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Factors That Contribute to Knowledge Sharing Within Research Based Organizations

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FACTORS THAT CONTRIBUTE TO KNOWLEDGE SHARING WITHIN RESEARCH BASED ORGANIZATIONS

BY

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DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy
Organizational Learning and Instructional Technology

The University of New Mexico
Albuquerque, New Mexico

July, 2011

Dedication

I dedicate this dissertation to my family, especially to my mother the potter who shaped life with her hands and taught me that there is nothing a woman cannot do; my father the risk taker who inspired me to challenge myself, supported me on every journey and raised my spirit; my children Dane and Jillian who believed in me even when I didn't; and Jeremy who set the example for me to keep my goal in focus.

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ABSTRACT

Organizations struggle with the need for an aggregate of the knowledge that is known by individuals in their employment. Generally this is knowledge that was gained through effort completed for the business. In the technical industry this is often emergent knowledge that is discovered through work experience and not always documented in general publication. Knowledge is acquired by an individual through personal endeavor and investment and is not always easily captured or shared with others.

It is necessary for management to have access to this knowledge in order to make decisions that will provide the ability for an organization to respond to change, reduce the costs of redundant work and ultimately, remain competitive in their industry. Individuals need this knowledge to validate their technical direction, remain innovative, and ensure their productivity. Thus, knowledge must be shareable to be of optimal value to an organization.

This study determined factors that contribute to individuals' technical knowledge sharing and provides propositions for business processes that organizations can adopt to ensure that their technical knowledge will be shareable. Using constructivist grounded theory method of qualitative inquiry, fifteen individuals in technical organizations participated in interviews to determine the factors that affected their sharing of technical knowledge. Through open-ended questions, these participants shared their experiences and opinions of technical knowledge sharing.

The findings in this study are presented in a theoretical framework comprised of 6 themes that emerged from the data gathered in the interviews. These themes define factors that contribute to technical knowledge sharing. These are: 1) sharing as a sense of responsibility, 2) values from knowledge sharing, 3) degree that sharing was affected by role, 4) impact of method on knowledge sharing, 5) obstacles to knowledge sharing, and 6) culture as it affects knowledge sharing. These themes are used to provide propositions for employers to consider when investing in technical knowledge sharing solutions for their organizations.

TABLE OF CONTENTS

List of Figures

List of Tables

Chapter 1

Introduction

Organizations are increasingly interested in information exchange as it relates to collecting internal knowledge, increasing innovation, and managing costs. With the impending retirement of the baby-boomer generation, organizations face a potential loss of their corporate knowledge. These concerns amplify the need for well-planned knowledge management (KM) systems to ensure knowledge retention. In order for KM solutions to be valuable to the organization, they provide access to the inclusive knowledge of the organization. This knowledge is derived in large part, through knowledge sharing (KS). Researchers have studied knowledge sharing in terms of the type of actual information shared (tacit versus explicit), and how widely the information is shared within the firm and across organizations (Nonaka, 1994). Knowledge sharing in relation to social practices (Brown & Duguid, 1991), the creation of internal communities (Wenger, 1998a), and the learning that occurs in a group as a result of sharing knowledge on-line is also of interest to researchers (Dwyer & Suthers, 2006). As business needs and technical capability to share information expand, so does the need to learn more about the factors that influence knowledge sharing and the practices for managing this knowledge which make it available for sharing.

Knowledge sharing, in the context of this study, is the intentional transformation of data into knowledge that can be used publicly or shared within an organization at a later date. There is significant documentation on theory and methodology for how KS occurs and its value as a capital asset to the organization (Hutchins, 1995; Salisbury & Plass, 2001; Silver & Shakshuki, 2002), and the contribution KS has provided to project-based management and

to the enhancement of learning in the workplace (Ajmal & Koskinen, 2008; Brown & Duguid, 1991; Sabherwal & Becerra-Fernandez, 2003). Theories of on-line collaboration; methods for gathering, sharing, and managing electronic information; and contexts used for providing information exist in abundance (Davenport & Prusack, 1998; Hutchins, 1995; Nonaka & Toyama, 2007). However, using proven methods for designing knowledge management systems and supplying tools to facilitate knowledge sharing does not guarantee that the individuals in an organization will use them (Appleyard, 1996).

There is a need in the research and business communities to understand the characteristics that may contribute to knowledge sharing (Allen, James & Gamlen. 2007; Silver & Shakshuki, 2002). Designers know that individuals will utilize information resources that are valuable to them (Kim, 2000). The perceived value of knowledge to individuals is determined in large part by the experts participating in social networks within which information is created (Kollock, 2003). Knowledge sharing is necessary for industry that depends on technical innovation. An engineer needs the history of past projects to begin a new project. Successful knowledge resources contain information that is derived from both tacit and explicit knowledge from past experience (Brown & Duguid, 1991: Wenger, 1998b).

Determining the factors that influence and encourage individuals' participation is necessary to create a knowledge resource that will be utilized. Understanding the business procedures that an organization requires for employees to document their work, and how, or if, the organization mandates employee contribution to share documentation, may also affect how individuals will utilize the KM systems (Conway & Silgar, 2002). Firms with permeable boundaries to their information encourage participation from everyone, regardless of role, in the organization (Tapscott & Williams, 2006). Additionally, individuals' culture of origin has

shown to be a key contributing factor in their communications in general, and may affect collaboration and knowledge sharing (Ardichvill, Maurer, Li, Wentling, & Stuedemann, 2006; Hall & Hall, 1989; Hofstede, 2001). This study seeks to understand the contribution of these factors to the matter of knowledge sharing as it occurs in technology focused research organizations.

Impetus

Recently a national research laboratory required the coordination of formal technical support for the users and developers of supercomputers. The individuals for whom this program was developed included the users of the system, the vendors of the hardware and software, and the developers themselves. This group was comprised of individuals who had the opportunity for face-to-face interactions and those who were working at distant locations who generally used email and telephone as their means of communication with those local to the laboratory.

The supercomputer industry is emergent, thus the development process is very dynamic, with frequent changes made as the systems are created. The software and hardware that operate the systems are custom designed for optimal code efficiency, and they continuously stretch the computational capability of the systems. Frequent changes are made to the systems as knowledge is acquired, consequently, the development history of the systems also change frequently. Although final achievements are documented through shared publications, developers rarely take the time to formally document the knowledge that they acquire through their day-to-day technical advances on the systems. Additionally, complete technical support history does not always exist. Thus, redundant effort is incurred as a result of developing solutions for repeated problems. Solution providers, not knowing

that the problem has previously been resolved (or how), address the problem as new. The ability to find a solution to an operational question is dependent on the socialization of experts who are currently working in the field. Developing the answers to these technical complexities requires managed collaboration.

In 2001, the Department of Energy issued their "Request For Procurement" (RFP) for the next national super computer to be developed. Prior to this RFP, technical support was provided informally to users by developers, system administrators, and other high performance computing users in a loosely organized manner. A directive was issued by the funding sources of this system that *formalized* support be included in the final deliverable. This would, in part, provide a means for users to request assistance, the ability for experts to collaborate on a solution, and the means to track the request history and generate associated metrics. After a thorough requirements gathering process, the results suggested that on-line user support would be the best method for providing the technical support needed by the users. This user support solution was designed as custom software and was centered on a resource base of shared technical knowledge. What was necessary then was a knowledge management tool to enable collaboration among individuals while providing a means to gather, manage, and share knowledge.

Within the high performance computing (HPC) development world, both information that is externally shared (explicit), such as documentation, as well as knowledge held internally (tacit) need to be shared to solve technical solutions. Informally coded information exists in databases, websites or other forms of electronically accessible documentation. Individuals developing technology through collaboration share their tacit knowledge by

means of social interaction. This type of information exchange is referred to as socio-techno processing (Pieterse, 2006).

An electronic application was designed to address the requirement to formally manage technical collaboration through the management of shared knowledge. This application was to serve as a tool for developing socio-techno outcomes into a knowledge management solution.[1] The identified requirements included the need for data gathering to be intrinsic to individuals' day-to-day work activities and to allow users to access and search the acquired information on their own. A project was created to supply the means for an organization to provide customer support to the users of the high performance computing systems that they were developing. The design and implementation of the application included classical software engineering, project management, application design, and implementation. The software designers worked with a group of experts who would be using the application to create a software interface to assist them in providing support while maintaining a historic collection of the work experiences for later access. To ensure satisfaction and usefulness, the developers met regularly with individuals (customers) for whom the application was designed. These customers gave feedback, provided ideas, and approved the interface design. Not all of the individuals from the customer "group" participated in the development. When the application was released for use, the customers who participated in the design were satisfied with the solution, while others refused to use it. Thus, not all of the individuals for whom the custom solution was built were willing to use it.

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[1] Collaborative Learning, Information, and Knowledge; CLIK. This web-based system was designed to use email and web browser interface to enable collaborative technical knowledge sharing. Intrinsic to the job at hand, it facilitated the gathering, managing, and sharing of knowledge as it developed among users and experts.

Research shows that an individual's reluctance to use KM applications in the organizational setting is not an unfamiliar response (Scholl, König, Meyer, & Heisig, 2004). This study considers factors that may affect individuals' willingness to participate in knowledge sharing and use of knowledge management applications.

The author of this research was the designer of the application provided for this technical knowledge sharing at the laboratory. The design and implementation of the application were customized for the needs of this customer base. In this case, there were competing projects, each providing a solution for management of technical information, which contributed a different bias on which to judge the use of the application. Therefore, use of this application was not a good candidate to include in this study. However, the experience gained by the researcher was very useful and provides a basis on which the study was formed.

Problem

Procedures to manage and enable the process of formal documentation do not exist in all organizations and sharing knowledge is entirely at the discretion of the individual. Typically, individuals will use the most readily available and convenient means to document their work. Use of diverse and informal documentation processes are the cause of significant challenges to making information accessible from a single source. With informal documentation there is no guarantee of the level of detail of information that will be gathered, or of the ability for the information to be accessed in the future (Hutchins, 1995). A common concern expressed by individuals is the lack of time in the workday to document their work or make contributions to a knowledge base. Electronic communication among individuals co-developing a solution is a form of informal documentation. This further

provides a means for gathering information intrinsically, which can enable the process of sharing (Davenport & Prusack, 1998, as cited in Sabherwal & Becerra-Fernandez, 2003).

However, providing access to information does not ensure that the members of the organization will use it. The knowledge value to the organization may differ from that to an individual. Learning, and hence accumulation of knowledge, does not occur in isolation. It is acquired through individuals' experiences and the experiences shared by their peers. Peer groups, specifically those who work together and share their knowledge, are organically formed communities of practice (CoP). The knowledge that is provided or gathered within an organization is productive when communities of practice within an organization are aware of each other and when the shared knowledge is being utilized. Hence, knowledge is valuable if the organization "knows what it knows" (Wenger, 1998a). Participation in a CoP process must be voluntary; it cannot be forced. Individuals will use applications that they feel are useful, those they gain value from. Therefore, the concern for an organization is to understand the essential factors that contribute to knowledge sharing within a community of practice.

Perceived usefulness and technology acceptance have been identified as impetus for users' participation in an on-line CoP (Wenger, 1998a; Kim, 2000). Earlier studies address the effect of the technology acceptance model (TAM) in the workplace, as it relates to user acceptance of technology and how users feel a specific technology may "enhance their work performance" (Davis, 1989). Individuals' informational and social environments also have been shown to have an effect on their adaptation of information technology (IT) in the workplace. This was explained in the social information-processing model or SIPM (Salancik & Pfeffer, 1978). Diverse interactive features exist for applications with web access, and

many are specifically designed to be attractive for use by experienced computer users (Kim, 2000; Carroll, 1998).

Early attempts for businesses to automate functions were met by employees' fear of their manual contributions being replaced by automated processes. John Seeley Brown and Paul Duguid address this as technologies designed to "down skill" (Brown & Duguid, 1991). They posit that organizations' attempts to modernize work processes could "threaten the robust working, learning, and innovating communities and practice of the workplace" (Brown & Duguid, 1991). Another consideration is that of knowledge transfers across organizations. Researchers Dyer and Noebeka (2000) studied the concept of inter-organizational routines designed to facilitate knowledge transfer in a method across organizations that they refer to as "production network."

My direct work experience has demonstrated that accountability for knowledge developed within an organization and making it accessible to other employees is a struggle. This is particularly a challenge for organizations whose business is developing new technology. One consequence of not having access to information is unintentional redundancy. Instead of being able to continue where another researcher has left off in their research, individuals may duplicate a previous study as a precursor to forging ahead with new ideas. Consequently, lack of access to knowledge can be a detriment to innovation.

It is common corporate practice that knowledge created by employees of an organization is considered the property of the organization. This knowledge is often referred to as a corporate capital asset. Knowledge is only valuable as an asset when it is tangible and accessible to others. The reality is that, foremost, individuals' knowledge is *tacit*. It resides within individuals and it is their choice to share what they know. Knowledge that is shared is

considered to be *explicit*. Not all *tacit* information can be converted to an *explicit* form. A challenge that business environments struggle with is this need to encourage individuals to make their *tacit* knowledge available to others within the organization. This can be facilitated through a means of fusing processes for knowledge management, learning technologies, and workgroup collaborations. Soren Kaplan (2000) suggests that this can be accomplished through seamless incorporation of community as a means to capture the information. His research demonstrates that this can be accomplished in part through shared need and trust.

Standards[2], methods, and theories on "how to accomplish knowledge management" are plentiful (Nickerson & Zenger, 2004; Nonaka & Takeuchi, 1995; Salisbury, 2003). Organizations define and implement operational processes according to standards, at times only to discover that individuals are unwilling to employ them. Employees will claim lack of time available to document work while complaining that they often must solve the same problem over again due to the lack of documented history.

Additional reasons given for lack of knowledge capture include project time constraints, cultural and social barriers, lack of motivation and lack of management support. These factors can all be affected by the culture of the organization (Ajmal & Koskinen, 2008).

This study aims to seek a solution to this problem by understanding factors that influence knowledge sharing.

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[2] The following are examples of organizations for IT Standards: ITIL, Information Technology Infrastructure Library; NIST, National Institute of Standards and Technology; ISO/ITS International Standards Organization/Information Technology Standards.

Background

Individuals acquire knowledge through an interaction or experience as defined in the Spiral of Knowledge Creation (Nonaka & Takeuchi, 1995). Figure 1 is an enhanced graphical description of the original Spiral of Knowledge Creation, adapted by this researcher to indicate the process of knowledge transfer within a corporation.

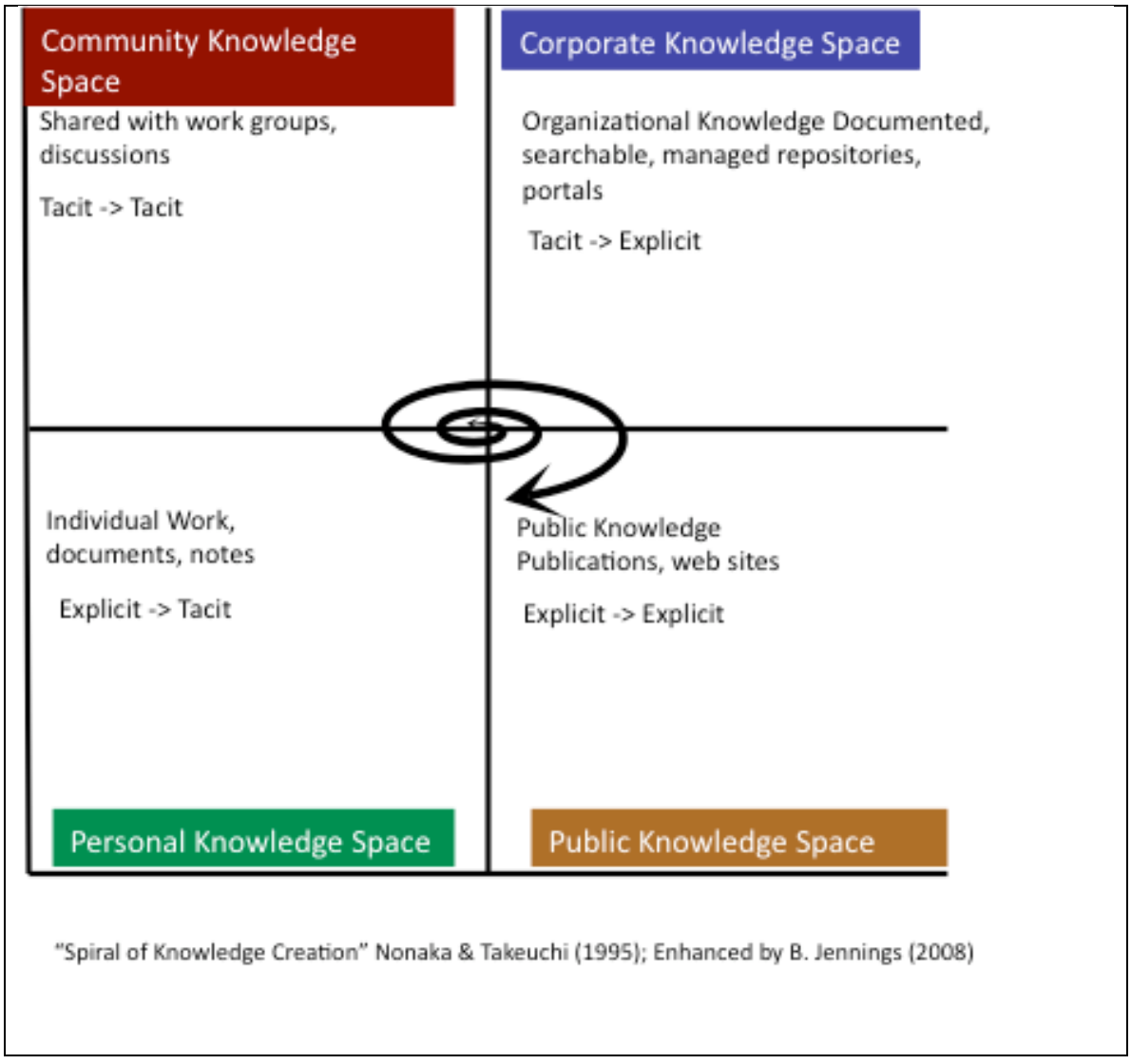


Figure 1. **Corporate Knowledge Sharing Process**

Knowledge is acquired through interaction. Edwin Hutchins performed research indicating that individuals do not learn in isolation (Hutchins, 1995). Literature exists indicating that individuals will work together in groups when they share a common interest (Wenger, 2004). These groups, or communities of practice, are often are created through organic formation, and initiated within informal work situations (Kim, 2000). Sharing of individuals' tacit knowledge is enabled within these communal settings (Leonard & Sensiper, 1998).

When individuals document their knowledge in a shared corporate resource, this demonstrates the process of knowledge transfer from tacit to explicit. Empirical data indicate that individuals at all levels of formation within a corporation (Individual, Group, and Corporate) benefit from the perceived effectiveness that comes from having a shared knowledge resource (Sabherwal & Becerra-Fernandez, 2003). Innovation is enabled when knowledge resources are accessible to others. This is the stage indicating explicit-to-tacit transfer of the knowledge spiral.

Software vendors and proponents of design to gather knowledge and manage business process will attest to the benefits that organizations can experience through implementation of software applications to enable knowledge sharing. To the confusion of many, however, automated applications don't always hit the mark that the company which implemented them had expected. This failure is generally in the use of the application by employees, rather than by the technical operation of the application.

