

CHANNEL PREFERENCE OF KNOWLEDGE SOURCING

by

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DEDICATION

This dissertation is dedicated

to my grandma

Hong, Xingyi

And

to my parents

Jiang, Xiaoying and Zhang, Yongsui

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ABSTRACT

Knowledge is the critical success factor for organizations to compete in the contemporary business world. Organizations that can make full use of their collective expertise and knowledge are likely to be more innovative, efficient and effective in the marketplace. With the development of advanced information and communication technology, organizations are undertaking various knowledge management initiatives to augment traditional ways of knowledge transfer. This dissertation intended to understand how various factors influence knowledge workers' knowledge sourcing behavior in the multimodal knowledge network. More specifically, our research question is: *How do task characteristics, knowledge characteristics and individual characteristics influence knowledge workers' channel preferences during their knowledge sourcing activities?*

We built a knowledge sourcing preference model which predicts knowledge workers' preferences among various knowledge channels. We identified eight important antecedents from a wide spectrum of task characteristics, knowledge characteristics, and individual characteristics. We also identified three representative knowledge sourcing channels: face-to-face communication with colleagues, knowledge repositories, and discussion forums. We developed eight hypotheses on how each of the antecedent influence channel preferences.

We tested our hypotheses through a survey we conducted in an international information technology company. Out of the eight hypotheses, the hypotheses on the influences from

knowledge codifiability, knowledge volatility, extroversion/introversion dimension of the personality, and reciprocity awareness are supported. The hypotheses on the influences from task interdependency and task urgency are partially supported. The hypotheses on the influences from task routineness and expertise are not supported.

This study furthers our understanding of knowledge workers' knowledge sourcing behavior in a multimodal knowledge network. The results of this study help organizations understand the advantages and disadvantages of various sourcing channels under certain circumstances of tasks, knowledge, and individuals. With this understanding, organizations will be able to have reasonable expectations on the utilization of knowledge transfer approaches, and to improve the effectiveness of knowledge transfer initiatives. This will enable organizations to cultivate environments or design systems to develop the types of channels to accommodate the preferences of knowledge workers with various combinations of tasks, knowledge and individual characteristics.

CHAPTER 1: INTRODUCTION

“The most important, and indeed the truly unique, contribution of management in the 20th century was the fifty-fold increase in the productivity of the manual worker in manufacturing. The most important contribution management needs to make in the 21st century is similar to increase the productivity of knowledge work and knowledge workers. The most valuable asset of a 20th-century company was its production equipment. The most valuable asset of a 21th-century institution (whether business or nonbusiness) will be its knowledge worker and their productivity.”

---- Drucker (1999, p.79)

1.1. Statement of the Problem

In the current knowledge era, knowledge is the critical success factor for organizations. In the knowledge-based view of firms, knowledge is the source of a firm’s competitive advantage and the primary driver of a firm’s value (Grant 1996; Spender 1996; Teece 2000). Organizations that can make full use of their collective expertise and knowledge are likely to be more innovative, efficient and effective in the marketplace (Argote and Ingram 1999; Grant 1996). The key players in this competition are knowledge workers.

These are workers with high information content in their work inputs and outputs (Davis et al. 1993) who are the action takers to utilize the collective expertise and knowledge of the organization.

To fully utilize knowledge within organizations, knowledge workers need to engage in knowledge transfer activities. Compared to markets, organizations are conceptualized as superior settings for the transfer and integration of knowledge between knowledge workers (e.g., Argote et al. 2003; Davenport and Klahr 1998). However, knowledge transfer within an organization is still considered one of the most difficult activities in organizational knowledge management practice (Szulanski 1996; Zander and Kogut 1995).

Knowledge transfer can be realized through various channels. Traditional modes of knowledge transfer include speaking to co-located colleagues, reading printed publications, etc. With the development of advanced information and communication technology (ICT), organizations are undertaking various knowledge management initiatives to augment traditional ways of knowledge transfer. Two examples of these initiatives are: electronic communities of practice (eCoPs) and knowledge repositories.

The availability of multiple channels raises the following questions: Do knowledge workers prefer certain knowledge channels over others? If so, what are the determinants of channel preference? Finding answers to these questions will enable organizations to understand how knowledge workers use various channels to transfer knowledge. This

will enable the organizations to cultivate environments or design systems to develop the types of channels that a particular knowledge worker or a particular group of knowledge workers prefers.

Knowledge transfer has two sides, knowledge sharing and knowledge sourcing¹.

Knowledge sourcing refers to intentional individual efforts to locate and access other's expertise, experience, insights, and/or opinions in response to problems, issues, or challenges faced by that individual (Gray and Meister 2005). While prior research has tended to focus on knowledge sharing (Constant et al. 1996; Jarvenpaa and Staples 2000), research on knowledge sourcing has been limited (Gray and Meister 2005; Kankanhalli et al. 2005). To address this gap, the current study focuses on the knowledge sourcing side of knowledge transfer.

There are many factors that influence the channel preferences of knowledge workers during their knowledge sourcing activities. We identify three sets of factors based on the signaling metaphor (Shannon and Weaver 1949). The signaling metaphor has been deemed the most important stimulus for the development of models and theories in communication (Serevin and Tankerd 1988). It has a formative influence on the study of knowledge diffusion and transfer (Attewell 1992; Straub and Karahanna 1998). This

¹ In the literature, some authors use "knowledge seeking"(e.g., Hertzum and Pejtersen, 2000; Kankanhalli, 2005) and "knowledge-acquiring"(e.g., Greenwald, 1985). Following Gray and Meister (2004; 2005), we use "knowledge sourcing."

metaphor specifies the basic elements of a transfer: source, channel, message, recipient, and context.

It is suggested that sources are inseparable from channels (Bystrom and Jarvelin 1995), since a source contains (or is expected to contain) relevant information when a channel guides (or is expected to guide) the worker to pertinent sources. Thus, we use the term “channel” to refer to both “source” and “channel” as in the signaling metaphor.

According to the signaling metaphor, the selection of a channel and source is influenced by the remaining three elements: message, recipient, and context.

In the context of knowledge sourcing, the message is the knowledge that is being sourced, the recipient is the knowledge worker who sources the knowledge, and the context is the task that the knowledge worker is involved in. This research investigates how the three categories of characteristics, namely task characteristics, knowledge characteristics and individual characteristics, influence knowledge workers’ channel preferences. The specific characteristics in each category are identified from the literature on ICT and the literature on knowledge transfer.

While new channels may still emerge with the advances in technology and organizational innovation, in this study we select three representative knowledge sourcing channels based on the underlying communication mode and the popularity in organizational knowledge transfer practice. These three channels are colleagues via face-to-face

communication, knowledge repositories, and electronic communities of practice (eCoPs.)

We describe in detail the rationale for this choice later.

In summary, the major research question of this study is:

How do task characteristics, knowledge characteristics and individual characteristics influence knowledge workers' channel preferences during their knowledge sourcing activities?

1.2. Importance of the Research

How to promote and facilitate effective knowledge sharing and sourcing is an increasingly important challenge for managers (Kogut and Zander 1992). Organizations spend considerable effort, time, and money buying, introducing, and using new communication systems to improve knowledge sourcing and sharing activities.

While the strategic information systems literature proposes various knowledge management approaches and information system design principles (e.g., Earl 2001; e.g., Hansen et al. 1999; Zack 1999a), more research is needed to understand the usage and effectiveness of the system. As suggested by Agarwal (2000), whether individuals adopt and like to use a system is the most important factor determining the success of an information technology or a new system.

With the rapid deployment of new media in the workplace, researchers have started to note that it may be limiting to examine only the way in which an individual interacts with a single information system. Researchers have also started to promote the view of multimodal knowledge networks. A multimodal knowledge network is defined as the collection of multiple people and multiple information management systems with which those individuals interact to provide or receive information to perform tasks (Monge and Contractor 2003). Researchers (Argote et al. 2003; Davenport and Klahr 1998; Kane and Alavi 2005) are calling for extensive research of multimodal knowledge networks.

However, most knowledge management literature investigates the use of a single channel (e.g., Kankanhalli et al. 2005; Poston and Speier 2005), or treats different methods of sourcing knowledge as broadly exchangeable (e.g., Davenport et al. 1998; Earl 2001). It is only very recently that research has started to view the different methods and channels of knowledge sourcing differently, and started to investigate the antecedents and outcomes of knowledge sourcing behaviors in the multimodal knowledge network.

Some innovative empirical work has been carried out by Gray and his colleagues. Gray and Meister (2005) found different classes of knowledge sourcing methods not as interchangeable as the knowledge management literature might suggest. Gray and Durcikova (2006) uncovered a set of antecedents that have markedly different effects on different knowledge sourcing behaviors.

This study builds on and extends the research above, and is intended to further our understanding of knowledge workers' knowledge sourcing behavior in a multimodal knowledge network. The results of this study will help organizations to understand the advantages and disadvantages of various sourcing channels under certain circumstance of knowledge, tasks and individuals. With this understanding, organizations will be able to have reasonable expectations on the utilization of knowledge transfer approaches, and to improve the effectiveness of the knowledge transfer initiatives.

The remainder of this dissertation is organized as follows. Chapter 2 comprises two literature review sections. The first section reviews the literature of knowledge sourcing channels and identifies three representative knowledge sourcing channels; the second section reviews task characteristics, knowledge characteristics, and individual characteristics. Eight characteristics are selected as antecedents for channel preferences. Chapter 3 presents a conceptual model and develops hypotheses on how the eight characteristics identified in the previous chapter influence channel preferences. Chapter 4 develops construct measures for the model and outlines the survey procedure. Chapter 5 describes the analysis of measures and reports the hypothesis testing results. Contribution, limitation and future research directions are discussed in Chapter 6.

CHAPTER 2: LITERATURE REVIEW

The literature review has two sections. The first section surveys knowledge sourcing channels in organizations and selects three representative channels; the second section reviews three sets of characteristics, and identifies eight characteristics as antecedents of channel preferences.

2.1. Knowledge Sourcing Channels

Organizations are conceptualized as superior settings for the transfer and integration of knowledge between individuals (e.g., Argote et al. 2003; Davenport and Klahr 1998).

Knowledge transfer happens through a variety of channels, including co-located colleagues, printed publications, telephone, e-mail, knowledge repositories, communities of practice, etc.

With the advances in technology and organizational innovation, knowledge transfer studies do not, and cannot, enumerate all available channels. Instead, most studies, including media choice studies and recent knowledge transfer studies (e.g., Gray and Meister 2005), either select representative channels or categorize channels. For example, the studies in the media choice literature have focused on the fundamental difference of media in terms of technology and forms of messages. For example, Lind and Zmud (1995) separated the use of written media and verbal media in predicting business unit performance and manager satisfaction, while Jarvenpaa and Staples (2000) categorized

media into electronic media and non electronic media to study individual use of electronic media.

Gray and his colleagues used a learning and pedagogical perspective when investigating knowledge workers' knowledge sourcing activities. Their categorization was based on Harasim's (1989) typology of communication-based learning models. Harasim (1989) argued that pedagogical techniques could be understood as a function of their underlying communication model, and described three basic educational models: one-to-one, one-to-many, and many-to-many. Culnan and Markus (1987) employed a similar trichotomy (one-to-one, one-to-many and in group) to categorize the types of communication model for a variety of electronic media.

Gray and Meister's (2004; 2005) research drew on this typology of communication-based learning models, and delineated generic classes of knowledge sourcing methods into three types: dyadic knowledge sourcing, published knowledge sourcing, and group knowledge sourcing. Dyadic sourcing is based on person-to-person communication where a single knowledge provider communicates directly with a single knowledge seeker. Published sourcing involves the codification and storage of knowledge from a single knowledge provider that may be accessed by many knowledge seekers. Group sourcing is where knowledge is exchanged amongst multiple seekers and multiple sources in an open venue.

In this study, our objective is to select the most representative channels as the channel options. There are two aspects of “representative” that we identify. First, the channels we select are popular in contemporary knowledge sourcing activities in organizations. The channels may include both the traditional methods and the new knowledge transfer initiatives that organizations are starting to implement. Second, the channels we select are representative in terms of their underlying communication models.

According to the criteria above, we choose three knowledge sourcing channels: sourcing knowledge face-to-face from colleagues, sourcing knowledge from knowledge repositories, and sourcing knowledge from discussion forums of electronic communities of practice. These three channels represent three popular knowledge sourcing channels. These three channels also fall into the categories of dyadic, published, and group sourcing, the typology of communication-based learning model proposed by Harasim (1989) and adopted by Grey and Meister (2004; 2005).

Before the development and diffusion of telecommunication technologies, the common practice of knowledge transfer in the workplace is to direct questions to or discuss issues with co-located colleagues. Knowledge repositories came to the organizational knowledge management practice in the 80’s, and they are used to store and organize documents such as those recording organizational routines and procedures (Earl 2001). The development and growth of electronic communities of practice began to attract the attention of knowledge management researcher in the mid 90’s (Goodman and Darr

1998). Discussion forums provide a public space for electronic communities of practice to exchange knowledge.

2.1.1. Face-to-face Communication with Co-located Colleagues

Sourcing knowledge face-to-face from co-located colleagues has been the most traditional channel and still continues to be the most popular channel (Yitzhaki and Hammershlag 2004). A number of studies has found that people often turned to co-located colleagues as readily-accessible sources of information even when better information would be available through more extensive searching (Allen 1977; Monge et al. 1985; O'Reilly 1982).

Sourcing from co-located colleagues is convenient and can involve extensive interactions. For example, Pentland (1992) described face-to-face communication among technical analysts. An analyst obtains knowledge from another analyst by asking for help either in the form of a “quick question” or through more involved requests to “take a look”. This type of direct interaction with colleagues encourages a dialogue about the nature of the problem being faced and supports the matching of knowledge to context, thus creating the possibility for interactive sense making (Daft and Weick 1984).

However, the effectiveness of this channel is constrained by a few factors. First, the experts may not always be available. This applies to both location and time. The colleague in question may not be located in our vicinity, or may not have time to talk to

us. Second, the knowledge seeker may not be able to understand and master the issue. A colleague is not like a book or system that we can refer to at anytime and with which we can spend as much time as we want. A knowledge seeker has to have adequate absorptive capacity to assimilate the information received during the interaction. Third, the co-located colleague might not be the most knowledgeable person to speak to for a particular subject matter and may not provide trustworthy information.

2.1.2. Knowledge Repositories

A great deal of organizational knowledge about how to do things is stored in the forms of standard operating procedures, routines and scripts (Feldman 1989). Knowledge repositories act as on-line computer-based storehouses of expertise, knowledge, experience, and documentation about a particular domain of expertise (Liebowitz and Beckman 1998). Davenport et al.(1998) found that 80% of KM projects that they had surveyed involved some form of knowledge repository. In creating knowledge repositories, knowledge is collected, summarized, and integrated across sources. Knowledge repositories are usually managed as formal organizational efforts and the knowledge stored is assumed to have been validated by experts.

Knowledge repository systems facilitate access to knowledge artifacts, for example, structured data, diagrams, text-based documents, and images (Stein and Zwass 1995). Knowledge repositories differ from colleagues in that knowledge repositories capture successful solutions to past problems in a searchable format and enable analysts to

quickly locate candidate solutions (Davenport and Klahr 1998).

However, depending on how well-organized they are and how frequently they are updated, the qualities of knowledge repositories vary. In Markus's (2001) review paper on knowledge reuse, she purported that knowledge repositories could play a relatively unimportant role in knowledge reuse, arguing that face-to-face communication and good knowledge sharing processes between the sources and intended recipients of knowledge were the keys to successful knowledge reuse. Despite the case studies that demonstrate positive benefits of repositories in certain business contexts, such as in Hansen et al. (1999) and Davenport and Klahr (1998), the effect of knowledge repositories on performance may not always be positive. For example, contextual information of when or under which conditions the knowledge can be used is not clearly documented, and transferring knowledge to a different context may be dangerous.

2.1.3. Electronic Community of Practice

A community of practice (CoP) is a group of "people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis." (Wenger et al., 2002, p.4). People who belong to a community of practice are usually geographically separated, and are referred to as an electronic Community of Practice (eCoP). In the workplace, a CoP or eCoP is a collection of individuals performing similar work or engaged in the pursuit of solutions to similar problems (e.g., Brown and Duguid 1991; Lave and Wenger 1991). Compared to a

formal organizational unit, such as working groups, CoPs and eCoPs are informal social networks that are not part of any organizational chart or hierarchy (Brown 1998). They usually have online discussion forums for communication and learning among themselves.

Compared to face-to-face communication and knowledge repositories, eCoPs have unique advantages in terms of their diversity and popularity. Granovetter (1973) proposed the theory of “strength of weak ties”. The theory suggests that relative strangers could offer an advantage over friends and colleagues in obtaining useful information: this is due to the diversity of resources that they encounter. Later empirical studies have shown positive results on the “strength of weak ties.” Constant et al. (1996) found that information providers do give useful advice and solved the problems of information seekers despite their lack of a personal connection with the seekers. Goodman and Darr (1998) showed how electronic communication networks that function as distributed question-and-answer systems help employees improve their performance. Wenger and Synder (2000) documented a variety of ways that communities of practice add value in organizations, including enhancing the development of professional skills.

However, there are a few major barriers that limit the success of eCoPs, including information overload, information quality, and lack of motivation to contribute. A discussion thread can go as long as hundreds of messages and still not get to the point. It could be a lot of work to read through the messages before the answer is located. This

creates a huge cognitive overload. In addition, there may be uncertainty as to the trustworthiness of the answer if there is no indication of the expertise of the author. Also, in contrast to a formal organization where a proper rewarding mechanism that is tied to work performance encourages participation, eCoPs are informal organizations and the existence of key players may put an end to an eCoP.

2.1.4. Research Status of Multimodal Knowledge Networks

There is ample research investigating knowledge sourcing within a single type of channel with many studies formulating sophisticated models and rigorous testing of the models. We select one recent research study from each of the three knowledge channels (Borgatti and Cross 2003; Kankanhalli et al. 2005; Wasko and Faraj 2005) and report their discoveries below.

Borgatti and Cross (2003) investigated the antecedents determining the probability of seeking information from another person. They proposed and empirically tested a formal model of information seeking in which the probability of seeking information from another person is a function of (1) knowing what that person knows; (2) valuing what that person knows; (3) being able to gain timely access to that person's thinking; and (4) perceiving that seeking information from that person would not be too costly. They also found that "knowing" and "access" mediate the relationship between physical proximity and information seeking.

Kankanhalli et al (2005) studied the antecedents that motivate employees' usage of a knowledge repository. They found that perceived output quality directly affects knowledge repository usage for knowledge seeking, and resource availability and incentives also affect usage in particular situations.

