	0.70	0.84	0.65	0.11	0.72	0.49	0.52	**0.81**		
AwRKC	0.85	0.91	0.78	0.02	0.73	0.51	0.43	0.77	**0.88**	
KAC	0.90	0.93	0.83	0.03	0.49	0.42	0.05	0.51	0.56	**0.91**

Note: Diagonal elements are square roots of corresponding AVE (Average Variance Extracted).

Harman's single factor test shows that a maximum of 36.39% of the variance regarding knowledge seeking from close colleagues can be explained by a single factor. We also added a common method factor to analyze the potential common method bias (Liang et al., 2007). As shown in Appendix C.1, the average variance explained by the indicators is 0.76, whereas the average variance explained by the common method factor is rounded to 0.00. In addition, most factor loadings of the common method are not significant. Therefore, the common method is unlikely to be a serious concern for this set of measures.

4.5.2.5 Measures of Knowledge Seeking from Distant Colleagues

Similar to the measures related to knowledge seeking from close colleagues, AwIN3 was removed from further analysis because of outer loadings below 0.4. All other measurement items and their loadings are shown in Table 4-9. Table 4-10 presents the reliability and validity indicators of constructs regarding knowledge seeking from distant colleagues.

According to Table 4-10, the minimum value of Cronbach's alpha is 0.74 and the composite reliabilities fall into the satisfactory interval from 0.70 to 0.95, so all of the measures used here are reliable for their corresponding constructs. The minimum value of AVE is 0.67, indicating good convergent validity. The square root of AVE is greater than any construct correlation, indicating good discriminant validity.

Table 4-9 Overview of measures related to knowledge seeking from distant colleagues

Construct	Measurement item	loading
SNS use_D	USEDC1: I use SNS a lot through which I am connected with **distant colleagues**.	0.95***
	USEDC2: I am a heavy user of SNS through which I am connected with **distant colleagues**.	0.83***
ARKD	ARKD1: I am capable of understanding **distant colleagues'** knowledge.	0.89***
	ARKD2: I have the competence to absorb **distant colleagues'** knowledge.	0.90***
	ARKD3: I am good at integrating **distant colleagues'** knowledge for my task performance.	0.91***
MRKD	MRKD1: I think it is right to seek **distant colleagues'** knowledge rather than reinvention.	0.84***
	MRKD2: I like to ask **distant colleagues** for help when I encounter a problem at work.	0.94***
	MRKD3: I am motivated to seek **distant colleagues'** help first when I encounter a work-related problem.	0.94***
AwIN	AwIN1: When I encounter a problem at work, I normally know what knowledge is needed to solve it.	0.89***
	AwIN2: When I encounter a problem at work, in general I can understand the problem clearly.	0.90***
AwDCH	AwDCH1: I am aware of **distant colleagues'** expertise.	0.76***
	AwDCH2: I know what **distant colleagues** are good at.	0.77***
	AwDCH3: I know what knowledge has been documented by **distant colleagues** in the repository.	0.58***
AwRKD	AwRKD1: I understand the value of **distant colleagues'** knowledge to my task performance.	0.89***
	AwRKD2: I know whether **distant colleagues** have relevant expertise regarding my work.	0.94***
	AwRKD3: I know whom of **distant colleagues** I shall turn to for help when I encounter a work-related problem.	0.91***
KAD	KAD1: I have gained knowledge from **distant colleagues**.	0.92***
	KAD2: I have used knowledge documented by **distant colleagues**.	0.94***
	KAD3: D**istant colleagues** have helped me with their knowledge.	0.93***

***p<0.001 (two-tailed t-test)

Table 4-10 Overview of reliability and validity of constructs regarding knowledge seeking from distant colleagues

Construct	Cronbach Alpha	Composite reliability	AVE	SNS use_D	ARKD	MRKD	AwIN	AwDCH	AwRKD	KAD
SNS use_C	0.74	0.88	0.79	**0.89**						
ARKD	0.88	0.93	0.81	0.06	**0.90**					
MRKD	0.89	0.93	0.82	0.18	0.65	**0.91**				
AwIN	0.74	0.89	0.79	0.22	0.52	0.26	**0.89**			
AwDCH	0.86	0.91	0.78	0.12	0.57	0.59	0.33	**0.88**		
AwRKD	0.90	0.94	0.84	0.06	0.68	0.70	0.36	0.81	**0.92**	
KAD	0.92	0.95	0.86	0.10	0.54	0.72	0.20	0.60	0.73	**0.93**

Note: Diagonal elements are square roots of corresponding AVE (Average Variance Extracted).

Harman's single factor test shows that a maximum of 41.04% of the total variance regarding knowledge seeking from distant colleagues can be explained by a single factor. We used the common latent factor method again to assess the variance explained by substantive indicators versus the common method factor. As shown in Appendix C.2, the average variance explained by indicators is 0.81, whereas the average variance explained by the common method factor is only 0.01. In addition, most factor loadings of the common method are not significant. Therefore, CMV is unlikely to be a problem for this set of measures (Liang et al., 2007).

4.5.3 Structural Model Results

Having confirmed that the construct measures are reliable and valid, this section presents an assessment of the structural model results. It mainly examines the model's predictive power and the significance of the path estimates (Chin, 2010). Predictive power is assessed by the R^2 values of the endogenous constructs. The acceptable levels of R^2 differ from discipline to discipline. In consumer behavior studies, R^2 values of 0.20 are considered high (Hair et al., 2013). The R^2 values of the endogenous constructs in our models range from 0.20 to 0.63, indicating good predictive power. Furthermore, the effect size, which is based on change in R^2, is employed to show the contribution of an exogenous construct in explaining an endogenous construct (the calculation of effect size can be found in Appendix B). Values of 0.02, 0.15, and 0.35 represent small, medium, and large effects respectively (Chin, 2010). Significance is obtained via a bootstrapping procedure consisting of 500 runs (Chin et al., 2003). Table 4-11, which is shown at the end of this section, summarizes the results of the hypothesized relationships regarding

close colleagues and distant colleagues in parallel. The detailed results of the main effects of knowledge sharing and seeking regarding close colleagues and distant colleagues can be found in Appendix D.

First we discuss the results when employees act as knowledge producers (Hypotheses H1 to H5). As expected, awareness of what knowledge others need has a substantial effect on awareness of what knowledge to share (H1a is supported by feedback regarding both close colleagues and distant colleagues at $p<0.001$; the effect size is much greater than the threshold value of large effect). Awareness of what knowledge one has influences one's awareness of what knowledge to share with close colleagues to a large extent, whereas the effect is smaller when sharing with distant colleagues (H1b is supported by feedback regarding close colleagues at $p<0.001$ and distant colleagues at $p<0.05$). Awareness of what knowledge to share indeed affects the extent one provides knowledge to others, especially to distant colleagues (H2 is supported by feedback regarding close colleagues at $p<0.05$ and distant colleagues at $p<0.001$). SNS use increases the awareness of what knowledge distant colleagues need (H3a is supported at $p<0.05$), but not what knowledge close colleagues need. The use of SNS to connect with close colleagues slightly increases one's awareness of what knowledge one has (H3b, significant at $p<0.1$).

Surprisingly, the interaction effect between autonomous motivation to share and SNS use is negative for awareness of what knowledge others need (H4a, significant at $p<0.05$). The interaction effect between ability to share and SNS use on awareness of what knowledge one has is positive regarding close colleagues, but negative regarding distant colleagues (H5b, significant at $p<0.05$). The interaction effect between ability to

share and SNS use on knowledge provision is also negative (H5c is supported by feedback regarding close colleagues at $p<0.1$ and distant colleagues at $p<0.001$). We will discuss the possible reasons for this and the implications for managers in later sections.

Next we discuss the results when employees act as knowledge consumers (Hypotheses H6 to H10). Awareness of what knowledge others have is very critical to the awareness of reusable knowledge (H6b is supported by feedback regarding both close colleagues and distant colleagues at $p<0.001$; the effect size is much greater than the threshold value of large effect). Interestingly, awareness of what knowledge one needs has a positive influence on the awareness of what knowledge close colleagues have (H6c, significant at $p<0.05$), but the association is not supported regarding distant colleagues. Awareness of reusable knowledge is highly associated with the extent that one seeks knowledge from others (H7 is supported by feedback regarding close colleagues at $p<0.05$ and distant colleagues at $p<0.001$; the effect size is medium to large). In addition, SNS use has a significant positive effect on the awareness of what knowledge one needs (H8a is supported by feedback regarding both close colleagues and distant colleagues at $p<0.05$).

The interaction between SNS use and motivation to reuse has a positive effect on the awareness of what knowledge one needs (H9a is supported by feedback regarding close colleagues at $p<0.05$ and distant colleagues at $p<0.1$). However, their interaction effect on the awareness of what knowledge others have is negative (significant at $p<0.1$ regarding close colleagues and $p<0.05$ regarding distant colleagues). In addition to the indirect effect through the awareness level, their interaction has a positive direct effect on one's knowledge acquisition from close colleagues (significant at $p<0.05$). To our

surprise, the interaction of between SNS use and ability to reuse knowledge has contrasting effects regarding close colleagues and distant colleagues: their interaction has a positive effect on awareness of what knowledge close colleagues need, but the relationship is not significant for distant colleagues. Furthermore, their interaction has no significant effect on either awareness of what knowledge close colleagues have or knowledge acquisition from close colleagues. However, their interaction has a negative effect on awareness of what knowledge others have (significant at $p<0.05$), but a positive effect on knowledge acquisition from distant colleagues (significant at $p<0.1$).