This study identifies factors for organizations to consider when they design and implement an automated solution to enable knowledge sharing. It specifically analyzes the need of the organization is to regenerate implicit knowledge into shared corporate resources.

Hopefully, it also will assist companies to provide a useful business process for developing organization-wide shared knowledge resources.

Need for This Study

Industry is accustomed to accepting the adaptation of information technology (IT) to facilitate business operations. Organizations dependent on required IT infrastructure for communications and transactions are investigating strategies for managing business processes. They are designing ways for IT to facilitate workflow and contribute to the skills required for mission-critical systems, and at the same time they must be mindful of decisions requiring their financial investments. This automation affects the basic communication within an organization. Subsequently, the culture of the organization is changing, depending on the way the business utilizes IT (Vecchio & Kyte, 2008).

There is significant documentation of theory and methodology for developing "successful" knowledge management systems in organizations (Allen, James, & Gamlen, 2007; Davenport & Prusack, 1998; Silver & Shakshuki, 2002). Studies detail how knowledge occurs and its value as a capital asset to the organization (Conway & Silgar, 2002; Davenport, 2005; Nonaka & Toyama, 2007). Theories of on-line collaboration; methods for gathering, sharing, and managing electronic information; and contexts for using the information exist in abundance (Hutchins, 1995; Salomon, 1993). Recent studies provide data that report on individuals' perception of benefit that arises through knowledge sharing within organizations (Burton & Bailey, 2000; Sabherwal & Becerra-Fernandez, 2003). However, providing processes and proven methods to design and implement applications to facilitate knowledge management does not guarantee that the individuals in an organization

will use them (Szulanski, 2003). In other words, there is no assurance that knowledge sharing will actually occur.

Despite the given benefits of knowledge sharing and management within organizations, there is still reluctance by many employees to share what they know and to build a learning organization. Corporate managers and knowledge management experts ask, "Why don't individuals share knowledge more freely?" This study attempts to answer this question through first hand experience, literature, and the opinion of experts in the field gathered by means of a qualitative research design.

To validate the need for this research beyond person experience and the available literature, a pilot study was conducted. The pilot study consisted of a survey of 40 individuals who attended a technical conference that was specifically targeted to individuals and organizations who have interest in the super computing industry. The detailed results of the pilot study follow in Chapter 2. From the pilot study, the following five factors emerged as having specific influence on knowledge sharing: 1) culture of origin, 2) role in organization, 3) procedures for managing knowledge, 4) perceived value of knowledge and 5) media used for interaction. These factors were used to formulate the research questions in the second phase of the research conducted through administered interview.

Purpose

The purpose of this study was to determine if specific factors affect technical knowledge sharing within research organizations and to understand how an organization can ensure that sharing of technical knowledge will occur. This information was derived from data gathered through interviews and surveys conducted with individuals employed in the fields that conduct technical research.

Pilot Study

A pilot study was conducted through a survey and independent interviews with individuals who work in organizations where technical research is conducted. The purpose was to determine if there was commonality among these individuals' perceptions of how knowledge is shared in technical industry. Qualitative analysis was conducted on the data gathered in the pilot study from which validation was made to carry on further investigation. The results from the pilot study were used to determine the second set of questions to be posed in the final study. The questions posed were designed to enhance the understanding of how knowledge is shared by experts in a research-based industry. The goal was to formulate theory from the data and to determine factors that contribute to knowledge sharing based on the independent responses. Recommendations were made for consideration that should be given when implementing a knowledge sharing system into the organizational infrastructure. This method provided a heuristic approach to the study through derivation of research questions that could be altered based on the responses obtained.

Research Questions

The overarching question addressed in this study is, "Do specific factors influence technical knowledge sharing in a research industry?" Through results obtained from the pilot study the following five questions were derived as those to initially explore:

1) How does one's role within the organization contribute to knowledge sharing?
2) How does one's culture of origin affect sharing technical knowledge?
3) How are technical employees' perceptions of value associated with shared knowledge resources, affected by business procedures to manage knowledge?
4) What business procedures affect individuals' participation in knowledge sharing?

5) Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?

Analysis of data gathered from the pilot study indicated that each of these five factors can impact how individuals share technical information within an organization: 1) culture of origin, 2) role in organization, 3) existence of internal business procedures, 4) perceived value of knowledge sharing and 5) media used for sharing information. These results were a guide for the second phase of questions that were answered in this constructivist grounded theory research design.

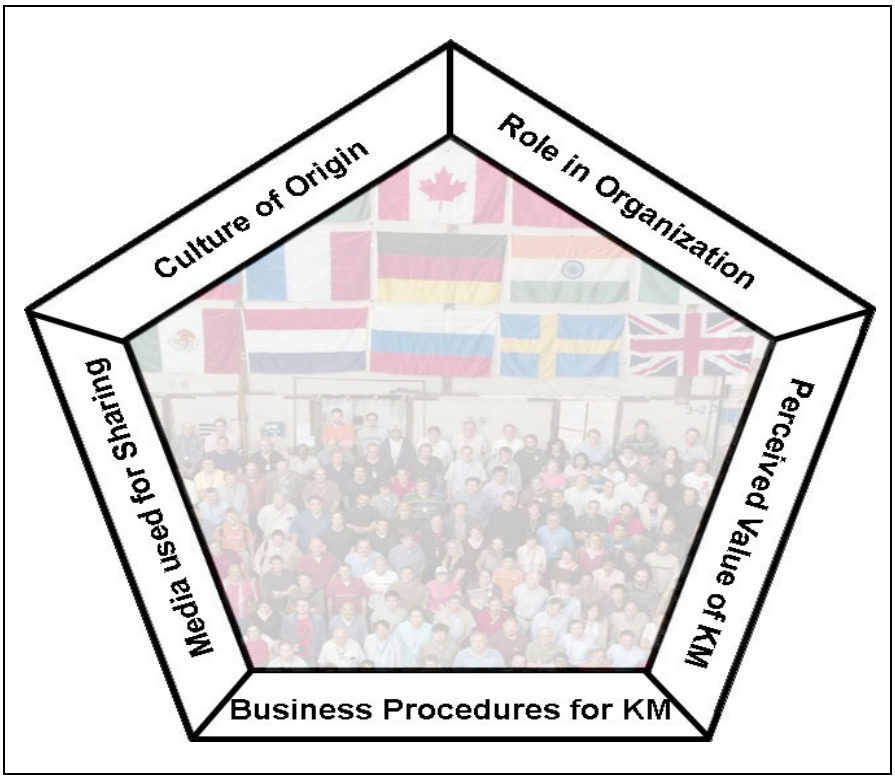


Figure 2. **Pilot study results: Primary factors contributing to technical knowledge sharing.**

Method for the Study

The methodology for this study is described in detail in Chapter 3. In general, this is a grounded theory study conducted through a constructivist approach. Grounded theory is

completed with the intent of developing theory from data. No a priori approach is used, as this may influence the outcome. The primary distinction that classifies grounded theory research as constructivist is that the results are derived through mutuality between researchers and respondents. Researchers are no longer objective observers. Instead, they work with respondents to construct the meaning of the interviews. As in grounded theory, constructivist researchers rely on constant comparison of results from each respondent and they apply subjective interpretation to derive theory. The rigor of this method is applied systematically by constant comparison of elicited responses, codifying those responses, and ultimately developing theory based on the outcome. This approach is a heuristic process driven by the opinion of experts in conjunction with the researcher.

Significance of the Study

It was the aim of this study to assist organizations that participate in technical innovation in determining if there are specific factors they should be considering when implementing a knowledge management system. The results of this research identified factors that contributed to individuals' willingness to share their knowledge and provide recommendations that an organization can utilize to design processes to enhance knowledge sharing.

Theoretically, the results of this study provide reliable information that can be utilized by organizations where socio-techno outcomes occur to facilitate knowledge sharing. These solutions also provide methods by which an organization may model their KM solutions.

Delimitations

The restrictions in this study are that the research gathered is limited to technical research organizations and, as such, may not be applicable to another industry. The analysis

generalizes the findings to the operations related to computing, thus the participants all have a level of expertise associated with the use of computer applications.

Additionally, the analysis to determine the effect of *culture of origin* on knowledge sharing is based on a very small representative set of individuals and does not fully represent the culture of an entire country. Previous studies were consulted to assist in validating cultural generalizations and to determine the expectation of how culture of origin might influence an individual's participation in knowledge sharing (Hofstede, 2001).

Lastly, the argument for generalizability of qualitative data in previous studies using qualitative design suggests that statistical generalizability cannot be made and that decisions about the generalizability of data belong with the reader (Eybe & Schmidt, 2001). In grounded method studies validity is measured by trustworthiness of the study. Validity of the research is based on informal triangulation of the data to previously completed research and informal member checking of the responses. The trustworthiness of this research is discussed in detail in Chapter 3.

Definitions of Terms Used in This Study

The following terms are used to provide specific descriptions of the findings in this research. To clarify their meaning, an explanation of how the terms are used in the context of this research is included.

Knowledge Management (KM): In this study, KM refers to the system of gathering, sharing, and managing knowledge used by an organization. Knowledge is collected from individuals' experience and discovery that occur as a result of socio-techno interactions in the course of their day-to-day work activities. The goal is to provide meaningful content that can be shared with others resulting in information that can assist a person in doing their job.

Knowledge: Knowledge is defined as an individual's experience or learning that has occurred. It may be presented in the form of an issue and resolution, case history, or as the result of a discovery. Knowledge, in the context of distributed information, is that which is shareable by individuals, and as such, is further associated by the relative importance of ownership and the value determination of the owner to share it with others.

Knowledge Sharing (KS): KS is the process that an individual consciously chooses to present their knowledge for access by others. It can be evidenced as the result of formal or informal documentation. The communication can occur in organic or intentionally formed groups or between individuals. Knowledge sharing is also defined as "the transfer of useful know-how or information across company lines" (Appleyard, 1996).

Community of Practice (CoP): In this context, a CoP is a group of individuals who share knowledge with each other while they are working on a common goal. In the work place, colleagues most often form CoPs in order to get their jobs done (Wenger, 1998a). These may be organically created groups or divisions identified through the structure of an organization. The core role of a community of practice is to provide individuals with like needs access to one another. This may include communicating with each other in the course of day-to-day work activities. The roles and context of information shared are not significant in this study. What is of relevance in this study is the ability of individuals to identify a resource, with access to colleagues and information, to assist them in doing their jobs. Also of interest is how one's culture affects the formation of the group and how the group consciousness affects participation in a KM system.

Culture of Origin: Culture of Origin is defined as the culture of the country that predominately influenced the traditions and normative social mannerisms of an individual

over a significant period of time: that which an individual is taught from childhood. It is widely believed that culture may influence how individuals communicate with others. In this study, the respondents defined their culture of origin.

Information Management (IM): IM is the management of content or collections of information. This process is necessary to facilitate organization of data.

Information Technology (IT): IT is the physical infrastructure that provides the operations of hardware and software for electronic communication. These systems enable creation, management, and sharing of data within the organization.

Information Systems (IS): Information systems are the application of human interaction and data that facilitate business processes within a provide IT infrastructure. These human interactions are facilitated by electronic means using a variety of media.

Chapter 2

Review of Literature, The Pilot Study Results & Grounded Theory Method Research

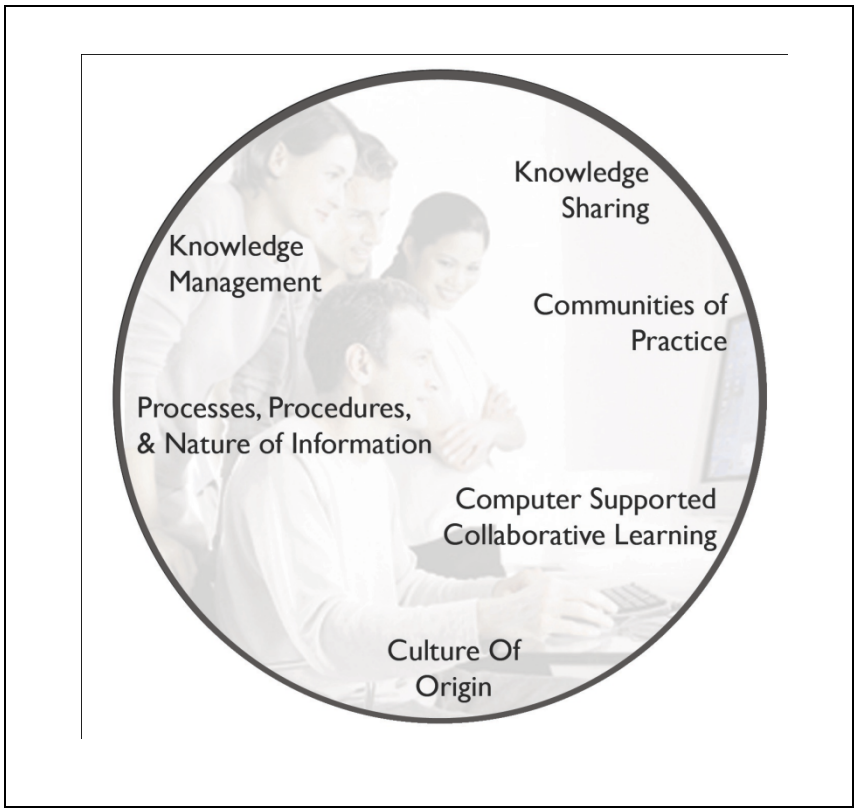


Figure 3. **Literature review topics**

This section will review areas of literature that are specifically relevant to knowledge sharing within organizations, the results of the pilot study and grounded theory as a method to study knowledge sharing. Areas of literature that were considered are: knowledge management; communities of practice; computer supported collaborative learning; processes, procedures and nature of information; and culture of origin.

Knowledge Management

In the work place, working, learning, and innovation are interrelated. The process for facilitating the interaction of these areas, labeled as Knowledge Management (KM), eventually contributes to the capital assets of an organization (Brown & Duguid, 1991). The information that is gathered becomes a beneficial tool for the organization at the time it is created as well as in the future. A company's reliability and security are built in part on the awareness of the existence of this information (Hutchins, 1995). With their knowledge history accessible, an organization is better prepared for meeting the challenge of rising competition.

It has been shown that integrated KM has positive effects on the organization (Allen, James & Gamlin, 2007). This is particularly true when knowledge that is held by an individual (tacit knowledge) is shared among groups within the organization and made accessible throughout the organization (explicit knowledge). Finally, making what is "known to some" widely available to others through publicly distributed information enables use of the knowledge for further research and innovation (Nonaka, 1994).

This is evidenced in a study addressing the use of knowledge management for problem solving, which created teams within the company as part of the solution (Nonaka & Takeuchi, 1995). In this context, the researchers illustrated Nonaka's Knowledge Spiral, a process of knowledge sharing, and the transformation of the knowledge through four zones as it is converted from tacit to explicit. Each zone requires a unique kind of thinking and interaction by those who use the information, which may occur among all role levels held by individuals within a company.

Nonaka's four-step knowledge transformation process defines a dynamic process of sharing knowledge among individuals. The basis of this process is the Japanese concept of *ba*. The direct translation of the word is place. The concept that it describes is the state of human existence, understanding, and cognition in concert with the creation of knowledge. Nonaka uses *ba* to describe the dynamic human process of knowledge sharing through the transformation of information into knowledge (Nonaka, 1998). The exchange of explicit knowledge among individuals and groups enables others to internalize the information for themselves. Individuals learn the tacit knowledge held by another individual though shared experience. Tacit knowledge is that which is well known to the individual to whom it belongs and which through use, becomes automatic. As the tacit knowledge is shared and used by others, it then becomes explicit. Explicit knowledge is exchanged among individuals and groups within four zones (See Figure 4).

These four zones are socialization, externalization, combination, and internalization (SECI). The role of each in the transformation process is defined as follows: internalization (explicit to tacit), externalization (tacit to explicit), socialization (tacit to tacit), and combination (explicit to explicit). Within an organization, the *internalization* process is demonstrated when an individual creates new knowledge from existing information that is shared (explicit to tacit). At this stage in the process, the information is internalized to the individual. As the individual shares this knowledge with the group of colleagues that he works with, the information moves into the *externalization* stage of the process. In this stage, the individual is making the knowledge understandable to others and may take on another form such as visual or graphical (tacit to explicit).

The next zone is *socialization*. In this phase, individuals share tacit information through interactions with one another. It is in this phase where mentors work with novices, ideas are exchanged, and information is built into common knowledge (tacit to tacit). This phase often requires face-to-face interaction and, as such, a degree of proximity to allow the interaction.

The last phase of the model is when knowledge enters the *combination* zone. Here knowledge is shared across an entire organization and can be accessed freely by other individuals within the organization (explicit to explicit). This can be done by means of electronic exchange as well as face-to-face interactions. Information readily accessible to all employees or members of a group entity enriches the entire organization.

In this study, the expansion of technical knowledge into the combination phase is considered fully shareable. The means by which information has been advanced to this level and contributing factors is of interest.

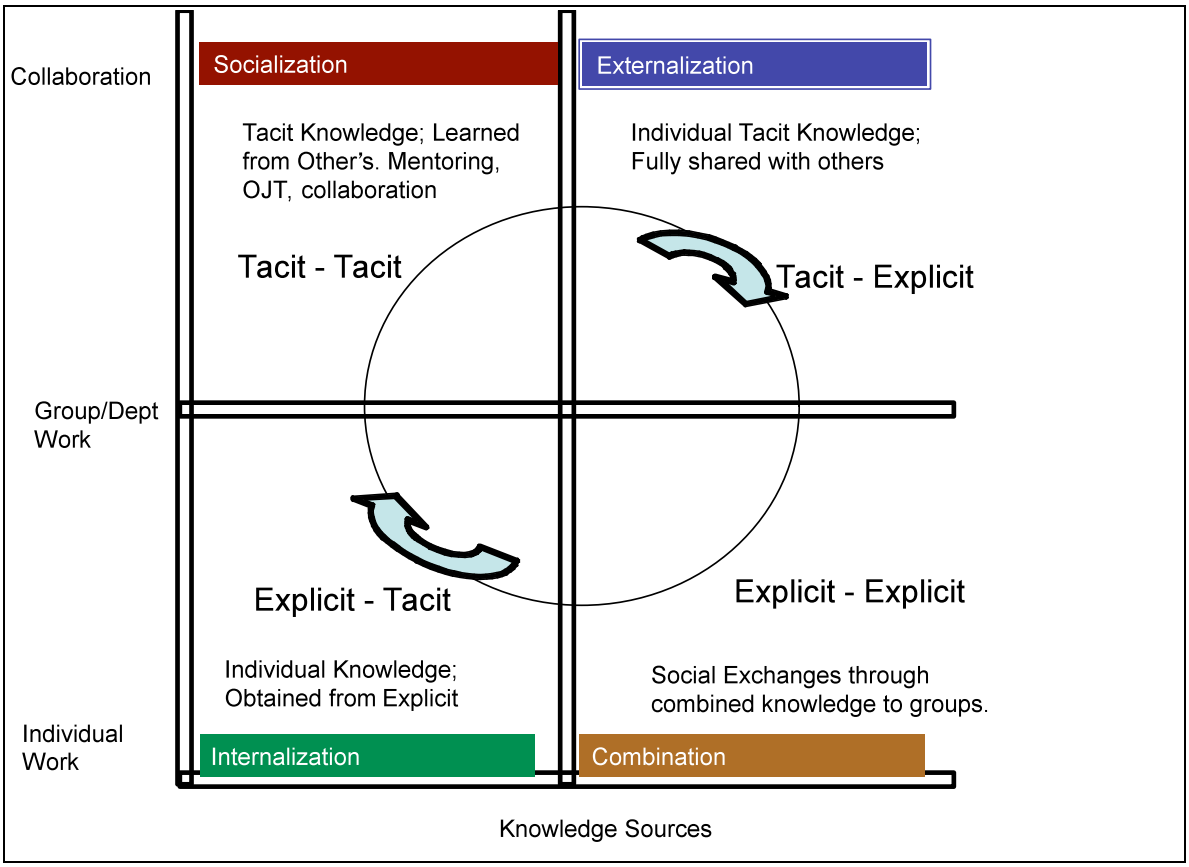


Figure 4. **Ikujiro Nonaka's spiral model annotated by B. Jennings 2007.**

Capturing the information and making it available is the immediate goal of KM. Nonaka illustrates how knowledge is transferred and transformed by means of the Knowledge Spiral. Tacit information exists in the minds of the experts and is shared by means of communications: electronic and verbal. As it becomes available for use, it is then transformed into explicit information. When the explicit knowledge is utilized, it becomes transformed back into tacit knowledge for another individual (Nonaka, 1994).