Wasko and Faraj (2005) studied why people contribute knowledge and help others in eCoPs. Their results showed that people contribute knowledge when they perceive that it enhances their professional reputations, when they have the experience to share, and when they are structurally embedded in the network. They also found that, contrary to their expectation, contributions occur without regard to expectations of reciprocity from other high levels of commitment to the network.

However, there are very few studies conducted on multimodal knowledge networks. Most knowledge management literature treats different methods of sourcing knowledge as being broadly interchangeable (Davenport et al. 1998; Earl 2001). The understanding of knowledge workers' channel preference is very limited. Research (Argote et al. 2003; Davenport and Klahr 1998; Kane and Alavi 2005) has called for extensive investigation of multi-modal knowledge networks. For example, Massey and Montaya-Weise (2006) recognized that knowledge conversion often requires a mixture of media, and call it a polyphasic temporal structure when the participants deploy multiple channels simultaneously. They articulated a set of research propositions and called for research to discover the complex phenomena associated with that.

Recent empirical research conducted by Gray and his colleagues has revealed some interesting discoveries in the context of multiple sourcing channels. Gray and Meister (2005) investigated the relationship between knowledge sourcing channel characteristics and performance outcomes. They found that (1) different classes of knowledge sourcing methods are not as interchangeable as the KM literature might suggest; (2) technology-based methods are neither inherently superior nor inferior to traditional methods; and (3) that group knowledge sourcing supports a wider range of performance outcomes than other methods.

Gray and Durcikova (2006) investigated why technical support analysts would seek out and access knowledge from knowledge repositories, as opposed to more traditional sources of such knowledge—colleagues and manuals. Their research elaborated upon the role played by analysts' learning orientation, perceived work demands, and risk aversion in predicting their knowledge sourcing behavior. They uncovered a set of antecedents that have markedly different effects on different knowledge sourcing behaviors. The results painted a picture of technical support knowledge repositories that may not be able to enhance simultaneously, both analysts' speed of response and their learning.

2.2 Task Characteristics, Knowledge Characteristics, and Individual Characteristics

There are many factors influencing knowledge sourcing channel preferences. The initial selection of the factors is based on the signaling metaphor or the mathematical theory of communication (Shannon and Weaver 1949). The signaling metaphor has been deemed

the most important stimulus for the development of models and theories in communication (Serevin and Tankerd 1988) and has a formative influence on the study of knowledge diffusion and transfer (Attewell 1992; Straub and Karahanna 1998). This metaphor specifies the basic elements of a transfer: source, channel, message, recipient, and context. As suggested by Bystrom and Jarvelin (1995), source and channel are inseparable, and are combined and referred to as channel in this study.

Within knowledge sourcing, message is the knowledge that is being acquired, recipient is the knowledge worker who acquires the knowledge, and the context is the task the knowledge worker is involved in. In this section, we review how each category might affect knowledge sourcing behavior and what important characteristics of each category are most likely to influence knowledge workers' channel preference. The number of characteristics included in our model shall be limited to six to nine; otherwise, the model could be overly complex in theory and the results could be difficult to apply to knowledge management practice. Thus, although there are many important characteristics in each category, for this review we shall prudently select only two to three of the most relevant ones from each category.

2.2.1. Task Characteristics

Channel preference is affected by the characteristics of the task in which an individual is involved. It is generally agreed that information needs and information-seeking processes depend on workers' tasks (Bystrom and Jarvelin 1995). The tasks impose information

requirements that must be met if the tasks are to be completed (Wersig 1973). A person's information seeking depends upon his or her tasks and the problems encountered in performing them (Bystrom and Jarvelin 1995).

Fry and Slocum (1984) suggested a general characterization of tasks, combining Perrow's (1967) and Thompson's (1967) dimensions to create a three dimensional construct of task characteristics: variety (number of exceptions), difficulty (non analyzable search behavior) and interdependence (with other organizational units). This characterization captures many of the salient dimensions used by a variety of organizational researchers, e.g., Van de Ven and Delbecq (1974), O'Reilly (1982), and Campbell (1988)

However, Perrow (1970) raised the possibility that two of the dimensions, variety and difficulty, might tend to be very correlated in practice and could therefore be combined into a single dimension of routineness vs. non-routineness. The work by Van de Ven and Delbecq (1974) supported the notion that it is often difficult to tease out these two separate dimensions in practice. Goodhue (1995) also found a high correlation between variety and difficulty.

Many empirical studies have used routineness and interdependence in their task characteristics (Goodhue and Thompson 1995; Gray and Meister 2004; Kettinger and Grover 1997; Steinfield and Fulk 1986). For example, Goodhue (1995) measured a two-dimensional construct of task characteristics: non-routineness and interdependence. Gray and Meister (2004) used routineness and interdependence to measure the intellectual

demand of the knowledge workers. Thus, routineness and interdependence capture key task dimensions.

Task complexity is also a widely used task characteristic, but is excluded from our model for its correlation with task routineness. Task complexity affects task performance as observed in psychological experiments (Wood et al. 1987), in organizational studies (Van de Ven and Ferry 1980), as well as in information-seeking studies (Hart and Rice 1991). However, task complexity has been found to be correlated with routineness (Campbell 1988; Gray and Meister 2004). Gray and Meister (2004) also found that the items they used to measure task complexity did not load clearly and accordingly removed the complexity construct in their final model.

In addition to routineness and interdependence, some research has examined task urgency. Task urgency, sometimes referred to as time pressure or time urgency, has gained increasing attention. Businesses today often operate in competitive environments that are increasingly turbulent and unpredictable. Since individuals need to respond differently based on the urgency of the tasks, task urgency has been considered important in individual behavior and performance. It has been investigated in various studies such as Picot et al. (1982), Steinfield (1986), Koys and DeCotiis (1991), Straub and Karahanna (1998), and Gray and Durcikova (2006).

In summary, we have considered three task characteristics in our study: task routineness, task interdependence, and task urgency.

2.2.1.1. Task Routineness

Task routineness has been an important consideration in organizational research.

Lawrence and Lorsh (1967) conceptualized routineness as a function of the rate of change of an organization's environment. It has been conceptualized or described in various ways in the literature. For example, Perrow (1967; 1970) posited that task routineness consists of two dimensions, analyzability and exception. He defined analyzability as the extent to which the action required to accomplish a body of work could be specified in advance, and the number of exceptions is a measure of variety or variability. Wettinger and Grover (1997) used "task predictability" to describe routineness. Gray and Meister (2004) defined routineness as the extent to which a body of work involves repetitive processes that remain stable over time.

The literature has generated equivocal results on the relationship between forms of routines and types of knowledge sourcing activities. Kettinger and Grover (1997) studied the relationship between a variety of characteristics and the frequency of email for task, social or broadcast purpose in an inter-organizational context. They found that the degree of work routines (which they label "task predictability") related to only e-mail usage for social use. However, Grey and Meister (2004) found significant results and showed not only that routineness is a predictor of cognitive demands, but also that the more routine the task, the less the workers engage in knowledge sourcing. Thus, apart from being an

important task characteristic, routineness also may influence channel preference and knowledge sourcing behavior in general.

2.2.1.2. Task Interdependence

Interdependence is conceptualized as the degree of cooperation or collaboration required to accomplish work (Thompson 1967) or the degree to which individuals are reliant on each other in accomplishing a goal (Campion et al. 1993). The degree of task interdependence typically increases as the work becomes more difficult and individuals require greater assistance from others to perform their jobs.

When tasks are highly interdependent, knowledge workers need to coordinate with others, and need to know more about others' work (Leonard and Sensiper 1993). Indeed, interdependence among employees is a major challenge in coordinating collective action (Tushman and Nadler 1978). It has spurred a variety of solutions including matrix organizations, teams, workflow systems, and collaboration tools.

A number of authors have argued that a greater need for coordination (via communication) arises when units have highly interdependent tasks (March and Simon 1958; Thompson 1967). For example, Thompson (1967) argued that highly interdependent business units require higher levels of coordination through information exchange; while such coordination is not identical to knowledge sourcing, they are both

communication-based interactions. Thus, we can see the important role of knowledge exchange when tasks are highly interdependent.

2.2.1.3. Task Urgency/Time Pressure

Performing a task in a limited time creates time urgency. Landy et al. (1991) defined task urgency as the individuals' perceptions of deadlines and the rate at which tasks must be performed. Similarly, Koys and DeCotiis (1991) defined time pressure as the perception of time demands with respect to task completion and performance standards. To compete in a highly competitive business environment, individuals, groups and organizations need to compete under time pressure. For example, the tasks of a help-desk analyst must be performed when a customer is on the phone (Davenport and Klahr 1998).

ICT literature has found that time pressure impacts a person's media choice. Empirical studies (Picot et al. 1982; Steinfield and Fulk 1986; Straub and Karahanna 1998), have shown that the more urgent the task, the less likely a knowledge worker choose an asynchronous medium for communication. Steinfield and Fulk (1986) found that time pressure have a strong influence on managers' media choice.

Recent studies in knowledge sourcing behavior have found that task urgency affects knowledge sourcing behavior. Drucikova (2004) found that support for online action is more useful in environments with high time pressure than in environments with lower time pressure. Gray and Durcikova (2006) found that analysts' perception of time

pressure is negatively related to their use of knowledge repositories, while having no significant impact on the use of colleagues or documents.

2.2.2. Knowledge Characteristics

Knowledge is the object that is transferred during knowledge sourcing, and the characteristics of knowledge surely affect channel preference (Te'eni 2001). There are a number of different characteristics of knowledge. For example, Holsapple and Joshi (2001) listed more than twenty dimensions of knowledge. Knowledge characteristics have been found to play a significant role in various levels of knowledge transfer, including inter-organization/inter-unit (Hansen 2002; Zander and Kogut 1995) and inter-personal (Hsiao et al. 2003; Sussman and Siegal 2003).

In their seminal work on knowledge characteristics and knowledge transfer effectiveness, Zander and Kogut (1995) developed five central constructs of knowledge: codifiability, procedural complexity, teachability, system dependence and observability. The constructs were build based on Rogers's (1980) and Winter's (1987) taxonomies on innovation. Zander and Kogut (1995) conducted this study in the context of inter-organizational knowledge transfer, and later Brown et al. (2006) applied these five knowledge constructs in the context of person-to-person knowledge transfer.

According to Zander and Kogut (1995), the five central constructs of knowledge are defined as follows. *Codifiability* refers to the degree to which knowledge can be encoded

and stored. *Procedural complexity* refers to the variety of procedural resources that must be combined to create knowledge. *Teachability* refers to the degree to which the knowledge can be shared via training, either in school or on the job. *Observability* refers to the degree to which knowledge can be imitated or copied by observing the performance of a task or its products. *System dependence* refers to the degree to which knowledge is dependent on and derived from many different people.

As central as these five constructs are to knowledge characteristics, we only adopt knowledge codifiability in our model. The other four constructs are either found to have no significant impact on knowledge transfer research in general, or are expected to perform homogeneously in the three knowledge channels of this study. Both in the inter-organizational study conducted by Zander and Kogut's (1995) and the inter-personal study conducted by Brown et al. (2006), observability and system dependence have no significant results on knowledge transfer effectiveness. Brown et al. (2006) also found that system dependence had a very low reliability with a Cronbach's alpha of 0.41.

Both studies found teachability a significant antecedent in knowledge transfer effectiveness, and we expect it to have significant impact on the knowledge sourcing effectiveness. However, teachability would most likely have similar effect to the three channels, and thus would not affect channel preference. As stated previously, *teachability* refers to the degree to which the knowledge can be shared via training, either in school or on the job. The channel through which training is conducted is not specified, and the

measures in previous studies were mostly developed based on the research context. For example, both Zander and Kogut (1995) and Brown et al. (2006) measured teachability through the easiness to learn the knowledge from talking to people and the easiness to learn the knowledge from studying documents.

Procedural complexity is also excluded from our study. The results from previous studies are mixed. Zander and Kogut (1995) found no significant impact from procedural complexity on knowledge transfer effectiveness, while Brown et al. (2006) found it significant. However, procedure complexity is more concerned with knowledge creation than knowledge transfer. As stated in the previous chapter, procedural complexity refers to the variety of procedural resources that must be combined to create knowledge. Thus, we expect minimal impact from procedural complexity on channel preference.

In addition to knowledge codifiability, we propose to examine the impact of knowledge volatility on channel preferences. Although knowledge volatility has rarely been conceptualized and investigated, there are two reasons that make knowledge volatility an important knowledge characteristic. First, given the business environment in which “change is the only constant” (Drucker et al. 1997), volatility should be an indispensable consideration in organizational practice. Second, volatility has been used to qualify data in the data management literature and used as a measurement of software behavior.

Thus, we examine the influence of knowledge codifiability and knowledge volatility on channel preference.

2.2.2.1. Knowledge Codifiability

Knowledge codifiability refers to how easily the knowledge can be coded into written documents. Studies on the characteristics of knowledge have long acknowledged the tacit dimension of knowledge in addition to the explicit dimension (Polanyi 1966). In Polanyi's (1966) original definition of tacit knowledge, explicit and tacit are not dichotomous, but two ends of a continuous measure.

It is widely agreed that tacit knowledge is much more difficult to exchange through written documents and that codification is expensive. Tacit knowledge of one knowledge worker, such as insights, intuitions, and hunches, is accumulated through dynamic, unstructured and often subtle processes, and is not easily codified into written form or captured in information systems (Markus 2001). This is also true in inter-organizational or inter-unit knowledge transfer. For example, it takes time to explain and learn tacit knowledge. Tacit knowledge tends to slow the transfer of manufacturing capabilities (Zander and Kogut 1995) and the progress of new product development projects (Hansen 1999).

In his study on knowledge management strategy, Zack (1999a) suggested that organizations should choose their knowledge management approach based on the codifiability of their knowledge. Since tacit knowledge is difficult to articulate, attempting to codify it may result in losing its essence, which leads to unexpected low performance. For example, the costs of searching for relevant solutions in knowledge

repositories may be higher if these solutions involve more tacit knowledge (Kankanhalli et al. 2005). In contrast, learning tacit knowledge through inter-personal relationships can provide value-added customization (Hansen et al. 1999).

2.2.2.2. Knowledge Volatility

According to Webster, one of the explanations of volatility is “characterized by or subject to rapid or unexpected change.” Holsapple and Joshi (2001) used “knowledge volatility” to refer to the extent to which knowledge is subject to change. While researcher in knowledge management has not been using “knowledge volatility” frequently, “volatility” has been an important dimension of the economic and business environment (Kankanhalli et al. 2003). It reflects the rapidity of change in the business environment. Knowledge volatility thus is appropriate to be used to refer to the rapidity of knowledge change.

Volatility is an important and operationable concept in the data quality literature, and is closely related to the timeliness of data. In the classical paper by Wang and Strong (1996), they proposed four components of data: contextual, intrinsic, representational, and accessibility. Timeliness is the one of the most important dimension in the contextual category (Ballou and Pazer 1985). Timeliness reflects how up-to-date the data is with respect to the task it is used for (Pipino et al. 2002). Volatility has been used to measure timeliness. The lower the volatility, the more timeliness the data remains, or the higher the volatility, the less timeliness the data remains.

In the software development literature, “software volatility” has been used as a key measurement of a characteristic of software behavior, describing the changeable nature of software (Barry and Slaughter 2000). Software volatility is a factor that drives enhancement costs and errors, and refers to the frequency and number of enhancements of per unit of application functionality over a specific time frame.

With the rapid changes in every aspect of the business world, a temporal measurement for knowledge is important. The higher the volatility, the less likely we can reuse the knowledge after a certain period of time. Depending on how volatile the knowledge is, different knowledge channels may have their own pros and cons in storing or conveying it. Thus, the impact of knowledge volatility on channel preferences is tested.

2.2.3. Individual Characteristics

Intrinsic individual differences may represent some of the habitual and non conscious influences on channel usage and preference. Zmud (1979) argued that it is intuitive that individual differences would affect information system activities. He reviewed the impact of individual difference in the broad range of success of information system, and grouped individual difference believed most relevant to MIS success into three classes: cognitive style, personality, and demographic/situational variables.

Cognitive style is an individual’s preferred way of gathering, processing, and evaluating information (Messick 1984). Personality refers to the cognitive and affective structures

maintained by individuals to facilitate their adjustments to the events, people and situations encountered in life (Gough 1976). Research related to cognitive style focuses on simple/complex dimension, field-dependent/field-independent dimension and systematic/heuristic dimension. Research related to personality includes locus of control, dogmatism, ambiguity tolerance, extroversion/introversion, need for achievement, risk taking propensity, evaluative defensiveness, and anxiety level.

The psychology literature finds significant overlap between cognitive style and personality. It shows cognitive style constructs and the personality constructs have been intertwined both in theoretical and empirical research. For example, Adorno et al. (1950) proposed a psychological theory integrating personality theories into cognitive preference studies; Eysenck (1978) noted that personality and cognitive styles are closely related; Hashway (1998) proposed that many cognitive theories are personality based. There are also some empirical studies showing that cognitive/learning style is a sub-set of personality (Furnham 1992; Furnham et al. 1999; Furnham 1996a; Furnham 1996b)

Many of these scholars argued that since cognitive style is a sub-set of personality, there is no need to measure cognitive style independently, unless cognitive style is of interest in its own right. Since cognitive style is not of such interest in this study, we select one or two of the most important characteristics from cognitive style and/or personality.

As reviewed by Zmud (1979), the demographic/situational variables cover a broad spectrum of personal characteristics, such as sex, age, experience, education, professional

orientation, and organizational level. Proficiency based variables, such as experience and education, are usually hypothesized and tested and have showed significant impact in knowledge transfer activities, while demographic information, such as sex and age, are often used as control variables or used to subset the subjects. We thus include proficiency based characteristics in our model, and capture other demographic information and use them as control variable if necessary.

To be consistent with the naming of cognitive style, we call proficiency based characteristics cognitive ability in this study. Cognitive ability is different from cognitive style (Hayes and Allinson 1998). Cognitive ability refers to mastery of content and an individual's capacity to perform (Hayes and Allinson 1998). While cognitive style is more concerned with what the individual will do in a given situation, that is, with the manner, form, and nature of performance (Messick 1984), cognitive ability concerns the capacity of the individual to perform. In general, cognitive style is considered more stable than capability in that an individual's cognitive ability increases when he/she acquires more knowledge and skills.

In addition, social characteristics from the social psychology discipline are of interest in this study. Compared to personal psychology, social psychology is often conceived to be the study of how individuals perceive, influence, and relate to others (Baron and Kenny 1986). Knowledge sourcing activities involve interaction with others directly or indirectly, and we expect that social characteristics would influence channel preference.

We now examine the impact of cognitive style, cognitive ability, and social characteristics of individuals on channel preference. To keep the model simple, we select one critical dimension of each category from previous literature.