Table 4-11 Coefficient and effect size (shown in parentheses) of significant paths

Hypothesis	Close colleagues	Distant colleagues
H1a: Awareness of what knowledge others need→Awareness of what knowledge to share	0.52***(0.53)	0.52***(0.41)
H1b: Awareness of what knowledge I have→ Awareness of what knowledge to share	0.39***(0.29)	0.21**(0.07)
H1c: Awareness of what knowledge others need→ Awareness of what knowledge I have	Not supported	Not supported
H2: Awareness of what knowledge to share→Knowledge provision	0.28**(0.07)	0.39***(0.14)
H3a: SNS use→ Awareness of what knowledge others need	Not supported	0.21**(0.05)
H3b: SNS use→ Awareness of what knowledge I have	0.16*(0.03)	Not supported
H3c: SNS use→Knowledge provision	Not supported	Not supported
H4a: SNS use*Motivation to share→ Awareness of what knowledge others need	-0.13**(0.16)	-0.23**(0.09)
H4b: SNS use* Motivation to share → Awareness of what knowledge I have	-0.2*(0.05)	Not supported
H4c: SNS use* Motivation to share →Knowledge provision	Not supported	Not supported
H5a: SNS use*Ability to share→ Awareness of what knowledge others need	0.17*(0.17)	Not supported
H5b: SNS use* Ability to share → Awareness of what knowledge I have	0.25**(0.08)	-0.21**(0.03)
H5c: SNS use* Ability to share →Knowledge provision	-0.08*(0.10)	-0.42***(0.32)
H6a: Awareness of what knowledge I need→Awareness of reusable knowledge	Not supported	0.11**(0.03)
H6b: Awareness of what knowledge others have→Awareness of reusable knowledge	0.75***(0.98)	0.77***(1.58)
H6c: Awareness of what knowledge I need→ Awareness of what others have	0.16**(0.04)	Not supported
H7: Awareness of reusable knowledge→ Knowledge acquisition	0.4**(0.11)	0.47***(0.24)
H8a: SNS use→ Awareness of what knowledge I need	0.22**(0.08)	0.21**(0.06)
H8b: SNS use→ Awareness of what knowledge others have	Not supported	Not supported
H8c: SNS use→Knowledge acquisition	Not supported	Not supported
H9a: SNS use*Motivation to reuse→ Awareness of what knowledge I need	0.27**(0.13)	0.14*(0.14)
H9b: SNS use* Motivation to reuse → Awareness of what knowledge others have	-0.13*(0.04)	-0.27**(0.12)
H9c: SNS use* Motivation to reuse →Knowledge acquisition	0.20**(0.05)	Not supported
H10a: SNS use*Ability to reuse → Awareness of what knowledge I need	0.23**(0.10)	Not supported
H10b: SNS use* Ability to reuse → Awareness of what knowledge others have	Not supported	-0.39**(0.32)
H10c: SNS use* Ability to reuse →Knowledge acquisition	Not supported	0.11*(0.03)

***significant at p<0.001 (two-tailed t-test)

** significant at p<0.05 (two-tailed t-test)

* significant at p<0.1 (two-tailed t-test)

4.6 Discussion and Implications

4.6.1 Discussion of the Results

In a departure from the overview of SNS use within firms, this section discusses the findings from the perspectives of both knowledge producers and consumers and compares the different effects when necessary.

- *Overview of SNS use within firms*

According to our sample, the majority of employees use some kind of SNS through which they are connected with colleagues. Facebook is the most popular choice. Internal SNS is underutilized. When it comes to knowledge sharing and seeking, only about 10% of employees will first think about using SNS. Therefore, it might be problematic that not enough work-related knowledge exists on the SNS platforms that employees use. For the hypothesized relationships, the direct effect of SNS use is significant only on the awareness of what knowledge distant colleagues need and awareness of what knowledge one needs. It does not help much in becoming aware of what knowledge others have. One possible explanation is that it is not appropriate to share work-related knowledge on public SNS (Archambault and Grudin, 2012). People may post knowledge-related questions online and get answers in a private way. The other reason may be that firms do not know how to instruct and nurture the use of SNS for knowledge reuse purposes.

- *Knowledge producer's perspective*

Our results show that the use of SNS to connect distant colleagues significantly influences the awareness of what knowledge others need, whereas the use of SNS to connect close colleagues does not significantly improve the awareness of what knowledge others need. This is consistent with previous findings that SNS is more helpful for connecting distant colleagues (DiMicco and Millen, 2007). It is to our surprise that the interaction effect between autonomous motivation to share and SNS use is negative for awareness of what knowledge others need. One possible explanation is that employees who are highly autonomously motivated to share will proactively understand others' work and promote their knowledge regardless of SNS, whereas those who are not highly motivated will only share knowledge when provided with certain conveniences (Bordia et al., 2006). Another interesting finding is that the interaction effect between SNS use and ability to share has a significant negative effect on knowledge provision, indicating that employees may be distracted by SNS use from providing knowledge to others if their perceived ability to share is high. This confirms that SNS is not always useful and relevant (Lüders, 2013). Therefore, firms are advised to carefully develop instructions and training to educate employees about the use of SNS for knowledge sharing purposes, especially employees whose perceived motivation and ability to share are high.

- *Knowledge consumer's perspective*

Very different from the knowledge producer's perspective, the motivation to reuse knowledge strengthens the positive association between SNS use and awareness of what knowledge one needs. In addition to the indirect effect through increasing awareness, the interaction effect between motivation to reuse knowledge and the use of SNS to connect close colleagues has a direct and significant positive effect on knowledge acquisition. The interaction effect between SNS use and ability to reuse knowledge has a positive effect on the awareness of what knowledge one needs, but a negative effect on the awareness of what knowledge distant colleagues have. In other words, when one perceives his or her ability to reuse as high, the use of SNS helps one become aware of what knowledge he or she needs, but the use of SNS cannot help one become aware of what knowledge distant colleagues have. One possible explanation is that the content on SNS is less likely to be related to work.

4.6.2 Implications and Suggestions for Integration

There is no doubt that social media can help in knowledge sharing and reuse (Leonardi et al., 2013). The problem is how firms should direct employees to effectively use SNS for that purpose. We developed a questionnaire to survey the relationship between the use of SNS and knowledge reuse performance at work. Based on the above analysis and the integrative framework proposed in Chapter 2, we present the following implications and suggestions for managers in terms of

making decisions on whether or not and how to integrate social media for knowledge reuse purposes.

First of all, high awareness is demonstrated to be very significant for knowledge transfer. We identified different aspects of knowledge reuse at the Awareness stage, including awareness of what knowledge one has and awareness of what knowledge others need when employees take the role of a knowledge producer, awareness of what knowledge one needs and awareness of what knowledge others have when employees take the role of a knowledge consumer. The survey results support that distinction. Furthermore, it provides an approach for managers to identify effective ways to solve problems regarding knowledge reuse.

Secondly, it is important to recognize that motivation and ability to share knowledge differ from motivation and ability to seek knowledge. For instance, the interaction effect between motivation to share and the use of SNS has a negative impact on the the awareness of what knowledge others need, whereas the interaction effect between motivation to reuse and the use of SNS has a positive impact on the awareness of what knowledge one needs. This difference is further influenced by interpersonal relationships, i.e., relationships with close colleagues or distant colleagues. For example, the interaction effect between the use of SNS and the ability to share knowledge with close colleagues has a positive impact on the awareness of what knowledge one has, but the interaction effect between the use of SNS and the ability to share knowledge with distant colleagues has a negative impact on the awareness of what knowledge one has. According to the

results of the survey, firms are advised to make specialized incentive schemes to encourage knowledge sharing. For employees who lack the motivation or ability to share, firms should emphasize the convenience and ease of use. For those who are motivated and capable of sharing, firms should encourage them to increase the size of their influence through social media. Firms should also encourage employees to use an integrated platform for connecting with both close and distant colleagues so that spillover effects can be maximized.

In addition to the suggestions on managing individual employees for knowledge reuse, managers are advised to consider the influence of social media on the organizational cost of deploying a system and integrating it with existing information technology infrastructure. They are advised to periodically assess the costs and benefits of knowledge reuse and adjust the balanced strategy of codification and personalization based on the approach proposed in the previous chapter.

4.7 Conclusion

This study addresses the questions of whether and how the use of social media — social network site (SNS) in particular — influences knowledge reuse performance at work. We differentiated the roles of employees in knowledge reuse as either producers who created the knowledge, or as consumers who seek knowledge from others and put it into practice in their task performance. We conducted a survey mainly among engineers who are part-time students at a well-known Singapore university. The survey results show that SNS is not yet a

popular way to share or seek/reuse knowledge related to work. Based on the survey results, we provide many insights as above for managers to integrate social media with traditional KM tools.