Further research on the application of this theory was conducted at the National Aeronautics and Space Administration, John F. Kennedy Space Center. The resulting analysis indicated a measurable perception of effectiveness reported by individuals working

alone, in groups, and within the organization when applied to Nonaka's four-step knowledge process (Sabherwal & Becerra-Fernandez, 2003). The researchers surveyed employees to measure their perceived effectiveness of knowledge management processes representative of activities that occur within Nonaka's Knowledge Spiral. For example, perception of internalization or explicit-to-implicit knowledge sharing was measured through learning by doing, learning by observation, and on-the-job training. The perceived value of externalization or tacit-to-explicit knowledge sharing was indicated in a problem-solving system based on case-based reasoning technology. Value was measured for individuals, groups, and the entire organization. High correlation between the predicted outcome and actual data points was revealed. The researchers found significant levels of perceived value for individuals varying from $R^2 = 0.16$ to 0.46 (0= no correlation, 1= perfect correlation, significant beyond 0.01). What is unique in this study is the measurement that the researchers made on the perceived value of these processes at the group and organizational level. Here the R^2 values were significantly lower than at the individual level. Perceived effectiveness at the groups-level was 0.67 and at the organizational-level was 0.74 (significant beyond 0.05) as shown in Figure 5.

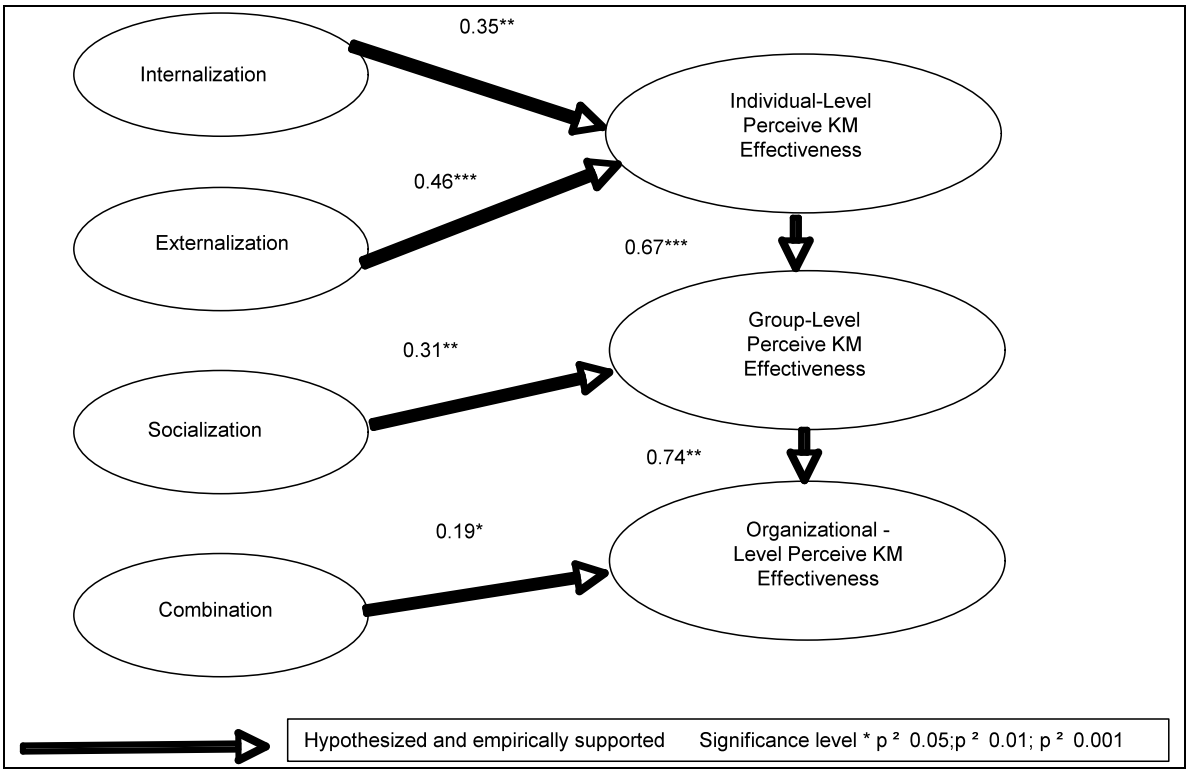


Figure 5. **Sabherwal & Becerra-Fernandez: The structural model for perceived effectiveness of shared knowledge.**

The process of capturing information is wide-ranging and requires consideration of knowledge management from both the objective sense of information as an object and the subjective sense of the individual's perspective of the value of the information to others (Brown & Duguid, 1991). The subjective perspective is discussed further in the Communities of Practice literature section that follows. The objective perspective values information as a separate entity from its creator, and consideration is given to management of the information as objects. From this standpoint, the procedure of documenting knowledge as an object and the access to it is considered outside of any personal knowledge creation or belief process that may have occurred (Sabherwal & Becerra-Fernandez, 2003). The lack of consideration

for an individual's personal contribution may add to the explanation of why, in general, individuals do not always share their knowledge.

Researchers Mark Salisbury and Jan Plass (2001) created an extension to the general definition of KM for managing knowledge in their Collaborative Cognition Model, which was designed for management of distributed knowledge in an organization (Figure 6). The Collaborative Cognition Model extends research of how people learn through the inclusion of technological solutions for KM. By defining the process for an organization to solve a problem, this model illustrates the transformation of knowledge that occurs through the transfer of individuals' knowledge from tacit to explicit. What is not shown in the illustrated model is the definition of information shared in the organization by category: factual, conceptual, procedural, and meta-cognitive. This model provides a KM process that facilitates access to documents as objects that are used in the day-to-day business processes of a research laboratory and the external organizations that it does business with. To understand the need to obtain information as it develops and changes within the environment, these researchers designed what they describe as a "living system." The theory that they put forth posits that diverse categories impact how knowledge is gathered and shared within various organizational levels. The authors assert that the varied categories offer capabilities for the capture and sharing of knowledge while learning is taking place (Salisbury & Plass, 2001). The researchers determined that for a solution to be useful, it must be a combination of technical and organizational design to meet the knowledge management needs by category. This model was designed as a KM solution for a national laboratory that shares information and work processes within the organization and externally to other affiliates. It proved very successful in this environment.

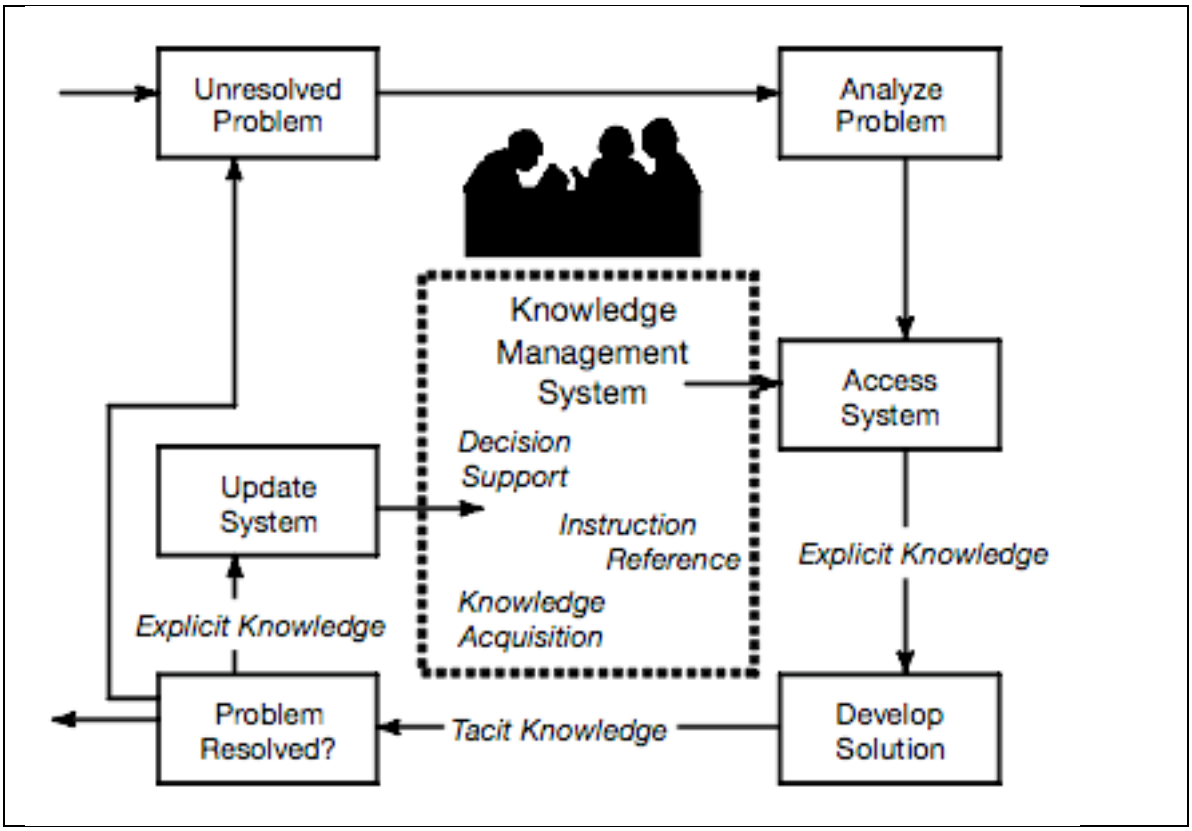


Figure 6. **Salisbury & Plass (2001). Workflow with the knowledge management system.**

Concentration on the physical components of information technology alone was a failure of early knowledge management models. To address this, researchers Silver and Shakshuki (2002) considered IT as a cooperative design of technology-centered and people-centered perspectives in a model titled Integrating Perspectives (Figure 7). The goal of this hybrid approach was to design management of organizational knowledge that works with the same efficiency as individuals. This model teamed the organizational IT experts who consider information as objects to be managed, with people-focused individuals who value life-long learning, knowledge creation, and creating an atmosphere of information sharing and trust. Also included in their model was the consideration of machines to automate processes in a means complimentary to the human processes. Using a four-step management

cycle of knowledge management, this model is focused on information, processing, and communication. Individuals consolidate information gathered through gained experiences, success and failures. As illustrated in this model, learning is a cycle or an iteration of end-to-end processes. Each endpoint provides knowledge for the next phase of information processing.

Silver and Shakshuki (2002) were early authors to discuss the difference between information and knowledge management. They address this primarily through the perspectives of IT-centered systems and people-centered solutions. The authors define IT solutions as processes that compartmentalize information into data objects that can be accessed for reuse. The distinction they make between the two is that people-centered solutions give recognition to the tacit knowledge that individuals hold. At a high level, the authors focus the differences between IT and people-centered systems as dependent on individuals' educational background and personal and professional motivations. Purporting that people-centered knowledge management is composed of three components: IT, people, and information, they designed a model of the knowledge management cycle. Based on the human process of transforming data and information into knowledge and then to value added information, the authors identify the cycle as a naturally occurring process (Figure 7). The authors distinguish the satisfaction that individuals derive from their ability to learn and obtain knowledge through experience as prime motivational factors. Discussing how organizations can mimic the human process as defined in the model, they found that small organizations are more competent at duplicating the human process for knowledge management. Their findings purport that this was due to necessity and the ability of a smaller organization to respond and organize more readily than large organizations. Interdependence

on one another in smaller operations, results in a higher level of synergy among individuals. Large organizations tend to develop and operate in disparate silos. Communication in large organizations is hampered by technical and political constraints, and there are a greater number of resources from which to cull solutions. Operationally it is harder to organize knowledge in a larger organization. The results of this research indicated that two specific areas are required for the success of this approach: creating environments of trust to enable sharing knowledge and defining and providing information through intelligent systems that can manage information based on how humans process knowledge (Silver & Shakshuki, 2002).

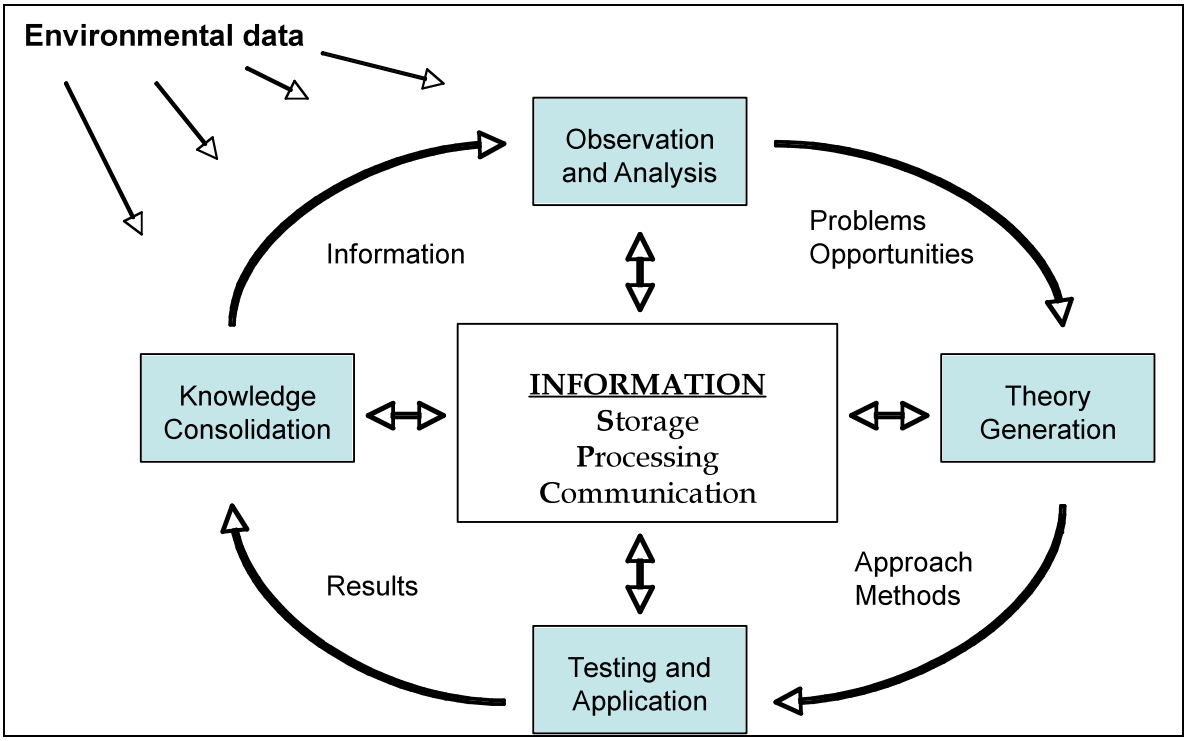


Figure 7. **Silver & Shaksjuki (2002). The knowledge management cycle.**

Respondents from the pilot study conducted by this research state that organizations frequently have difficulty getting their employees to use the KM solutions that they have

instituted. Documentation of successful implementations of KM is not common. Research by Ikujiro Nonaka and Ryoko Toyama (2007) provides examples of the success of companies who invested in future goals. They posit that the strategy of how a firm operates has impact on the way that knowledge is shared. Specifically, how the organization exists within the environment of their business world. Companies with a longer vision for their future tend to pursue values as goals rather than solely as a means of profit maximizing. They place a higher value on the subjective understanding that individuals have as tacit knowledge. This is in contrast to the short-term vision of the profit maximization firm that places higher value on knowledge that is tangible, objective and explicit. These researchers illustrate that companies with long-term goals value the opinion of the individual and encourage sharing of personal insights. Their model of a knowledge sharing firm defines a process of knowledge creation that centers on dynamic interactions and dialogues between employees within the organization and is influenced by the environment of the firm (Figure 8). Nonaka and Toyama (2007) define seven basic components by which the knowledge-based firm operates: 1) dialogue, 2) practice, 3) knowledge vision, 4) driving objectives, 5) knowledge assets, 6) the environment or *ba*, and 7) knowledge leadership. This model illustrates an organizational strategy for knowledge sharing and uses the earlier discovery of SECI to encompass the processes of dialogue and practice and *ba* to describe the environment as a context for sharing (Nonaka 1998). Operating as an interdependent ecosystem, organizational differences depend in large part on their multilayered *ba* as the foundation of their knowledge-creating activity.

Dialogues in this process are used to create knowledge rather than form logic. In earlier works, the authors state that knowledge creation is a process of synthesizing contradictions (Nonaka & Toyama 2002, 2003 as cited in Nonaka & Toyama, 2007). Synthesis is accomplished through dialogue and the understanding of how conflicting views may be considered as a part of the whole rather than as absolute truth in themselves. Using an

example of process at Toyota, employees at every level of operation are encouraged to ask "Why?" five times in a day. The concept here is that having to rethink the basis for an idea enables one to look at the idea at its core and thus enable synthesis of contradictions that may occur. Engaging in this process enabled Toyota to address the contradiction that existed between cost and quality. Toyota was able to create processes that made high quality possible through lowered manufacturing costs.

This synthesis, or knowledge, is shared by being put into action through practice. In the SECI model, this is identified as socialization; the process of converting explicit knowledge into the tacit state. The authors discuss the value of active reflection in this process. Through consideration of constant improvement capabilities employees are asked to look at an outcome for how if might be improved in the next iteration. This process directs the practice of reflection towards the possibility of constant growth of knowledge.

Organizations are directed by their knowledge vision, the inspiration of intellectuals' passion for creating knowledge. Designed to inspire employee's individual creativity, this process combines the practical (objective) facets and individuals' subjective beliefs into future-creating knowledge. This is illustrated in an example given of a Japanese pharmaceutical firm that believes that rather than being market driven, productive conceptual advances in their business also come from the social viewpoint. The firm sent employees to work in nursing homes to understand the needs of the elderly patients. The result was the design of medications that dissolve to ease the difficulty of elders having to swallow pills.

The driving objective in this model refers to concepts, goals, and action that are continuous and without a specific end. Driving objectives influence the organizational *ba* through a commonly shared ambition that everyone in the company strives to attain. The researches provide these examples of driving objective: cashflow, cutting opportunity loss, and clearly defined concrete goals for which to aim. In another example provided by the authors, the Japanese motorcycle company Suzuki set a goal to develop a scooter than

equated cost to engine size, 1cc=1000 yen. Achieving this goal involved the entire company from design engineers, to production and marketing. The result was a scooter built by adding only the necessary parts for operation to the bare frame.