2.2.3.1. Cognitive Style - Extraversion/Introversion

Whether cognitive style affects channel preference has created several debates in the communication literature. Huber (1983) offered a critical review of this literature, and had uncovered inconsistent results in study findings and found only small amounts of various explained. He suggested that future research of cognitive style may be unwarranted. However, other researchers (e.g., Straw et al. 1986) still consider cognitive styles worthy of further investigation.

Among several taxonomies regarding cognitive styles or personalities, we investigate the extraversion/introversion dimension of cognitive style employing Myers-Briggs type indicator (MBTI) (Mayer and McCaulley 1985). While in cognitive style and personality literature, both MBTI and five-factor model are the most influential metrics, MBTI is considered more appropriate for the studies in organizations based on the argument from McCrae and Paul (1989). According to McCrae and Paul, MBTI is based on one of the classic statements of psychological style theory by Jung (1923; 1971), and is widely used to explain individuals' personality characteristics to professionals. These distinctions have made the MBTI a popular instruments for organizational and industrial psychologists.

MBTI measures four pairs of cognitive styles: sensing/intuiting, thinking/feeling, and judgment/perception, and extraversion/introversion. The reasons for choosing extraversion/introversion other than other three dimensions are as follows.

Extraversion/introversion is one of the most salient and visible personality traits (Eysenck and Eysenck 1975), and one of the few which researchers generally agree provides 'consistent and valid information' (Jonassen and Grabowski 1993p. 367). The five-factor personality model (McCrae and John 1992), another highly influential personality measure instrument, also has extroversion/introversion, and McCrae and Costa (1989) showed high correlation among the measurement results of extraversion/introversion from both inventories.

According to MBTI (Mayer and McCaulley 1985), extroverted individuals tend to relate to the outside world, whereas introverted individuals relate to their own inner thoughts. Extroverts are known to be sociable, interactive, externally oriented, and gregarious. Introverts are more internally oriented, intensive, territorial, enjoy limited relationships, are reflective, and are energy conservative (Mayer and McCaulley 1985). For example, Barkhi (2002) found that during a mixed-motive negotiation tasks, an extroverted person have different perceptions of the trust and frustration than an introverted person.

2.2.3.2. Cognitive Capability - Expertise

An individual's expertise has been one of the most widely used constructs for knowledge worker's cognitive ability in organizational studies. Researchers use expertise to refer to

how efficiently and effectively an individual can solve a problem in a particular domain.

The level of the expertise impacts an individual's information seeking behavior. Sussman and Siegal (2003) found that the expertise of the individual would help to identify the credibility of the information especially when there were very few signals indicating the quality of the knowledge sources. Teigland and Wasko (2000) found that expertise significantly predicted creativity and performance. They also found that a measure of group tenure (experience as part of an electronic community) predicts the degree to which individuals used that community to acquire knowledge.

2.2.3.3. Social characteristics - Reciprocation wariness

Recent research suggests that people differ in their beliefs concerning the morality and utility of compensating help (Cotterell et al. 1992). Greenberg and Westcott (1983) proposed that some individuals, termed *creditors*, believe in obligating others by returning greater help than they have received. A corresponding factor, *reciprocation wariness*, represents a general fear of exploitation in interpersonal relationships (Eisenberger et al. 1987). Reciprocation wariness expresses disinclinations to accept aid, return aid, or contribute a great deal to social relationships (Cotterell et al. 1992). Lynch et al. (1999) used a slightly different term "reciprocity wariness," and defined it as a generalized cautiousness in reciprocating aid stemming from a fear of exploitation in interpersonal relationships.

Individuals who are reciprocation wary fear being exploited in an exchange relationship may have different behavior in social exchange than individuals who are not reciprocation wary. Early studies of Eisenberger et al. (1987) and Cotterell et al. (1992) showed that individuals do have differences in generalized fear of exploitation, and it influences the exchange of resources in interpersonal relationships. Gallucci and Perugini (2003) showed that participants with high reciprocity wariness (high motivation to reciprocate, as in the study) have different information seeking behavior than participant with low reciprocity wariness.

2.3. Chapter Summary

Based on the literature, we have identified three groups of characteristics, including task, knowledge, and individual characteristics that would affect knowledge workers' sourcing preference. Within each group, we have identified two to three characteristics that we believe most likely to cause channel preference. The task characteristics include routineness, interdependence, and time urgency. The knowledge characteristics include codifiability and volatility. The individual characteristics include extraversion, expertise, and reciprocation wariness. In the next section, we develop hypotheses on how channel preferences are affected by each identified characteristic.

CHAPTER 3: CONCEPTUAL MODEL AND HYPOTHESES

DEVELOPMENT

The characteristics of tasks, knowledge and individuals affect channel preference as illustrated in Figure 1. The following sections develop hypotheses for each characteristic.

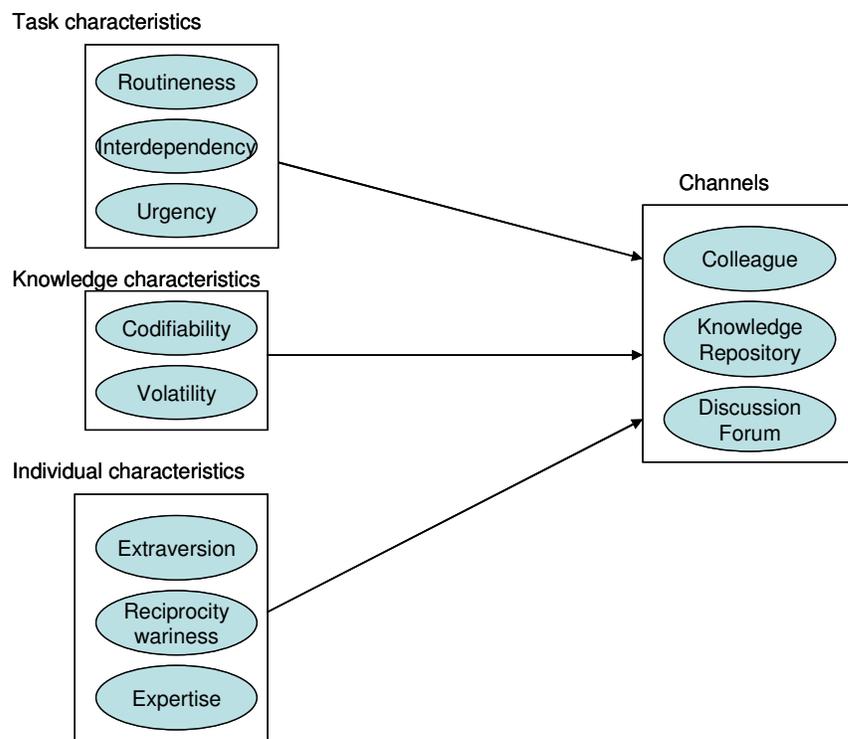


Figure 1. Knowledge Sourcing Model

3.1. Influences of Task Characteristics

3.1.1. Task Routineness

Task routineness has been conceptualized or described in different ways in previous literature. For example, Wettinger and Grover (1997) used “task predictability” to describe routineness. Lawrence and Lorsh (1967) conceptualized routineness as a function of the rate of change of an organization’s environment. We adopt Gray and Meister’s (2004) definition, that routineness is the extent to which a body of work involves repetitive processes that remain stable over time. With this definition, we focus on the procedures or the steps involved in completing a task. We thus exclude the specific knowledge that is required to carry on each step of the task, which we referred to as “knowledge volatility.” The influence of knowledge volatility will be discussed in the knowledge characteristics.

It is common that organizations document a set of routines and policies into knowledge repositories for employees to retrieve (Hansen et al. 1999; Zack 1999b). By doing so, the objective is to maintain organizational memory (Huber 1991), as well as to facilitate knowledge reuse (Markus 2001). On the other hand, when the task is nonroutine, organizations are less motivated to document for the “economic of use” (Kankanhalli et al. 2003) and have fewer resources (e.g., knowledge workers familiar with the processes) to do the documentation. Therefore, knowledge workers would expect to find relevant knowledge in the knowledge repository when their tasks are routine.

Discussion forums are used for spatially separated communities of practice to exchange work related experience (Wenger and Snyder 2000). They are used especially for emerging topics that the knowledge workers can not solve by themselves, and a certain level of professionalism implies that it is a courtesy to not ask easy questions (Yates et al. 1999). Colleagues might be an alternative source to repositories, since they are familiar with the routine and are easy to access. However, Dewhirst (1971) suggested that there is a psychological cost in selecting colleagues as knowledge sources. He argued that when the information seeker asked an accessible colleague for knowledge, he or she implicitly made a partial admission of limited technical competence. Therefore, if the knowledge is easily assessable and easy to understand, it would be unlikely that the knowledge worker would choose to turn to colleagues because of the psychological cost associated with being seen as less knowledgeable.

As discussed in the literature review, task complexity is associated with task routineness, and empirical evidence related to task complexity may be relevant here. Bystrom (2002) found that as the complexity of knowledge required to perform a task increase, people are more likely to seek knowledge from people rather than from a codification-based knowledge management system. Massey and Montaya-Weiss (2006) found that as complexity increases, the need for contextualizing the knowledge and the need for interactivity increase, so the value of person-to-person knowledge sharing should increase as well. As complexity increases, the number of different sources from which knowledge is needed increases, so that the knowledge seeker is more likely to rely on

people rather than documents. These studies add to the evidence that when the tasks are non routine, knowledge workers are less likely to turn to knowledge repositories.

Hypothesis 1. The higher the task routineness, the more likely knowledge workers turn to repository than to colleagues and forums.

3.1.2. Task Interdependence

Interdependence is conceptualized as the degree of cooperation or collaboration required to accomplish work (Thompson 1967) or the degree to which individuals are reliant on each other in accomplishing a goal (Campion et al. 1993). When the tasks are highly interdependent, knowledge workers need to coordinate with others, and need to know more about others' work (Leonard and Sensiper 1993).

Knowledge workers who have interdependent tasks involve two aspects that are related to our discussion. First, as interdependence involves transactions and requests across jobs, knowledge workers with highly interdependent tasks are more likely to interact with others than knowledge workers with comparatively low interdependent tasks. Rice et al. (1999) suggested that when an organization embeds high interdependence among knowledge workers, this design enables knowledge workers to know each other's work better, to identify the specific knowledge workers who might have useful information quicker, and to access others' knowledge easier. They found that the employees are more likely to seek information from the one who has high task interference with them rather

than from other colleagues or other information sources. Zipperer (1993) also found that close working relationships with colleagues enable these knowledge workers to know their colleagues better with the advantage of being able to select the best person in a given situation.

Second, when interdependence exists, knowledge workers often use the output from their colleagues as their input, and it is also beneficial to use the colleagues as complementary resources for explanations and interpretations (Hertzum and Pejtersen 2000). Allen (1988) found that the outputs from one knowledge worker are usually in a form that can not be directly used as inputs to other knowledge workers, and that knowledge workers using others' output need some explanation and interpretation of the information contained in the documentation. He concluded that for knowledge workers, it is efficient to ask the author of the input document for an explanation and request extra information than to figure it out by themselves. Zipperer (1993) found similar results. In his study, design engineers who depended on documentation, such as a requirement analysis from colleagues, showed strong preference for getting information from their colleagues.

On the other hand, using knowledge repositories and discussion forums requires the knowledge worker to ask the right questions or use the right queries. However, when there is high interdependence with other workers, the knowledge worker may not have adequate knowledge to ask the right questions. The knowledge worker might need background information not only in the knowledge worker's own area, but also in the

area of his coworkers. At the same time, even if the knowledge worker forms well-framed questions or queries, he might get a lot of information or documents while using knowledge repositories since there could be many documents relevant to the task with high interdependence. This would intensify the information overloading problem in using repositories and forums (Butler et al. 2004; Jones 1995). The problems decrease the likelihood for knowledge workers with highly interdependent tasks to use repositories or forums.

Research on the organizational unit level also supports the positive relationship between task interdependence among units and communication frequency among units. Thompson (1967) argued that highly interdependent business units require higher levels of coordination through information exchange, and a variety of authors have argued that a greater need for coordination (via communication) arises when units have highly interdependent tasks (Kettinger and Grover 1997; Zander and Kogut 1995).

Hypothesis 2. The higher the task interdependence, the more likely knowledge workers turn to colleagues than to repositories and forums.

3.1.3. Task Urgency/Time Pressure

The urgency of the task or time pressure of the task is also an important task characteristic. For example, in the service-providing scenario, serving customers in a timely manner is critical. A good example could be the tasks of a help-desk analyst

(Davenport and Klahr 1998). Steinfield and Fulk (1996) found that geographic distance and time pressure have a strong influence on managers' media choices.

While the communication literature shows that the more urgent the task, the less likely a knowledge worker will choose an asynchronous medium for communication (Picot et al. 1982; Steinfield 1986; Straub and Karahanna 1998), there is less evidence to infer how task urgency affects knowledge seeking behavior, which involves intense information processing. Gray and Durcikova (2006) postulated that analysts' perceptions of time pressure is negatively related to their use of knowledge repositories, while having no significant effect on the use of colleagues or documents. Based on the fact that analysts who feel they are under more time pressure sourced less knowledge via the repository in their study, Gray and Durcikova suggested that the process of finding and accessing knowledge in repositories remains too time-consuming.

We argue that under high time pressure or dealing with urgent tasks, knowledge workers would prefer to source knowledge from colleagues than repositories or forums. There are a few theories, including the theory of planned behavior (Fishbein and Ajzen 1975), theory of reasoned action (Ajzen 1985; Ajzen 1991), and the decomposed theory of planned behavior (Taylor and Todd 1995), that predict the use of a specific resource under certain circumstances. The resources include the time and opportunities to access the technology. According to these theories, the availability of resources facilitates the decision to use a technology. Studies have shown that the lack of "slack" time can inhibit

usage of a knowledge management system (Goodman and Darr 1998; Orlikowski 1993). It is also suggested that under time pressure, knowledge workers usually need to sacrifice quality for timeliness (Das 2003). Without consideration of quality, colleagues are generally considered the most preferred knowledge source (Allen 1977). The questions in the discussion forums are often solved after a couple of hours or even days, since the participants in the discussion forums have different schedules.

Hypothesis 3. The higher the task urgency, the more likely knowledge workers turn to colleagues than to repositories and forums.

3.2. Influences of Knowledge Characteristics

3.2.1. Knowledge Codifiability

Knowledge codifiability refers to how easily the knowledge can be coded into written documents. Studies on the characteristics of knowledge have long acknowledged the tacit dimension of knowledge in addition to the explicit dimension, and the tacit dimension determines how easily the knowledge can be codified into documents (Polanyi 1966). If the knowledge is of low codifiability, it is a difficult task for both knowledge contributors and knowledge seekers to communicate through written forms.

While explicit knowledge can be expressed in numbers and words and shared formally and systematically in the form of data, specifications and manuals, tacit knowledge is difficult to express and formalize (Argote et al. 2003; Desouza and Evaristo 2003). There

is a wide range of tacit knowledge, such as insights, intuitions, and hunches of a knowledge worker. Tacit knowledge is accumulated through dynamic, unstructured and often subtle processes, and is not easily to be codified into written form or captured by information systems (Markus 2001). When the knowledge is difficult to be codified into written forms, knowledge seekers need to acquire it through other forms, such as observation and conversation.

Face-to-face communication with colleagues is the effective way of acquiring tacit knowledge. In his seminal paper on knowledge transfer, Nonaka (1994) identified four possible modes in which knowledge is shared through the interaction between tacit and explicit knowledge. The mode of sharing tacit knowledge between individuals is called “socialization.” Socialization is often conducted through verbal communication and other joint activities rather than written instructions. Also, the master of tacit knowledge is realized when knowledge workers put that knowledge into practice, during which process the help from more experienced knowledge workers is often involved (Szulanski 1996). The communication with the more experienced knowledge workers is usually frequent, intensive, and timely, and usually requires rich media such as face-to-face communication (Becerra-Fernandez and Sabherwal 2001). Additionally, face-to-face communications cultivate an environment supporting interactive reasoning, clarification or elaboration, and thus benefit the transfer of complex knowledge, including tacit knowledge.

Both knowledge repositories and discussion forums by nature cannot capture knowledge with low codifiability. Even if a knowledge repository stores a piece of relevant information, it can only capture a very limited portion of the knowledge. Discussion forums do support interactions between knowledge contributors and knowledge seekers to some extent. However, according to media richness theory (Daft and Lengel 1986; Daft et al. 1987), forums are characterized by low media richness, and have low ability to provide immediate feedback and the multiple cues necessary for multiplexed communication (Hansen and Haas 2001).

Hypothesis 4: the higher the knowledge codifiability, the more likely knowledge workers turn to repositories and forums than to colleagues.

3.2.2. Knowledge Volatility

In Webster, one of the meanings of volatility is “characterized by or subject to rapid or unexpected change.” Holsapple and Joshi (2001) used “knowledge volatility” to refer to the extent to which knowledge is subject to change. This characteristic concerns the temporary value of the knowledge. While the researchers in knowledge management have not used “knowledge volatility” frequently, “volatility” has been an important dimension of economic and business environment (Kankanhalli et al. 2003), reflecting the rapidity of change in the business environment. The volatility dimension of knowledge reflects the rapidity of change in knowledge and thus the extent to which knowledge can be economically reused.

When knowledge has low volatility, it is more likely to be put into knowledge repositories and to be reused over time. The reuse of knowledge saves work and reduces communication costs among colleagues. Hansen et al. (1999) categorized organizational knowledge approaches into codification strategy and personalization strategy. Companies that follow a codification strategy rely on the “economics of reuse” (Hansen et al. 1999; Kankanhalli et al. 2003). Once a knowledge asset – software code or a manual, for example – is developed and paid for, it can be used many times over at very low cost, provided it does not have to be substantially modified each time it is used.

By contrast, for knowledge with high volatility, organizations use a personalization strategy. A personalization strategy relies on the logic of “expert economics.” For example, at Microsoft, where the software life cycle is short, an up-to-date expert directory is used to rapidly provide software development teams with people who have the desired expertise (Clayton and Foster 2000). Hansen et al. (1999) found consulting firms utilizing these two strategies based on the business nature of their customers. For example, Anderson consulting and Ernst & Young rely more on a codification strategy because they are dealing with similar problems over and over, while Bain, Boston Consulting, and McKinsey & Co. rely more on a personalization strategy since the solutions they provide are sensitive to the changing business environment.

Discussion forums as a comparatively newly evolved knowledge channel have their own advantages at communicating or transferring knowledge with high volatility. When a

specific knowledge is highly volatile, a current expert of that knowledge at a time may not be an expert at a later time. Thus, the chance of meeting or personally knowing an expert of this knowledge decreases. Discussion forums reach to large audiences through both synchronized and unsynchronized communication. We expect knowledge seekers to turn to discussion forums in addition to colleagues for highly volatile knowledge.

Hypothesis 5. The higher the knowledge volatility, the more likely the knowledge workers turn to colleagues and forums than to repositories.