This study contributes to theory in terms of developing more detailed constructs to understand knowledge reuse. At the outset, we identified the difference between a knowledge producer and a knowledge consumer in knowledge reuse. From a knowledge producer's perspective, we identified the two dimensions, namely awareness of what knowledge one has and awareness of what knowledge others need, for awareness of what knowledge to share at the first stage of knowledge sharing. From a knowledge consumer's perspective, we identified awareness of what knowledge one needs and awareness of what knowledge others have for the awareness of reusable knowledge. This identification makes it possible for firms to better understand the lack of sharing or lack of reuse due to ignorance of certain knowledge or needs. In addition to the analysis of social media characteristics suitable for knowledge sharing and reuse, this study provides a new perspective for firms to understand the effect of social media use on knowledge reuse that provides insights on organizational decision-making to integrate social media for knowledge reuse purposes.

However, this study has some limitations and future work can be done to improve this study. On one hand, the content of SNS connecting close colleagues and distant colleagues was not explicitly examined. As a result, we can only guess the reasons why SNS use does not help improve awareness of what knowledge others have. Future research could address questions about whether employees

share work-related knowledge or simply use SNS to build and maintain relationships with colleagues. On the other hand, the participants of the survey are from different firms. Although firm size and context didn't show significant effect on the findings, we suggest further studies to be conducted in a single firm and compare the two sets of results. In addition, future work can be done to use this analytical pattern and the same procedure for dealing with other emerging tools.

Chapter 5 Conclusion

The overarching objective of this thesis is to shed some light on decision-making to optimize knowledge reuse within firms. Since every firm is different, optimum decisions can only be made according to the context of the firm. As the old saying goes, teaching firms how to fish is more important than offering some fish. Taking this point of view, we present three studies that focus on different but related aspects of decision-making to optimize knowledge reuse within firms: i) an integrative framework for understanding the problem of knowledge reuse within firms, ii) a formal approach to develop optimum strategies for optimizing knowledge reuse within firms, and iii) some insights on integrating emerging technologies (social media in particular) for optimizing knowledge reuse within firms.

In order to optimize knowledge reuse, firms must clearly and comprehensively understand the problem of knowledge reuse. As such, the first study (Chapter 2) developed an integrative framework that provides a complete view and structured way to organize the various influencing factors that have been studied separately by different researchers. The second study (Chapter 3) proposed a formal approach for decision-making about optimum knowledge management (KM) strategy according to an assessment of the benefits and costs of managing knowledge in specific firms. Since the modern world is changing rapidly with emerging technologies that may provide alternative tools for implementing KM strategies, firms face the problem of whether and how to

integrate them with traditional KM tools and techniques. Taking social media (SNS in particular) as an example, the third study (Chapter 4) provided a novel perspective about integration by investigating the relationship between the use of social media and knowledge reuse performance at the individual level. The theoretical contributions and practical implications of these studies as well as limitations and directions for future research, are discussed as follows.

5.1 Theoretical Contributions

This thesis contributes to the literature in several ways. First of all, it develops an integrative framework for understanding knowledge reuse within firms in a comprehensive manner (Szulanski, 1996; Argote et al., 2003; Foss et al., 2010). This framework contributes to the literature by providing a structured way to organize various influencing factors that have been studied separately by different researchers. It also enables researchers to place existing/future research on the management of knowledge reuse within firms in a holistic picture. As a result, contributions can be interpreted in a more accurate way.

The second contribution is the identification of knowledge producers and consumers as well as their different needs along the stages of the knowledge reuse process. Factors influencing knowledge sharing and seeking at the individual level are identified as either motivation-related or ability-related. The third study (Chapter 4) further contributes to this aspect by proposing refined constructs of awareness of what knowledge one has and awareness of what knowledge others need from a producer's perspective and awareness of what knowledge one needs

and awareness of what knowledge others have from a consumer's perspective. This differentiation advances the existing understanding of why knowledge sharing (or seeking) fails and how to effectively remedy it.

Understanding the factors influencing knowledge reuse is the first step, and how to leverage it comprehensively for decision-making is the second and more important step. The third theoretical contribution of this thesis is in introducing a Markov Decision Process (MDP) model as a formal approach to balancing codification and personalization in decision-making about KM strategies for optimizing knowledge reuse. More specifically, the proposed MDP model provides a way to take into account the benefits and costs of different reuse activities, interdependencies among the different stages, and contingent factors such as the number of reusable knowledge pieces and reuse patterns. In doing so, we propose a formal model that can offer detailed insights on how to achieve optimum policies by analyzing different organizational scenarios.

Another contribution of this thesis is that we provide a novel theoretical perspective regarding the integration of emerging tools (social media in particular) for knowledge reuse purposes. The existing studies have mainly employed technology acceptance model and theory of planned behavior to explain the adoption of information technologies (e.g., Hsu and Lin, 2008; He and Wei, 2009). However, the adoption of social media for work-related purposes is different from the adoption of traditional information systems because social media has already been widely accepted in daily lives. Therefore, a perspective based on motivation,

ability, and opportunity provides more pertinent insights on directing employees on the use of emerging tools for knowledge reuse purposes.

5.2 Practical Implications

This thesis was motivated by improving the return of KM investment through optimizing knowledge reuse within firms, so it has significant implications for managers in practice. First of all, managers are advised to keep reuse in mind when they design KM initiatives within firms. The proposed integrative framework provides a holistic picture for firms to identify knowledge reuse problems. In addition to motivation-related factors influencing knowledge sharing and seeking, this thesis has drawn attention to ability-related factors. This will help managers identify effective ways to improve knowledge reuse performance.

When it comes to decision-making about KM strategy for better returns, this thesis suggests that managers first analyze their organizational reuse context, including how many knowledge items are worth reusing, organizational benefits/costs under different strategies, reuse patterns, etc., and then conduct a what-if analysis to decide their overall KM strategy using the proposed MDP model. This approach also makes it possible to connect KM strategies with the profitability of organizational business performance. As a result, it helps knowledge managers demonstrate the value of KM to senior managers and board members.

Another important contribution to practice is the identification of knowledge producers and consumers as well as their different needs along the

stages of the knowledge reuse process. It helps managers identify the source of problems in terms of managing knowledge in their firms and effective ways to remedy any problems. For example, determining whether the lack of reuse is a problem of low awareness of what knowledge others have, a problem of low awareness of what knowledge one needs, or a problem of transfer resulting from a lack of motivation and/or ability at the producer's and/or consumer's side.

As to decision-making about whether and how to introduce emerging tools at a certain time, managers are advised to evaluate the alternatives more accurately by assessing both the effect on organizational cost of investment and the influence on employees' motivation and ability at the individual level. Firms can conduct periodic surveys to understand employees' perceptions of emerging technologies and their association with knowledge reuse performance. For example, the famous consulting firm EY has conducted surveys of KM within the firm twice a year since 2009 (Callahan and Usher, 2013). The feedback can be incorporated into further decision-making about optimizing knowledge reuse. In doing so, a virtuous cycle of managing knowledge reuse can be built.

5.3 Limitations and Future Research

The focus of this thesis is developing approaches for organizational decision-making to optimize knowledge reuse within firms. It is noteworthy that the specific suggestions for decision-making about KM strategy and emerging tools may not be readily available for application as they are only examples to

demonstrate how firms can develop insights. Firms are advised to make decisions according to assessments in their own specific context.

In Chapter 3, as the proposed MDP model is a first attempt, more refinement may be done by relaxing the assumptions. For example, future research may extend this model for the situation when the benefits and costs of each stage may be dependent of each other. It is also possible for future research to include different levels of codification and personalization in the action space. Then, interesting findings might be released by comparing the results. In addition, the model was validated using data from previous studies (Chai and Nebus, 2012). Future studies may be conducted in companies to validate the usefulness of the model.

In Chapter 4, one limitation is that the content of SNS connecting close colleagues and distant colleagues was not explicitly examined. As a result, we can only guess the reasons why SNS use does not help improve awareness of what knowledge others have, as discussed in Chapter 4. Future research could address questions about whether employees share work-related knowledge or simply use SNS to build and maintain relationships with colleagues. The other limitation of this study is that the participants are part-time students from different companies, and future research could be conducted in a single firm by following the same procedure. Conducting this kind of survey in a single firm could provide more specific insights on integrating SNS for knowledge reuse within that firm.

Another direction for future research is toward the metrics of benefits and costs of knowledge reuse for employees' task performance. Thanks to social

media, there are more hard data available related to the metrics (Callahan and Usher, 2013). Research along this stream will complement the research of the proposed MDP model for optimizing knowledge reuse. In addition, longitudinal studies on the management of knowledge reuse within a firm over multiple years could be conducted to better understand the evolution of KM strategies over time.

Bibliography

Agarwal, N. K., Y. Xu, et al. (2011). "A context-based investigation into source use by information seekers." Journal of the American Society for Information Science and Technology **62**(6): 1087-1104.

Alavi, M. and D. E. Leidner (2001). "Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues." MIS Quarterly **25**(1): 107-136.