Knowledge assets as defined in the knowledge-creating firm model, consist of assets that are actual and already known, as well as intangible assets, which provide a base for creating new knowledge. This knowledge is based on the whole of an organization's social capital. It includes the knowledge of the workers with what is known by others within the operating environment of the firm, including customers, suppliers, and other research facilities. The Eastern concept of knowledge is different from the Western perspective. In the Eastern philosophy, seeing something for what it is, actually means seeing if for the possibilities of what it may become. Thus knowledge assets become subjective and dynamic, tangible and intangible, essentially an expansion of capability. The authors include one firm-specific knowledge asset of *kata*. *Kata* is the process that defines how dialogue and practice are accomplished in an organization. In English, the word *kata* translates into "pattern" or "way of doing things." There are three steps to *kata*: 1) learning or mastering a process, 2) breaking out of the pattern of the learned process, and 3) creating a new process or routine. This continuous process is dynamic and unique in that it provides self-renewal through feedback. Firms that consider *kata* are directed into the future through past experience.

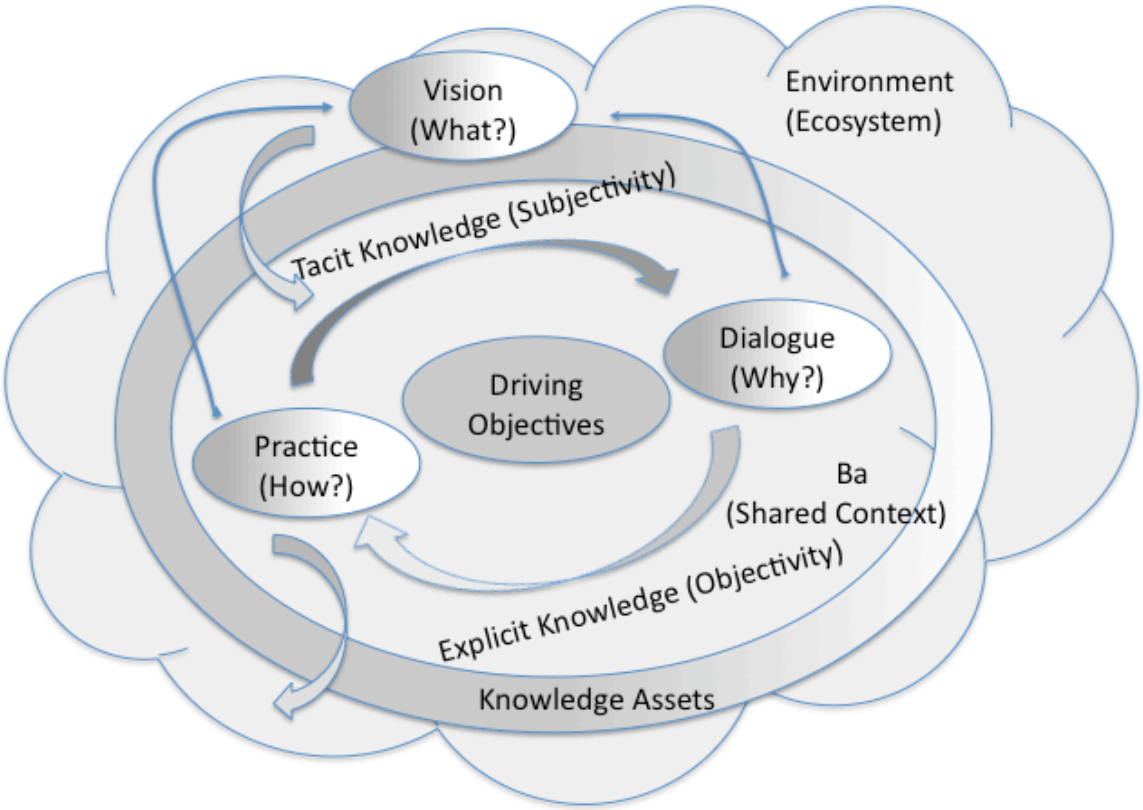
The last element that is central to this model is that of knowledge leadership. In a knowledge-creating firm, the role of middle leadership has a very significant role. Unlike top-down or bottom-up approaches it is crucial for these managers to be able to interpret and distribute information between knowledge workers and top leadership. From this requirement, the classification of the "bottom-up-down" style of management emerged.

Consistency is essential in a knowledge-creating firm. Every member of the organization is considered as a contributing source, and it is not enough for upper level

management to set a vision. They must exemplify the behavior required to see the attainment of the vision.

The role of leadership also involves contribution to the *ba*. Leaders must organize, promote and facilitate the practices in the organization that contribute to the continuous operation of a knowledge-creating environment. The authors discuss the additional requirement of leadership to energize the *ba* of the firm through the contributions such as: autonomy, creative chaos, redundancy, requisite variety, love, care, trust, safety, and commitment (Nonaka & Toyama, 2007).

These are new considerations for managers of traditionally Western style of management. The inclusion of long-term vision verses short-term, the necessity to value the individual's subjective contribution and application of this practice by everyone in the organization are not common characteristics of a traditional Western form of management.



Source: Nonaka and Toyama, 2007

Figure 8: **The model of a knowledge-creating firm.**

One final example of the process illustrated by a knowledge-creating firm is seen in Honda. Now a global market leader, they began as a small motorcycle company in Japan. The long-term vision of Honda was to enter the global automobile market was stated in the company's mission as a goal in the 1950s, and it continues to direct the company today as evidenced in the current philosophy statement as follows:

> We see the world not as it is, but as it could be.
>
> We see the world through the eyes of dreamers. Because we are a company founded by a dreamer. And we are a company built on dreams.
>
> We see the pursuit of impossible dreams as an empowering force, capable of

producing revolutionary ideas. Dreams inspire us to create innovative products that enhance human mobility and benefit society. Honda encourages all of its associates to pursue their dreams. And it's our mission to share these dreams with others and to make them a reality.

We see "The Power of Dreams" as a way of thinking that guides us and pushes us forward. The strength of our company comes from this philosophy — which is based on the visionary principles of our founder, Soichiro Honda.

We see things from a global perspective, always striving to create and produce products of the highest quality at a reasonable price for worldwide customer satisfaction. The power of Honda's dreams will continue to lead to new insights and technologies in automobiles, motorcycles, power products, parts and other fields of mobility.

We see it as our responsibility to serve humanity through our global commitments to helping protect the environment and enhancing safety in a mobile society. In every endeavor we pursue, we strive to be a company that people all over the world want to exist.

We see a bright future fueled by the Power of Dreams. Can you see it, too?[3]

Communities of Practice and Social Networks

The subjective perspective, or information as knowledge valued by individuals, is taken into consideration as a factor of interest in this study. In the work environment, individuals create information within dynamic communities (Wenger & Lave, 1991 as cited

[3] Honda Philosophy Statement retrieved from http://corporate.honda.com

in Wenger, 1998a). Cultural adaptations can be seen emerging within these communities that enable participation. Defining contributors' roles as an association within their area of expertise or level of knowledge is one way that the users of the information will associate a level of value to the community (Kim, 2000). Public acknowledgement of users' contributions to a web presence may associate a value to one's contributions. The presentation of metrics for individuals' contributions can also serve to encourage participation and encourages community growth. Privileging by allowing control of the rights of creation of information to the originator encourages participation through a sense of ownership and control (Wenger, 1998a). Knowledge sharing is also affected by the "economies of cooperation" or the reciprocal interaction that occurs in sharing information (Kollock, 2003). The Internet provides a world of minimally controlled direction and therein lays the opportunity for chaotic operations. It is curious, then, to monitor unrestricted information exchange and to understand the drive that invites such cooperation. Oftentimes these exchanges occur among individuals who have never met or spoken to each other.

Information exchange develops within social networks and social networks develop out of information exchanges. Individuals' interaction with each other can serve as a precursor to consensus that is derived from agreement through these interactions. Individuals are influenced by each other through interactions. The opinion of a highly regarded individual can influence the perceived validity of information. The impetus to participate in the community is dependent in large part by the number of individuals participating in the agreement. This is the basis of social impact theory (Nowak, Szamrej, & Latané, 1995). In addition to influence is the question, "What is the effect of an individual's social skills on the successful outcome of a business?" A recent study presented significant findings which

illustrate that successful entrepreneurial businesses in the technical industry were positively influenced by individuals who exhibited skills in: social perception, impression management, persuasiveness, social adaptability and expressiveness, and emotional intelligence (Baron & Markham, 2003). Successful social networks within an organization are similar to those in entrepreneurial businesses. They are developed in large part from innovation and discovery that occurs as people work together to solve problems and meet their knowledge needs.

An additional form of social networking is "coopetition." Researcher Wenpin Tsai (2002) explains this as a term to represent knowledge sharing that occurs in a multiunit organization consisting of lateral work units. These work units need to share information at the same time that they have to compete with each other for internal resources. In his study he found that without effective coordination, knowledge would not flow evenly across the work units. His research demonstrates that increasing centralized hierarchical structure and social interaction among the distinct work units encouraged internal knowledge sharing among the individuals in unique work units (Tsai, 2002).

Social networks develop naturally from face-to-face interactions. Individuals in high tech industry, even when provided with the newest telecommunication technologies, prefer to share what they know within a personal situation (Pollard, 2006). This information was an unexpected result from the pilot study as well. Social networks that are encouraged as noncanonical (spontaneous) versus canonical (espoused) practices produce valuable practices by the participants (Brown & Duguid, 1991). The knowledge creation process is continuous and expanding. This occurrence of a network is encouraged through social networks. Although tacit knowledge cannot be captured, the members of a social network have a clear understanding of who knows what. Processes for explicit documentation of knowledge

management are not necessary for all of the information (Smits & de Moor, 2004). Spontaneous, internal sharing of information leads to trusted relationships.

Industry historically has placed emphasis on providing applications for knowledge sharing. This is useful for information that has already been gathered and managed in an accessible repository. This focus on managing existent data, however, does not take into consideration the necessity to provide an environment in which knowledge is initially being created or gathered. It is necessary to develop an environment that collects knowledge as it is being created. Marleen Huysman addresses this in her research by identifying that the individual's willingness to use KM applications is influenced by the organization's perception of the value of information technology separate from the social environment (Huysman & Wulf, 2006).

In the technical industry, information is typically managed electronically and access to on-line sharing occurs in a community of practice. Individuals will participate in a community that offers useful information (Kim, 2000). Experienced computer professionals have expectations for on-line resources among which are: accessibility, ease of navigation, and the usefulness of information. Access to the community must be efficient, reliable, and timely. Navigation tools should provide an intuitive approach to access the data and are particularly appreciated when a level of custom configuration is available. Individuals who access an on-line "site" for information do not want to have to figure out the tool to get information. Nor do they want to have to read pages of data to find a simple answer. The information provided must assist them in doing their work (Carroll, 1998). Extraneous information and "filler" are not valued by the experienced computer user who is searching for knowledge.

The space and the software applications need to be flexible to allow for the dynamic requirements of knowledge creation by means of socialization, but providing this capability will not guarantee knowledge sharing. A community evolves as socialization develops. In technical industries this development is socio-technical and is largely based on social networks that develop along with the solutions. There are many variables that affect social networking and an individual's choice of inclusion. For some, there may be an economy of scale issue where individuals judge whether or not they will make a contribution based on reciprocal arrangements. For others, the idea of group learning and benefiting the organization is an impetus to participate. In research and development (R&D) communities, informal networks have shown to be more effective for knowledge transfer than formal organizational structure. Formal structure tends to restrain knowledge transfer by enforcing boundaries. Formal structure can inhibit spontaneous information development though myriad of processes that essentially restrict communication (Allen, James & Gamlen, 2007).

Peer-to-peer production networks are another example of emergent and unrestricted social networks that enable knowledge creation. Members cooperate to develop a resource out of a "common good" without the requirement of hierarchical control (Saveri, Rheingold & Vian, 2008). In an expanded idea of social networks within the organization, Rheingold identifies the next generation of the sharing of information through "swarms" and "smart mobs" where through the use of Internet technology, organic networks form on a global basis (Rheingold, 2003).

Processes, Procedures, and Nature of Information

Standards provide a framework and a systematic approach to business operations. The question that we ask is, "Does implementation of standards positively affect individuals' participation in sharing knowledge?"

Management generally agrees upon the effective utilization of standards in an organization; but the same benefit is not always seen from the employee's perspective. Thomas Davenport (2005) reports that there are not many studies directly related to the study of business use of KM process and its contribution to an organization. He purports that in order for a business to function properly at least three business processes must occur: activity flow standards, performance standards, and process management standards. An organization that provides these capabilities can identify how work is done and measure how well it is done. Of interest is that these processes are all top down approaches to dictating how work will be completed within an organization. Use of these processes is then mandated to the employees. Davenport references the Software Engineering Institute capability maturity model (CMM), which encourages repeatability in process and insurance of reliability. Still lacking in this work is how individuals are actually using the process to encourage KM creation (Davenport, 2005).

John Seely Brown and Paul Duguid (1991) suggest that there is a variance between the way that organizations formally document processes and the actual work that is performed. Specifically, the documented processes omit the details of abstract knowledge that occurs out of necessity in day-to-day work performance. Predefined processes do not always address all of the required steps. This omission of actual practice becomes a source of opposition for employees and a detriment to them doing their work.

The Software Engineering Institute at Carnegie Mellon also released a version of process management referred to as the people capability maturity model (People CMM). This framework, designed to address the critical people issue is based on: best practices in human resources, knowledge management, and organizational development. This model provides a process for organizations to implement continuous improvement of the processes for managing and developing workforces. Intel Corporation uses a hybrid approach of the People CMM and Six Sigma[4] to produce accelerated quality improvement. They reported that the business impact over a three year period was a business value of $138-$277k (Lutz, Isenberger, Zevenberger, 2008).

Computer software is designed using standard protocols for operation. In this way programmers can have an expectation of operation from which to design software codes. SystemC [5]is an example of an IEEE standard that was designed for standard communications among technical individuals who work with electronic system-level design. Unlike top-down approaches to KM, technology experts in the Open SystemC Initiative (OSCI) promote SystemC. This standard has been accepted and used worldwide by user groups in industry. Increasingly, system designers report that use of this standard has increased interoperability and reuse in models that are developed using this standard. Fujitsu employs a SystemC methodology for development, modeling, and training and claim that it shortens time to start-up (D&R Headline News, 2007).

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[4] Originally developed by Motorola in 1981, Six Sigma is a method used by business to achieve quality management through identification and correction of error.
[5] SystemC is a set of standard codes promoted by Open SystemC Initiative (OSCI) which allows C++ programmers a defined operational environment to code with expected results.

Even though industry agrees that process standards are a major contributing factor to KM, this is not an assurance to such processes being utilized by the employees of an organization. The Fraunhofer Competence Center for Knowledge Management and the Institute for Psychology of the Humboldt-University in Berlin initiated the First Global Delphi Study on "The Future of KM" in 2001. The statistical interpretation, completed in 2002, indicated that organizational, technical, and emotional responses are the biggest barriers to KM implementation. Stakeholders must be openly supportive, the technology must be integrated into the daily business processes, and the IT systems must be well matched with the usability (Scholl, König, Meyer, & Heisig, 2003).

A case study conducted by a Canadian firm provides a different perspective on KM. This KM system provided an integrated framework of quality management and knowledge management. The functionality of this system was designed for the group that provided technical support for users a national telecom corporation. It provided metrics of the services supplied, past support experience, and knowledge solution resource to the support team. Instead of concentrating solely on business processes for KM, management at TELUS[6] supported the definition of process for IT operations. The framework was centered on people, process and technology. This resource gave assurance to the TELUS employees enabling them a level of trust in the applications when sharing information. It served as a resource for knowledge and training. A challenge that was met by the application was balance of the data control enforced through standards while still maintaining openness to allow innovative

[6] TELUS is a Canadian Telecommunications Company.

thinking. Of interest to note, is that the organization's management mandated use of this KM solution (Krell & Wiseman, 2004).

Culture of Origin

The direction of the global economy is affected by the way that individuals share knowledge in business and industry. Companies doing business outside of their domain of origin introduce an additional complexity that needs to be considered in KM: cultural differences. Cultural values influence the way individuals share information, contributing to competition and trust, in some cases. Expectation and recognition of roles within industry or firms can differ greatly among cultures, and this can affect collaborative opportunities. An exploratory study contrasted use of KM systems by employees of an international firm (Caterpillar, Inc.) in three countries: China, Russia, and Brazil. Research exploring the cultural difference in information seeking and knowledge sharing through on-line corporate resources, indicated that method of communication is also a factor; i.e. face-to-face, telephone, email. The study of these three countries was completed using on-line research. The findings indicated that the cultural influence is great enough for the researchers to recommend that, at a minimum, a company planning to implement a KM solution in another country possess a thorough understanding of the cultural values of those individuals who will be using the system (Ardichvili, Maurer, Li, Wentling & Stuedemann, 2006).

In a study of the semiconductor industry, Melissa Appleyard's (1996) research compared inter-firm knowledge exchange by two countries: Japan and the US. This study considered knowledge sharing among competitors external to an organization, what Appleyard refers to as "the transfer of useful know-how." Her findings show that companies in emergent industries have a rapid pace of technological change, and need to share

information with one another to increase their innovative capability. Knowledge sharing in this environment is influenced by reciprocity. In this study, she identified three unique means of sharing channels: private (email, telephone, face-to-face meetings, and consortia), public (publications, trade journals, conferences), and restricted (limited distribution). Appleyard's hypothesis was that individuals in the U.S. would be more inclined to share knowledge via private channels than their Japanese counterparts, in part due to the higher turnover that occurs in this industry in the U.S. adding that reciprocity would be a contributing factor.

Appleyard found was that none of these influenced knowledge sharing. The two factors that did have an influence were type of business (integrated circuit) and individual's tenure at the company. Additional findings were that individuals in the semiconductor industry in the U.S. were more likely to share knowledge via private channels and those in Japan were more likely to share via public channels. Appleyard attributed this finding, as specifically related to country legislation for intellectual property. The regulations on filing patents differ greatly between the U.S. and Japan. Appleyard reasoned that knowledge sharing in Japan is encouraged by Japan's "first to file" patent creating system. In Japan, patents are issued based on an idea and there is a *race* to the patent office with ideas. In the US, patents are filed by first to invent. An idea must be fully developed and adequately operational before the originator can secure property rights over the idea, even when others use them. In general, within the semiconductor industry, Appleyard's study found that country of origin did not have a significant difference on participation in sharing knowledge. The difference was more heavily weighted by each country's legislation for patents (Appleyard, 1996).

The most widely cited study of cultural effects on the individual is the study of IBM that was completed by Geert Hofstede (1980). Hofstede categorized culture based on the cultural norms that he defined as: *power distance, individualism* versus *collectivism, masculinity* versus *femininity, uncertainty avoidance, and long term orientation.* Of particular interest is how individuals may conduct themselves in the business setting based on the category that typifies their country of origin. *Power distance,* in part, refers to the expectation of individuals that "power" is distributed hierarchically. It affects the way individuals interact with individual as various levels of superiority within an organization and how they participate within the organization.

Collectivism and *individualism* are terms that define characteristic traits of society by culture. Generally, individuals living in a country that is considered *collectivist* place high significance on the belief that family is a core value. They tend to see every other group that they interact with as an off-shoot of family. Their actions are influenced by considering how their contribution will benefit the family, the organization, those beyond one's self. This perspective flows over to their place of employment where they consider work for the good of the organization before their individual benefit. One effect experienced by individuals from a *collectivist* country is the belief that sharing of one's accomplishment is like bragging and, as such, not acceptable (Ardichvili, et al., 2006). In contrast, within a society that is characterized as *individualist,* people tend to place themselves first and work for individual gain. This affects employee to employer relations and working style through prioritization of task versus relationship. It further influences whether individuals prefer to work alone or in groups. Those whose origin is an *individualist* country may resist attempts at collaboration (Jones & Alony, 2007).