3.3. Influences of Individual Characteristics

3.3.1. Cognitive Style - Extraversion / Introversion

Cognitive style is a person's preferred way of gathering, processing, and evaluating information. It influences how people scan their environment for information, how they organize and interpret this information, and how they integrate their interpretation into the mental model and subjective theories that guide their actions (Messick 1984). The theoretical work in this field originally developed by Jung (1923; 1971) has been used to construct a reliable way to classify individuals in the Myers-Briggs Type Indicator (MBTI) (Myers et al. 1985). The cognitive style is a broad term and has a lot of components, what we study here is introversion vs. extroversion.

According to MBTI (Mayer and McCaulley 1985), extroverted individuals tend to relate to the outside world, whereas introverted individuals relate to their own inner thoughts.

Extroverts are known to be sociable, interactive, externally oriented, and gregarious.

Introverts are more internally oriented, intensive, territorial, enjoy limited relationships, are reflective, and are energy conservative (Mayer and McCaulley 1985). This dimension affects channel preference since different channels represent different opportunities for interaction with the outside world or inner thoughts.

Seeking knowledge from colleagues is a socialization process as well as an information processing process. Through the process, the knowledge worker not only satisfies his knowledge requirements, but also the socialization requirements. As described in Eysenck and Eysenck (1975), “The typical extravert is sociable, likes parties, has many friends, needs to have people to talk to, and does not like reading or studying by himself. ...The typical introvert is a quiet, retiring sort of person, introspective, fond of books rather than people...” Previous studies in the communication literature have found significant effect of extrovert style on media choice (Barkhi 2002; Daly 1986). For example, Barkhi (2002) found that during a mixed-motive negotiation tasks, an extroverted person had a different perception of the trust and frustration than an introverted person.

On the contrary, knowledge repositories do not support effective socialization.

Repositories are passive objects and do not respond to knowledge seekers. Discussion forums support interaction through the form of questions and answers. Discussion forums also have some characteristics of socialization, such as acknowledgement and use of

humor (Jones 1995; Yates et al. 1999). However, compared to direct communication between knowledge workers, discussion forums provide limited capability to carry on social interaction (Diker 2003).

Hypothesis 6. The more extroverted the knowledge worker, the more likely knowledge workers turn to colleagues than to repositories and forums.

3.3.2. Cognitive Ability: Expertise

Expertise refers to how efficiently and effectively that the individual can solve the problem in a particular domain. Many previous studies have considered expertise either as an important predictor (Sussman and Siegal 2003) or as a control variable (Gray and Meister 2004). Studies have found a significant relationship between expertise and knowledge seeking behavior.

Research shows that organizations may have legitimate programs or processes to facilitate knowledge workers with low expertise to directly seek knowledge from knowledge workers with high expertise. Becerra-Fernandez and Sabherwal (2001) found knowledge workers with low expertise often had access to and preferred seeking help from more experienced colleagues or an organization-assigned mentor. They also found that each younger engineer had a mentor who would transfer knowledge to the younger engineer. In their interview, a new-timer trying to learn a position said, “You find this out just by talking to people because, obviously, I haven’t been in this job long enough to

know the history of this position. Nobody writes these kinds of things down” (Becerra-Fernandez and Sabherwal 2001). Markus (2001) also found similar results in her interviews with new employers that the answers to a wide range of questions were often not included in the documentation but were communicated through face-to-face conversation. Some of questions were “why a procedure is required” (p. 70) and “why a certain process has to be reused as-is and not changed and how it fits within the larger organizational processes” (p. 81).

On the contrary, knowledge workers may encounter psychological costs (Dewhirst 1971) and do not gain much in knowledge (Saunders and Jones 1990) from colleagues. Dewhirst (1971) suggested that there is a psychological cost when knowledge workers ask an accessible colleague for information: they are implicitly making a partial admission of limited technical competence. He argued that this cost is more significant when the subjects are assumed to have high expertise. In addition, a saturation effect may occur if the knowledge worker already has high expertise in the subject, and acquiring information from a colleague with similar experience and environment may appear obviously unfruitful (Saunders and Jones 1990). Saunders and Jones (1990) found that over time, external and less accessible sources might be reached via telephone and other media requiring more efforts.

Sourcing knowledge from a repository requires that knowledge workers know the directory in the organization, and sourcing knowledge from a forum requires that

knowledge workers know the right question to ask. Empirical studies have found that searching without adequate knowledge is time consuming. For instance, one virtual team committed to using a sophisticated knowledge management system found that they could easily spend 10 minutes out of a 45-minute team meeting searching a 1,000-entry knowledge base for the information they needed (Malhotra et al. 2000).

It has often been noted that one characteristic separating experts from novices is that experts know what questions to ask (Markus 2001). Sussman and Siegal (2003) found that expertise of the individual help to identify the credibility of the information especially when there are very few signals indicating the quality of the knowledge sources.

Hypothesis 7. The higher the expertise, the more likely knowledge workers turn to forums and repositories than to colleagues.

3.3.3. Social Characteristic - Reciprocation Wariness

Recent research suggests that people differ in their beliefs concerning the morality and utility of compensating help (Cotterell et al. 1992), and use reciprocation wariness to represent a general fear of exploitation in interpersonal relationships (Eisenberger et al. 1987). Reciprocation wariness expresses disinclination to accept aid, return aid, or contribute a great deal to social relationships (Cotterell et al. 1992). Lynch et al. (1999) used a lightly different term “reciprocity wariness”.

Individuals who are reciprocation wary fear being exploited in an exchange relationship and may have different behavior in social exchanges than individuals who are not reciprocation wary. Early research from Eisenberger et al. (1987) and Cotterell et al. (1992) has shown that individuals do have differences in generalized fear of exploitation, and it influences the exchange of resources in interpersonal relationships. Gallucci and Perugini (2003) showed that participants with high reciprocity wariness (called high motivation to reciprocate as in this study) have different information seeking behavior than participants with low reciprocity wariness.

Eisenberger et al. (1987) and Cotterell et al. (1992) have shown that reciprocation wariness influences the exchange of resources in interpersonal relationships. Flynn (2005) posited that people who seek knowledge directly from others are committing themselves via the norm of reciprocity to help that person at some point in the future. The evidence indicates that if a knowledge worker is wary of reciprocation, he or she might try to avoid direct one-to-one contact.

On the contrary, knowledge workers have no obligation to return the favor to a specific person if they use the knowledge from a repository, since repositories are used as a communal source of knowledge built by the organization for the knowledge workers to reuse (Holsapple and Joshi 2001; von Krogh 2002). Also, knowledge workers feel less obligated to return the favor when sourcing knowledge from forums for the following two reasons. First, the form of social exchange causes knowledge seekers to be less

obligated than in individual exchange. When there are more than two people participating, the exchange is called a social exchange (Fulk et al. 1996). In contrast to individual exchange, social exchange does not have a pair of specific senders and receivers, thus people benefiting from forums feel less obligated to return the favor. Second, knowledge workers may not feel obligated to return the favor since the identity is not necessarily exposed.

Hypothesis 8. The higher the reciprocation awareness, the more likely knowledge workers turn to repositories and to forums than colleagues.

3.4. Chapter Summary

In this chapter, we have developed hypotheses on how the identified eight characteristics affect knowledge workers' knowledge sourcing channel preferences. The eight hypotheses are summarized in Table 1.

Characteristics	Hypotheses
Tasks	
Routineness (H1)	The higher the task routineness, the more likely knowledge workers turn to repositories than to colleagues and forums
Interdependence (H2)	The higher the task interdependence, the more likely knowledge workers turn to colleagues than to repositories and forums.
Urgency (H3)	The higher the task urgency, the more likely knowledge workers turn to colleagues than to repositories and forums.
Knowledge	
Codifiability (H4)	The higher the knowledge codifiability, the more likely knowledge workers turn to repositories than to colleagues and forums.
Volatility (H5)	The higher the knowledge volatility, the more likely the knowledge workers turn to colleagues and forums than to repositories.
Individual	
Extraversion (H6)	The more extroverted the knowledge worker, the more likely knowledge workers turn to colleagues than to repositories and forums.
Expertise (H7)	The higher the expertise, the more likely knowledge workers turn to forums and repositories than to colleagues.
Reciprocation awareness (H8)	The higher the reciprocation awareness, the more likely knowledge workers turn to repositories and forums than to colleagues.

Table 1. Research hypotheses summary

CHAPTER 4: RESEARCH METHODOLOGY AND DATA COLLECTION

This chapter operationalizes the constructs identified in the research model and describes the research methodology. A survey methodology is used to gather quantitative data to test the hypotheses.

Survey research involves examination of a phenomenon in a wide variety of natural settings. Survey research is preferred to other research methods, such as case study and laboratory experiment, when the researcher has very clearly defined independent and dependent variables and a specific model of the expected relationships that are tested against observations of the phenomenon (Pinsonneault and Kraemer 1993).

According to Pinsonneault and Kraemer (1993), survey research is most appropriate when the following conditions apply:

- a. The research is to answer questions about what, how much, and how many, and to a greater extent than is commonly understood, questions about how and why.
- b. Control of the independent and dependent variables is not possible or not desirable.
- c. The phenomena of interest must be studied in their natural setting.
- d. The phenomena of interest occur in current time or the recent past.

The features of this study fit the conditions specified above. The central questions of this study are about which channels knowledge workers prefer and to what extent these three sets of characteristics affect channel preference. Knowledge sourcing activities happen in the daily life of knowledge workers, and it is not possible to control the independent variables (task characteristics, knowledge characteristics, and individual characteristics), or the dependent variable (the use of various channels). Without the natural setting of organizational knowledge sourcing behavior, the research loses its value. The types of channels in this study are representative channels used in current organizational knowledge management practice.

A web-based survey was used to deliver the instrument to participants. The online survey delivery is appropriate because the subjects targeted by this study are knowledge workers who use both knowledge repositories and online discussion forums, and therefore are skilled in working with web-based systems. Thus, the possibility of introducing a non-response bias because of the online survey delivery is reduced.

The first four sections in this chapter develop the measurement for the constructs. Most constructs are adapted from previous literature, except for knowledge volatility. The items are measured by a 7-point scale ranging from “strongly agree” to “strongly disagree” unless they are specified otherwise. The last section describes the survey procedure, including the characteristics of the research site.

4.1. Task Characteristics

4.1.1. Task Routineness

A considerable body of research has employed measures of routineness. The early conceptual development can be traced to Lawrence and Lorsch (1967) and Perrow (1967; 1970). Perrow proposed that two dimensions of organizational technology (broadly conceptualized as the efforts required to transform inputs into outputs), analyzability and exceptions, would form a dimension of work routineness/non-routineness. Lawrence and Lorsch emphasized that the rate of change of an organization's external environment predicts the degree of routineness of work.

Key operationalizations of the construct were developed by Withey et al. (1983), Steinfield (1986), and Goodhue and Thompson (1995). To measure Perrow's two dimensions, Withey et al. (1983) summarized six instruments developed by Lynch (1974), Van de Ven and Delbecq (1974), Simons et al. (1976), Glisson (1978), Van de Ven and Ferry (1980), and Daft and Macintosh (1981). Withey et al. found an inter-scale correlation of 0.79 between refined scales for analyzability and exceptions, and finalized a four-item instrument. Steinfield (1986) tested a five-item scale that was split into two subscales in a factor analysis, labeled "standardization" and "routines." However, he did not point out any conceptual differences between the two labels, and we consider both measures for routineness. Goodhue and Thompson (1995) used a three-item scale.

Kettinger and Grover (1997) and Gray and Meister (2004) adapted the scale from previous studies. The items are presented in Table 2.

Study	Definition	Measurement	Alpha
Withey et al. (1983) <i>Number of Exceptions</i> Adapted from (Daft and Macintosh 1981; Glisson 1978; Lynch 1974; Simons et al. 1976; Van de Ven and Delbecq 1974; Van de Ven and Ferry 1980)	The frequency of unexpected and novel events that occur in the conversion process	<ol style="list-style-type: none"> 1. How many of these tasks are the same from day-to-day 2. To what extent would you say your work is routine 3. People in this unit do about the same job in the same way most of the time 4. Basically, unit members perform repetitive activities in doing their jobs. 	0.81
Steinfield (1986) <i>routineness</i>		<ol style="list-style-type: none"> 1. My job involves routine repetitive tasks. 2. My job involves finding novel solutions to problems. 	0.52
Steinfield (1986) <i>standardization</i>		<ol style="list-style-type: none"> 1. My job involves well-defined subject matter. 2. My job involves tasks with clearly defined outcomes. 3. My job is governed by standard operating procedures. 	0.67
Goodhue and Thompson (1995) <i>Non-routineness</i>	The degree to which the job is ill-defined, non-routine, and novel	<ol style="list-style-type: none"> 1. I frequently deal with ill-defined business problems. 2. I frequently deal with ad-hoc, non-routine business problems. 3. Frequently the business problems I work on involve asking questions that have never been asked in quite that form before. 	0.73
Kettinger and Grover (1997) <i>Task predictability</i> Adapt from Withey et al. (1983)		<ol style="list-style-type: none"> 1. How often are your tasks the same from day to day? 2. How often would you say your work is routine? 3. How often do you perform repetitive activities in doing your job? 	0.75

Gray and Meister (2004) <i>Routineness</i> Adapted from (Steinfeld 1986) (Goodhue and Thompson 1995) (Kettinger and Grover 1997)	The extent to which a body of work involves repetitive processes that remain stable over time	1. My work is routine and repetitive. 2. I usually do my work in the same way, without a lot of variation.	0.84
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Table 2. Scales measuring task routineness from previous studies

We adopt Gray and Meister’s (2004) definition for task routineness in our study. Their work defined routineness in a more general way, from a process-oriented view. Since we specifically emphasize the task or process perspective and leave the knowledge perspective to knowledge volatility in our study, Gray and Meister’s definition fits our purpose well.

Task routineness is the extent to which a body of work involves repetitive processes that remain stable over time.

Construct	Proposed Items
Task routineness	1. My work is routine and repetitive. 2. I usually do my work in the same way, without a lot of variation. 3. My job involves finding novel solutions to problems. 4. I frequently deal with ill-defined business problems. 5. Frequently the business problems I work on involve asking questions that have never been asked in quite that form before.

Table 3. Proposed items for task routineness

Gray and Meister measure task routineness using two items, with one emphasizing “repetitive” and the other emphasizing “stable over time.” In order to examine the reliability and explore the psychometric prospectively, we add several additional items from other studies. First, the properties of the problem encountered, including the way the problem is presented, are also indicative of routineness. Thus, we add the second item of

routineness from Steinfield's (1986) study, and the second item from Goodhue and Thompson's (1995) study to our proposed items. In addition, the novelty of the solution also implying the routineness of the work, and we add the third item from Goodhue and Thompson's (1995) study. The proposed items are listed in Table 3.

4.1.2. Task Interdependency

Pioneering research on task interdependence was advanced by Thompson (1967), who examined the flow of work between organizational units and the type of coordination that would best address such task interdependencies. Based on Thompson's work, Steinfield (1986) developed a four-item scale to measure interdependency. This scale has been adapted in the studies conducted by Kettinger and Grover (1997) and Gray and Meister (2004). Goodhue and Thompson (1995) developed a two-item scale. The scales are presented in Table 4.

Study	Definition	Measurement	Alpha
Steinfield (1986) <i>interdependency</i>	The extent, to which tasks were completed independently, fed into another person's or work group's work, or were completed in a team approach.	<ol style="list-style-type: none"> 1. In my group, the products of my work are independent of other's work. 2. In my group, the products of my work feed into someone else's work. 3. In my group, the products of my work require input from someone else's work. 4. In my group, the products of my work are completed with others in a team approach. 	0.73
Goodhue and Thompson (1995) <i>Interdependency</i>		<ol style="list-style-type: none"> 1. The business problems I deal with frequently involve more than one business function. 2. The problems I deal with 	0.76

		frequently involve more than one business function.	
Kettinger and Grover (1997) <i>Interdependency</i> Adapted from Steinfield (1986)		<ol style="list-style-type: none"> 1. How often do the products of your job require input from someone else's work? 2. How often do the products of your job feed someone else's work? 3. How often are the products of your job independent of another's work? 4. How often are the products of your job completed with others as a team? 	0.70
Gray and Meister (2004) <i>Interdependency</i> Adapted from (Steinfield 1986) (Goodhue and Thompson 1995) (Kettinger and Grover 1997)	The extent to which the work carried out by an individual requires interaction with others for successful completion	<ol style="list-style-type: none"> 1. My work requires constant coordination of what I do with other employee's efforts. 2. What I produce at work is part of a team effort. 	0.82

Table 4. Proposed scales for measuring task interdependency from previous studies

Since we specifically emphasize the task or process perspective and leave the knowledge perspective to knowledge volatility, we adopt Gray and Meister's (2004) definition for task interdependence as we adopt their definition for task routineness.

Task interdependence refers to the extent to which tasks were completed independently, fed into another person's or work group's work, or were completed in a team approach.

We have the same problem as for the task routineness -- Gray and Meister's (2004) study only has two items for measuring task interdependency. However, the definition from

Steinfield (1986) of task interdependency is very similar to the definition we adopt. The scales Steinfield developed for his study also exhibit high reliability and served as the basis for many later studies. However, we do not emphasize a group scenario as in his study, and thus the words “in my group” are removed from our items. The proposed items are listed in Table 5.

Construct	Proposed Items
Task routineness	<ol style="list-style-type: none"> 1. The products of my work are independent of other’s work. 2. The products of my work feed into someone else’s work. 3. The products of my work require input from someone else’s work. 4. The products of my work are completed with others in a team approach.

Table 5. Proposed items for task interdependency

4.1.3. Task Urgency/Time Pressure

Time urgency or time pressure is the perception of time demands with respect to task completion and performance standards (Koys and DeCotiis 1991). Steinfield (1986) developed a five-item scale to measure crises and time pressures. Koys and DeCotiis (1991) developed a five-item scale and Gray and Durcikova (2006) adapted this scale. Both reported acceptable reliability in their studies. The scales are presented in Table 6.

Since Koys and DeCotiis’s (1991) study was specifically focused on the measure of time pressure, we adopt their definition.