Anderson, M. H. (2008). "Social networks and the cognitive motivation to realize network opportunities: a study of managers' information gathering behaviors." Journal of Organizational Behavior **29**(1): 51-78.

Archambault, A. and J. Grudin (2012). A longitudinal study of Facebook, LinkedIn, & Twitter use. Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems, ACM.

Argote, L. (1999). Organizational learning: Creating, retaining, and transferring knowledge, Springer Netherlands.

Argote, L., B. McEvily, et al. (2003). "Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes." Management Science **49**(4): 571-582.

Armistead, C. and M. Meakins (2002). "A framework for practising knowledge management." Long Range Planning **35**(1): 49-71.

Baldwin, T. T. and J. K. Ford (1988). "Transfer of Training: A Review and Directions for Future Research." Personnel Psychology **41**(1): 63.

Barrick, M. R. and R. A. Alexander (1991). "Assessing the Utility of Stochastic Employee Movements." Decision Sciences **22**(1): 171.

Bartol, K. and A. Srivastava (2002). "Encouraging knowledge sharing: The role of organizational reward systems." Journal of Leadership & Organizational Studies **9**(1).

Baumgartner, H. and C. Homburg (1996). "Applications of structural equation modeling in marketing and consumer research: A review." International Journal of Research in Marketing **13**(2): 139-161.

Bemret, A. and D. Bennetz (2003). The partnership between organizational learning and knowledge management. Handbook on Knowledge Management, Springer-Verlag, Heidelberg. **1:** 439-460.

Blumberg, M. and C. D. Pringle (1982). "The Missing Opportunity in Organizational Research: Some Implications for a Theory of Work Performance." Academy of Management Review **7**(4): 560-569.

Bock, G. W., A. Kankanhalli, et al. (2006). "Are norms enough? The role of collaborative norms in promoting organizational knowledge seeking." European Journal of Information Systems **15**(4): 357-367.

Bohn, R. E. (1994). "Measuring and managing technological knowledge." Sloan Management Review **36**(1): 61-73.

Bordia, P., B. E. Irmer, et al. (2006). "Differences in sharing knowledge interpersonally and via databases: The role of evaluation apprehension and perceived benefits." European Journal of Work and Organizational Psychology **15**(3): 262-280.

Borgatti, S. P. and R. Cross (2003). "A relational view of information seeking and learning in social networks." Management Science **49**(4): 432-445.

Boyd, D. M. and N. B. Ellison (2007). "Social network sites: Definition, history, and scholarship." Journal of Computer-Mediated Communication **13**(1): 210-230.

Brzozowski, M. J. (2009). WaterCooler: exploring an organization through enterprise social media. Proceedings of the ACM 2009 international conference on Supporting group work, ACM.

Brzozowski, M. J., T. Sandholm, et al. (2009). Effects of feedback and peer pressure on contributions to enterprise social media. Proceedings of the ACM 2009 international conference on Supporting group work, ACM.

Burnett, S., D. Williams, et al. (2013). "Reconsidering the Knowledge Audit Process: Methodological Revisions in Practice." Knowledge and Process Management **20**(3): 141-153.

Callahan, M. and R. Usher (2013) What's it Worth? Measuring the Value of Knowledge.

Campos, E. B. and M. P. S. Sánchez (2003). "Knowledge management in the emerging strategic business process: information, complexity and imagination." Journal of Knowledge Management **7**(2): 5-17.

Cao, X., D. R. Vogel, et al. (2012). Understanding the Influence of Social Media in the Workplace: An Integration of Media Synchronicity and Social Capital Theories. 45th Hawaii International Conference on System Science (HICSS).

Carla, O. D. and C. J. Grayson (1998). "If only we knew what we know: Identification and transfer of internal best practices." California Management Review **40**(3): 154-174.

Chai, K.-H., M. J. Gregory, et al. (2004). "An exploratory study of intrafirm process innovations transfer in Asia." IEEE Transactions on Engineering Management **51**(3): 364-374.

Chai, K.-H., M. J. Gregory, et al. (2004). "An exploratory study of intrafirm process innovations transfer in Asia." Engineering Management, IEEE Transactions on **51**(3): 364-374.

Chai, K.-H. and J. Nebus (2012). "Personalization or Codification? A Marketing Perspective to Optimize Knowledge Reuse Efficiency." IEEE Transactions on Engineering Management **59**(1): 33-51.

Chai, K. H., M. Gregory, et al. (2003). "Bridging islands of knowledge: a framework of knowledge sharing mechanisms." International Journal of Technology Management **25**(8): 703-727.

Chai, K. H. and C. M. Yap (2004). "Effective knowledge transfer in virtual teams: linking contents and mechanisms." International journal of networking and virtual organisations **2**(4): 312-322.

Chang, Y.-Y., Y. Gong, et al. (2012). "Expatriate Knowledge Transfer, Subsidiary Absorptive Capacity, and Subsidiary Performance." Academy of Management Journal **55**(4): 927-948.

Chen, A. N. K. and T. M. Edgington (2005). "Assessing value in organizational knowledge creation: Considerations for knowledge workers." MIS Quarterly: Management Information Systems **29**(2): 279-309.

Chin, W. W. (2010). How to write up and report PLS analyses. Handbook of partial least squares, Springer**:** 655-690.

Chin, W. W., B. L. Marcolin, et al. (2003). "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion / adoption study." Information Systems Research **14**(2): 189.

Choi, B., S. Poon, et al. (2008). "Effects of knowledge management strategy on organizational performance: a complementarity theory-based approach." Omega **36**(2): 235-251.

Chua, A. and W. Lam (2005). "Why KM projects fail: a multi-case analysis." Journal of Knowledge Management **9**(3): 6-17.

Clark, B. H., A. V. Abela, et al. (2005). "Organizational motivation, opportunity and ability to measure marketing performance." Journal of Strategic Marketing **13**(4): 241-259.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive capacity: a new perspective on learning and innovation." Administrative Science Quarterly: 128-152.

Cohendet, P. and F. Meyer-Krahmer (2001). "The theoretical and policy implications of knowledge codification." Research Policy **30**(9): 1563-1591.

Davenport, T. H. and L. Pruzak (1998). Working knowledge: How organizations manage what they know, Harvard Business Press.

De Bruijn, O. and R. Spence (2001). Serendipity within a ubiquitous computing environment: A case for opportunistic browsing. Ubicomp 2001: Ubiquitous Computing, Springer.

de Heer, J. and T. Poiesz (1998). "Dynamic characteristics of motivation, ability and opportunity to process commercial information." Advances in Consumer Research **25**: 532-537.

Demian, P. (2004). CoMem: Design Knowledge Reuse from a Corporate Memory. Dept. of Civil and Environmental Engineering, Stanford University.

DiMicco, J., D. R. Millen, et al. (2008). Motivations for social networking at work, ACM.

DiMicco, J. M. and D. R. Millen (2007). Identity management: multiple presentations of self in facebook. Proceedings of the 2007 international ACM conference on Supporting group work, ACM.

Dixon, N. M. (2000). Common knowledge: How companies thrive by sharing what they know, Harvard Business Press.

Doz, Y. L. and J. F. Santos (1997). On the management of knowledge: from the transparency of collocation and co-setting to the quandary of dispersion and differentiation, INSEAD Fontainbleau,, France.

Drew, S. (1999). "Building knowledge management into strategy: making sense of a new perspective." Long Range Planning **32**(1): 130-136.

Earl, M. (2001). "Knowledge management strategies: Toward a taxonomy." Journal of Management Information Systems **18**(1): 215-233.

Eisenberger, R., J. Jones, et al. (2004). "Perceived organizational support." The employment relationship: Examining psychological and contextual perspectives: 206-225.

Engelmann, T., J. Dehler, et al. (2009). "Knowledge awareness in CSCL: A psychological perspective." Computers in Human Behavior **25**(4): 949-960.

Faraj, S. and L. Sproull (2000). "Coordinating expertise in software development teams." Management Science **46**(12): 1554-1568.

Foss, N. J. (2007). "The Emerging Knowledge Governance Approach: Challenges and Characteristics." Organization **14**(1): 29-52.

Foss, N. J., K. Husted, et al. (2010). "Governing Knowledge Sharing in Organizations: Levels of Analysis, Governance Mechanisms, and Research Directions." Journal of Management Studies **47**(3): 455-482.

Gagné, M. (2009). "A model of knowledge-sharing motivation." Human Resource Management **48**(4): 571-589.

Gagné, M. and E. L. Deci (2005). "Self-determination theory and work motivation." Journal of Organizational behavior **26**(4): 331-362.

Garud, R. and A. Kumaraswamy (2005). "Vicious and Virtuous Circles in the Management of Knowledge: The Case of Infosys Technologies." MIS Quarterly **29**(1): 9-33.

Gefen, D., E. E. Rigdon, et al. (2011). "An Update and Extension to SEM Guidelines for Administrative and Social Science Research." MIS Quarterly **35**(2): iii-A7.

Goh, S. C. (2002). "Managing effective knowledge transfer: An integrative framework and some practice implications." Journal of Knowledge Management **6**(1): 23.

Gottschalg, O. and M. Zollo (2007). "Interest Alignment and Competitive Advantage." The Academy of Management Review **32**(2): 418-437.