The category of *uncertainty avoidance* associates the threat that individuals feel based on ambiguity or uncertain situations. The effect in the work place is the necessity of giving greater consideration to rules and processes to ensure predictability. Hofstede (2010) posits that individuals from countries defined as high-level *uncertainty avoidance* also have heightened emotional responses and often express nervous energy when in a situation that is uncomfortable. These individuals have a strong need for exactness and understanding of expectations of operations (Hofstede, 2010). This would need to be taken into consideration when creating processes that allow for ad hoc interactions. Individuals from differing cultures would have nearly the opposite expectation for the required rules in the workplace. They would also contrast widely in their individual comfort levels associated with sharing information and the rules that need to be in place to facilitate knowledge sharing.

An example of cultural differences of sharing knowledge in the work place is demonstrated in the Japanese philosophy of *kaizen.* The English translation is, "continuous improvement." This system involves every role level of employee and every level of operation in a company. It is a long term investment approach of process improvement which contrasts with the Western point of view of "leaving well enough alone" or "if it isn't broken don't fix it" and immediate approaches to profit making. Every employee is seen as one who contributes value. The company is seen as a team and this team spirit fosters morale. Kaizen also is representative of continuous learning and knowledge sharing in the workplace where employees study methods to make them better, more efficient, and more effective (Elsey & Fujiwara, 2000). An often referred to case in point is that of the Toyota auto manufacturing company. Toyota's knowledge network demonstrates three areas of knowledge sharing that are typically problematic for other organizations. These are: 1) motivation of members to

share knowledge, 2) the ability to prevent "free riders" - those who do not contribute but do use the information, and 3) reduction in costs associated with knowledge gathering. Their success is not only due to an internal policy of learning and sharing, but they also share knowledge with their suppliers (Dyer & Noebeka, 2000).

In January of 2010, Toyota's reputation took on a completely different perspective, one of a company that could not be trusted. Their downfall stemmed from their management's decision to overlook a manufacturing problem that was brought to their attention by one of the line employees up to three years earlier. Instead of management addressing the problem properly, consumers who experienced problems from sudden acceleration and bad braking brought the failure to the attention of the U.S. National Highway Traffic Safety Administration. The result has been for the company to issue several major vehicle recalls in the U.S., Europe and China totaling over 11 million cars. This raises the question, "Why did a company known for their knowledge sharing, which had served as a leader in the automotive industry for 30 years, and had laid a solid foundation for the country of Japan to be known as an industry leader in automobile production, fail to respond to a known error?" (The Associated Press, 2010).

Toyota representatives have been brought before the U.S. Congress to answer this question and the company is fielding thousands of lawsuits (Charette, 2010). As the case in currently being addressed in courts it will be some time, if ever, that the answer to this question is known. What is known is that the company "lost face" and placed the whole of Japan in a position of shame. Entirely new management was put in place and they are trying to take corrective action to regain the confidence of the consumer and regain their place in the global market (Glionna & Masters, 2010).

Whether it was management's fear of losing market status or the failure or the problem to be shared with management are still to be uncovered. Either of these situations can be explained by societal pressure in the Japanese culture. First, shame or losing face is a situation that individuals in Asian cultures want to prevent for themselves, as well as for others. Secondly, the power distance between employee ranks may have kept the information from being brought up to the appropriate level of management in a timely manner.

It will be of interest to watch the methods that Toyota employs to recover from this situation and to regain the trust that they have held for many years in the auto industry.

Computer Supported Collaborative Learning

Socially based structure for knowledge sharing is also proven in research on Computer Supported Collaborative Learning (CSCL). Literature on CSCL maintains that computer systems can enable group processes in ways that face-to-face interaction cannot. This goal of the CSCL process of collaboration is to facilitate learning and allow individuals to gain knowledge through work experience, learn from the experience, share it with others, and then through peer review further their learning. In his chapter on e-Learning environments, Som Naidu (2003) presents a framework for individual learning as the basis for Computer Supported Collaborative Learning. Through a problem-solving example, Naidu defines a four-step method of action that begins with an individual collecting an incident report of significance from their work place. After codification, they enter the data into a log, which is then shared electronically with their peers. This step allows individuals to reflect on their response and self-evaluate it critically to see how they might have altered the process. Peers then begin a collaborative process through critical review of each other's logs. In this last step, individuals contribute their reflections to their peers' logs. In this phase they can see

where their individual theoretical knowledge differs from or is on the mark with others' (Naidu, 2003).

If the goal of the organization is to gather or facilitate knowledge sharing through use of a software application that provides CSCL capability, consideration must be given to the flexibility of the application. Studies have shown that social shaping of technology occurs when individuals will use an application in the way that is most useful for them. Unplanned use may cause a drift in the ability to gather the desired knowledge. In a recent study of the use of CSCL in the classroom, Dutch researchers Overdijk and van Diggelen (2008) found supporting evidence that given a tool without definitive procedures for use, students developed reuse of the tool to meet their needs. A recommendation then is due to the diverse possibility of use. If specific learning goals are to be met then the software application and the desired use must be carefully introduced to the prospective users (Overdijk & van Diggelen, 2008).

Literature concludes that many factors contribute to how individuals work together and particularly how communication occurs within an organization. From this literature, five factors that commonly exist in businesses of technical origin were chosen to determine if they have an effect on knowledge sharing. These five factors are: culture of origin, role in organization, procedures for managing knowledge, perceived value of knowledge, and media used for interaction.

In addition to the review of literature, a pilot study was conducted in order to determine how knowledge sharing occurs within technical industry. Technology changes with great frequency and knowledge sharing are common occurrences required to perform

day-to-day work functions and to create new sources of hardware and software. The study description and findings follow.

Pilot Study

In order to determine the feasibility of studying technical knowledge sharing, a pilot study was conducted in November of 2007, in which 40 surveys were administered randomly to willing attendees of the Super Computing Conference held in Reno, Nevada, USA. The goal of the survey was to collect a first level of data to determine if the topic seemed worthy of further study and if the industry reflected a need for the overall study.

This information was gathered from an international representation of individuals employed in high technology industry, specifically super computing, who have a need to share their information with others in their day-to-day work activities. Subsequent analysis of the data would validate if there was a need for the proposed dissertation and to determine if the four questions initially posed in the dissertation study were relevant for continued study.

Initial pilot research questions. The four questions initially addressed by the research in the pilot study were:

1) Does type of industry contribute to sharing technical knowledge?
2) Does one's culture of origin affect sharing technical knowledge?
3) Do individuals employed at businesses with procedures in place to manage knowledge management have a perceived value associated with technical knowledge sharing?
4) Do "need-to-know" information access restrictions affect sharing technical knowledge?

Pilot Survey Method

A survey was administered to random respondents who, upon invitation from the researcher, agreed to participate. (University of New Mexico IRB number 27210.) The respondents were kept anonymous. They participated by providing written answers to questions posed on a questionnaire and through discussion with the researcher. From this survey, general information regarding knowledge sharing within their organization was obtained.

The survey was organized to gather data from five areas related to the individual and their employer: 1) organizational demographics, 2) knowledge creation and access (within the organization), 3) internal knowledge processes, 4) domestic and global operations of the organization, and 5) respondent's demographics. Data were gathered from the responses to the survey's 36 primary questions (SQ1-36) and 6 sub-questions (SQ1a-f). The format of the answers was both discrete and open-ended inquiry. Respondents were also given the option to ask questions and include additional written comments to the survey on the whole. This data provided the means to conduct qualitative and limited quantitative analysis on the answers (Pilot Questionnaire Survey; Appendix A).

The respondents were first categorized based on their technical or administrative role in the organization. Then, due to the small number of responses, Chi Square analysis was applied to the discrete responses to validate likelihood of the results being statistically sound. The written responses were analyzed using qualitative analysis technique. Additional criteria that were considered when analyzing the responses were: the respondent's country of origin, their preferred media for communicating technical ideas, and how widely they shared the information within their organization.

Results of the Pilot Survey

The pilot survey results further assisted in determining the role that the factors (type of industry and culture of origin) might contribute to a future study as well as determining the initial questions to be asked in the grounded theory study.

The initial surveys were analyzed to determine if individuals' roles in the organizations correlated with their participation in knowledge sharing. Respondents were categorized based on their response identifying their "role" in the company as being either administrative or technical. These answers were considered along with the responses to the question "Do you share technical information with others?"

A chi-square analysis was completed using SPSS to see if there was a relationship between the two categorical variables defining role, administrative and technical. Each respondent provided an answer to this question (See Table 1). The general finding that emerged from the conducting the cross tab was that in the super computing industry, technical knowledge sharing was done without regard to role as defined by category of administrative or technical.

Table 1: ***Cross tab of Role; Administrative vs. Technical to Sharing Technical Knowledge***

Cross Tab Count			
Role Code	ShareTechW/Others		
	No	Yes	Total
0[a]		10	10
1[b]	2	28	30
	2	38	40

a. Administrative Roles
b. Technical Roles

Due to the small number of surveys conducted, Fisher's Exact Test was run on the initial Chi-Square results, to ensure independence of the data. The analysis returned a p-value result of .702 from the chi-square analysis indicating that there was no significant difference between individuals' roles and their response to sharing technical knowledge with others (shown in Table 2).

Table 2: ***Chi-Square Tests of Sharing Technical Knowledge by Role***

Chi-Square Tests					
	Value	Df	Asymp. Sig. (2-sided)	Exact. Sig. (2-sided)	Exact. Sig. (1-sided)
Pearson chi-Square	.702[b]	1	.402		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	1.185	1	.276		
Fisher's Exact Test				1.000	.558
Linear-by-Linear Association	.684	1	.408		
N of Valid Cases	40				
a. Computer only for a 2 x 2 table b. 2 cells (50.0%) have expected count less than 5. The minimum expected count in .50					

From the "Internal Knowledge Processes" section of the survey, respondents were asked whether their company had processes or procedures defined for knowledge sharing and whether these processes were: mandatory, highly encouraged, or optional. The responses were then compared to those obtained from the question "Are these [processes/procedures] effective for you?" A qualitative analysis was completed which included the results that the respondents provided through written contributions to these questions. The goal was to determine how individuals' perceptions of the effectiveness of the processes and procedures

for sharing information within their organization was affected by the level of participation that was required by their employers. This was determined based on cross analysis of the responses given to the question of level of effectiveness and the respondents rating of the value of the knowledge resource that they use.

Individuals' perceptions of the effectiveness of collected knowledge held by their organizations appeared to be influenced by the level of requirement that their companies had for their participation in contributing to the knowledge base. Of those who reported mandatory requirements to use company procedures and processes for knowledge management 90% rated the KB as effective. Where participation was highly encouraged 67% of the individuals rated the procedures as effective. Respondents from organizations where participation was optional rated the perceived effectiveness at 38% (Table 3).

Table 3: ***Respondents' Perception of KB Procedure Effectiveness***

Table 3: **Respondents' Perception of KB Procedure Effectiveness**

Company Process Use Rule	Number Response	Rated KB Effective	Percentage
Mandatory	10	9	90%
Highly Encouraged	15	10	67%
Optional	8	3	38%

The survey results indicate that the level at which these organizations required individuals' participation in knowledge sharing strongly influenced the individuals' perceived effectiveness of shared technical knowledge. The results to Question 3 "Do individuals employed at businesses with procedures in place to manage KM have a perception of value associated with technical knowledge sharing?" suggest that the

mandatory business procedures for knowledge sharing do influence individuals' perceived value of the knowledge that was shared.

Two additional questions with answers that revealed significant qualitative data results were those that pertained to individuals' preferred form of media for sharing information and the media method (one-to-one or group) that was provided by the organization for this purpose.

Twenty of the forty respondents preferred a form of communication that was different from that which was offered by the organization for sharing knowledge. Fifteen preferred "face-to-face" or one-to-one interaction to electronic communications, which could be shared with more than one intended individual. Five respondents listed specific preferred tools or applications as follows: 2 telephone, 1 Instant Relay Chat (IRC), 1 Share Point (SP) application, and 1 to communicate with a "blog" or web log shared collaborative space.

Of specific interest in these findings was the difference in the tool or application that organizations offered to that which the employee preferred. The solution provided by the organization for the individual who listed SharePoint was: email, face-to-face, and phone. In her response, she specifically stated that she used SharePoint for sharing project management information. Through her specification of use for project management, her answer deviated from the original question, which asked if her company provided specific tools to use for sharing technical knowledge. Her response indicated that she may not have understood the questions and suggested that this response was an outlier.

Blogging was preferred by the respondent who listed the common form of interaction in his organization as email. The individual who listed IRC was also provided with email as the common tool (see Table 4).

Table 4: ***Interaction Tool Preference***

Number Responses	Tool or Application Offered	Tool Preferred
15	Email, Phone, Wiki, Video Conference, Face-to-Face, IM, Jabber, RT	Face-to-Face
2	Email, SharePoint	Phone
1	Email, Phone, Face-to-Face	SharePoint
1	Email	Blog
1	Email	IRC

The results in all but one response indicated that individuals who preferred a tool or application that was different from the one provided by their employer, elected to use media that enabled face-to-face for communication. In each case, the preferred tool enabled individuals to be associated directly to their contribution. In retrospect, this is not surprising as use of electronic media inherently allows the originator little control over the data once it is shared. Once a message is sent, it can easily be duplicated, altered or distributed beyond the originator's intended audience. This lack of control over the response once it leaves the originators domain can be of concern and inhibit sharing electronically. Individuals by far preferred face-to-face interactions when sharing technical knowledge. With this form of sharing, individuals can study the physical cues given by the recipient indicating whether or not the information shared is understood as intended.

Twenty respondents (50%) preferred the form of communication that was offered by their employers (see Table 5). Of these, 9 were offered "live" or one-to-one communication and 11 preferred email as their primary tool for interaction. Although email allows sharing with multiple recipients, it is generally utilized as a tool for one-to-one communication. These preferences are shown as follows:

Table 5: ***Preferred One-to-One Communication Applications***

Number Responses	Tool or Application
1	Phone
1	Instant Messaging (IM)
1	Jabber
6	Face-to-Face
11	Email

In summary, the responses to the questions regarding "preferred" method of interaction in comparison to "provided" method of interaction were that 68% of the respondents preferred "live" or one-to-one real time communication. Twelve answered that email was preferred and one individual listed SharePoint specifically for sharing project information. The latter appears as a possibly skewed response and may have been a misinterpretation in what was being asked in the question. The other responses to this question indicated that these individuals prefer "live" communication when sharing technical information.

The next question that yielded qualitative responses worthy of notice asked if the respondents felt that country of origin contributed to how they share knowledge. For those who indicated that it did, their responses were cross-checked with the questions indicating whom the individuals shared information with throughout their day-to-day responsibilities. Specifically, the question was presented to learn with whom in their organization these employees were communicating. The choices were comprised of: their group (peers), the whole organization, and external customers. Responses that demonstrated that the individuals only communicated with people within their peer group were interpreted to indicate a sense of trust preferred among immediate colleagues. Responses that indicated communication

with external customers were interpreted to indicate the fulfilling of job requirements, for example, providing a customer with technical support. Those who indicated that they shared information with the whole organization illustrated a willingness to fully share information. These responses were then compared to the individual's country of origin. These responses were considered in relation to Geert Hofstede's (2001) theory on culture of origin and willingness to share. The analysis indicated that specifically, individuals from the U.S. (which is defined as an individualist country) do not typically share information with others outside of their work group or with those that they do not work with directly.

Lastly, responses to the question asking the level that individuals shared knowledge provided some unexpected results. Consideration of Ikujiro Nonaka's (1994) divisions of within group, across organization, and public sharing of knowledge to define how widely information was shared was applied. There was a distinct difference in the responses from individuals listing the U.S. as their country of origin and those from other countries. Of 24 respondents who identified their country of origin as US, 9 reported sharing information across their organization. Similarly, of 16 individuals reporting other than U.S. as their country of origin, 13 stated that they shared information with everyone in their organization. Percentage-wise, 81% of non-U.S. origin individuals reported sharing knowledge across their organization versus 27% of respondents from the US. The resulting probability (*p-value)* from a chi-square test with confidence intervals (CI) for two proportions on this data at a 95% CI was 0.002. Thus, there was a very small probability that this data could arise from chance. The Fisher's exact test was also run due to the small size of the sample, and the *p-value* returned from this test was 0.010. These results indicated that individuals from the U.S. were less likely than their non-U.S. counterparts to share technical knowledge with others in

their own organization. These results indicated that research Question 2 “How does one’s culture of origin affect sharing of technical knowledge?” would be a valid question to pose in this study.

The pilot study indicated that greater consideration should be given to the effect of: culture of origin, applications for communication, and processes used to perform knowledge sharing. These research questions created for the final study were based on the results obtained from the pilot research. The pilot project proved that this study did warrant further research.

The qualitative review of the initial pilot data provided unexpected and convincing evidence of potential effects from factors that would influence knowledge sharing were not previously considered. This increased interest in new areas suggested that changes should be applied to the original four questions. The explanation of these changes is clarified next.

Since all of the respondents were from technical industry, Question 1 was changed to consider the individual's role within the organization rather than type of industry they were working in. Based on the respondents’ answers to questions intended to identify their role within their organization, two categories of role were defined: administrative and technical. Question 1 was then altered to reflect this change, “How does one’s role within the organization contribute to knowledge sharing?”

The responses that individuals gave to the question “Do you feel that your country of origin contributes to how you share knowledge?”, were markedly different between individuals reporting country of origin as US, and those reporting other than US. The majority of individuals residing outside of the U.S. indicated that they shared information with everyone within their full organization at a rate more than twice that of their

counterparts in the US. Individuals within the U.S. were more likely to limit their knowledge sharing to the group of individuals with whom they worked directly. The data suggested that Question 2 should be retained in its original form, “How does one’s culture of origin affect sharing of technical knowledge?”

The responses to Question 3, “Do individuals employed at businesses with procedures in place to manage KM have a perception of value associated with technical knowledge sharing?” indicated greater perceived value in association with mandated procedures. These results gave rise to the additional question of “What business procedures affect individuals’ participation in knowledge sharing?” This question was added as Question 4.

Participant responses to “Please list the most common form of interaction for sharing information within your organization” and “What is your preferred form of communication?” illustrated that preferred interaction format as well as type of media used differed from that provided by the employer. This suggested that individuals’ preference for style of interaction may have a significant role in whether or not they shared technical knowledge with others. From this finding, a fifth question was added to the study to reflect this: “Does type of media provided for interaction influence individuals’ involvement in sharing technical knowledge?”

In the pilot research survey, a question was included to determine if there was an effect from "need-to-know" restrictions on knowledge sharing. The response to this question did not provide any unexpected results. Thus it was removed this from the final research questions in the dissertation study

Five questions emerged from the pilot research which were the most appropriate to address in the final study:

1. How does one’s role within the organization contribute to knowledge sharing?

2. How does one's culture of origin affect their sharing of technical knowledge?
3. How are technical employees' perceptions of value associated with shared knowledge resources affected by business procedures to manage knowledge?
4. What business procedures affect individuals' participation in knowledge sharing?
5. Does type of media or interaction influence individuals' involvement in sharing technical information?