Time pressure refers to the perception of time demands with respect to task completion and performance standards

Study	Definition	Measurement	Alpha
Steinfeld (1986) Crises and time pressures		<ol style="list-style-type: none"> 1. Crises/urgent matters 2. Time pressures 3. Unexpected problems/situations 4. Rules, policies, and regulations 5. Working with people I'm not acquainted with 	0.73
Koys and DeCotiis (1991) Pressure	The perception of time demands with respect to task completion and performance standards.	<ol style="list-style-type: none"> 1. I have too much work and too little time to do it. 2. I find this organization a relaxed place to work. (rc) 3. I often have to deal with work related problems in my off hours. 4. I feel like I never have a day off. 5. Many employees at my level get "burned out" by the demands of their jobs in this organization 	0.81
Gray and Durcikova (2006) Time pressure Adapted from Koys and DeCotiis (1991)	The frequency and pace of the tasks	Dropped the 3rd item from Koys and DeCotiis	0.76

Table 6. Scales for measuring time pressure from previous studies

Although Koys and DeCotiis (1991) reported a high alpha value, Gray and Durcikova's (2006) study reported a poor fit of the third item from Koys and DeCotiis's (1991) scale. This implies that time pressure in the working place is not necessarily carried over to

employees' personal off-job time. Following Gray and Durcikova, we drop the third item of Koys and DeCotiis' scale in our study. The proposed items are listed in Table 7.

Construct	Proposed Items
Task time pressure	<ol style="list-style-type: none"> 1. I have too much work and too little time to do with it. 2. I find this organization relaxed place to work. (rc) 3. I feel like I never have a day off. 4. Many employees at my level get "burned out" by the demands of their jobs in this organization

Table 7. Proposed items for task time pressure

4. 2. Knowledge Characteristics

4.2.1. Knowledge Codifiability

The conceptual work in knowledge codifiability can be traced back to Polanyi (1966) who acknowledged the tacit dimension of knowledge in addition to the explicit dimension. Winter (1987) proposed "tacit/articulable" as one dimension of organizational knowledge. Zander and Kogut (1995) used the term codifiability to refer to the extent to which the knowledge could be articulated in documents and software, and operationalized it with a four-item scale.

Compared to Zander and Kogut (1995) who emphasized perceived codifiability, Hansen (1999) emphasized the existence of codified knowledge and developed a three-item scale to measure it. Brown et al. (2006) adapted Zander and Kogut's measurement. In Zander and Kogut's study, perceived codifiability was measured against whether or not the

Study	Definition	Measurement	Alpha
Zander and Kogut (1995) Perceived codifiability	The extent to which the knowledge could be articulated in documents and software	<ol style="list-style-type: none"> 1. A useful manual describing our manufacturing process can be written. 2. Large parts of our manufacturing control are embodied in standard type software that we modified for our needs. 3. Large parts of our manufacturing control are embodied in software developed within our company exclusively for our use. 4. Extensive documentation describing critical parts of the manufacturing process exists in our company. 	0.678
Hansen (1999) Noncodified Knowledge	The extent to which the knowledge transferred from the source division to receiving project team was not fully documented	<ol style="list-style-type: none"> 1. How well documented was the knowledge that your team leveraged from this division? Consider all the knowledge [0=it was very well documented, 3=it was somewhat well-documented, 6=it was not well documented] 2. Was all this knowledge sufficiently explained to your team in writing (in code comments, written reports, manuals, e-mails, faxes, etc.)? [0=all of it was, 3=half of it was, 6=none of it was] 3. What type of knowledge came from this division? [0=mainly reports, manuals, documentations, self-explanatory software, etc. 3=half know-how and half reports/documents, 6=mainly personal practical knowl-how, tricks of the trade.] 	0.81
Brown et al.(2006) Availability of codified knowledge Adapted from Zander and Kogut (1995)	Not only whether knowledge for a given task can be codified, but also whether it has been codified	<ol style="list-style-type: none"> 1. Large parts of the documentation for this task are embodied in the shared drive. 2. Extensive documentation describing critical parts of the process for completing this task exists within the Prevention Division. 3. Extensive documentation describing critical parts of the process for completing this task exists in the WCB. 	.82

Table 8. Scales for measuring time pressure from previous studies

knowledge “could be codified”. Brown et al.’s study considered whether or not the knowledge “has been codified” in addition to whether or not the knowledge “could be codified”. The scales are presented in the Table 8.

The perception of whether the knowledge “could be codified” and the perception of whether the knowledge “has been codified” are equally important, thus we adopt the definition from Brown et al. (2006).

Knowledge codifiability refers to not only whether knowledge for a given task can be codified, but whether it has been codified.

Brown et al. (2006) also reported a high alpha value, and we adapt their scales in our study. The proposed items are listed in Table 9.

Construct	Proposed Items
Knowledge codifiability	<ol style="list-style-type: none"> 1. Large parts of the documentation for this task are embodied in the [system name]. 2. Extensive documentation describing critical parts of the process for completing this task exists within the [organization name]. 3. Extensive documentation describing critical parts of the process for completing this task exists in [organization name].

Table 9. Proposed items for knowledge codifiability

4.2.2. Knowledge Volatility

Holsapple and Joshi (2001) used “knowledge volatility” to refer to the extent to which knowledge is subject to change. Since there is no measure in the literature for knowledge

volatility, we examined the literature on data volatility. Data volatility was found to be used to calculate data timeliness, but itself was not measured.

In the data quality studies, a general metric to measure data timeliness has been proposed by Ballou et al. (1998). They suggested that timeliness of data is governed by two factors, currency and volatility. In their metric, *currency* refers to the age of the data, and *volatility* refers to how long the item remains valid. An exponent can be used as a *sensitivity factor*, with the max value raised to this exponent. For example, suppose the timeliness rating without using the sensitivity factor (equivalent to a sensitivity factor of 1) is 0.81. Using a sensitivity factor of 2 would then yield a timeliness rating of 0.64 (higher sensitivity factor reflects fact that the data becomes less timely faster) and 0.9 when sensitivity factor is 0.5 (lower sensitivity factor reflects the fact that the data loses timeliness at a lower rate).

We adopt Holsapple and Joshi's (2001) definition of knowledge volatility. Based on their definition, we develop a set of items, listed in Table 10.

Knowledge volatility refers to the extent to which knowledge is subject to change.

Construct	Proposed Items
knowledge volatility	1. The knowledge required to perform my task will soon be out of date. 2. The knowledge required to perform my task change quickly. 3. The knowledge I am using to perform my task now will remain valid for a long time. (rc)

Table 10. Proposed items for knowledge volatility

4.3. Individual Characteristics

4.3.1. Extraversion/Introversion

Extraversion/introversion is measured both in MBTI (Mayer and McCaulley 1985) and the five-factor personality model (McCrae and John 1992). Both measures are not freely available. However, Goldberg and his peers created the International Personality Item Pool (IPIP) for the free use by researchers. Goldberg (2006) suggested that placing a set of personality items in the public domain might free researchers from the constraints imposed by copyrighted personality inventories. Now researchers can rapidly and easily access the items from the IPIP Web site at <http://ipip.ori.org/>, and use the items in their research for free. Scales from IPIP have been used in many academic studies (Goldberg et al. 2006). The scale for extraversion and introversion is presented in Table 11.

Study	Definition	Measurement	Alpha
Goldberg et al. (2006)	A personality trait characterized by a tendency to be more concerned with the outside world and social relationships than with one's inner thoughts and feelings.	I. am the life of the party. II. feel comfortable around people. III. start conversations. IV. talk to a lot of different people at parties. V. don't mind being the center of attention. Reversely coded I. don't talk a lot. II. keep in the background. III. Have little to say. IV. Don't like to draw attention to myself. V. am quiet around strangers.	0.87

Table 11. Scales for measuring extraversion from IPIP

We adopt the definition given by Goldberg et al. (2006). We discard their reversely coded items to keep balance among the numbers of items used to measure various constructs.

The first item in their measurement is discarded, and the wording of the fourth item is changed to fit into the scenarios in the workplace. The proposed items are listed in Table 12.

Extraversion/introversion is a personality trait characterized by a tendency to be more concerned with the outside world and social relationships than with one's inner thoughts and feelings.

Construct	Proposed Items
Extraversion	<ol style="list-style-type: none"> 1. I feel comfortable around people. 2. I start conversations. 3. I like to talk to a lot of different people at work. 4. I don't mind being the center of attention.

Table 12. Proposed items for extraversion

4.3.2. Reciprocation wariness

Reciprocation wariness is a construct that measures an individual's fear of being exploited in an exchange relationship (Lynch et al. 1999). Eisenberger et al.(1987) and Cotterell et al. (1992) developed scales for reciprocation wariness. Eisenberger later reorganized these items (Eisenberger et al. 1998), which were adopted by Lynch (1999).

Study	Definition	Measurement	Alpha
Eisenberger et al.(1998) and Lynch et al.(1999)	A generalized cautiousness in reciprocating aid stemming from a fear of exploitation in interpersonal relationships	<ol style="list-style-type: none"> 1. It generally pays to let others do more for you than you do for them. 2. When I help someone, I often find myself thinking about what is in it for me. 3. The most realistic policy is to take more from others than you give. 4. In the long run, it is better to accept favors than to do favors for others. 5. You should give help only when it benefits you. 6. You should only help someone if that person will help you in the future. 7. How many favors you do for someone should depend on how many favors they do for you. (rc) 8. I feel used when people ask favors of me. 9. You should not bend over backwards to help another person. 10. People who act nicely toward others are often just trying to get something. 	0.80
Gray and Meister (2004) Adapted from Lynch et al.(1999)	The fear being exploited in an exchange relationship	<ol style="list-style-type: none"> 1. People who help others are often just trying to get something in return. 2. In return for doing me a favor, people often ask me for more than they deserve. 	0.84

Table 13. Scales for measuring reciprocation wariness from previous studies

The scale development from Cotterell et al. (1992) and Eisenberger et al. (1987) reported that the wariness items had a unitary factor with high internal reliability ($\alpha = .80$). The 10 items measuring reciprocation wariness involve a fear that others would take advantage of one's help (e.g., "I feel used when people ask favors of me"), a hesitancy to provide help unless asked (e.g., "You shouldn't offer to help someone if they don't ask for your help"), and a fear of the consequences of accepting help (e.g., "Asking for another's help

gives them power over your life”). Gray and Meister (2004) adapted the scale to a 2-item scale in their study. The scales are presented in Table 13.

Both scale listed in Table 13 exhibit adequate reliability. While the 10-item scale has too many items to be included in this study, the 2-item scale is also not adequate. We select three items from the 10-item scale and add them to the 2-item scale. To avoid cognitive overload to survey subjects, we select Item 5 and 6 for the simplicity of the sentence, and item 10 for its strong logic statement. The proposed items are listed in Table 14.

Construct	Proposed Items
knowledge volatility	<ol style="list-style-type: none"> 1. People who help others are often just trying to get something in return. 2. In return for doing me a favor, people often ask me for more than they deserve 3. You should give help only when it benefits you. 4. You should only help someone if that person will help you in the future. 5. People who act nicely toward others are often just trying to get something.

Table 14. Proposed items for reciprocation wariness

4.3.3. Expertise

Expertise refers to how efficiently and effectively an individual can solve a problem in a particular domain. Expertise can be measured through tenure in position or self-efficacy.

Tenure in position refers to the length of time an individual has been in his or her current job. Tenure in position can be measured by tenure in departments, tenure in organizations,

tenure in profession, and education. For example, Teigland and Wasko (2000) and Gray and Meister (2004) used tenure in position/job.

Self-efficacy refers to perceptions about one's capabilities to organize and implement actions necessary to attain designated performance of skills for specific tasks (Bandura and Cervone 1986). Spreitzer (1995) used a 4-item scale to measure self-efficacy, and reported high reliability. The scale is presented in Table 15.

Study	Definition	Measurement	Alpha
Spreitzer (2003)	The extent to which an individual perceives mastering a subject matter	<ol style="list-style-type: none"> 1. I have confidence in my ability to provide knowledge that others in my organization consider valuable. 2. I have the expertise needed to provide valuable knowledge for my organization. 3. It doesn't really make any difference whether I add to the knowledge others are likely to share anyway. 4. Most other employees can provide more valuable knowledge than I can. 	0.80

Table 15. Scales for measuring expertise from previous studies

We adopt the general definition of expertise.

Expertise refers to how efficiently and effectively an individual can solve a problem in a particular domain.

While using tenure in position might overlook individual differences in abilities to improve over a certain time period, self-efficacy measures might be too subjective. Thus we mainly use self-efficacy measure and at the same time ask questions to obtain tenure

in position information to validate the self-efficacy measure. In the preliminary analysis, we will look at the correlation between the two measures. If they are not highly correlated, we will use the average of the two, otherwise we will only use the results from self-efficacy measure. The proposed items are listed in Table 16.

Construct	Proposed Items
Expertise	<ol style="list-style-type: none"> <li data-bbox="586 665 1377 730">1. I have confidence in my ability to provide knowledge that others in my organization consider valuable. <li data-bbox="586 737 1382 802">2. I have the expertise needed to provide valuable knowledge for my organization. <li data-bbox="586 808 1365 873">3. It doesn't really make any difference whether I add to the knowledge others are likely to share anyway. <li data-bbox="586 879 1409 945">4. Most other employees can provide more valuable knowledge than I can.

Table 16. Proposed items for expertise

4.4. Knowledge Sourcing Channels

The measure of the frequency of using various knowledge sourcing channels is adapted from the studies conducted by Gray and Meister (2004) and Gray and Durcikova (2006). However, Gray and Meister (2004) emphasized the difference among dyadic knowledge sourcing, published knowledge sourcing, and group knowledge sourcing. Gray and Durcikova (2006) noted the comparison among knowledge sourcing from repositories, colleagues and documents.

4.4.1. Knowledge Sourcing from Colleagues Face-to-Face

Face-to-face knowledge sourcing from colleagues refers to obtaining knowledge from an individual colleague face to face. The relevant scales from Gray and Meister (2004) and Gray and Durcikova (2006) are presented in Table 17. The proposed items adapted from their scales are presented in Table 18.

Study	Definition	Measurement	Alpha
Gray and Meister (2004) Dyadic knowledge sourcing	A single knowledge seeker engaging in dialogue with an individual source.	1. I rarely use targeted one-on-one conversations with other employees to acquire work-related knowledge [r]. 2. When I need to access to knowledge, I frequently use personal communication with individual employees.	0.76
Gray and Durcikova (2006) Knowledge sourcing from colleagues		1. I frequently discuss problems with people at my organization when I need to improve my knowledge on a topic or issue related to work. 2. When I am working on a difficult problem, I often communicate with employees who may have encountered similar issues.	0.83

Table 17. Scales for knowledge sourcing frequency from colleagues face-to-face

Construct	Proposed Items
Knowledge sourcing face-to-face from colleagues	1. I frequently discuss problems with my colleagues face-to-face at my organization when I need to improve my knowledge on a topic or issue related to work. 2. When I am working on a difficult problem, I often communicate with employees face-to-face who may have encountered similar issues. 3. When I need to acquire new knowledge, I frequently ask my colleagues for the new knowledge face to face.

Table 18. Proposed Items for knowledge sourcing frequency from colleagues face-to-face

4.4.2. Knowledge Sourcing from Knowledge Repositories

Knowledge sourcing from knowledge repositories refers to obtaining knowledge by browsing and searching knowledge repositories. The relevant scales from Gray and Meister (2004) and Gray and Durcikova (2006) are presented in Table 19. The proposed items adapted from their scales are presented in Table 20.

Study	Definition	Measurement	Alpha
Gray and Meister (2004) Published knowledge sourcing	Based on a one-to-many pedagogical model (and thus many-to-one from the perspective of the learner), where many knowledge seekers can benefit from the codification of the knowledge of one source.	<ol style="list-style-type: none"> 1. I often obtain useful knowledge by reading written materials authored by <CompanyName> people. 2. I rarely read documents written by <CompanyName> people to increase my knowledge on a topic or issue (rc). 	0.85
Gray and Durcikova (2006) knowledge sourcing from repositories	none	<ol style="list-style-type: none"> 1. I rarely use the KM system as a way of acquiring knowledge. (rc) 2. I frequently check in the KM system when I need to improve my knowledge on a topic or issue. 3. When I am working on a challenging problem, I often look in the KM system to find solutions to similar problems. 	0.91

Table 19. Scales for knowledge sourcing frequency from knowledge repositories

Construct	Proposed Items
Knowledge sourcing from knowledge repositories	<ol style="list-style-type: none"> 1. I rarely use the knowledge repository as a way of acquiring knowledge. (rc) 2. I frequently check in the knowledge repository when I need to improve my knowledge on a topic or issue. 3. When I am working on a challenging problem, I often look in the knowledge repository to find solutions to similar problems.

Table 20. Proposed Items for knowledge sourcing frequency from knowledge repositories

4.4.3. Knowledge Sourcing from Discussion Forums

Knowledge sourcing from discussion forums refers to sourcing knowledge by searching for solutions, posting questions, and waiting for replies in discussion forums. The relevant scales from Gray and Meister (2004) and Gray and Durcikova (2006) are presented in Table 21. The proposed items adapted from their scales are presented in Table 22.

Study	Definition	Measurement	Alpha
Gray and Meister (2004) Group knowledge sourcing	Involves knowledge exchange in a setting containing multiple individuals.	<ol style="list-style-type: none"> 1. I frequently consult with groups of <CompanyName> employees when I need to improve my knowledge on a topic or issue. 2. I rarely use conversations with a group of <CompanyName> employees as a way of acquiring knowledge [r]. 	0.82

Table 21. Scales for knowledge sourcing frequency from discussion forums

Construct	Proposed Items
Knowledge volatility	<ol style="list-style-type: none"> <li data-bbox="537 327 1382 394">1. The knowledge required to perform my task will soon be out of date. <li data-bbox="537 401 1341 432">2. The knowledge required to perform my task change quickly. <li data-bbox="537 438 1382 499">3. The knowledge I am now using to perform my task will remain valid for a long time.

Table 22. Proposed items for knowledge sourcing frequency from discussion forums

4.5. Other Demographic Information

Information about a knowledge worker's position, education, age and gender will be collected using single-item measures. These variables have been found significant in knowledge sourcing studies. For example, Rice et al. (1992) found that the level on the organizational managerial structure significantly correlated with managers' media choice. Teigland and Wasko (2000) found that education was a significant predictor of performance. Giambra et al. (1992) found that older adults preferred to learn through more passive means such as reading, while younger adults preferred direct interaction. Jarvenpaa and staples (2001) found significant difference between men and women in their propensity to share their expertise with others. We expect that these variables might have impact on the channel preferences, and we collect these data to understand the composition of the subjects, and use them as control variable if possible.

The scales and items are presented Table 23.

Scale	Items
Position	What is your position in your organization?
Education	What is the highest level of education you have attained? High school, Some undergraduate studies, Undergraduate degree, Some masters studies, Masters degree, PhD
Age	What is your year of birth?
Gender	What is your gender? Male, Female

Table 23. Other Demographic Information

Survey Procedures

The targeted survey subjects are knowledge workers who use, or at least have access to, the three types of knowledge sourcing channels specified in our research model. Since quality of knowledge channels may affect channel preference, we prefer one single research site to a few small research sites. In this way, we minimize the influence of knowledge channel quality.