Götz, O., K. Liehr-Gobbers, et al. (2010). Evaluation of structural equation models using the partial least squares (PLS) approach. Handbook of partial least squares, Springer**:** 691-711.

Grant, R. M. (1996). "Toward a Knowledge-Based Theory of the Firm." Strategic Management Journal **17**(ArticleType: research-article / Issue Title: Special Issue: Knowledge and the Firm / Full publication date: Winter, 1996 / Copyright © 1996 Wiley): 109-122.

Gray, P. H. and D. B. Meister (2004). "Knowledge Sourcing Effectiveness." Management Science **50**(6): 821-834.

Greenes, K. A. (2001). "Peer Assist: Learning Before Doing." Retrieved October 4, 2011, from http://www.nasa.gov/offices/oce/appel/ask/issues/40/40i_peer_assist.html.

Greiner, M. E., T. Bohmann, et al. (2007). "A strategy for knowledge management." Journal of Knowledge Management **11**(6): 3-15.

Haas, M. R. and M. T. Hansen (2007). "Different knowledge, different benefits: toward a productivity perspective on knowledge sharing in organizations." Strategic Management Journal **28**(11): 1133-1153.

Hahn, J. and A. Mukherjee (2007). Impact of Knowledge Management Strategy on Organizational Learning: A Simulation Study. AMCIS 2007 Proceedings.

Hair, J. F., G. T. M. Hult, et al. (2013). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), SAGE Publications.

Hanna, R., A. Rohm, et al. (2011). "We're all connected: The power of the social media ecosystem." Business Horizons **54**(3): 265-273.

Hansen, M. T. (1999). "The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits." Administrative science quarterly **44**(1): 82-111.

Hansen, M. T. (2002). "Knowledge Networks: Explaining Effective Knowledge Sharing in Multiunit Companies." Organization science **13**(3): 232-248.

Hansen, M. T., M. L. Mors, et al. (2005). "Knowledge sharing in organizations: Multiple networks, multiple phases." Academy of Managment Journal **48**(5): 776-793.

Hansen, M. T. and N. Nohria (2004). "How to Build Collaborative Advantage." MIT Sloan Management Review **46**(1): 22-30.

Hansen, M. T., N. Nohria, et al. (1999). "What's your strategy for managing knowledge?" Harvard Business Review **77**(3): 106-116.

He, W. and K.-K. Wei (2009). "What drives continued knowledge sharing? An investigation of knowledge-contribution and -seeking beliefs." Decision Support Systems **46**(4): 826-838.

Heneman, H. G., III and M. G. Sandver (1977). "Markov Analysis in Human Resource Administration: Applications and Limitations." The Academy of Management Review **2**(4): 535-542.

Hoong, A. L. S., T. M. Lim, et al. (2012). A study on the use of "Yams" for enterprise knowledge sharing. Digital Information and Communication Technology and it's Applications (DICTAP), 2012 Second International Conference on, IEEE.

Hsu, C.-L. and J. C.-C. Lin (2008). "Acceptance of blog usage: The roles of technology acceptance, social influence and knowledge sharing motivation." Information & Management **45**(1): 65-74.

Hughes, J. (2007). The ability-motivation-opportunity framework for behavior research in IS. 40th Annual Hawaii International Conference on System Sciences, 2007, IEEE.

Jackson, A., J. Yates, et al. (2007). Corporate Blogging: Building community through persistent digital talk. System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on, IEEE.

Jasimuddin, S. M. and Z. Zhang (2009). "The symbiosis mechanism for effective knowledge transfer." Journal of the Operational Research Society **60**(5): 706-716.

Jensen, K. W. (2010). "Relational effects on knowledge integration: the differential effects on search and transfer." Knowledge Management Research & Practice **8**(2): 146-160.

Jue, A. L., J. A. Marr, et al. (2009). Social media at work: How networking tools propel organizational performance, Jossey-Bass.

Junco, R. (2012). "Too much face and not enough books: The relationship between multiple indices of Facebook use and academic performance." Computers in Human Behavior **28**(1): 187-198.

Kankanhalli, A., B. C. Tan, et al. (2005). "Understanding seeking from electronic knowledge repositories: An empirical study." Journal of the American Society for Information Science and Technology **56**(11): 1156-1166.

Kankanhalli, A., B. C. Y. Tan, et al. (2005). "Contributing knowledge to electronic knowledge repositories: An empirical investigation." MIS Quarterly: Management Information Systems **29**(1): 113-143.

Kaplan, A. M. and M. Haenlein (2010). "Users of the world, unite! The challenges and opportunities of Social Media." Business Horizons **53**(1): 59-68.

King, W. R. and P. V. Marks Jr (2008). "Motivating knowledge sharing through a knowledge management system." Omega **36**(1): 131-146.

Koene, R. (2006). "Case study-Fluor Corporation." Inside Knowledge **3**(2).

Koenig, M. (2001). "Don't fall for that false dichotomy! Codification vs. personalization." KMWorld Magazine **10**(8).

Kumar, A. and L. Ganesh (2011). "Balancing Knowledge Strategy: Codification and Personalization during Product Development." Journal of Knowledge Management **15**(1): 118-135.

Lee, D.-J. and J.-H. Ahn (2007). "Reward systems for intra-organizational knowledge sharing." European Journal of Operational Research **180**(2): 938-956.

Lee, D. and E. Van den Steen (2010). "Managing Know-How." Management Science **56**(2): 270.

Leonard, D. and S. Sensiper (1998). "The role of tacit knowledge in group innovation." California Management Review **40**(3): 112.

Leonardi, P. M., M. Huysman, et al. (2013). "Enterprise Social Media: Definition, History, and Prospects for the Study of Social Technologies in Organizations." Journal of Computer-Mediated Communication **19**(1): 1-30.

Levin, D. Z. and R. Cross (2004). "The Strength of Weak Ties You Can Trust: The Mediating Role of Trust in Effective Knowledge Transfer." Management Science **50**(11): 1477-1490.

Liang, H., N. Saraf, et al. (2007). "Assimilation of enterprise systems: the effect of institutional pressures and the mediating role of top management." MIS Quarterly **31**(1): 59-87.

Liebowitz, J., B. Rubenstein-Montano, et al. (2000). "The knowledge audit." Knowledge and Process Management **7**(1): 3-10.

Lüders, M. (2013). "Networking and notworking in social intranets: User archetypes and participatory divides." First Monday **18**(8).

Luo, X., J. Zhang, et al. (2013). "Social media and firm equity value." Information Systems Research **24**(1): 146-163.

MacCormack, A. D. and H. B. School (2002). Siemens ShareNet: Building a Knowledge Network, Harvard Business School Publishing.

Maclnnis, D. J. and B. J. Jaworski (1989). "Information processing from advertisements: Toward an integrative framework." The Journal of marketing: 1-23.

Maddah, B., L. Moussawi-Haidar, et al. (2010). "Dynamic cruise ship revenue management." European Journal of Operational Research **207**(1): 445-455.

Majchrzak, A., L. P. Cooper, et al. (2004). "Knowledge Reuse for Innovation." Management Science **50**(2): 174-188.

Majchrzak, A., S. Faraj, et al. (2013). "The Contradictory Influence of Social Media Affordances on Online Communal Knowledge Sharing." Journal of Computer - Mediated Communication **19**(1): 38-55.

Majchrzak, A., C. Wagner, et al. (2013). "The Impact of Shaping on Knowledge Reuse for Organizational Improvement with Wikis." MIS Quarterly **37**(2).

Malhotra, N. K., S. S. Kim, et al. (2006). "Common Method Variance in Is Research: A Comparison of Alternative Approaches and a Reanalysis of past Research." Management Science **52**(12): 1865-1883.

Markus, M. L. (2001). "Toward a theory of knowledge reuse: types of knowledge reuse situations and factors in reuse success." Journal of Management Information Systems **18**(1): 57-93.

Martin, B. (2008). "Knowledge management." Annual Review of Information Science and Technology **42**(1): 369-424.

Milton, N. (2014). "Quantified KM success stories." from http://www.nickmilton.com/search/label/success%20story.

Minbaeva, D., T. Pedersen, et al. (2003). "MNC Knowledge Transfer, Subsidiary Absorptive Capacity, and HRM." Journal of International Business Studies **34**(6): 586-599.

Minbaeva, D. B. (2013). "Strategic HRM in building micro-foundations of organizational knowledge-based performance." Human Resource Management Review **23**(4): 378-390.

Minbaeva, D. B., K. Mäkelä, et al. (2012). "Linking HRM and knowledge transfer via individual-level mechanisms." Human Resource Management **51**(3): 387-405.

Mottl, J. (2001). "How Xerox got its engineers to use a knowledge management system." from http://www.techrepublic.com/article/how-xerox-got-its-engineers-to-use-a-knowledge-management-system/.

Murray, P. (2002). "Knowledge management as a sustained competitive advantage." Ivey Business Journal **66**(4): 71-76.

Nissen, M. E. (2006). Harnessing knowledge dynamics: Principled organizational knowing and learning. Hershey, PA, IRM Press.

Nonaka, I. and H. Takeuchi (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation, Oxford University Press, USA.