Outside of the specific survey questions, many respondents verbalized that their organizations were struggling with the issue of knowledge sharing and that they would be very interested in the results of the research. Several respondents provided unsolicited referrals of additional individuals within their organizations who they felt would be able to contribute to or benefit from this study.

IT Research Conducted Using Grounded Theory Method

Originally designed for research and analysis in the field of social sciences, the grounded theory method (GT) of analysis can be broadly applied to other fields for both qualitative and quantitative analysis (Strauss & Corbin, 1990). This model has specifically been applied to areas of research interested in processes affected by social life, learning of tacit knowledge, and perspectives held by others (Piantanida, Tananis, & Grubs, 2002).

Glaser and Strauss define the element of theory as "conceptual categories and their conceptual properties; and the generalized relations among the categories to their properties" (1967). To ensure the emergence of theory, the founders strongly suggested that researchers "ignore the theory promoted by literature" (Glaser & Strauss, 1967). Shortly after publication of their original theory, the originators diverged philosophies and each formed their own definition of GT as evidence in individual works; Glaser (1978) and Strauss and Corbin

(1990). Although both stayed with a method of theory building, the approaches differ. Glaser purposed to develop theory about a phenomenon solely from constant comparison of data collected. Strauss and Corbin adjusted their approach to theory that is inductively derived through systematic data collection. They suggest that the researcher include her experiences in theory building. They further differed from Glaser by emphasizing rigor in procedures for analyzing the data to more than constant comparative analysis. Additionally, the originators differed in opinion of coding techniques. The original approach of Glaser and Strauss (1967) used initial coding of data to refine the data into separate parts: word, line, page. Strauss and Corbin press the analysis further in an additional step, axial coding. Axial coding puts the separate parts back together again to define concepts (Charmaz, 2006).

Researchers using the GT method of analysis concur with the dependence on "theoretical relevance" of data gathered rather than on literature to direct the development of theory (Charmaz, 2006: Hood, 2006). The flexibility of this method has allowed for slightly different models to be developed through adaptations made to the core process of GT. Each adapted method facilitates development of theory from data gathered. These are: grounded action research, generic inductive qualitative model, and grounded theory with constructivist approach. Also in this chapter are presented various studies as applied specifically to the field of Information Systems (IS).

Grounded action research was developed out of the theory formulation portion developed by Strauss and Corbin (Baskerville, & Pries-Heje, 1999). This method joins action research (AR) and GT methods and is used specifically to study situations that require participation and change processes within the operation of an organization. AR is based on the impact of change introduced to complex social processes and the data collected through

observation and participation of the effect if this change. In this method, the researchers actually participate in the subject under study, thus, requiring another level of rigor and structure to ensure the integrity of the data gathered. Copious amounts of field notes are taken. To assist in data analysis, GT is incorporated into this method by integrating two primary processes: 1) GT notation through memos and diagrams during the action research cycle and 2) GT coding to describe the evaluation, learning, and diagnosis phase of AR.

Jane Hood (2006) presents empirical data, which suggests that although more researchers over the last two decades claim to use grounded theory as their research method, many in fact, are using a method that she refers to as the generic inductive qualitative model (GIQM). Whereas, there are similarities and overlap in the two methods, the primary difference is the final design and discovery of new theory derived from analysis of the data. This factor, a requirement in grounded theory, is not compulsory in the GIQM format. In GT, researchers produce an analytical work based on variations in the data and how these variations are associated with one another. Questions are posed to determine the process ("how") instead of the variance ("how much"), as in GIQM. The final product in the GIQM study is a descriptive account of the findings and may be based on existing theory. GT researchers develop data from an information gathering process. Samples are not based on *a priori*, rather they are taken theoretically and derived from ongoing data analysis. In "purist" GT, the focus is on "constant comparison," comparing each successive case to previous findings.

The goal of the research question varies between the GT and GIQM as well. Hood (2006) contends that GT research questions are posed to gather the variance in responses and to elucidate processes. "How do women become regulated to the lower ranks on the

academic ladder?" In GIQM, the questions are posed to determine the difference among the respondents. For example, "How do female and male participants differ on …" GT will often begin analysis at the point where GIQM considers the study complete.

Comparing the two methods, Hood presents commonalty shared between GIQM and GT in the process of generalization across case studies. The findings of one study may become the starting point for another. Citing the results from her research on "uncertainty contexts" she derives that the theory of individuals managing illness (Charmaz, 1991) could be generalized to create strategies for individuals in other situations of uncertain outcomes. Examples that she gives are families of individuals charged with felonies who are pending court appearances and couples awaiting adoption. Individuals in situations of unpredictability are forced to live one day at a time and consequently cannot plan for the future. The research on managing illness then would be a starting point to learn how individuals might deal with other situations with uncertain outcomes (Hood, 2006).

Kathy Charmaz, Professor of Sociology at Sonoma College, is known as a leading theorist in grounded theory. Charmaz identifies the earlier "purist" GT method as defined by Glaser and Strauss (1967), as objectivist, residing on the positivist view of data as "real" and of itself. Objectivists look at the initial data from a neutral stance remaining separate from the research participants. The positivist approach studies the phenomenon and attempts to offer predictions. Charmaz affirms that, "experimentation and predictions can lead to scientific control over the studied phenomenon" (2006). Conversely, in the constructivist approach the researcher incorporates a social science perspective, which promotes the view that individuals construct their realities through participation. To accomplish this, constructivist researchers enter into the phenomenon being studied to form their interpretation.

Charmaz (2006) explains constructivist grounded theory (CGT) by defining five guidelines for researchers to follow when using this method: 1) Literature review *a priori* might contaminate the research and can impede the researchers definition of category when coding; 2) Coding must be descriptive of the findings, interpretive with reference to the context of data segments, and with some pattern or link to inferential coding. Additionally, the relationship between axial (Strauss & Corbin, 1990) and theoretical coding (Glaser, 1978) categories provides the base for developing theory; 3) Include "memo writing" and diagrams to construct comparisons and "elucidate" the key theoretical developments; 4) Build on emerging theory and engage other theorists' findings. This step is the process for theory development. Charmaz lists two parts to this step: the process to generate theory that can be used with others' research and the manner of the judgment used to determine if the first step is to be accomplished; 5) Define clarity of procedures on the chain of evidence. The last step allows readers to generate their assessment of the researcher's claims (2006). An example of her method is demonstrated in a study she conducted on individuals living with illness. Charmaz (1991) developed her theory of "living one day at a time" which maintains that individuals who are living in uncertain situations find that breaking the day down into smaller moments makes it possible for them to find value in their day-to-day existence. Through responses gathered in interviews, she derived that the feelings individuals have in living with uncertainty of the future lead them to focus their attention on the present. She noted that for these individuals, the present moment becomes fuller. Through this she elicited a strategy for living with illness in a day-by-day approach that is focused, rather than fatalistic.

There is a dearth of research in scientific and technical fields that use grounded theory for analysis. The field of information systems (IS) is a hybrid of technical and social science, as human interface and social interaction are required. For successful IS it is imperative that processes be followed. An expensive investment for organizations in both time and money, it is particularly important to define processes that are flexible for future needs.

Cathy Urquhart (2007) demonstrates the adaptability of the GT model in her research through five modifications that she customized for application to information systems analysis. 1) Researchers performing GT studies are not supposed to have any bias and as such it is recommended that they do not complete a literature review. Urquhart argues that the researcher does need to conduct a literature review in as much as one need to understand the current thinking in the field. Initially, the review should be broad across the problem being researched. The literature review should be examined again and extended when the theory has been generated. 2) Urquhart suggests that researchers should code for theory generation. Rather than coding at the line-by-line level as stated in the GT model by Glaser (1978), she suggests that when investigating organizational data it may be more appropriate to code at the paragraph or page level. 3) In addition to memo writing, Urquhart recommends the use of diagrams as a means to identify relationships among categories. 4) Urquhart identifies that one of the strengths of GT is that theory developed on data alone may not be suitable for emergent technologies such as IS. She states that this type of theory may not scale and does not support abstract thinking. She suggests engaging other theories as a means to address the scaling issue as illustrated through her research in negotiating requirements, for example, comparing the interactions of computer analysts and their clients to interactions between patients and professionals in the health field to enable her theory expansion. 5) A

strength of GT that is very useful to the field of IS is the ability to provide a chain of evidence. This adds to the plausibility of the researcher's findings while allowing readers to assess the findings for themselves. Overall, she suggests that defining the interdependent relationships between data categories will help researchers to develop a "depth of theory." It is also important to note that the field of IS is inclusive of communications which occur at the individual, group, and corporate level (Urquhart, 2007).

Two factions of IS analysis using GT are presented by European researchers, Esteves, Ramos and Carvalho (2002). These are enterprise resource planning (ERP) and user satisfaction of computer-based systems. Conducting case studies based on data collected from literature, the researchers applied the traditional approach of GT to the ERP case. In this case analysis they identified four problem areas: strategic, tactical, organizational, and technological. From these four perspectives, they proposed a critical success factor (CSF) model. Three main issues were identified through this case analysis: the coding process, experience in the field, and the use of research techniques. Lacking the data necessary to pursue axial coding, the researchers applied only open coding. Demonstrating the inclusion of additional analysis methods, they expanded their statistical analysis to include quantitative as well as qualitative techniques.

In the study of user satisfaction with computer-based systems, two case studies designed to support work processes were conducted. Researchers applied the constructivist GT approach to data collected through dialog, observation, and review of technical documents. Their research was in understanding the use of the systems, and the structural, social, political, and symbolic contexts in which the systems were being used. The result was identification of the transformation process and the effect the application had on this

transformation. They accomplished this by looking at how the users interacted with the system, how they felt about the interaction, and how they integrated the system into their work. The findings were related to sampling, the coding process, data collection and analysis, and ethical considerations in reporting findings. Some individuals were more influential to the transformation process and formal interviews were conducted with them. The coding process portion of the data analysis was greatly influenced by an extensive review of literature *a priori*. Extensive field notes were developed which allowed identification of conflicting perspective and contradictions. The iteration between the data collection and analysis allowed for interactions with the participants and their acceptance of the study. From this contact emerged the awareness that the report could be used later to employ or weaken internal conflicts. This generated a strong concern for the need for expressing equally all perspectives and the decision not to report all GT findings (Esteves, Ramos & Carvalho, 2002).

Findings of GT use in IT would be incomplete without the inclusion of Orlikowski's (1993) GT research on the adoption and impact of CASE (computer-aided system engineering) technology on system developers in two organizations. In her study Orlikowski identified three areas that were affected as a result of organizations' adoption of CASE tools: contextual elements, procedural elements and the interactions of individuals from which she determined her empirical findings. Inclusion of these criteria met the original GT model framework of Glaser and Strauss (1967). From the data gathered she identified incremental and radical organizational changes that occurred as a result of the adoption of the CASE tools. The general study was designed to examine the process of change and the location and type of change in the organization, both intended and experienced. The results showed that

the two organizations had significantly differing reactions. These differences were attributed to the way in which the two organizations handled variations in the change process, the organizational context, and the intentions and actions of the key individual responsible to adopt the change.

One important finding in this study was the general concern that consideration of social interaction needs to occur when implementing IS in an organization. Orlikowski (1993) also found that very little business change actually occurred. Employees resisted making the modifications to current processes that the new architecture required. The changes threatened the operational norms of the business and individuals were unwilling to share their information. Her research identified both facilitating and constraining effects of a Computer Aided Software Engineering (CASE) application on system developers as being highly related to the reaction of individual, organizational, and technological influences. Individuals who expected a career in their position were less likely to accept the CASE application as they associated it as their replacement. The impact on the organization was also highly affected by management's response. Senior managers' lack of expectation for change was identified as a factor that influenced the implementation. In general, managers did not intend for the CASE solutions to change business processes, rather to merely make them more efficient. Olikowski's study affirmed that successful implementation of CASE tools requires process changes. She proposed a theoretical framework conceptualizing the process of change and identified the locus of change by level of change, and result on process and product (Orlikowski, 1993).

Chapter 3

Methodology

Overview

There is no argument in the technical industry, over the benefits that knowledge sharing provides to the individual as well as for the business organization on the whole. Yet businesses continue the elusive chase to gather, manage, and share the combined technical knowledge within their organizations. Organizations need to know what they know, collectively. This knowledge is difficult to acquire.

A formal pilot study was conducted in the fall of 2007 to ascertain if commonality in knowledge sharing exists among organizations in technical industry. This study was approved by the Institutional Review Board of the University of New Mexico as Protocol Number 27210; "How Cultural and Institutional Norms Affect Knowledge Sharing in Technical Industry." The format for the pilot was a survey administered to attendees of an international computing conference, "Super Computing 2007." The results obtained indicated that certain factors may have an impact on if, or how, a person will participate in sharing their personally held technical knowledge. The outcome of the pilot also provided data that directed the design of this study, specifically the research questions.

The intent of this qualitative research study was to understand how such factors contribute to knowledge sharing and to derive a theoretical process framework that organizations can use as a guide when designing information technology based solutions for knowledge sharing. This chapter details the research method and procedures used in this research.

This study was conducted using constructivist grounded theory method, an approach that was developed by Kathy Charmaz (2006). By using this inductive method of analysis, this research was guided by data collected through interviews focused on participants' experience obtained through their work. The researcher used the process of theoretical sampling as defined by Glaser & Strauss (1967) to guide the gathering of data and to determine the selection of individuals for this research. Interviews were conducted until there was repetition, or data saturation developed in the answers. The criterion of saturation determines the theoretical point at which adequate data has been generated thus, the number of individuals to be included.

The answers to the research questions and the resulting theory determination were developed from the data that emerged as the research was being conducted. The constructivist method of grounded theory was conducted on data gathered through purposeful sampling, constant comparative analysis of the data, and the researcher's interaction with respondents. Findings gathered in the pilot research, as discussed in Chapter 2, guided the development of the questions for this study. The pilot analysis served to deepen the understanding of the respondents' answers and to provide additional contextual information.

Research Questions

The goal of this research was to answer the overarching research question, "Do specific factors influence technical knowledge sharing in a research industry?" To answer this, 5 sub-questions were devised to guide the research. They are as follows:

1) How does one's role within the organization contribute to knowledge sharing?
2) How does one's culture of origin affect sharing technical knowledge?
3) How are technical employees' perceptions of value associated with shared

knowledge resources, affected by business procedures to manage knowledge?

4) What business procedures affect individuals' participation in knowledge sharing?
5) Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?

Data Collection

Interviews were conducted with experts in the emergent field of computing who participate in work that involves technical knowledge sharing. The interviews were carried out using a variety of methods consisting of: face-to-face, email, and telephone. Through the inclusion of open-ended questions, the participants were invited to share unlimited answers and to elaborate as they chose in their responses. Often times the participants shared stories of personal experiences to develop and clarify their responses.

Participants. With the exception of one individual, the 15 participants all work in various positions of computing and were referred to the researcher through colleagues and her research committee. Although the roles of the participants' within their organizations varied, all were employed by companies or institutions, whose primary mission was technical in nature. The conclusion is that this was a homogeneous group of participants. There were three individuals from the U.S. and one each from: Canada, India, Greece, Spain, Bosnia, Columbia, Belgium, the Netherlands, China, Japan Russian and the United Kingdom.

Data. The primary data that was analyzed was obtained through 15 interviews that were conducted in the fall of 2009 and spring of 2010. The interviews were guided by a list of questions that were posed to each participant. The results of the pilot study also contributed to this research as another source for comparative analysis. This dissertation is a culminating study that began with the researcher's first-hand experience implementing a

knowledge sharing system at her place of employment, the results of the pilot research conducted in 2007, and the results of the research conducted in this study.

Interviews. Participants were contacted by the researcher and invited to take part in the study as per the protocol specified in the institutional research request. Each participant in this study agreed to take part in at least one interview. Depending on the results generated from the initial analysis, the option was left open for future contact with the participants for additional data gathering. Under the approval of Institutional Review Board number 09-306 issued by the University of New Mexico, each participant was presented with notification of the study and a list of actual questions that would be posed in the interview. A waiver was authorized for the standard signing of Consent to Participate documents as the majority of interviews were conducted at a distance, making obtaining signatures cumbersome. Instead, participants signified their consent via email response.

The participants, male and female, were of legal age to participate in the research, provided their country of origin and defined their role within their organization. The interviews were conducted in person and at a distance using telephone, and email. A list of the participant group utilized in this study is presented in Table 6. Pseudonyms are used to provide anonymity.

Table 6: ***Respondent Demographics***

Name	Role	Culture of Origin	Age	Interview Method
Caleb	Lead Tech. Support – University	Canada	31-35	Phone
Mick	Private Consultant - Computer Security	U.S.	46-50	Email
Raj	Owner/Director – University/High Performance Company	India	36-40	Phone
Damon	Manager – Research Laboratory	U.S.	41-45	Phone
Nicolas	Designer/Researcher – International Software Company	Greece	36-40	Phone
Caspar	Director – University	Spain	41-45	Email
Biljana	Researcher – Research Laboratory	Bosnia	31-35	Email
Leo	Manager – Research Laboratory	U.S.	51-55	Phone
Alonzo	IT Specialist – International Software Company	Columbia	26-30	Email
Lin	Consultant/Engineer – International Software Company	Taiwan/ China	46-50	F2F
Peter	IT Consultant – International Software Company	Belgium	56-60	F2F
Jordan	Manager/Researcher – Research Laboratory	Netherlands	36-40	Email
Robert	Designer/Facilitator – Aerospace Company	Japan/N.Amer.	>60	Phone
Lyndon	VP Human Resources – Hydrology Equipment Manufacturer	U.K.	51-55	F2F
Mila	Researcher – University	Russia	26-30	Email

The interviews for this study were conducted with the 15 participants each of whom were interviewed individually. The participants were either direct colleagues or were

referrals from colleagues and committee members. Thus, the researcher and the participants had at least one link in common. This commonality provided a level of informality with which to conduct the interview.

Each interview began with a single open-ended question, "Can you please share your definition of technical knowledge sharing?" This question provided a context to base the respondents' interpretation of technical knowledge sharing. The opening question also provided a framework for continued discussion between the interviewer and the respondent of the interview questions that followed.

The interviews continued with brief collection of demographic data that included age and level of education. This was followed by 35 additional questions. The remaining questions were open-ended and presented more opportunity for respondents to share candidly their experience and opinion. These questions were prearranged under five topics: participant's role, cultural impact, general participation in knowledge sharing, preferred media for sharing and business processes used for knowledge management at their place of employment.

Context from previous research studies. The pilot study that the researcher conducted to rationalize this research, provided a context from which to deepen the understanding of the phenomena in this study. Data were gathered for the pilot through surveys conducted with 40 individuals from over 20 countries whose day-to-day work duties included technical knowledge sharing. The research questions for this research were formed directly from analysis of the pilot study data.

Data Analysis

Procedures. This research used constructivist grounded theory method, a systematic approach of inductive and comparative inquiry for the purpose of generating theory (Charmaz, 2006). The Charmaz method of analysis is based on the original grounded theory model (Glaser & Strauss, 1967) consisting of four stages of analysis: codes, concepts, categories, and theories. Charmaz enhanced this method of theory building through the inclusion of the researcher's thoughts and experiences obtained during the analysis. Rather than searching for a single core category to emerge from the data, the goal of this constructivist approach was to illuminate the complexities and the breadth of generalization of the theory.

The following presents the details of how this analysis of this research was conducted using the Charmaz method of constructivist grounded theory

The data collection and analysis was conducted through interviews. These processes occurred simultaneously using constant comparison where the data from each interview was collected and compared to that obtained in the previous interviews. As interviews were conducted and comparison analysis completed on the responses, the results directed the researcher in her determination of how to proceed with the selection of the next interview. This process continued until the interviews no longer provided differing information. In this methodology, this is referred to as data saturation.