Our research site is a Fortune 100 company. It is one of the largest and most prestigious global technology companies. The company has an internal research unit that is engaged in studying and improving the performance of knowledge workers and interactions between information systems and knowledge workers. We contacted one of the supervisors/managers and sent a letter explaining the purpose of the survey and the benefits to the organization (refer to Appendix A for the letter). The manager agreed to promote our survey in the organization and for security reasons suggested we use their internal survey site to host our survey.

We decided to include both U.S. and Chinese knowledge workers in this survey, since this organization has growing research units in China, and the Chinese knowledge workers comprise a significant portion of their total population of knowledge workers. However, to minimize the effect of culture factors or region factors, we decided to exclude knowledge workers from other regions. A survey questionnaire in Chinese was prepared in advance to better accommodate the Chinese knowledge workers.

The author visited one research and development center of the organization, and conducted three face-to-face interviews and two phone interviews (refer to Appendix B for sample interview questions). The interviews established that the research site met our requirements. Most knowledge workers had access to the three types of knowledge channels on which our research is focused.

We also conducted a pilot study to examine whether all the survey questions are easy to understand by the knowledge workers, especially by the Chinese knowledge workers. Due to the limited language support of the survey software that the organization had, we could not use the Chinese version of the survey questionnaire for the Chinese knowledge workers. While English is the working language inside the organization, and the author observed high English proficiency among the Chinese knowledge workers, it still is important to use the pilot study to ensure that the Chinese knowledge workers can understand our survey. Two U.S. knowledge workers and four Chinese knowledge workers were invited to participate in the pilot study. The pilot study verified that

Chinese knowledge workers could easily understand the survey and the time they took to complete the questionnaire was comparable to the time that the US knowledge workers took to complete the survey. No questions appeared to be confusing to either the English or Chinese knowledge workers.

The general format of the full survey followed the guidelines recommended by Dillman (1978). A cover letter was prepared as a tool for stimulating respondent interest and two reminder letters were designed to boost the response rate. The researcher in the organization helped identify a sample of 600 knowledge workers, and sent an email (please refer to Appendix C) to invite participation. The first invitation letter was sent at the end of October, and two reminder emails were sent in early December and mid January.

The subjects were directed to the organization's internal website where our survey was published. Some of the demographic information was directly pulled from the employee database when the subjects submitted their surveys. This shortened the time for the subjects to finish the survey, and at the same time increased data accuracy.

4.7. Chapter Summary

In this chapter, we described our research methodology. We developed measures for the constructs by adapting similar construct measures from previous studies. We also described the survey procedures, including the characteristics of the research site.

Chapter 5: DATA ANALYSIS AND RESULTS

This chapter is divided into five sections. The first section presents the preliminary data analysis, including the data preparation and descriptive statistics of the survey data. The second section provides an assessment of construct reliability and validity. The third section tests the hypotheses and reports the results of hypotheses testing. The fourth section discusses the hypothesis testing results and looks into potential explanations for the hypotheses that are not supported. The last section concludes the chapter.

5.1. Preliminary data analysis

5.1.1. Data preparation

Out of the 600 invitations, 144 responses were received. Among the 144 responses, we excluded one response with missing data. We performed another two steps of filtering and excluded two unqualified responses and four careless responses. Thus, the number of responses in the hypothesis testing is 137. The effective response rate is 22.8%.

Unqualified responses were identified by reading the comments of the responses.

Although our interviews and pilot study confirmed the availability of the three knowledge channels to the responses, some respondents reported not aware of their existence. One subject commented that “To my knowledge, my team does not have a knowledge repository or discussion forum outside of email lists”, and the other commented that

“Discussion forum is not presently true in my org. It has been in the past, though.” These two responses were excluded.

Careless responses were identified by looking at the consistency demonstrated by the answers to reverse engineered questions. In the questionnaire, eight out of the eleven scales used in the survey employed at least one reverse-coded item. Reverse-coded items should be negatively correlated with other related items. By assessing the extent to which reverse-coded items were scored in the same direction as other items, we were able to identify the individuals whose scales were inconsistently scored. We excluded four responses that did not take reasonable care in answering the survey. The next paragraph describes the detail of how we defined and identified the “careless” responses.

Following Gray’s approach (2002), we adopted a stringent interpretation for “inconsistency.” If there was a difference of 5 or greater between the minimum and maximum score on the series of seven-point Likert-format scales that were intended to measure the same construct, the individual was coded as having an inconsistent response to a reverse coded item. For example, a response of (7, 1, x) or (7, 2, x) was considered to be inconsistent, while a response of (6, 2, x) was not. Each response had a number indicating the frequency of inconsistency, the cut-off number beyond which the response was considered as not taking reasonable care in responding to the survey was 3. Four correspondences were removed based on this criterion.

5.1.2 Demographic Information and descriptive statistics

The demographic information of the 137 subjects is presented in Table 24. Among the 137 respondents, a few of them missed some demographic information. However, the missing data scattered among a wide range of responses, and it made the use of these variables as control variable less meaningful. We decided not to employ them as control variable in the model. Tenure with the company exhibits high correlation with the results of self-efficacy measure of expertise, and is not further employed for justifying expertise measure in the model.

Characteristics	Distribution
Tenure with the company	Mean=83months (Max=411, Mean=3, Medium=59)
Gender	Male: 65.7% Female: 27.1% Missing: 6.2%
Region	US: 59.0% APAC: 31.7% Missing: 9.3%
Job type:	Technical: 43.2% Non-Technical: 18.0% Research&Development: 25.2% Administrative: 4.3% Missing: 9.3%
Role:	Individual Contributor: 82.1% Manager: 8.6% Missing: 9.3%

Table 24. Demographic Information of the Survey Responses

Table 25 provides descriptive statistics for each item in the questionnaire. The descriptive statistics show that in most instances a full range of responses was recorded, the number

of valid observation listwise was 125. Skewness ranged from -1.20 to 1.57, and kurtosis ranged from -1.15 to 1.91. Thus, the data are not severely non-normal.

		N	MIN	MAX	Mean	Std. Dev.	Skewness	Kurtosis
Task Routiness	TR1	137	1	7	3.81	1.67	-0.11	-0.84
	TR2	136	1	7	3.54	1.44	0.43	-0.78
	TR3	137	1	7	3.67	1.60	0.22	-0.64
	TR4	137	1	7	3.85	1.37	0.00	-0.35
	TR5	137	1	7	3.07	1.36	0.72	0.40
Task Interdepend- ency	TI1	137	2	7	5.26	1.33	-0.40	-0.74
	TI2	137	1	7	5.47	1.34	-1.20	1.48
	TI3	134	1	7	5.24	1.27	-0.77	0.45
	TI4	137	1	7	5.01	1.42	-0.60	-0.22
Task Urgency	TU1	137	1	7	4.36	1.43	-0.25	-0.39
	TU2	136	1	7	4.38	1.75	-0.10	-0.93
	TU3	137	1	7	3.76	1.77	0.23	-0.94
	TU4	137	1	7	4.59	1.37	-0.53	0.22
Knowledge Codifiability	KC1	135	1	7	4.78	1.43	-0.67	0.14
	KC2	134	1	7	3.97	1.53	-0.23	-0.69
	KC3	135	1	7	4.22	1.66	-0.30	-0.73
Knowledge Volatility	KV1	135	1	7	3.56	1.50	0.32	-0.60
	KV2	135	1	7	4.54	1.38	-0.18	-0.55
	KV3	134	1	7	3.63	1.42	0.45	-0.11
Cognitive Style- Extraversion	CS1	137	2	7	5.78	1.12	-0.91	0.39
	CS2	137	1	7	5.18	1.27	-0.47	0.05
	CS3	135	2	7	5.36	1.35	-0.50	-0.53
	CS4	137	1	7	4.20	1.59	-0.12	-0.82
Cognitive Ability- Expertise	CA1	137	2	7	5.70	1.08	-0.83	0.45
	CA2	137	2	7	5.61	1.09	-0.78	0.47
	CA3	137	1	7	4.99	1.50	-0.53	-0.43
	CA4	136	1	7	4.65	1.52	-0.38	-0.30
	CA5	136	1	7	4.96	1.36	-0.80	0.63
Reciprocation Wariness	RW1	137	1	7	2.94	1.64	0.74	-0.23
	RW2	137	1	7	2.99	1.43	0.87	0.20
	RW3	136	1	7	2.17	1.71	1.57	1.38
	RW4	137	1	7	2.61	1.48	1.11	0.85
	RW5	137	1	7	3.72	1.66	0.22	-0.89
Face to Face	FF1	134	2	7	5.58	1.21	-1.11	1.11

	FF2	133	1	7	5.65	1.18	-1.20	1.91
	FF3	133	1	7	5.35	1.30	-0.98	0.96
Knowledge Repository	KR1	133	1	7	4.50	1.70	-0.39	-0.81
	KR2	134	1	7	4.60	1.67	-0.57	-0.49
	KR3	133	1	7	4.50	1.65	-0.46	-0.63
Discussion Forum	DF1	133	1	7	3.38	1.80	0.27	-1.15
	DF2	133	1	7	3.50	1.86	0.21	-1.14
	DF3	134	1	7	3.57	1.85	0.11	-1.14

Table 25. Items Descriptive Statistics

5.2. Construct Reliability and Validity

This section describes the analysis of construct reliability and validity, including the assessments of internal consistency, item loadings, convergent validity and discriminant validity.

The reliability of each construct is usually assessed through Cronbach's alpha. However, Cronbach's alpha is known to be biased against short scales (Carmines and Zeller 1979). An alternative to Cronbach's alpha is Fornell and Larcker's (Fornell and Larcker 1981) measure of internal consistency. This measure uses the averages of item loadings. Item loading is the degree to which an item loads on its intended construct. In this research, most scales are measured by three to five items, and are reduced to two to four items after revision (as described in the next paragraph). To measure the reliability of these short-scaled constructs, we use the measure of internal consistency. We kept Cronbach's alpha for comparison purpose.

The initial reliability analysis is shown in Table 26. The general rule of thumb is that items should display loadings higher than 0.7 (e.g., Chin and Gopal 1995). A loading of 0.7 suggests that there exists more shared variance between the construct and its items than the error variance (Carmines and Zeller 1979). Therefore, items loading below the recommended level were dropped from a construct. Task routiness and task interdependency showed lower reliability in the initial reliability analysis, and only two items were kept during revision. Table 27 shows the reliability analysis after removing items whose loading was less than 0.7. After that, the internal consistency ranged from 0.75 to 0.92.

Construct	# of Items	Internal Consistency	Cronbach's Alpha	AVE
Task Routiness (TR)	5	0.75	0.73	0.39
task interdependency (TI)	4	0.80	0.53	0.41
Task Urgency (TU)	4	0.79	0.72	0.50
Knowledge codifiability (KC)	3	0.79	0.60	0.56
Knowledge volatility (KV)	3	0.80	0.63	0.57
Cognitive Style-Extraversion (CS)	4	0.77	0.59	0.46
Cognitive ability-expertise (CA)	5	0.84	0.74	0.51
Reciprocity Wariness (RW)	5	0.84	0.76	0.52
Face-to-Face (FF)	3	0.93	0.88	0.81
Knowledge Repository (KR)	3	0.90	0.84	0.76
Discussion Forum (DF)	3	0.94	0.90	0.84

Table 26. Initial Reliability Analysis

Validity is the extent to which inferences can legitimately be made from the operationalization of a construct (Trochim 2001). Among validity measures, convergent validity and discriminant validity are the most important ones. Average variance

extracted (AVE) is examined to assess convergent validity and item loading on constructs is examined to assess the discriminant validity.

Construct	# of Items	Internal Consistency	Cronbach's Alpha	AVE
Task Routiness (TR)	2	0.88	0.73	0.79
task interdependency (TI)	2	0.88	0.55	0.78
Task Urgency (TU)	3	0.84	0.72	0.64
Knowledge codifiability (KC)	3	0.79	0.60	0.56
Knowledge volatility (KV)	3	0.80	0.63	0.57
Cognitive Style-Extraversion (CS)	3	0.80	0.61	0.57
Cognitive ability-expertise (CA)	4	0.85	0.75	0.59
Reciprocity Wariness (RW)	4	0.85	0.77	0.60
Face-to-Face (FF)	3	0.93	0.88	0.81
Knowledge Repository (KR)	3	0.90	0.84	0.76
Discussion Forum (DF)	3	0.94	0.90	0.84

Table 27. Revised Reliability Analysis

AVE is the percentage of the total variance of a measure represented or extracted by the variance due to the construct. AVE ranges from 0 to 1. Although the average variance shared by a construct is more clearly thought of as a measure of internal consistency among items than convergent validity, a reasonable level of convergent validity is generally accepted when the average variance shared by a construct items is at least 0.5, meaning that the construct contains less than 50% error variance (Fornell and Larcker 1981). The AVE column in Table 27 shows that all constructs have AVE greater than 0.5, demonstrating reasonable convergent validity.

	TR	TI	TU	KC	KV	CS	CA	RW	FF	KR	DF
TR1	0.90	-0.15	-0.06	0.24	-0.04	-0.18	-0.22	0.26	-0.11	0.12	0.20
TR2	0.87	-0.04	0.13	0.19	-0.05	-0.16	-0.08	0.24	-0.05	0.03	0.01
TI1	-0.13	0.84	0.08	0.02	-0.02	0.13	0.15	-0.08	0.16	0.06	-0.15
TI3	-0.07	0.82	0.28	-0.02	0.20	0.17	0.16	0.10	0.04	-0.03	-0.18
TU1	0.11	0.00	0.78	0.09	0.03	0.00	-0.01	-0.08	0.05	0.03	-0.04
TU3	-0.05	0.30	0.83	0.01	0.07	-0.01	0.09	0.03	0.02	0.03	-0.20
TU4	0.06	0.18	0.79	-0.08	0.14	-0.03	0.07	0.07	-0.03	-0.12	-0.20
KC1	0.17	0.04	-0.03	0.69	-0.26	0.17	0.15	-0.02	-0.02	0.36	0.19
KC2	0.22	0.01	0.01	0.77	0.08	-0.06	-0.03	0.12	-0.04	0.41	0.44
KC3	0.14	-0.04	0.05	0.77	-0.11	0.06	-0.03	0.05	-0.06	0.33	0.27
KV1	0.07	0.00	0.04	-0.04	0.80	-0.07	-0.02	0.28	-0.05	-0.04	0.09
KV2	-0.07	0.17	0.16	0.02	0.73	0.10	0.26	0.14	0.05	-0.02	0.11
KV3	-0.11	0.09	0.03	-0.26	0.74	-0.17	-0.03	0.11	-0.02	-0.03	-0.02
CS1	-0.19	0.11	-0.10	-0.02	0.02	0.73	0.36	-0.25	0.38	0.00	-0.07
CS2	-0.22	0.18	-0.01	0.07	-0.09	0.75	0.39	-0.13	0.30	0.15	0.06
CS3	-0.05	0.11	0.05	0.10	-0.08	0.77	0.27	-0.01	0.27	0.05	0.08
CA1	-0.14	0.16	-0.02	0.05	0.09	0.49	0.72	-0.09	0.28	0.16	0.05
CA2	-0.17	0.17	0.16	-0.03	0.03	0.46	0.80	-0.12	0.32	0.05	-0.04
CA4	-0.20	0.15	-0.01	-0.06	0.08	0.21	0.77	-0.10	-0.01	-0.01	0.04
CA5	-0.05	0.09	0.10	0.16	0.06	0.30	0.76	0.03	0.08	0.00	0.06
RW1	0.25	0.05	-0.11	0.14	0.19	-0.13	-0.13	0.77	0.07	0.16	0.17
RW2	0.24	-0.08	-0.04	0.08	0.15	-0.09	-0.05	0.80	0.03	0.08	0.33
RW3	0.20	0.04	0.09	-0.01	0.21	-0.12	-0.04	0.75	-0.14	-0.03	0.26
RW4	0.19	0.03	0.07	0.02	0.17	-0.16	-0.04	0.76	-0.03	-0.08	0.10
FF1	-0.16	0.12	0.06	-0.06	0.00	0.43	0.20	-0.04	0.90	0.12	0.02
FF2	-0.05	0.09	0.02	0.01	0.01	0.36	0.22	-0.06	0.92	0.23	0.08
FF3	-0.03	0.10	-0.01	-0.09	-0.04	0.32	0.09	0.06	0.88	0.10	0.03
KR	0.00	0.04	0.00	0.32	-0.09	0.13	0.19	-0.09	0.14	0.81	0.26
KR2	0.08	0.00	-0.03	0.50	-0.03	0.08	0.03	0.06	0.15	0.92	0.46
KR3	0.14	0.01	-0.03	0.45	0.02	0.03	-0.08	0.14	0.14	0.88	0.51
DF1	0.05	-0.15	-0.15	0.25	0.08	0.04	0.08	0.21	0.04	0.34	0.87
DF2	0.14	-0.23	-0.20	0.47	0.05	0.05	0.04	0.27	0.08	0.45	0.95
DF3	0.16	-0.17	-0.16	0.39	0.09	0.03	-0.01	0.30	-0.01	0.50	0.93

Table 28. Loadings and Cross-Loadings of measures

Both item discriminant validity and construct discriminant validity were assessed. Item discriminant validity requires that the items correlate more highly with their intended

constructs than with unintended constructs. Table 28 shows that all items meet this criterion, demonstrating high item discriminant validity.

Construct discriminant validity was assessed by comparing the square root of AVE for each construct (on the diagonal of the table) to the correlations between that construct and the other constructs in the model. Table 29 shows that for each construct, the square root of AVE is greater than the correlations between constructs, indicating that all the constructs exhibit discriminant validity.

	TR	TI	TU	KC	KV	CS	CA	RW	FF	KR	DF
TR	0.89										
TI	-0.11	0.88									
TU	0.04	0.21	0.80								
KC	0.24	0.00	0.01	0.75							
KV	-0.05	0.11	0.10	-0.13	0.76						
CS	-0.20	0.18	-0.02	0.07	-0.07	0.75					
CA	-0.18	0.18	0.07	0.03	0.09	0.45	0.77				
RW	0.28	0.01	0.01	0.07	0.24	-0.16	-0.08	0.77			
FF	-0.10	0.12	0.02	-0.05	-0.01	0.41	0.19	-0.02	0.90		
KR	0.08	0.02	-0.02	0.49	-0.04	0.09	0.05	0.04	0.17	0.87	
DF	0.13	-0.20	-0.19	0.40	0.08	0.04	0.04	0.28	0.04	0.47	0.92

Table 29. Correlation of Constructs

5.3. Hypothesis Testing

5.3.1. Data Analysis Technique

Our data analysis employed Partial Least Square (PLS). PLS is a flexible and powerful tool for statistical model building involving latent constructs measured by multiple indicators. PLS employs a generalization of canonical correlation analysis and principal component analysis that permits the formulation and estimation of complex path models (Noonan and Wold 1988). It is particularly valuable in situations characterized by small amounts of data and untested theory where classical distributional assumptions of normality may not hold. The PLS software we use in this analysis is called SmartPLS, developed by the researchers at the University of Hamburg (Ringle et al. 2005)

The eight characteristics - Task Routiness (TR), Task Interdependence (TI), Task Urgency (TU), Knowledge Codifiability (KC), Knowledge Volatility (KV), Extraversion (EV), Expertise (EP), and Reciprocation Wariness (RW) - and three channels - Face to Face channel (FF), Knowledge Repository (KR), Discussion Forum (DF) - are put into one single PLS model. There is a path from each of the characteristics to each of the channels. All measures of the constructs are reflective. The model calculated path coefficients from each characteristic and each of the knowledge sourcing channels. To get t-statistics, the bootstrap technique was used.