Nonaka, I. and G. Von Krogh (2009). "Perspective—Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory." Organization science **20**(3): 635-652.

Pagani, M., C. F. Hofacker, et al. (2011). "The influence of personality on active and passive use of social networking sites." Psychology & Marketing **28**(5): 441-456.

Phang, C. W., A. Kankanhalli, et al. (2009). "Usability and sociability in online communities: A comparative study of knowledge seeking and contribution." Journal of the Association for Information Systems **10**(10): 721-747.

Podsakoff, P. M., S. B. MacKenzie, et al. (2003). "Common method biases in behavioral research: a critical review of the literature and recommended remedies." Journal of Applied Psychology **88**(5): 879.

Polyani, M. (1966). The tacit dimension. New York, Doubleday.

Porter, M. E. (1991). "Towards a dynamic theory of strategy." Strategic Management Journal **12**(S2): 95-117.

Puterman, M. L. (1994). Markov decision processes: Discrete stochastic dynamic programming, John Wiley & Sons, Inc. New York, NY, USA.

Rao, M. (2012). Knowledge management tools and techniques, Routledge.

Reagans, R. and B. McEvily (2003). "Network structure and knowledge transfer: The effects of cohesion and range." Administrative Science Quarterly **48**(2): 240-267.

Reinholt, M. I. A., T. Pedersen, et al. (2011). "Why a Central Network Position isn't Enough: The Role of Motivation and Ability for Knowledge Sharing in Employee Networks." Academy of Management Journal **54**(6): 1277-1297.

Rooksby, J. and I. Sommerville (2012). "The Management and Use of Social Network Sites in a Government Department." Computer Supported Cooperative Work (CSCW) **21**(4-5): 397-415.

Rubenstein-Montano, B., J. Liebowitz, et al. (2001). "A systems thinking framework for knowledge management." Decision Support Systems **31**(1): 5-16.

Scheepers, R., K. Venkitachalam, et al. (2004). "Knowledge strategy in organizations: refining the model of Hansen, Nohria and Tierney." The Journal of Strategic Information Systems **13**(3): 201-222.

Schmidt, K. (2002). "The problem with awareness: Introductory remarks on awareness in CSCW." Computer Supported Cooperative Work (CSCW) **11**(3-4): 285-298.

Seebach, C. (2012). Searching for Answers--Knowledge Exchange through Social Media in Organizations. 45th Hawaii International Conference on System Sciences, IEEE.

Sepp, M., V. Liljander, et al. (2011). "Private bloggers' motivations to produce content–a gratifications theory perspective." Journal of Marketing Management **27**(13-14): 1479-1503.

Siemsen, E., A. V. Roth, et al. (2008). "How motivation, opportunity, and ability drive knowledge sharing: The constraining-factor model." Journal of Operations Management **26**(3): 426-445.

Siemsen, E., A. V. Roth, et al. (2009). "The Influence of Psychological Safety and Confidence in Knowledge on Employee Knowledge Sharing." Manufacturing & Service Operations Management **11**(3): 429-447.

Skeels, M. M. and J. Grudin (2009). When social networks cross boundaries: a case study of workplace use of facebook and linkedin. Proceedings of the ACM 2009 international conference on Supporting group work, ACM.

Spector, P. E. (2006). "Method variance in organizational research truth or urban legend?" Organizational research methods **9**(2): 221-232.

Swan, J., S. Newell, et al. (2000). Limits of IT-driven knowledge management initiatives for interactive innovation processes: towards a community-based approach. System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on.

Szulanski, G. (1996). "Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm." Strategic Management Journal **17**(Winter Special Issue): 27-43.

Szulanski, G., R. Cappetta, et al. (2004). "When and How Trustworthiness Matters: Knowledge Transfer and the Moderating Effect of Casual Ambiguity." Organization Science **15**(5): 600-613.

Szymczak, C. C. and D. H. T. Walker (2003). "Boeing-a case study example of enterprise project management from a learning organization perspective." The Learning Organization **10**(3): 125-137.

Tan, H. C., C. J. Anumba, et al. (2010). Knowledge Management – Key Concepts, Wiley-Blackwell.

Taylor, C. (1993). "To follow a rule." Bourdieu: critical perspectives **6**: 45-60.

Teece, D. J. (2000). "Strategies for Managing Knowledge Assets: the Role of Firm Structure and Industrial Context." Long Range Planning **33**(1): 35-54.

Teece, D. J. (2007). "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance." Strategic Management Journal **28**(13): 1319-1350.

Treem, J. W. and P. M. Leonardi (2012). "Social Media Use in Organizations: Exploring the affordances of Visibility, Editability, Persistence, and Association." Communication Yearbook **36**: 143-189.

Tsoukas, H. (2005). Complex knowledge, Oxford University Press Oxford.

Tsoukas, H. and E. Vladimirou (2001). "What is organizational knowledge?" Journal of Management Studies **38**(7): 973-993.

Umemoto, K., A. Endo, et al. (2004). "From sashimi to zen-in : the evolution of concurrent engineering at Fuji Xerox." Journal of Knowledge Management **8**(4): 89-99.

Velicer, W. F. and J. L. Fava (1998). "Affects of variable and subject sampling on factor pattern recovery." Psychological methods **3**(2): 231.

Von Krogh, G. (2012). "How does social software change knowledge management? Toward a strategic research agenda." The Journal of Strategic Information Systems **21**(2): 154-164.

Wang, S. and R. A. Noe (2010). "Knowledge sharing: A review and directions for future research." Human Resource Management Review **20**(2): 115-131.

Watson, S. and K. Hewett (2006). "A Multi-Theoretical Model of Knowledge Transfer in Organizations: Determinants of Knowledge Contribution and Knowledge Reuse." Journal of Management Studies **43**(2): 141-173.

White, D. J. (1993). "A Survey of Applications of Markov Decision Processes." The Journal of the Operational Research Society **44**(11): 1073-1096.

Wu, A., J. M. DiMicco, et al. (2010). Detecting professional versus personal closeness using an enterprise social network site. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM.

Wu, C.-H. and Y.-T. Chuang (2010). "An innovative approach for strategic capacity portfolio planning under uncertainties." European Journal of Operational Research **207**(2): 1002-1013.

Wu, Y., S. Balasubramanian, et al. (2004). "When Is a Preannounced New Product Likely to Be Delayed?" Journal of Marketing **68**(2): 101-113.

Xu, Y., C. Zhang, et al. (2010). "Information Seeking in an Information Systems Project Team." Professional Communication, IEEE Transactions on **53**(4): 370-381.

Yan, Y. and R. M. Davison (2013). "Exploring behavioral transfer from knowledge seeking to knowledge contributing: The mediating role of intrinsic motivation." Journal of the American Society for Information Science and Technology **64**(6): 1144-1157.

Yu, T.-K., L.-C. Lu, et al. (2010). "Exploring factors that influence knowledge sharing behavior via weblogs." Computers in Human Behavior **26**(1): 32-41.

Yuan, Y. C., X. Zhao, et al. (2013). "The use of different information and communication technologies to support knowledge sharing in organizations: From e-mail to micro-blogging." Journal of the American Society for Information Science and Technology: n/a-n/a.

Zack, M. H. (1999). "Developing a Knowledge Strategy." California Management Review **41**(3): 125-145.

Zander, U. and B. Kogut (1995). "Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test." Organization science: 76-92.

Zhang, J., Y. Qu, et al. (2010). A case study of micro-blogging in the enterprise: use, value, and related issues. Proceedings of the 28th international conference on Human factors in computing systems, ACM.

Appendices

Appendix A Survey Questionnaire

This survey is an integral part of our research study on exploring the relationship between the use of social network sites and knowledge reuse behavior at work. **If you are aged 18 years old and above, currently work full-time at an organization, or have worked full-time in the past one year**, please help us fill the questionnaire. It will take about 20 minutes to complete. Where an exact answer is not available, please provide your best estimate rather than leaving it blank. Please be assured that each question is important and your input is very valuable to us.

Your participation is voluntary. This survey is anonymous and no personal identifiers will be collected. You are free to not answer any questions you do not wish to. As a token of appreciation, you will receive a small gift for each completed questionnaire.

Please read the definitions before proceeding.
(a) **Close colleagues** refer to the members in your department or project team;

(b) **Distant colleagues** refer to the rest of the members in your company other than those mentioned in (a).

(c) **SNS**, short for social network site, refers to a web-based platform which allows individuals to ***construct a public or semi-public profile*** within a bounded system, and ***articulate a list of others with whom they share a connection***, as well as ***share updates and links with their connections***. Examples of SNS: Facebook, LinkedIn, Twitter, as well as Yammer, Jive and other internal social network sites developed/adopted within companies.

(d) **Knowledge** refers to work-related experiences, tricks of the trade, useful information, etc.

(e) **Repository** refers to a common form of knowledge management systems that are designed specifically to facilitate the sharing and integration of an organization's knowledge. Examples: Lotus Notes used by Accenture to store best practices, and Eureka system in Xerox to store trouble shooting tips.

This questionnaire is jointly developed by Ms. Liu Hongmei and Dr. Chai Kah-Hin, Industrial & Systems Engineering, National University of Singapore. Should you have any inquiries, please email hongmeiliu@nus.edu.sg.