The next step in the analysis was to evaluate each interview for internal consistency. The researcher carefully read each response to determine if there were any contradicting views presented in the interview by the respondent. The respondent's answer to the first question, "Can you please share your definition of technical knowledge sharing?" along with

the responses given in the remainder of the interview revealed the respondent's perspective of knowledge sharing and in this study provided a unique theme for each (see Table 8).

Open coding is the next phase in this process. Here the interviews were read to determine the concepts contained in the responses. In this analysis the researcher chose to do line-by-line coding, reading each line or answer to identify concepts. Also noted in this level of coding were any occurrences of *in vivo codes*, language that actually condenses the meaning. An example of an *in vivo code* that was used by several respondents in this research is "all the stuff". It was intriguing that professionals in this field described their accomplishments and information as "stuff". "All the stuff" also meant all of the options or capability that was provided through a collection of information.

The next phase of analysis was focused or axial coding. This consisted of definition and application of the concepts identified through the free coding into categories and sub categories. The results of the focused coding were then formed into categories and subcategories. At times, themes appeared to emerge. Theoretical sampling was then conducted to validate the emergent themes. Interviews at this stage were conducted differently than in the initial data gathering phases as the participants were selected specifically to provide experiences that would validate or disprove the emerging themes. This portion of the analysis was the first stage of the development of the theoretical framework.

The categories that emerged from the axial coding were: method, necessity, key obstacles – hindrances, responsibility, value and culture. The focused coding results are presented with the corresponding respondent who used them. On an average there were 10 subcategories for each category. As an illustration, in the axial coding results table is reference to M.1.1, which represents Informal Method of Communication and was indicated

as a factor that contributed to knowledge sharing by 7 of the 15 respondents. (See Appendix C, Axial Coding Results). The categories and subcategories were further analyzed to eventually generate the framework for the theory (Glaser & Strauss, 1967).

The data were recorded electronically in a spreadsheet to determine consistency and gaps in the data and to make it possible to review the questions both individually and among all respondents. In some cases, the initial determination of influence by factors of interest was based on the review of combined responses to multiple questions. For example, the value of an application that was provided as a resource for managing shared knowledge was determined by the individual's response to effectiveness of the resource and their level of participation in sharing that the organization required of the individual for knowledge sharing. Cultural influence was also based on responses to multiple questions. In this case, comparing the respondent's answer to whether culture of origin influenced their knowledge sharing and the answer they gave when asked to provide an experience that would illustrate the influence of culture on sharing.

Hand drawn concept maps were also used to analyze the findings in a graphical context. From these maps, relationships among the categories became apparent, as the researcher was able to draw connections among the categories. The concept maps answered the researcher's often-asked question, "What am I looking at in this data?" Through this process further interdependencies emerged and more meaning emerged from the data (see Appendix D, Sample Concept Map). Ultimately, the concept map proved to be a quick and easy means to graphically represent the data. From this representation the researcher was then able to identify the relationships among the concepts and the theoretical framework became more apparent.

Another indication of synthesis in this analysis occurred through memo writing. A less calculated portion of the analysis, memo writing was conducted throughout the research. Memo writing captured early insights and conjuncture that arose from the data. This writing was spontaneous, free thought and without structure. There were 22 memos that resulted in all. The early findings that emerged through the memos included the difference of competition between employees working in public and private organizations. Profit as the primary goal of private industry actually reduced competition among employees and enhanced their motivation to share technical knowledge. Whereas the provision of "funds" for projects, directed the focus of technical development to include justification of the funds provided. Spending shortfalls resulted in smaller allocation of funds in the future. Consequently funded projects were influenced by the need to use or spend all of the funds provided. This environment encouraged individuals to keep their knowledge to themselves and gave rise to competition. An actual memo is presented in Appendix E. This is Memo 8, and refers to insight on sharing as social responsibility.

Memo writing enabled a structured method for spontaneous brainstorming to be captured. The informal documentation was both inviting because it was unstructured and functional as it provided a means to capture emerging ideas throughout the research. To enable a efficient review at a later data, the researcher did capture the date created and any directly correlated responses for each memo. A table of contents was also managed for the memos by title for management purposes. As the final manuscript was developing, the researcher returned to the content page several times reviewed just the memo titles to enable reflection, insight on concepts, and reflection on the process. Also due to the informal

process required for memo writing, creating a memo was a jumpstart to begin the writing flow for the researcher.

Through the combined processes for definition of categories and development of themes, hypothesis in relation to technical knowledge sharing came about. The end goal of the coding phases was the construction of an integrated theoretical framework from the data.

The researcher's personal experience with technical knowledge sharing in industry was also considered in the interpretation. Constructivist researcher Charmaz (2006) posits that theoretical development of phenomena is achieved through interpretive tradition, accomplished through both data gathering and the analysis created from shared experiences and relationships developed with the participants. This analysis strived to answer "why" sharing occurred, "what" was shared, as well as "how" sharing occurred in relation to the environment of the firm. The researcher was able to pull from her past experience to develop conclusions to these questions.

Tasked as a system administrator to provide support services to high performance computing users and later as project lead for the provision of formal user support, the researcher experienced and observed technical knowledge sharing as it occurred in the realm of a public entity, a national laboratory.

The main deliverable for the formal support was to design and create a business application to gather, manage and provide for sharing of technical discovery among the developers and the users of the computer systems. Through this responsibility, the researcher saw first-hand the reaction individuals using the applications had to both the automated and manual interactions required for knowledge sharing.

As a previous member of the team now using the support application, the researcher was able to call on her past experience in delivering support to the users of the high performance systems. The challenges for those providing the support in the arena of high performance computing include the intensity leveled by the number of individuals who are affected by a problem and often the urgency or the need for a solution to respond to a national emergency.

When the office environment provided a means for desk-to-desk verbal communication it was not uncommon to hear individuals verbally posing questions to the group by means of a "shout out" from the desk. Once a technical solution was obtained however, it was rarely if ever documented as a source of knowledge that could be shared among others at a later date. The more common communication scenario was that which used electronic means to facilitate communication such as email, instant messaging, and telephone. While enabling interactions between individuals, any concurrent documentation was seldom retained.

High performance computer systems are emergent and as such the computer code and hardware may incur daily changes. Particularly for initial release systems, there is little redundancy in the solutions; each support solution requires determining the problem and creating a solution. Emotions of the users and the support team run high as the stress level is compounded by the pressure to develop a solution as quickly as possible.

This researcher was well aware of the challenges of providing technical support. She understood the immediacy for information, the difficulty in creating shared documentation and the frustration from not being able to access documentation on past solutions. In her experience creating documentation was unpredictable as there was not a unique business

process to perform this task. Without direction, individuals used the form of documentation that worked best for them. Multiple structures for documenting information created a very complex problem when individuals want to create shared repositories for the information at a later date. Having this history and experience, the researcher was able to discuss these issues with the respondents using the common terminology, often relating similar experiences. This also assured the respondents that their experiences were understood and invited candid responses. Past experience definitely enhanced to researchers ability to reframe respondent's answers to validate the clarity of the researchers interpretation of the responses.

The researcher also had previous employment experience in the private sector providing technical services to customers and experts, which offered her the perspective of technical knowledge sharing in the profit driven business environment. In both employment situations, recalling previously applied technical solutions was often difficult.

Trustworthiness

The research method of constructivist grounded theory was selected for this research as this process enabled the researcher to illustrate the complexities and interpretations that emerged when explaining how specific factors contribute to the socio-technical activity of technical knowledge sharing (Charmaz, 2006). Moreover, this research specifically aims to understand why individuals chose to participate in the activity of technical knowledge sharing. This research represents a naturalistic paradigm and as such, validity, as used in traditional deductive research is replaced by the researcher's demonstration of the trustworthiness and accuracy of the findings. To confirm this, the researcher uses the process for conducting constructivist grounded theory research and triangulation of the data

interpretations offered through the literature review, member checking and findings from the pilot research study.

The basic information that this research was seeking to understand was if specific factors contribute to knowledge sharing in research-based organizations. The goal was to derive theory for successful knowledge sharing that could be applied by organizations that want to practice technical knowledge sharing. The process of grounded theory is self-corrective and verifiable at the conclusion of several different stages within the process. Data accuracy is imperative for generating theory. As the data were gathered it was also informally triangulated as it was posed back to the respondents for their concurrence. This group of individuals provided a homogenous base from which to gather data and the results of category and coding were cross-referenced within. Further, the originators claimed that the "integration of theory tends to correct inaccuracies or hypothetical inference and data" (Zetterberg in Glaser & Strauss, 1967). A theoretical framework was derived from this data and is presented in Chapter 5.

Triangulation through the comparison of the interpretations in this research to the findings from other sources of similar data was used to provide assurance of the findings in this study. The literature review provides evidence of theory, which supports the processes of knowledge sharing and knowledge management. Previous studies present knowledge sharing as it occurs in communities of practice (Wenger 1998a; Kim, 2000), through computer supported collaborative learning (Naidu, 2003), and how interactions in the work place are influenced by culture of origin (Hofstede, 2001). Comparisons of knowledge management as processes, procedures and nature of information in an organization were exhibited in the literature review as well (Silver & Shakshuki, 2002; Salisbury & Plass, 2001).

To insure the accuracy of the data gathered and as initial findings were reached, informal member checking was used to verify the conclusions. As with the initial interviews, the format for conducting member checking varied depending on the location of the participant. Informal communication with the participants was concluded through email and telephone to address the clarity of the translation and the resulting emerging themes for accuracy. In some cases the entire transcript was sent via email to verify the responses gathered. In other instances member checking was best accomplished through discussions conducted by phone.

The data gathered in this study was also compared to the findings in the pilot research study. The results from the pilot provided a context to compare the overall findings from this small group of participants to a larger set (40 respondents). When possible, the findings in this research were contrasted to those that developed from the pilot research. The emergence of findings common to the pilot survey and this research served to substantiate the results in this research.

Generalizability. The research goal of this study was to derive theory for successful sharing of knowledge within technical research organizations. Strauss and Corbin's explanation of generalizability is presented in research by Irish researchers who contend that GT is a methodology designed to build theory. To generalize their findings, researchers expound on the power of theory or explanatory power more than statistical generalizability (Strauss & Corbin, 1998, as cited by Coleman & O'Connor, 2007).

Jane Hood offers the application of cross-population generalizability as a means of generalization for non-probability studies (2006). She demonstrates this through the application of the outcomes of individual studies as a means to generalize a theory. Hood

provides an example through application of the findings from Charmaz's theory founded on the effects of people living in unpredictable chronic health conditions to theorize other strategies for individuals living with uncertain outcomes (Hood, 2006).

In this research generalizability is accomplished by the application of the themes to two models representing knowledge sharing: Nonaka's Knowledge Spiral (see Figure 4), and the Data, Information, Knowledge, Wisdom model (see Figure 9). The application of the themes that emerged in this research illustrated how the responses gathered are confirmed in the models.

Researcher's Role

Having spent 16 of the last 20 years working with experts in the field of high performance computing afforded me the capability to provide personal experience when assisting participants' in formulating their responses for this research.

My role in this field varied from being tasked to formulate solutions to solve technical issues, to being responsible for the capture of knowledge shared among my peers. In the last role of knowledge management, my colleagues were aware of my study and this may have influenced their participation and willingness to use the solutions for knowledge sharing that I provided. It was with this in mind that, although I involved several of my direct colleagues in the pilot research, I included only one in the final study.

My first hand experience was beneficial to understanding the need that individuals in this emergent field have for sharing technical knowledge as well as the need for the organization to have access to the collective knowledge of it's employees. As project lead for the design and implementation of the software application to address knowledge sharing, I was also able to learn first hand the requirements for the IT solution. The challenges in

bringing a knowledge management solution to production level afforded me an irreplaceable learning environment.

Summary

This chapter discussed the research design used for this study, the participants in the study, and the data analysis completed using constructivist grounded theory method. The choice of constructivist grounded theory method allowed for areas of research to develop from the actual process rather than the traditional method of proving or disproving a hypothesis. It was particularly well suited for analysis of socio-techno interactions and the infinite possibilities that may occur with human interaction. Unlike investigations that are dependent on the impartiality of the researcher, this method encouraged the researcher to induce theory based on her experience with the phenomenon that was explored and her interaction with the participants.

The participants in the research were all familiar with the technology discussed as they all had first hand experience using automated applications and electronic media for communications and collaborations. Although a small sample cannot represent the preferred actions for the whole population of a country, having individuals who originate from different countries did allow the researcher to get a broader context of cultural preferences and conflicts.

Combining the researcher's past experience with the experience that developed through data gathering and analysis, supported an inductive theory development from the findings. Additionally, this study will contribute to the growing body of literature detailing the use of constructivist grounded theory as well as to the design of knowledge management solutions for organizations. The analysis if this data is presented in complete in Chapter 4.

Chapter 4

Analysis

Introduction

At some point, every one of us has enjoyed the benefit of experience and knowledge that comes from others who have been down a similar path. We have also had the opportunity to share our experience with the understanding that it will help others in their pursuit of achievement. Knowledge sharing is vital in scientific and technological environments.

This research study explored the conditions under which people were willing to share their expertise with others. Based on the data collected through interviews with individuals in technical industry, this aim of this research was to ascertain if specific factors contribute to technical knowledge sharing within organizations. The study was designed to provide answers to five questions that were formulated based on the results of a pilot study. These five questions were:

1) How does one's role within the organization contribute to knowledge sharing?
2) How does one's culture of origin affect sharing technical knowledge?
3) How are technical employees' perceptions of value associated with shared knowledge resources affected by business procedures to manage knowledge?
4) What business procedures affect individuals' participation in knowledge sharing?
5) Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?

Data analysis was completed using constructivist grounded theory method as defined by Kathy Charmaz (2006). The process invites the researcher to use the original grounded

theory method (Glaser & Strauss, 1967) in complement with the flexible constructivist methodology. The Charmaz method allows researchers to include their experience in the theoretical interpretations.

This chapter presents the analyses of the data and offers discussion of the corresponding themes that emerged from the interviews. In order to determine their perspective on the topic of technical knowledge sharing, each respondent was first asked to give their definition of technical knowledge sharing. The respondents' answers to this question are given along with their country of origin, and the interview format (see Table 7).

Six overall themes emerged from the analyses. Interpretation and commentary on these themes are offered along with a sampling of the respondents' answers. The themes are presented following the participant's definitions given for technical knowledge sharing.

Responses were gathered through interviews with 15 participants whose culture of origin varied among 13 countries. Each respondent was posed the same interview questions, which were designed to determine the impact of five specific areas on knowledge sharing. These areas were: 1) respondent's role in the company, 2) impact of culture of origin, 3) respondent's general participation in knowledge sharing at the organization, 4) preferred media for sharing, and 5) the use of business processes provided by the organization for knowledge sharing.

The interviews were conducted in person, over the phone, and via email. The most detailed data were gathered from the interviews that were conducted by phone, followed by those carried out face-to-face. The responses gathered via email had the most brevity. Interviews by phone invited one-on-one communication while providing a sense of boundary that allowed individuals to speak frankly. As a rule, individuals tended to be more concise

when using email for communication. Use of the phone for interviews may have prevented the possible discomfort that one feels when being interviewed in the presence of a recording device or when watching the interviewer attempt to capture the interview by hand. All in all, the phone interview created a very comfortable environment for data gathering. Respondents were able to articulate their answers and candidly share opinions and views.

All of the participants were familiar with the various forms of media and technical methodology that were referenced in the study. This study was completed with the assurance that the identity of the participants would remain anonymous. In order to provide anonymity to respondents, they are referred to by pseudonym. The complete interview script is provided in Appendix B.

The primary topic of this study was *technical knowledge sharing*, which can have varying definitions or meaning. The following short discussion provides a description and context of technical knowledge sharing as referenced in this study.

What is technical knowledge sharing? Organizations treat knowledge as a corporate asset, but to the individual knowledge is not a commodity; rather, it is one's personally obtained and held tacit knowledge. Tacit knowledge is an accumulation of experience and achievements that required self-discipline and a self-motivated passion to acquire. In some cases, tacit knowledge is the result of a lesson learned through time and personal effort through trial and error. The individual owns this. Additionally, not all tacit knowledge can be converted to an explicit format or documented in a fashion that is shareable. A lack of useful applications available to the individual and poorly defined business processes can exacerbate the problem of sharing knowledge. Without prescription, individuals will use the application that they find most productive for their documentation,

and they will capture their experience in a format that is convenient and meaningful to them. Often times, this documented knowledge is duplicated in different resources in the organization. Conversely it may be kept separately in the individual's computers or files and not made available or accessible to others as a shared resource. To be shareable, information must be made publically available to others.

Brief overview of respondents. The participants in this study were discussed at length in Chapter 3. This overview is offered as an immediate reference. Respondents are presented by pseudonym along with their country of origin, the interview format, and their definition of technical knowledge sharing to understand their perspective of knowledge sharing. County of origin is included in the description as a means for the reader to have a better picture of each respondent. Likewise, although respondents spoke at least some English, their familiarity with the language may be seen in the directly quoted answers. When necessary, bracketed comments were added for clarification. The respondents' answers are presented immediately following the demographic data.

The demographics for each participant were as follows in Table 7:

Table 7: ***Respondent Demographics***

Name	Role	Culture of Origin	Age	Interview Method
Caleb	Lead Tech. Support – University	Canada	31-35	Phone
Mick	Private Consultant - Computer Security	U.S.	46-50	Email
Raj	Owner/Director – University/High Performance Company	India	36-40	Phone
Damon	Manager – Research Laboratory	U.S.	41-45	Phone
Nicolas	Designer/Researcher – International Software Company	Greece	36-40	Phone
Caspar	Director – University	Spain	41-45	Email
Biljana	Researcher – Research Laboratory	Bosnia	31-35	Email
Leo	Manager – Research Laboratory	U.S.	51-55	Phone
Alonzo	IT Specialist – International Software Company	Columbia	26-30	Email
Lin	Consultant/Engineer – International Software Company	Taiwan/ China	46-50	F2F
Peter	IT Consultant – International Software Company	Belgium	56-60	F2F
Jordan	Manager/Researcher – Research Laboratory	Netherlands	36-40	Email
Robert	Designer/Facilitator – Aerospace Company	Japan/N.Amer.	>60	Phone
Lyndon	VP Human Resources – Hydrology Equipment Manufacturer	U.K.	51-55	F2F
Mila	Researcher – University	Russia	26-30	Email

Respondents' Definition of Technical Knowledge Sharing

Each interview began with the respondents being asked to provide their definition of technical knowledge sharing. This supplies the reader with a means of understanding the respondents' perspective. The first interview was completed with a technical support lead from Canada, who is referred to as Caleb. He was a very enthusiastic participant in the study and offered a good deal of information. The initial contact was conducted by phone and lasted for nearly one hour. Several interactions followed the initial interview via email for clarification of answers. He defined his culture of origin as "Upper class, white, advantaged. No cultural heritage." Caleb is under 35 years of age and works at a university where his role in the organization is to provide technical support to users of high performance computing. His department provides access to distributed resources within a larger system of computers spread throughout the Internet. The primary customers he serves are from the university community and consist of students, faculty, and researchers. When asked for his definition of technical knowledge sharing, he provided the following response, "It is where we are transferring the ability to do something, to someone else." Caleb's definition is based on the need to transfer his acquired skills to others.