After we confirmed the adequacy of the measurement model, we tested the hypotheses in our knowledge sourcing model. Eight hypotheses were summarized in Table 1. That table is repeated here (as Table 30) for easy reference purposes.

Characteristics	Hypotheses
Tasks	
Routineness (H1)	The higher the task routineness, the more likely knowledge workers turn to repository than to colleagues and forums
Interdependence (H2)	The higher the task interdependence, the more likely knowledge workers turn to colleagues than to repositories and forums.
Urgency (H3)	The higher the task urgency, the more likely knowledge workers turn to colleagues than to repositories and forums.
Knowledge	
Codifiability (H4)	The higher the knowledge codifiability, the more likely knowledge workers turn to repositories than to forums and colleagues.
Volatility (H5)	The higher the knowledge volatility, the more likely the knowledge workers turn to colleagues and forums than to repositories,
Individual	
Extraversion (H6)	The more extroverted the knowledge worker, the more likely knowledge workers turn to colleagues than to repositories and forums.
Expertise (H7)	The higher the expertise, the more likely knowledge workers turn to forums and repositories than to colleagues.
Reciprocation awareness (H8)	The higher the reciprocation awareness, the more likely knowledge workers turn to repositories and forums than to colleagues.

Table 30. Summary of Hypotheses

We defined three types of hypothesis testing results: supported, partially supported, or not supported. Our hypotheses were stated in the following way, “The higher the Characteristics F, the more likely knowledge workers turn to channel **A than B and C**”

(Or “turn to channel **A and B than C**”, in which case, the following conditions can be slightly modified to fit the scenario).

Suppose the path coefficient between F and A is β_1 , the path coefficient between F and B is β_2 , and the path coefficient between F and C is β_3 . We defined condition 1 is true when $\beta_1 > \beta_2$, and defined condition 2 is true if $\beta_1 > \beta_3$. To compare the β s, t-test were employed.

The hypothesis is *supported* if both condition 1 and condition 2 are true. The hypothesis is *partially supported* if only one of the two conditions is true. A hypothesis is *not supported* if neither of the conditions is true. We translated our hypotheses into testable conditions in Table 31.

Hypothesis statement	Hypothesis Testing
Tasks	
Routineness (H1)	$\beta_2 > \beta_1$ & $\beta_2 > \beta_3$
Interdependence (H2)	$\beta_1 > \beta_2$ & $\beta_1 > \beta_3$
Urgency (H3)	$\beta_1 > \beta_2$ & $\beta_1 > \beta_3$
Knowledge	
Codifiability (H4)	$\beta_2 > \beta_1$ & $\beta_3 > \beta_1$
Volatility (H5)	$\beta_1 > \beta_2$ & $\beta_3 > \beta_2$
Individual	
Extraversion (H6)	$\beta_1 > \beta_2$ & $\beta_1 > \beta_3$
Expertise (H7)	$\beta_2 > \beta_1$ & $\beta_3 > \beta_1$
Reciprocity wariness (H8)	$\beta_2 > \beta_1$ & $\beta_3 > \beta_1$

Table 31. Hypothesis Testing Criteria

5.3.2. Results

The hypothesis testing was conducted in two steps. First, we calculated the path coefficients and their standard errors for all the paths. The significance of these path coefficients was then tested. Although the significance of these path coefficients is not necessary for the hypothesis testing, it provides us with more insightful information in analyzing the hypothesis testing results, especially when the hypothesis is not supported or only partially supported.

Figure 2 shows all the significant path coefficients from the characteristics to the channels. The beta and significance is presented for each correlation whose significance is less than 0.1. Figure 3 shows all path coefficients and it is presented in three small figures. Table 32 summarizes the path coefficients and their significances.

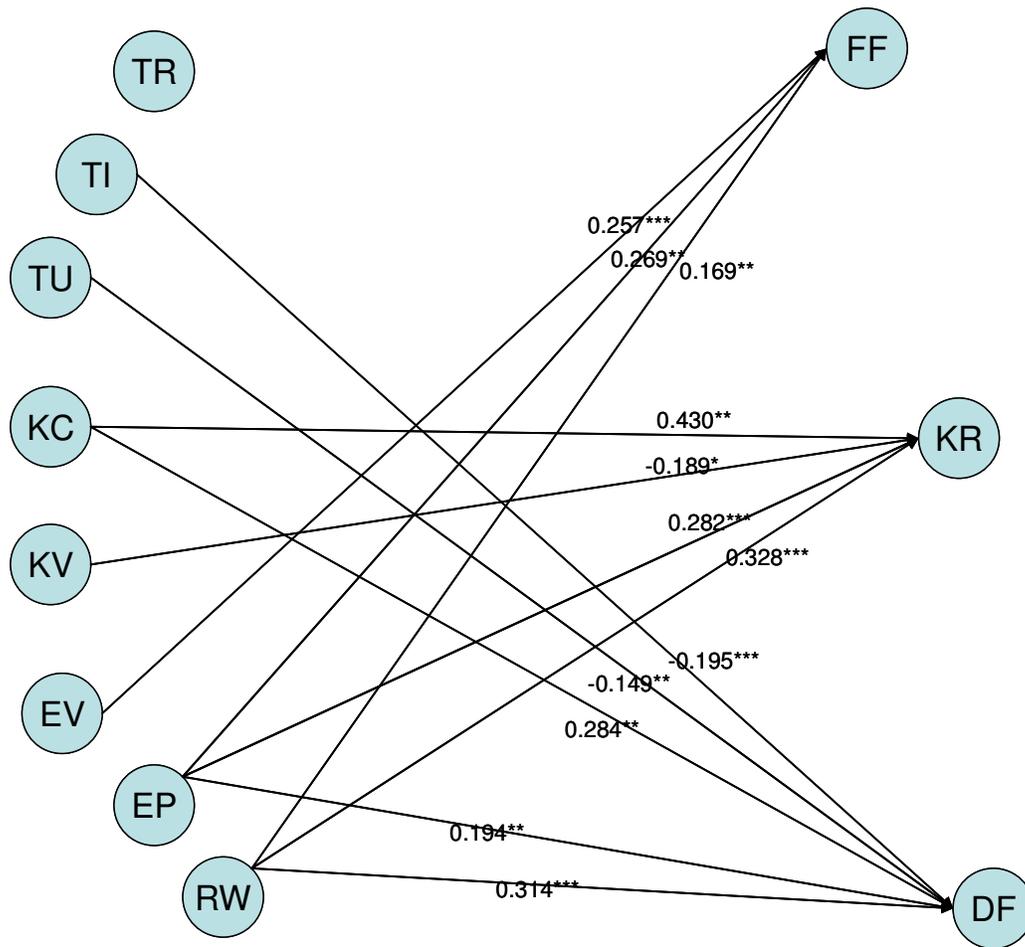


Figure 2: Significant Path Coefficients from Characteristics to Channels

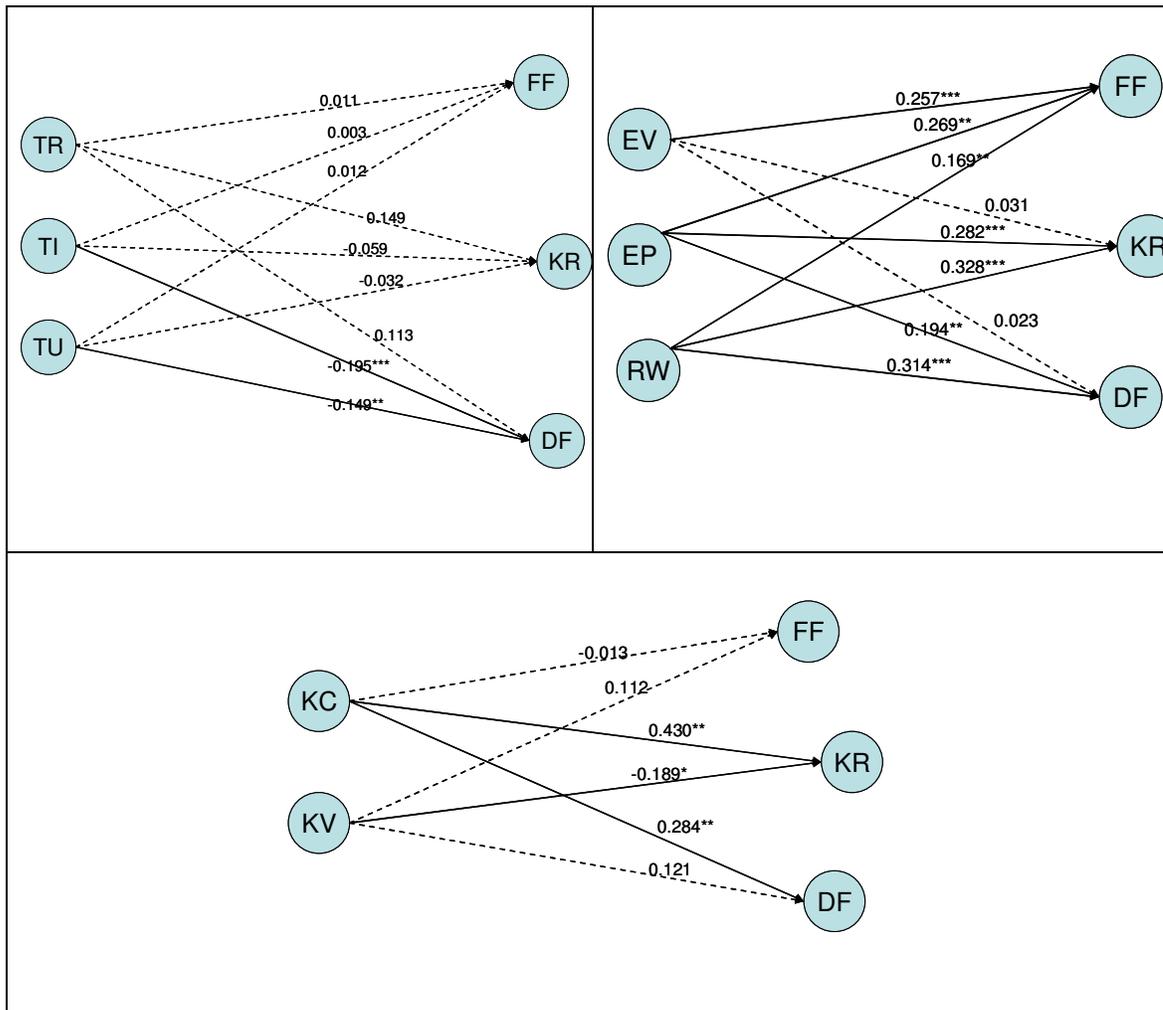


Figure 3: Path Coefficient from Characteristics to Channels

The path coefficients and corresponding standard error information was further used in the two dependent group t-test to decide the statistical difference between path coefficients. Based on the criteria we defined, we decided whether the hypothesis is supported (Y), partially supported (P), or not supported (N). Table 33 summarizes the t-test results and the last column in the table summarizes the final hypothesis testing results.

Task	FF			KR			DF		
	β_1	STE	Sig	β_2	STE	Sig	β_3	STE	Sig
H1	0.011	0.095	0.454	0.149	0.606	0.273	0.113	0.161	0.242
H2				-			-		
H3	0.003	0.076	0.486	0.059	0.090	0.257	0.195	0.078	0.007***
				-			-		
	0.012	0.094	0.450	0.032	0.097	0.370	0.149	0.084	0.040**
Knowledge									
H4	-								
	0.013	0.084	0.437	0.430	0.087	0.000***	0.284	0.064	0.000***
H5				-					
	0.112	0.119	0.173	0.189	0.132	0.077*	0.121	0.105	0.125
Individual									
H6	0.257	0.101	0.006***	0.031	0.122	0.399	0.023	0.110	0.419
H7	0.264	0.097	0.004***	0.282	0.111	0.006***	0.194	0.101	0.028**
H8	0.169	0.078	0.016**	0.328	0.072	0.000***	0.314	0.081	0.000***

*** (p<0.01); ** (p<0.05), * (p<0.10)

Table 32. Path Coefficients and Significances

Task		t	sig			t	sig		Y/N
H1	$\beta_2 > \beta_1$	0.235	0.407		$\beta_2 > \beta_3$	0.063	0.475		N
H2	$\beta_1 > \beta_2$	0.605	0.273		$\beta_1 > \beta_3$	1.987	0.024**	Y	P
H3	$\beta_1 > \beta_2$	0.378	0.353		$\beta_1 > \beta_3$	1.391	0.083*	Y	P
Knowledge									
H4	$\beta_2 > \beta_1$	4.250	0.000***	Y	$\beta_2 > \beta_3$	1.602	0.056*	Y	Y
H5	$\beta_1 > \beta_2$	1.964	0.026**	Y	$\beta_3 > \beta_2$	2.194	0.015**	Y	Y
Individual									
H6	$\beta_1 > \beta_2$	1.637	0.052*	Y	$\beta_1 > \beta_3$	1.718	0.044**	Y	Y
H7						-			
	$\beta_2 > \beta_1$	0.143	0.443		$\beta_3 > \beta_1$	0.545	0.793		N
H8	$\beta_2 > \beta_1$	1.738	0.042**	Y	$\beta_3 > \beta_1$	1.419	0.079*	Y	Y

*** (p<0.01); ** (p<0.05), * (p<0.10)

Table 33. Summary of Hypothesis Testing

Out of the eight hypotheses, four are supported, two are partially supported, and two are not supported. The testing results support our hypothesis on the impact of knowledge codifiability, knowledge volatility, and reciprocity wariness on channel preferences. The testing results partially support our hypothesis on the impact of task interdependence and task urgency on channel preferences. The testing results do not support our hypotheses on the impact of task routineness and expertise on channel preferences.

5.4. Discussion and Analysis Summary

5.4.1. Task Characteristics related hypotheses

H1 (task routineness, not supported)

This hypothesis posits that task routineness should have a higher path coefficient with knowledge repositories than with face-to-face communications, and a higher path coefficient with knowledge repositories than with discussion forums. Neither condition holds, and the hypothesis is not supported.

From Table 31, we found that no significant path coefficients were observed between task routineness and any of the channels. Task routineness is the only characteristic that does not show any correlation with any of the channels. To understand the results better, we conducted additional analysis on the relationship between task routineness and overall knowledge sourcing activities. A negative correlation was found between knowledge sourcing activity and task routineness, similar to that found by Grey and Meister (2004).

This implies that task routineness might not influence channel preference although it does seem to affect the intensity of knowledge sourcing activities.

H2 (task interdependency, partially supported)

This hypothesis offers that task interdependency should have a higher path coefficient with face-to-face communications than with knowledge repositories, and a higher path coefficient with face-to-face communications than with discussion forums. The results demonstrate that the first condition holds, while the second condition does not. The hypothesis is partially supported. From Table 31, we see that task interdependency has a significant negative path coefficient with discussion forums, but no significant path coefficient with either face-to-face communications or knowledge repositories. However, the path coefficients between task interdependency and other two channels are both positive, but not significant.

H3 (Task urgency, partially supported)

This hypothesis postulates that task urgency should have a higher path coefficient with face-to-face communications than with knowledge repositories, and a higher path coefficient with face-to-face communications than with discussion forums. Similar results for H2 were found for H3. The results show that the first condition holds, while the second condition does not. The hypothesis is partially supported. From Table 31, we found that task urgency had significant negative path coefficient with discussion forums,

but no significant path coefficient with either face-to-face channel or knowledge repositories. However, the path coefficients between task urgency and other two channels are both positive, but not significant.

5.4.2. Knowledge Characteristics related hypotheses

H4 (knowledge codifiability, supported)

This hypothesis proposes that knowledge codifiability should have a higher path coefficient with knowledge repositories than with face-to-face communications, and a higher path coefficient with discussion forums than with face-to-face communications. The results show that both conditions hold, and the hypothesis is supported.

H5 (knowledge volatility, supported)

This hypothesis posits that knowledge volatility should have a higher path coefficient with face-to-face communications than with discussion forums, and a higher path coefficient with discussion forums than with knowledge repositories. The results show that both conditions hold, and the hypothesis is supported.

5.4.3. Individual Characteristics related hypotheses

H6 (extroversion, supported)

This hypothesis posits that extroversion should have a higher path coefficient with face-to-face channel than with knowledge repositories, and a higher path coefficient with face-to-face channel than with discussion forums and knowledge repositories. The results show that both conditions hold, and the hypothesis is supported.

H7 (expertise, not supported)

This hypothesis submits that extroversion should have a higher path coefficient with knowledge repositories than with face-to-face communications, and a higher path coefficient with discussion forums than with face-to-face communications. The results show that neither condition holds, and the hypothesis is not supported.

From table 31, we found that expertise has significant positive path coefficient with any of the channel. Its path coefficient with face-to-face channel is comparable to its path coefficient with knowledge repositories, and both are moderately higher than its path coefficient with discussion forums. However, our hypothesis posits that its path coefficient with face-to-face channel should at least be the lowest. To understand the results, we did some extra analysis.

In our survey, we also collected information on how frequently the subjects use various channels for knowledge sharing. While we did not study knowledge sharing in this dissertation, we did do some preliminary analysis on the data related to knowledge sharing to help us better interpret the analysis results not consistent with our hypothesis in

our knowledge sourcing model. We found that the higher the expertise, the higher the knowledge workers share knowledge through face-to-face communication. This evidence suggests that knowledge sharing activities may lead to knowledge sourcing activities. For example, when an expert is approached for help, he or she might not know the answer immediately and exactly. The expert might use some interactive sense making (Daft and Weick 1984) to better understand the question and help solve the problem step by step. It is possible that the expert may consider this as both knowledge sharing and knowledge sourcing activity, since the expert also learns new things and benefits from it.

H8 (reciprocation wariness, supported)

This hypothesis offers that reciprocation wariness should have a higher path coefficient with knowledge repositories than with face-to-face communications, and a higher path coefficient with discussion forums than with face-to-face communications. The results show that both conditions hold, and the hypothesis is supported.