For an independent opinion regarding the research and the rights of research participants, you may contact a staff member of the National University of Singapore Institutional Review Board (Attn: Mr Chan Tuck Wai, at telephone (+65) 6516 1234 or email at irb@nus.edu.sg).

Questionnaire

Section I: The following questions/statements are about your use of SNS regarding connection with colleagues (Note: This connection might be for professional purpose and/or personal purpose.). Please circle your answer accordingly.

1. What's the number of employees in your company?

A. <50; B. 50 ─ 99; C. 100 ─ 249; D. 250 ─ 499; E. 500 ─ 749;
F. 750 ─ 999; G. 1000 ─ 2499; H. 2500 ─ 4999; I. ≥ 5000.

2. Which SNS do you use to keep connected with **close colleagues**? (You can circle more than one option)

A. Facebook; B. LinkedIn; C. Twitter; D. Internal SNS developed/installed in my company;
E. others, please specify_____; F. I don't use any SNS to connect with close colleagues.

3. Which SNS do you use to keep connected with **distant colleagues**? (You can circle more than one option)

A. Facebook; B. LinkedIn; C. Twitter; D. Internal SNS developed/installed in my company;
E. others, please specify_____; F. I don't use any SNS to connect with distant colleagues.

4. What's the percentage of colleagues with whom you are connected through SNSs?

A. < 1%; B. 1% — 10%; C. 10% — 20%; D. 20% — 40%;
E. 40% — 60%; F. 60% — 70%; G. ≥70%.

5. How often do you **browse updates on SNS** through which you are connected with **close colleagues**?

A. Several times a day; B. Once a day; C. Once a week; D. Once a month; E. Rarely.

6. How often do you **browse updates on SNS** through which you are connected with **distant colleagues**?

A. Several times a day; B. Once a day; C. Once a week; D. Once a month; E. Rarely.

7. How often do you **post updates on SNS** through which you are connected with **close colleagues**?

A. Several times a day; B. Once a day; C. Once a week; D. Once a month; E. Rarely.

8. How often do you **post updates on SNS** through which you are connected with **distant colleagues**?

A. Several times a day; B. Once a day; C. Once a week; D. Once a month; E. Rarely.

9. How much time do you spend on a typical day **browsing updates on SNS** through which you are connected with **close colleagues**?

A. < 0.5 hr; B. 0.5 ─1 hr; C. 1─2 hrs; D. 2─3 hrs; E. ≥ 3 hrs.

10. How much time do you spend on a typical day **browsing updates on SNS** through which you are connected with **distant colleagues**?

A. < 0.5 hr; B. 0.5 ─1 hr; C. 1─2 hrs; D. 2─3 hrs; E. ≥ 3 hrs.

11. How much time do you spend on a typical day **posting updates/comments on SNS** through which you are connected with **close colleagues**?

A. < 0.5 hr; B. 0.5 ─1 hr; C. 1─2 hrs; D. 2─3 hrs; E. ≥ 3 hrs.

12. How much time do you spend on a typical day **posting updates/comments on SNS** through which you are connected with **distant colleagues**?

A. < 0.5 hr; B. 0.5 ─1 hr; C. 1─2 hrs; D. 2─3 hrs; E. ≥ 3 hrs.

13. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a number that best describes you regarding both (a) AND (b) for each statement.	**(a)Close colleagues** Strongly Disagree						Strongly Agree	**(b)Distant colleagues** Strongly Disagree						Strongly Agree
1. I am connected with most of **them** through SNS.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I am connected with few of **them** through SNS.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. I use SNS a lot through which I am connected with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. I am a heavy user of SNS through which I am connected with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

Section II: The following statements are about your existing knowledge base. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a numberthat best describes you for each statement.	Strongly Disagree						Strongly Agree
1. I am aware of what knowledge I have.	1	2	3	4	5	6	7
2. I know what I am good at for work.	1	2	3	4	5	6	7
3. I don't summarize what knowledge I have.	1	2	3	4	5	6	7
4. When I encounter a problem at work, I normally know what knowledge is needed to solve it.	1	2	3	4	5	6	7
5. When I encounter a problem at work, in general I can understand the problem clearly.	1	2	3	4	5	6	7
6. When I encounter a problem at work, I usually need to seek help to understand it.	1	2	3	4	5	6	7
7. I have knowledge about many work domains in my company.	1	2	3	4	5	6	7
8. I have various experience regarding work domains in my company.	1	2	3	4	5	6	7
9. I have been extensively involved in job rotation.	1	2	3	4	5	6	7

Section III: The following question/statements are about your knowledge sharing behavior with colleagues. Please circle your answer accordingly.

1. Reflecting on your last experience of sharing knowledge with colleagues, which **ONE** of the following statements best describes you?

A. I broadcasted it first on SNS where I am connected with colleagues.

B. I documented it first into organizational repository.

C. I taught colleagues about it first through direct interaction.

D. Others, please specify_____

2. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a number that best describes you regarding sharing knowledge with both (a) AND (b)	**(a) Close colleagues** Strongly Disagree						Strongly Agree	**(b) Distant colleagues** Strongly Disagree						Strongly Agree
1. I am informed about what knowledge **they** need.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. **They** often ask me work-related questions.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. I don't know what knowledge **they** need.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. I understand the value of my knowledge to **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. I am aware of the usefulness of my knowledge to **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
6. I don't know the value of my knowledge to **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
7. I share knowledge with **them** because I enjoy it.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8. I share knowledge with **them** because I find it personally satisfying.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
9. I share knowledge with **them** because it is part of my job.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
10. Sharing knowledge with **them** may help me promoted.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
11. I share knowledge with **them** because I want them to praise me.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
12. I share knowledge with **them** because I may get a reward.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
13. I am an expert of the knowledge which I share with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
14. I am capable of articulating the knowledge which I share with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
15. I know very well of the knowledge which I share with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

3. Based on your experience in the past three months, please indicate to what extent you have performed the following activities.

Please circle a number which describes you best regarding sharing knowledge with both (a) AND (b)	**(a) Close colleagues** To little extent						To a large extent	**(b) Distant colleagues** To little extent						To a large extent
1. I have provided my knowledge to **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I have documented my knowledge and shared the documents with **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. I have spent time teaching **them** with my knowledge.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. **They** have reused my knowledge.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

Section IV: The following question/statements are about your knowledge seeking behavior from colleagues. Please circle your answer accordingly.

1. Reflecting on your last experience of seeking knowledge, which **ONE** of the following statements best describes you?

A. I asked a relevant question first through SNS where I am connected with others.

B. I asked another colleague first for help.

C. I searched the knowledge first through organizational repository.

D. Others, please specify_____

2. Based on your experience in the past three months, please indicate to what extent you have performed the following activities.

Please circle a number which describes you best regarding seeking knowledge from both (a) AND (b)	**(a) Close colleagues** To little extent						To a large extent	**(b) Distant colleagues** To little extent						To a large extent
1. I have gained knowledge from **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I have used knowledge documented by **them**.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. **They** have helped me with their knowledge.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

3. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a number that best describes you regarding seeking knowledge from both (a) AND (b)	**(a) Close colleagues** Strongly Disagree						Strongly Agree	**(b) Distant colleagues** Strongly Disagree						Strongly Agree
1. I am aware of **their** expertise.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I know what **they** are good at.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. I know what knowledge has been documented by **them** in the repository.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. I understand the value of **their** knowledge to my task performance.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. I know whether **they** have relevant expertise regarding my work.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
6. I know whom of **them** I shall turn to for help when I encounter a work-related problem.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
7. I think it is right to seek **their** knowledge rather than reinvention.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8. I like to ask **them** for help when I encounter a problem at work.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
9. I am motivated to seek **their** help first when I encounter a work-related problem.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
10. I am capable of understanding **their** knowledge.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
11. I have the competence to absorb **their** knowledge.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
12. I am good at integrating **their** knowledge for my task performance.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

Section V: The following statements are about the characteristics of your work, your perception of organizational context, and personal use of SNS. Please circle your answer accordingly.

1. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a number that best describes you regarding relationship with both (a) AND (b)	**(a) Close colleagues** Strongly Disagree						Strongly Agree	**(b) Distant colleagues** Strongly Disagree						Strongly Agree
1. I need to cooperate with **them** to perform my job well.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. My job activities are greatly affected by **their** work.	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. My job cannot be done unless **they** do their work well.	1	2	3	4	5	6	7	1	2	3	4	5	6	7

2. Please indicate the extent to which you agree or disagree with the following statements.

Please circle a number that best describes you.	Strongly Disagree						Strongly Agree
1. The tasks in my job are simple and uncomplicated.	1	2	3	4	5	6	7
2. My job comprises relatively uncomplicated tasks.	1	2	3	4	5	6	7
3. My job involves performing relatively simple tasks.	1	2	3	4	5	6	7
4. My company emphasizes documenting knowledge into a repository.	1	2	3	4	5	6	7
5. My company has invested heavily on building knowledge repository.	1	2	3	4	5	6	7
6. My company emphasizes writing reports after major problems.	1	2	3	4	5	6	7
7. My company emphasizes networking with colleagues for knowledge.	1	2	3	4	5	6	7
8. My company encourages dialogue among employees for knowledge.	1	2	3	4	5	6	7
9. My company emphasizes mentorship.	1	2	3	4	5	6	7
10. I have little free time to allocate during work.	1	2	3	4	5	6	7
11. I am usually under high time pressure at work.	1	2	3	4	5	6	7
12. The extra time I have available at work is limited.	1	2	3	4	5	6	7
13. I frequently use SNS in my personal life.	1	2	3	4	5	6	7
14. I spend much time using SNS in my personal life.	1	2	3	4	5	6	7
15. SNS use is an integral part of my life.	1	2	3	4	5	6	7

Section VI: Background Information

Please Circle the answer in the right column that best describes you.

Gender	A. Male B. Female
Age	A. < 25 years old; B. 25—30 years old; C. 30-35 years old; D.35—40 years old; E. 40—45 years old; F. ≥45 years old;
Education level	A. High school & below; B. Diploma; C. Bachelor; D. Master; E. PhD.
Job Function	A. Engineering; B. Marketing / Sales; C. Finance; D. Consulting; E. General Management; F. Others, please specify_____
Job Title	A. Technician; B. Engineer; C. Senior Engineer; D. Project Manager; E. General Manager; F. Director; G. Others, please specify_____
How long have you been working **in the company?**	A.< 3 months; B. 3 months — 1 year; C. 1—3 years; D. 3—5 years; E.5—10 years; F. ≥10 years.
How long have you been working in the **current position?**	A.< 3 months; B. 3 months — 1 year; C. 1—3 years; D. 3—5 years; E.5—10 years; F. ≥10 years.

You have reached the end of the questionnaire. We are very grateful for your time and effort in completing this questionnaire. **Thank you very much.**

Appendix B Calculations of Statistical Indicators

B.1 Measurement model indicators

Composite reliability measure $\rho_c = \dfrac{(\sum \lambda_i)^2 \operatorname{var} F}{(\sum \lambda_i)^2 \operatorname{var} F + \sum \Theta_{ii}}$

$$AVE = \frac{(\sum \lambda_i^2) \operatorname{var} F}{(\sum \lambda_i^2) \operatorname{var} F + \sum \Theta_{ii}},$$

where λ_i, F, and Θ_{ii} refer to factor loading, factor variance, and unique/error variance respectively.

B.2 Structural model indicators

Effect size $f^2 = \dfrac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$, where $R^2_{included}$ and $R^2_{excluded}$ refer to the R-squares provided on the dependent variable when the predictor variable is used or omitted in the structural equation respectively.

Appendix C Common Method Variance (CMV) Assessment

C.1 CMV assessment regarding knowledge seeking from close colleagues

Construct	Indicator	Substantive factor loading R_1	R_1^2	method factor loading R_2	R_2^2
SNS use_C	UseCC1	0.92**	0.84	-0.03	0.00
	UseCC2	0.91**	0.83	0.03	0.00
MRKC	MRKC1	0.72**	0.53	0.03	0.00
	MRKC2	0.91**	0.82	0.01	0.00
	MRKC3	0.92**	0.84	-0.03	0.00
ARKC	ARKC1	0.85**	0.73	0.04	0.00
	ARKC2	1.04**	1.08	-0.17	0.03
	ARKC3	0.77**	0.59	0.13	0.02
AwIN	AwIN1	0.91**	0.83	-0.05	0.00
	AwIN2	0.88**	0.78	0.05	0.00
AwCCH	AwCCH1	0.95**	0.90	-0.03	0.00
	AwCCH2	0.89**	0.79	0.04	0.00
	AwCCH3	0.49**	0.24	0.00	0.00
AwRKC	AwRKC1	0.91**	0.84	-0.08	0.01
	AwRKC2	0.94**	0.88	-0.01	0.00
	AwRKC3	0.79**	0.62	0.08	0.01
KAC	KAC1	0.84**	0.71	0.12**	0.01
	KAC2	1.03**	1.07	-0.20**	0.04
	KAC3	0.87**	0.75	0.07	0.00
Average		0.86**	0.76	-0.00	0.00

** $p<0.05$

C.2 CMV assessment regarding knowledge seeking from distant colleagues

Construct	Indicator	Substantive factor loading R_1	R_1^2	Method factor loading R_2	R_2^2
SNS use_D	UseDC1	0.89**	0.79	0.04	0.00
	UseDC2	0.90**	0.81	-0.04	0.00
MRKD	MRKD1	0.79**	0.62	0.05	0.00
	MRKD2	0.91**	0.83	0.04	0.00
	MRKD3	1.01**	1.03	-0.08	0.01
ARKD	ARKD1	0.76**	0.58	0.14	0.02
	ARKD2	1.09**	1.19	-0.23**	0.05
	ARKD3	0.85**	0.71	0.08	0.01
AwIN	AwIN1	0.88**	0.78	0.01	0.00
	AwIN2	0.90**	0.81	-0.01	0.00
AwDCH	AwDCH1	0.84**	0.71	0.09	0.01
	AwDCH2	0.82**	0.68	0.13	0.02
	AwDCH3	1.02**	1.04	-0.27**	0.07
AwRKD	AwRKD1	1.05**	1.10	-0.16	0.03
	AwRKD2	0.97**	0.94	-0.03	0.00
	AwRKD3	0.72**	0.52	0.20	0.04
KAD	KAD1	1.03**	1.07	-0.13	0.02
	KAD2	0.97**	0.94	-0.04	0.00
	KAD3	0.79**	0.62	0.17	0.03
Average		0.89	0.81	-0.00	0.00

** $p<0.05$

Appendix D Results of main effects of SNS use, Ability and Motivation on Knowledge Reuse

D.1 Knowledge sharing with close colleagues

Endogenous construct	Exogenous constructs	Path coefficient	t value	Effect size
AwWSC (R^2=0.54)	AwIH	0.39	5.21	0.29
	AwCCN	0.52	5.75	0.54
AwIH (R^2=0.22)	SNS use_C	0.16	1.90	0.03
	AMSC	0.15	1.42	0.02
	ASC	0.30	2.41	0.07
	AwCCN	0.07	0.88	0.00
AwCCN (R^2=0.28)	SNS use_C	-0.01	0.13	0.00
	AMSC	0.22	2.01	0.05
	ASC	0.38	4.41	0.15
KPC (R^2=0.25)	SNS use_C	-0.12	1.48	0.02
	AMSC	0.14	1.47	0.02
	ASC	0.19	1.69	0.03
	AwWSC	0.28	2.20	0.07

D.2 Knowledge sharing with distant colleagues

Endogenous construct	Exogenous constructs	Path coefficient	t value	Effect size
AwWSD (R^2=0.34)	AwIH	0.21	2.76	0.07
	AwDCN	0.52	7.05	0.41
AwIH (R^2=0.20)	SNS use_D	0.08	1.11	0.01
	AMSD	0.27	2.43	0.06
	ASD	0.27	2.70	0.07
	AwDCN	-0.08	1.30	0.00
AwDCN (R^2=0.22)	SNS use_D	0.21	2.20	0.05
	AMSD	0.35	2.89	0.12
	ASD	0.10	1.03	0.01
KPD (R^2=0.29)	SNS use_D	0.04	0.64	0.001
	AMSD	0.14	1.59	0.02
	ASD	0.10	1.11	0.01
	AwWSD	0.39	4.22	0.14

D.3 Knowledge seeking from close colleagues

Endogenous construct	Exogenous constructs	Path coefficient	t value	Effect size
AwRKC R^2=0.59	AwCCH	0.75	11.65	0.98
	AwIN	0.04	0.55	0.00
AwCCH R^2=0.55	SNS use_C	0.04	0.88	0.00
	MRKC	0.14	1.64	0.03
	ARKC	0.55	5.98	0.32
	AwIN	0.164	2.05	0.04
AwIN R^2=0.38	SNS use_C	0.22	2.57	0.08
	MRKC	-0.11	1.16	0.01
	ARKC	0.62	7.03	0.44
KAC R^2=0.35	SNS use_C	0.00	0.01	0.00
	MRKC	0.18	1.46	0.03
	ARKC	0.10	1.10	0.01
	AwRKC	0.40	3.04	0.11

D.4 Knowledge seeking from distant colleagues

Endogenous construct	Exogenous constructs	Path coefficient	t value	Effect size
AwRKD (R^2=0.66)	AwDCH	0.77	11.49	1.58
	AwIN	0.11	2.03	0.03
AwDCH (R^2=0.41)	SNS use_D	0.01	0.19	0.00
	MRKD	0.40	3.61	0.15
	ARKD	0.26	2.12	0.05
	AwIN	0.09	1.19	0.00
AwIN (R^2=0.33)	SNS use_D	0.21	2.52	0.06
	MRKD	-0.19	1.89	0.03
	ARKD	0.64	6.19	0.35
KAD (R^2=0.63)	SNS use_D	-0.01	0.15	0.00
	MRKD	0.44	3.34	0.22
	ARKD	-0.06	0.90	0.00
	AwRKD	0.47	3.65	0.24