5.5. Chapter Summary

In this chapter, we conducted data analysis and hypothesis testing. Among the eight hypotheses, four are supported, two are partially supported, and two are not supported. We also looked into the potential explanation of the hypotheses that were not supported.

CHAPTER 6: CONTRIBUTIONS, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This dissertation begins with a quote from Peter Drucker (1999, p.79). “The most valuable asset of a 21th-century institution (whether business or nonbusiness) will be its knowledge worker and their productivity.” One of the biggest and increasingly important challenges for today’s managers is understanding how to promote and facilitate effective knowledge sharing and sourcing (Kogut and Zander 1992).

Organizations spend considerable effort, time, and money buying, introducing, and using new communication systems to improve knowledge sourcing and sharing activities, but they do not necessarily see the outcomes from these investments. The decision becomes more complicated when information technology enables various channels for knowledge sourcing and sharing. Both researchers and managers face a series of questions, such as: Are some channels more valuable than others? What system or what culture shall we promote or cultivate to facilitate knowledge management? What should we invest in with a limited budget?

6.1. Contributions

6.1.1. Contribution to Research

This research is one of the first studies looking into a broad category of characteristics in a wide spectrum of knowledge sourcing channels. It contributes to knowledge management and communication research in the following three aspects.

First, it studies knowledge transfer behavior in a wide spectrum of knowledge sourcing channels. This broad and integrated view is more representative of reality and reflects the current status of knowledge management practice.

Previous research has tended to focus on a single channel or treat different channels as broadly interchangeable. However, different channels do not work the same way and do not contribute homogeneously to organizational knowledge management effectiveness. To answer the questions we raised at the beginning of this section, we have to take the view of a multimodal knowledge network. Given the large number of possible channels, we chose three most representative channels based on the popularity and the underlying communication mode: face to face communication with colleagues, knowledge repositories and discussion forums.

Second, this research builds a foundation upon which to understand how a set of broad characteristics of knowledge sourcing activities influence channel preferences. Focusing

on the sourcing side of knowledge exchange, this research identified a set of important characteristics from three major categories as the antecedents of channel preferences.

Based on the signaling metaphor (Shannon and Weaver 1949), we identified that task characteristics, knowledge characteristic and individual characteristics would affect channel preference. Within each category, a large number of characteristics have been studied in prior research and a vast range of theories have been built upon those characteristics. We started from a broad review of how these characteristics take effect in communication channels in general and ended with arguments of how they would or would not affect channel preferences. A theoretical base was drawn from a wide variety of literature, and hypotheses were built around how these characteristics influence knowledge sourcing channel preference. Eight characteristics were identified and various theories worked harmoniously and contribute towards an integrated model.

Third, it generated considerable support for the general knowledge sourcing channel preference model. The research hypotheses were operationalized and tested using a survey of employees at a global technology company. The results show that six out of the eight characteristics do impact knowledge workers' channel preferences in the direction our model predicted.

The results indicate that of the eight hypotheses built around the eight characteristics, four are supported, two are partially supported, and two are not supported. While not all hypotheses are supported, this research produces considerable support for the general

knowledge sourcing channel preference model, which stands as a significant contribution to knowledge management research. The results further extend our understanding of knowledge workers' knowledge sourcing behavior in a multimodal knowledge network.

In summary, this research is one of the first steps in building a theory in multimodal knowledge network. This serves as a basic model for others to replicate, build on, or to extend. It also provides a set of candidate characteristics for further exploration.

6.1.2. Contribution to Practice

This study builds a knowledge sourcing channel preference model and shows how task characteristics, knowledge characteristics, and individual characteristics influence channel preference. The results of this study can help organizations understand the advantages and disadvantages of various sourcing channels. Based on a critical review of the important characteristics, organizations will be able to promote a certain sharing channel, will be able to have reasonable expectations on the utilization of knowledge transfer approaches, and will be able to improve the effectiveness of knowledge transfer initiatives. More specifically, with the results from this study, organizations will be able to benefit from this research in the following aspects.

First, based on the nature of the business, organizations will be able to develop an overall knowledge transfer strategy. The nature of the problem that organizations are focusing on vary, thus the characteristics of knowledge vary. The results show that knowledge

characteristics have a significant impact on channel preference, and this helps organization in setting up their overall knowledge transfer strategy. For example, Hansen et al. (1999) found that consulting firms utilize two strategies based on the their customers' nature of business . Anderson consulting and Ernst & Young rely more on a codification strategy because they are dealing with similar problems over and over again, while Bain, Boston Consulting, and McKinsey & Co rely more on a personalization strategy since the solutions they provide are sensitive to the changing business environment.

Second, organizations will be able to customize knowledge systems for different function groups. One thing we need to keep in mind is that an organization is not necessarily a “homogeneous” unit. Most organizations are like a huge machine composed of various functional departments or working units, and each of them has its own task characteristics. For examples, manufacturing division follows the procedures and routines to produce identical and high quality products; research division tries different methodologies and techniques to come up with innovative solutions to solve problems. In order to promote and facilitate the most effective knowledge channels, organizations need to treat various functional departments or working units differently.

Third, organizations will be able to better tailor their knowledge transfer systems or tactics by understanding individual characteristics of their employees. Our results show that individual characteristics, especially extroversion and reciprocation wariness, have

significant impact on channel preference. While these characteristics are difficult to change, organizations may utilize the knowledge of their employees through development of various knowledge management strategies and tools.

For example, organizations may identify introvert employees, and let them be aware of their knowledge sourcing behavior to help them improve in their job. This would benefit both the individual employee and the organization. To alleviate the unwillingness to answer questions associated with reciprocation wariness, organizations can promote a sharing culture. Alternatively, organizations can design knowledge sharing channels in a way to minimize the impact of reciprocation, such as building discussion forums with no true identification. One step further, organizations need to be more flexible in system design to accommodate employees with different individual characteristics at the same time. For example, well-designed discussion forums can gather information (such as number of postings per week or month) to identify and acknowledge knowledge gurus who would be interested to disclose their true identities, while apprentices would be able to browse information and ask question as guests and therefore hiding their true identities.

In addition to the examples above, the research results can be especially valuable when managers have a fixed budget for knowledge management. For example, managers may need to choose between conference rooms, knowledge repositories and discussion forums. Through assessing relevant individual characteristics and knowledge characteristics, the

results of this research should help managers to make educated decisions regarding how to allocate resources.

6.2. Limitations and Future Research

As with any empirical research, there are limitations in this study. First, the survey was conducted in a single organization. As mentioned in the previous chapter, since the quality of knowledge channels plays an important role in channel usage, we would rather collect data from one site as opposed to multiple sites, if the total number of respondents is approximately the same. This limits the external validity of this research. Future research should include additional research sites from a variety of organizations to test the boundary conditions of the model.

Second, it is possible that some channels that were not examined in this study might have intervened with the results. There are additional important channels that can be examined in future research. For example, email exchange or phone conversations between two knowledge workers, or group discussions either in face-to-face setting or through virtual conferences, are also popular knowledge channels. If some of these channels have a similar underlying communication model as those in our research model, they could be integrated with the ones we studied. Including/integrating these channels into the model may lead to results better supporting the hypotheses we developed.

The third limitation is the selection of the characteristics. When taking a comprehensive view, the most difficult process was to choose the appropriate number of factors to prevent the study from being overwhelmingly complex. We selected three task characteristics, two knowledge characteristics, and three individual characteristics. There might be additional important factors, such as organizational climate, that could be considered in future research.

The fourth limitation is the absence of control variables. There is a set of demographic information that we expect to have impact on the knowledge sourcing activities, including knowledge worker's position, education, age and gender. We attempted to collect these data in the survey, but a significant portion of the respondents chose not to provide it. This made the inclusion of control variables meaningless. The missing data problem was mainly caused by our lack of control on the data collection process because the survey was hosted by the research team of the company on their internal website. Future research should include these demographic variables as control variables.

Other than extensions discussed above, we also would like to propose two new directions. First, we would like to extend channel preference research to the other side of knowledge exchange - knowledge sharing. It would be very interesting to develop a knowledge sharing channel preference model. Further more, it would be interesting to compare the results between the two models, and discover the similarities and differences between the two models, thus revealing the whole picture of knowledge flow in a multimodal

knowledge network. Second, future research should incorporate the temporal dimension in the channel preference model in order to examine the relationships among sourcing preferences. We may see, for example, that colleagues are preferred after a long period of relying on forums, perhaps because the forums did not provide sufficient information. This would help us to understand channel preferences from a dynamic perspective.

6.3. Chapter Summary

In this chapter, we have presented the research and practical contribution of this study. We have pointed out limitations of this study and discussed to improve it in the future research. We also proposed to extend this study to three directions, studying channel preference of knowledge sharing, introducing culture factors in the model, and incorporating the temporal dimension.

APPENDICES

APPENDIX A: A LETTER TO MANAGEMENT TEAM

Date

«First_Name» «Last_Name»

«Account»

«Address_1»

«Address_2»

«Address_3»

«City», «State» «Zip»

Dear «First_Name»,

Researchers at the University of Arizona invite you to participate in research and receive a report that describes knowledge transfer effectiveness at your company, especially knowledge workers' knowledge sourcing and sharing behavior through multiple channels, including from collocated colleagues, from organization knowledge repository, and from electronic community of practice. Your organization is invited to participate in this study because you have the three knowledge channels as mentioned above. If it is not true, please let us know. The participation is voluntary.

WHAT WILL PARTICIPATING FIRMS RECEIVE?

Participating firms will receive the following:

- Written report and discussion of the results of this study
- One or several of the individuals completing the survey will be selected at random to win a prize

WHAT DOES PARTICIPATION INVOLVE?

- Senior management approval and encouragement of employees' participation
- Interviews with two or three key individuals (managers and representative users) to establish organizational context
- Completion of a 20-minute online questionnaire by knowledge workers
- Information about the organizational geographical allocation of knowledge worker, features (archiving, searchability and approval process of knowledge entry) of knowledge repository, and features (monitoring and organizing) of the discussion forums
- The knowledge repository usage data and the discussion forums participation data if they are available and you are willing to share

This research will be conducted with an absolute guarantee of confidentiality, both for individual participants and for the companies involved. At no time will we reveal survey

respondents' identities or individual responses. No identifying details about your company will be released without your express written permission.

As a participating firm, you will have access to university research and will receive a report describing your current knowledge transfer practices and knowledge workers' knowledge sourcing behavior. You will also be able to use these findings of the study to evaluate the knowledge transfer effectiveness and to improve the knowledge transfer channels.

I will call you within the next week to discuss your possible participation in this research. At that time, I will be glad to answer any questions you have about this study. I look forward to talking with you.

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APPENDIX B: SAMPLE INTERVIEW QUESTIONS

1. Is there a knowledge repository that is used in your work?
2. What is the name of this knowledge repository?
3. How long has the knowledge repository be in use?
4. How has it been maintained?
5. What features does the knowledge repository has, such as searchability and knowledge quality?

6. Is there a discussion forum that is used in your work?
7. What is the name of this discussion forum?
8. How long has the discussion forum be in use?
9. How has it been maintained?
10. What features does the discussion forum has, such as, popularity and knowledge quality?

11. Please describe the features of the tasks you are involved in, such as repeatability and intellectual demand?

12. Please describe the features of the knowledge you are using to complete your tasks, such as explicability and time-sensitivity?
13. What are the other knowledge sources that you use?
14. Think of the last time you needed to get knowledge about something – where did you go to get that knowledge?

APPENDIX C: EMAIL FROM MANAGEMENT

Team,

[company name] has been recently approached by researchers at the University of Arizona, who are conducting research in the area of knowledge management. They are especially interested in knowledge sourcing and sharing channels including collocated colleagues, knowledge repositories, and electronic communities of practice.

The study will require that you complete an online survey that should take about 20 minutes of your time. You will shortly receive an email from one of the researchers that will provide you with details on how to access the online survey. Because this is independent university research, all responses will be completely confidential. Your responses will be collected off-site for analysis by these researchers; [company name] will not have access to your specific responses, and will receive only summaries of responses.

Please give serious consideration to participating in this study. However, your participation is voluntary.

Thanks,

[manager's name]

APPENDIX D: EMAIL FROM THE INVESTIGATOR

Dear Team Member,

Recently you received an email from [manager name] introducing an independent study being conducted by researchers at the University of Arizona. The research study focuses on the [KMS name].

The purpose of this study is to understand whether there is a knowledge channel preference and what antecedents cause the channel preference. We are asking you to fill out an online survey about your views about the task you are involved in, the knowledge you are using to complete your tasks, your perception of yourself and your colleagues, and the frequency of using various knowledge channels. Most people take about 15 to 20 minutes to complete the survey.

Your responses will be directly transmitted to the researchers at the University of Arizona and will be treated as confidential. Only aggregate data will be reported; no [company name] employees or managers will have access to your individual results. After data collection and analysis, we will provide [company name] with recommendations for how the knowledge transfer channels can be improved and used more effectively so that it better supports your everyday work

We would sincerely appreciate your cooperation with this research. Please go to the URL below in the next few days and complete the survey. As a way of thanking you for your time, we will be randomly selecting X people from among those who complete the questionnaire and awarding them with a gift certificate for Amazon.com (this survey targets XXX individuals).

If you have any questions or comments please contact Yiwen Zhang, the principal investigator.

Thank you,

Yiwen Zhang, Ph.D. Candidate
University of Arizona
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phone: 520-548-3003

Please take the survey by going to the following URL:
<http://seurat.ecom.arizona.edu:2080/survey/index.htm>

APPENDIX E: SURVEY QUESTIONNAIRE

Section 1: Tasks, Knowledge and Individuals

This section of the questionnaire collects your views about the task you are involved in and the knowledge you are using to complete your tasks, and your perception of yourself and your colleagues. Please indicate the extent to which you agree or disagree with each of these statements.

The following questions deal with the <u>tasks</u> that you are involved in.	strongly strongly disagree agree						
		↓					↓
1. My work is routine and repetitive.	1	2	3	4	5	6	7
2. I usually do my work in the same way, without a lot of variation.	1	2	3	4	5	6	7
3. I frequently deal with ill-defined business problems.	1	2	3	4	5	6	7
4. Frequently the business problems I work on involve asking questions that have never been asked in quite that form before.	1	2	3	4	5	6	7
5. My job involves finding novel solutions to problems.	1	2	3	4	5	6	7
6. The products of my work are independent of other's work.	1	2	3	4	5	6	7
7. The products of my work feed into someone else's work.	1	2	3	4	5	6	7
8. The products of my work require input from someone else's work.	1	2	3	4	5	6	7
9. The products of my work are completed with others in a team approach.	1	2	3	4	5	6	7
10. I have too much work and too little time to do with it.	1	2	3	4	5	6	7
11. I find this organization relaxed place to work.	1	2	3	4	5	6	7
12. I feel like I never have a day off.	1	2	3	4	5	6	7
13. Many employees at my level get "burned out" by the demands of their jobs in this organization.	1	2	3	4	5	6	7
The following questions deal with the <u>knowledge</u> that you are using to complete your tasks. To what extent...	strongly strongly						

	disagree						agree
	↓						↓
14. Most knowledge can be sufficiently explained to users in writing (in code comments, written reports, manuals, e-mails, faxes, etc.).	1	2	3	4	5	6	7
15. Large parts of the documentation for this task are embodied in the knowledge repository.	1	2	3	4	5	6	7
16. Extensive documentation describing critical parts of the process for completing this task exists within our group or department.	1	2	3	4	5	6	7
17. The knowledge required to perform my task will soon be out of date.	1	2	3	4	5	6	7
18. The knowledge required to perform my task changes quickly.	1	2	3	4	5	6	7
19. The knowledge I am using to perform task now will remain valid for a long time.	1	2	3	4	5	6	7
The following questions deal with your perception about <u>yourself and others</u>.	strongly						strongly
	disagree						agree
	↓						↓
20. I feel comfortable around people.	1	2	3	4	5	6	7
21. I start conversations.	1	2	3	4	5	6	7
22. I like to talk to a lot of different people at work.	1	2	3	4	5	6	7
23. I don't mind being the center of attention.	1	2	3	4	5	6	7
24. People who help others are often just trying to get something in return.	1	2	3	4	5	6	7
25. In return for doing me a favor, people often ask me for more than they deserve	1	2	3	4	5	6	7
26. You should only help someone if that person will help you in the future.	1	2	3	4	5	6	7
27. People who act nicely toward others are often just trying to get something.	1	2	3	4	5	6	7
28. People do not acknowledge the help they get from others.	1	2	3	4	5	6	7
29. I have confidence in my ability to provide knowledge that others in my organization consider valuable.	1	2	3	4	5	6	7

30. I have the expertise needed to provide valuable knowledge for my organization.	1	2	3	4	5	6	7
31. It doesn't really make any difference whether I add to the knowledge others are likely to share anyway.	1	2	3	4	5	6	7
32. Most other employees can provide more valuable knowledge than I can.	1	2	3	4	5	6	7

Section 2: Knowledge Sourcing Channels and Knowledge Sharing Channels

This section of the questionnaire collects the frequency of you using various knowledge channels **within** Intel. Please carefully read the definition of the words used in the question in this section.

Knowledge repository is an on-line computer-based collection of knowledge, procedure, experience, and documentation about a particular domain that you can refer to complete your job.

When answering the questions, you can have one or multiple knowledge repository in mind.

If you can specify the name or the url of the knowledge repositories, please

Discussion forum is where you can post and answer question to a collection of individuals performing similar work or engaged in the pursuit of solutions to similar problems.

When answering the questions, you can have one or multiple discussion forums in mind.

If you can specify the name or the url of the discussion forum(s), please _____

Please indicate the extent to which you agree or disagree with each of these statements.

	strongly disagree							strongly agree
	↓							↓
33. I frequently discuss problems with my colleagues face-to-face at my organization when I need to improve my knowledge on a topic or issue related to work.	1	2	3	4	5	6	7	
34. When I am working on a difficult problem, I often communicate with employees face-to-face who may have encountered similar issues	1	2	3	4	5	6	7	
35. When I need to acquire new knowledge, I frequently ask my colleagues for the new knowledge face-to-face.	1	2	3	4	5	6	7	
36. I rarely use the knowledge repository as a way of acquiring knowledge.	1	2	3	4	5	6	7	
37. I frequently check in the knowledge repository when I need to improve my knowledge on a topic or issue.	1	2	3	4	5	6	7	

38. When I am working on a challenging problem, I often look in the knowledge repository to find solutions to similar problems.	1	2	3	4	5	6	7
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39. I rarely use the discussion forums as a way of acquiring knowledge.	1	2	3	4	5	6	7
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40. I frequently check in the discussion forums when I need to improve my knowledge on a topic or issue.	1	2	3	4	5	6	7
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41. When I am working on a challenging problem, I often look in the discussion forums to find solutions to similar problems.	1	2	3	4	5	6	7
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