The next interview was conducted via email with Mick, a 49 year-old male who holds a masters degree in engineering. When asked to define his culture of origin, Mick explained that he comes from a small town in the Midwestern United States. He described his culture of origin as "generic WASP" (White, Anglo-Saxon Protestant). Mick is a private consultant who is contracted by independent organizations to provide solutions to their technical challenges, particularly in computer security. Mick related the following as his definition for sharing technical knowledge.

> Knowledge sharing is both the transfer of information and the confirmation that the transfer of meaning – as the sharer perceives that meaning - occurred. The mechanism for sharing is generally unimportant, but the feedback that the meaning was clear and commonly accepted is very important.

As a consultant, it is necessary for Mick to determine that the knowledge he has shared has been understood as he intended. Mick is a subject matter expert who is well known in the industry for his contributions to the field of computer security. He is hired for the information that he can provide to the customer to help them decide how they will secure their computer network operations. Ensuring that his customers employ the solution as he has recommended ultimately enables Mick to secure his reputation for providing reliable solutions and will assist him in acquiring future jobs. Mick shared that, at times, his participation requires input to persuade the customer to take a particular action.

As with Caleb, Mick used the word "transfer" in his definition of technical knowledge sharing. *Transfer,* as used by both participants, defined the process for sharing their skills. However, in contrast to Caleb, Mick expressed how sharing his knowledge not only benefits the recipient of the information but also benefits him in acquiring future jobs.

The following interview was conducted by phone with Raj, who has two roles in his field of work: 1) director of a research laboratory within a university and 2) owner of a software firm. Although he has two employment positions, both afford him the opportunity to share technical knowledge. One provides him with interactions with students and faculty, while in the position of "owner," Raj communicates with engineers and customer of his business. He gave the following account when answering the initial question.

> Technical knowledge sharing is the process of imparting and communicating scientific data and analysis of the data to one or more individuals. It can take a variety of forms and can be addressed to your peers, clients, and other recipients that you have contact with.

Up to this point, all of the participants had discussed knowledge sharing in terms of transferring knowledge. In this response, Raj specifically raised the idea of knowledge sharing as "imparting" or teaching. The areas of transfer and teaching contrast; they indicate two diverse approaches to sharing technical knowledge. Transfer indicates sharing by two-way interaction, whereas teaching is generally instructive or imparting one's knowledge to another. Transfer also indicates peer relation versus teaching or telling, which implies a student or subordinate relationship and knowledge flowing one way from teacher to student. Raj also mentions that as a Hindu, he feels compelled to "help his fellow man in as best he can." His religious beliefs contribute to his willingness to share knowledge.

Damon was the next participant to be interviewed. An engineer by training, his role at the time of the interview was as manager at a research lab. I spoke to Damon by phone and our interview lasted 45 minutes. Damon lamented that in his role as manager, he didn't have the opportunity to share technical knowledge with his colleagues as he had when he was a staff member doing technical work. When asked for his definition of technical knowledge sharing, he gave the following response.

> I can't give you a definition, but the first thing that comes to mind are examples and these are publications and presentations, which mostly occur externally [to his place of work]. The only other thing that immediately comes to mind, I guess, is mentoring post docs.

In his responses, Damon distinguished between collaboration with peers, publications, and mentoring by means of advising or leading. In comparison with the previous respondents, Damon was the first who suggested publication and mentoring. Publications in technical journals generally require peer review or, at a minimum, are verified for content value by the publisher. This is one-way sharing, not collaboration. Mentoring is aimed directly at guiding another person to develop their skills. It is a means to advise someone in career development. Whereas a person may share what one knows as a mentor, it is more likely one-way sharing. This response contrasted the previous participants' views as they shared their knowledge to teach someone to do a particular job versus showing another options to direct their personal career.

Up to this point, knowledge sharing is described as transfer, teaching, mentoring and publications. To the researcher, transfer is the only action that involves two-way sharing or collaboration.

Technical knowledge sharing for most of the respondents addresses their responsibilities at work. This makes sense, as one wouldn't expect technical knowledge sharing to occur commonly in a social situation. Damon, the manager who is of African American decent, presented this idea in a different light. Although he felt that culture seldom had an effect on sharing technical knowledge in the work arena, he did say that sharing in social settings was done differently in his culture. Damon frequently found that in social settings outside of his culture, individuals would share their technical knowledge in a boastful way. Social sharing in his culture was done differently, as a means of entertainment as he shared below.

> In the African American community it's more knowledge sharing as an explicit activity. For example an elder will say, 'I am going to sit down and explain something now.' Versus when you are socializing it's more about just enjoying each other, making each other laugh. Individuals of European decent do a lot of knowledge sharing socially - as part of social interaction - as opposed to specifically [using it] as a mode of social interaction - not even intending to be about knowledge sharing. I'm not really sure how to explain that. I guess what I am getting at is that at social settings, when I am around more Anglo Saxons, as you say, sometimes I feel like I am playing Trivial Pursuit. Even if it is just a normal conversation, it seems to be more a about the information sharing and less about, say, entertaining. There is more knowledge sharing in a social setting, in just sort of casual social interactions.

Damon explained to me that in the African American social settings, individuals might share knowledge as a form of entertainment, in a manner that is fun for others. While in the same type of social setting, he finds that Anglo Saxons will use this as an opportunity to demonstrate what they know, the latter being less enjoyable for him. This response introduces technical knowledge sharing in social environments as a means of personal advance more than as a means to contribute to the greater whole.

The next respondent was Nicolas, who defined his culture of origin as Greek and is now working for an international software company in the northwest United States. This interview was conducted by phone. Nicholas is a technical project lead. Trained as a software engineer, his role as team leader is different from that of a manager since his job responsibility includes technical contribution to the project. The most emphatic response defining sharing knowledge in the workplace came from Nicolas. He stated adamantly that

sharing was his personal responsibility. In his answer he presented this concept as though it were well ascribed to fact.

> One's responsibility is to make information available to others. So this is especially in the scientific field, sharing technical knowledge is all about sharing one's experiences. Not only taking information but also processes ... it's about effectively making available the experience whether those are successful or unsuccessful, or for following an assumption and effectively doing research, right?

Similarly to Raj, Nicolas explained that he felt a personal responsibility for sharing his technical knowledge. However, Raj was also inspired to share out of his religious convictions. Additionally, Nicolas stated that the knowledge one acquires at work belongs to the employer and it is the employees' responsibility to share what they have learned with others. Nicolas acknowledged that this was not the same case for everyone.

> Actually it is part of my role as I see it, that any information that I acquire as part of the work that I do, I have to share it with my team. Not everybody does it, but this is the way that I work.

In this response, Nicolas presented the view of sharing information that indicates his work ethic as well as his alliance to his employer. This response also indicates his values: personal and professional.

Caspar is Director of Learning Technologies at a university in Spain. The interview was conducted via email and his response was provided in the Catalonian language as well as English. Like Nicolas and Raj, he also referred to knowledge sharing as personal choice, "People have knowledge and people share … or not … but the scenario and the IT tools can help us to share knowledge."

In his answer, Caspar also indicated that environment and tools provided for sharing knowledge could have an effect on sharing knowledge. By tools he refers to media (telephone, internet) and software applications. An environment can either be conducive to and invite sharing, or it can be an impediment. References to environment were repetitive and are covered in more detail later in this chapter under the Theme 5: Obstacles to Knowledge Sharing.

The next interview was conducted with Biljana, the first female respondent in the study. Biljana's culture of origin is Bosnian. She stated that she is employed as researcher for a university in the Netherlands. Our interview was conducted by email. When asked for her definition of technical knowledge sharing she wrote:

> Technical knowledge sharing, what it means to me?! It is hard to give definition to something quite vague. When saying this, I think of Internet and all the application it gives nowadays that enable(s) knowledge sharing, technical or not, does it matter?! Besides, the human contact is the primary enabler to share things...

Biljana's response was very unique to the others' answers. She identified two requirements for sharing technical knowledge on-line, media and the human component. Neither of these topics had been brought up in the interviews to this point. She did concur with Nicolas and Raj in that apart from the responsibilities dictated at work, sharing of ones' acquired knowledge is very much a personal choice and, for some, a personally-felt responsibility. This concept was expressed in the interviews with Nicolas from Greece, Raj from India, and Biljana from Bosnia.

The next respondent was Leo, manager of training, documentation, and collaborations with outside partners at a national laboratory. He defined his culture of origin as U.S. The

interview with Leo was conducted by phone. The following is his definition of technical knowledge sharing.

> I don't really have a solid definition for this topic. It more or less describes itself. In my environment, it is everything that I do. It's like when two ants cross and they touch antennas. It is everything that goes on. Information and knowledge get blurred. Knowledge throughout the course of my day is very informal through ordered kind of exchange. It is also formal knowledge sharing via web pages. It is part of everything that I do.

Although stated by previous respondents Caleb and Raj, Leo implied the word "transfer" in his definition of technical knowledge sharing. He detailed the activity of sharing knowledge through an analogous description of ants and their process of touching antenna to *transfer knowledge.* Leo included that knowledge sharing is his responsibility in performing his job and he implied that others share in order to do their job as well. The term responsibility was shared in the definition given by Nicolas from Greece. However, Nicolas differentiates in meaning from Leo by saying that it is "one's responsibility" meaning that sharing knowledge is an individual's duty. The distinction is important and is repeated later in the study.

The next respondent was Alonzo. An IT Specialist from Colombia, Alonzo was also the youngest male to be interviewed in the study. The initial interview was conducted face-to-face, and there were a few follow-up sessions for clarification via email. His response to the initial question was also unique as illustrated in the following, "The ability and willingness to share technical information to [with] fellow peers."

Alonzo introduced unique terms in his definition that had not been used by previous respondents. He identified *ability* as having a specific skill(s)or experience(s) to share with others and *willingness*. In his response, the term willingness was used to convey one's personal choice to make a contribution to technical knowledge sharing.

The next participant that was interviewed was Lin. He was born and raised in Taiwan and identified his culture of origin as Chinese. The interview with Lin was conducted face-to-face and he was generous in sharing his expertise. Trained as a software engineer, Lin was employed by an international software company as a consultant. His role was to communicate information between the individuals who used a particular set of software applications and the developers of the applications. Like Biljana, he mentioned the importance of the process that was used for sharing. Lin's definition of technical knowledge sharing follows.

> It is not the process really. It is the results. The purpose is to let people do their job better. The rest is the content, media used. Good process is really the abstraction of data into knowledge. The idea is to process this information. We have three stages: data, information, and knowledge.

Lin discussed several topics in his answer. He brought to light three stages of information in his definition: data, information, and knowledge. Through process, he inferred a transition from data to knowledge. This is a common theme of knowledge management, specifically in organizations where knowledge transfer is a goal (Ajmal & Koskinen, 2008; Becerra-Fernandez, Gonzalez, & Sabherwal, 2004; Nonaka & Takeuchi, 1995). He also stated that the purpose of knowledge sharing is providing a means for people to "do their job better." Lin's opinion that the value of knowledge sharing "is the results" was unique to the

other respondents in the research. Lin stated that the core of knowledge sharing is the result, not the process. Lin also included the idea that the content being shared and the media used to share it could potentially affect knowledge sharing.

The next interview was conducted with Peter, a colleague of Lin. Peter gave his country of origin as Belgium. Peter is also an IT consultant who works independently but within a large international corporation. In his response, Peter also discussed knowledge transfer, and he included sharing with individuals external to his organization in his definition of technical knowledge sharing.

> The capability to impact other people in or outside of the organization with your technical knowledge and also the capability to benefit from other people's technical knowledge.

A comparison of Peter's answer to the previous responses resulted in more distinctness among the participants. While interactions with external customers were indicated in others' responses, Peter mentioned sharing as having an "impact" by making a difference in the lives of others. He also introduced a new topic to this research, reciprocity in the form of benefitting from the others' technical knowledge.

The next respondent interviewed was Jordan. Born and raised in the Netherlands, he defined his culture of origin as Dutch. We conducted our interview entirely through email exchanges. Jordan is both a technical project manager and a researcher. These roles provided Jordan a diverse audience to share information with, as made evident in his answer defining technical knowledge sharing.

> As a researcher, I share knowledge with my co-workers, co-authors, and the scientific community, and sometimes also with students. As a project manager, it is one of my

> main tasks to stimulate knowledge sharing within the team. This is particularly important in the type of projects I'm managing, which involve companies and research centers from across Europe working towards a common result. People are not always in 'sharing mode,' sometimes because that's the way they are, sometimes because they're not used to sharing knowledge with other organizations.

Jordan's answer contrasts the other respondents in this study as he indicates that dependent on his role, he has a wide variety of individuals with whom he shares technical knowledge. He shares with his colleagues, across his organization as a whole, and with individuals external to his organization. This response illustrates a definition of knowledge sharing that is reported by one of the forerunners of knowledge sharing theory, Ikujiro Nonaka (1994). Nonaka defines the full spectrum of knowledge sharing in his Knowledge Spiral. The spiral indicates the transformation of knowledge from what an individual holds tacitly, to that which others share with their peers, their organization, and eventually share with other individuals for whom the knowledge becomes tacit. The Knowledge Spiral moves through this four-quadrant process, enabling others to take existing knowledge and create new knowledge. This process can only occur when an individual makes their tacit knowledge fully available for others to learn, use, and eventually obtain as tacit knowledge for themselves. Jordan's answer demonstrates that process as he discusses sharing what he knows with other individuals, within groups, his organization, and across country boundaries.

A leader, Jordan also feels the responsibility to "stimulate knowledge sharing" within his team and across organizations. He indicated that "people aren't always in sharing mode" and that this may be their personal style or their lack of experience.

Robert was the next respondent and the interview was conducted by phone. The oldest respondent in this research, he described his culture of origin as Japanese-American. He has over 35 years of experience working in technical fields. Robert's breadth of experience contributed to this research on a deep level. Like Damon, Robert included mentoring in his definition of technical knowledge sharing. He also included teaching as descriptive of his sharing mode. At this point in the data gathering, several other respondents had included the term teaching in their definition of technical knowledge sharing. They illustrated how teaching was influenced by role and desired outcome.

> It is to teach, to mentor others who do not have that knowledge (which happens to be technical in nature). There are a wide variety of motives which lead us to this activity, but that is not what is being asked.

When asked what he thought motivated individuals to share, Robert replied that one benefit of shared knowledge was the opportunity it provided for him to do a better job by being aware "of other activities that are going on in the company which might be relevant." In our discussion, he suggested that having access to information that was being or had been done by others could assist him with his developments. This response echoes the ability of innovation to emerge from transferring knowledge.

The next respondent was recruited for this research specifically to understand the perspective of an executive within a technical organization. Lyndon, who gave his culture of origin as the United Kingdom, is Vice President of Human Resources (HR) for a worldwide organization. This company provides technical equipment and services. Lyndon is responsible for the HR of this company in three countries. Although he didn't feel that he had

much opportunity to share technical knowledge, in his answer he shared the value of knowledge to the organization on the whole.

> I think that if we look at technical knowledge as an asset to the company, then it is the protection of that asset as intellectual property. Information that is held by one individual is not an asset that can be used unless it can be shared. The information that is held by one person may be a technical asset but it is not an asset that can be used unless it is shared…. It is not an asset that can be used unless it can be shared. Unless you use an asset like every other asset, you are not getting the benefit of it.

Lyndon's response demonstrates the need for an organization to know what it knows to strengthen the organization on the whole. Knowledge as a corporate asset increases an organization's capability to compete (Peloquin, 2001). As with the technical contributors, Lyndon's definition includes the need for transition of knowledge from tacit to explicit. Lyndon takes explicit knowledge one step further in describing the value that the corporation places on knowledge as a corporate asset. It is specifically the latter, knowledge as an asset to the organization, that literature and empirical research shows have an unintended positive effect on individuals' perception of their capability to do their jobs when they have knowledge resources made available to them (Sabherwal & Becerra-Fernandez, 2003). Lyndon's contribution to this research is particularly valuable as a contrasting perspective in that he details the value placed on knowledge as an asset.

The last respondent was solicited for this research to provide another female perspective to determine if gender influenced how participants defined technical knowledge sharing. Mila is a young technical researcher who defines her culture of origin as Russian. This interview took place via email. Like Nicolas, the respondent from Greece, Mila called

out sharing of "experience" in her definition of technical knowledge sharing, "Sharing experiences, changes to standard protocols."

Further in her responses, Mila adds, "I'm sharing experience, not textbook knowledge." This response very succinctly provides the view that knowledge is based on an individual's practical knowledge. It clearly differentiates that knowledge as *experience* differs from information that is publically available from a book or communal resource. This interview also reiterates that an individual's experience is tacit knowledge that is shared only when one chooses to do so.

This concluded the respondents' answers to the initial question, "How do you define technical knowledge sharing?" Each respondent expressed a unique definition and their answers indicated the core basis for why that they share what they know. While the answers to this question generated a range of diversity in the foundation (see Table 8), in general it can be inferred that the respondents identify technical knowledge sharing as a task that occurs at work that involves sharing work related knowledge.

Table 8: ***Participants Definition of Technical Knowledge Sharing***

Participant	Foundation of Definition for Technical Knowledge Sharing
Caleb	Sharing as transfer of skills
Mick	Sharing as transfer of skills with validation
Raj	Sharing as transfer of skill by imparting knowledge
Damon	Sharing as interaction
Nicolas	Sharing because it is one's responsibility
Caspar	Sharing influenced by environment
Biljana	Sharing not just automated process, requires human factor
Leo	Sharing through work; transfer of knowledge – like ants
Alonso	Sharing influenced by willingness and ability
Lin	Sharing value in the outcome
Peter	Sharing for positive impact
Jordan	Sharing with everyone in the organization, not just colleagues and customers
Robert	Sharing to teach

Lyndon	Sharing to develop corporate assets
Mila	Sharing personal experiences not already accessible textbook knowledge

Themes

Utilizing the analysis process of constructivist grounded theory method along with constant comparison; each response was compared to the previous ones for repetition and commonality. Common terms were identified as codes and arranged by category. The categories were the basis for the themes.

Six themes emerged from the process of comparing the answers to the interview questions. In some cases, the themes were substantiated through analysis of a composite of specific answers. The themes did not emerge in any specific order and each generated between 6 and 12 responses. These are detailed in the Table 9. The remainder of this chapter details the responses given, which substantiate these themes.

Table 9: ***Emergent Themes***

Factors That Impact Sharing Knowledge	Number of Responses
Theme 1: Sharing as Sense of Responsibility	11
Theme 2: Value from Knowledge Sharing	12
Theme 3: Degree that Sharing was Affected by Role	6
Theme 4: Impact of Method on Knowledge Sharing	7
Theme 5: Obstacles to Knowledge Sharing	10
Theme 6: Culture as it Affects Knowledge Sharing	11

Theme 1: Sharing as sense of responsibility. The respondents indicated that their participation in technical knowledge sharing was due to a sense of personal responsibility, represented primarily through three different aspects as shown in Table 10.

Table 10: ***Theme 1***

Aspects of Sharing as a Sense of Personal Responsibility
To Better Society
For Personal Gain
As an Obligation to the Organization

First, sharing as fulfillment or demonstration of one's personal responsibility based on individual values or beliefs was performed to provide knowledge and to enhance the greater society. Next, others thought that it was necessary for them to share as a means to getting their job done. This reason suggested that these respondents were motivated by personal benefit. This type of sharing indicates personal gain and contrasts with sharing for the company's benefit. Lastly, for others, this sense of responsibility was out of obligation to the organization at which they were employed and was fulfillment of the duties associated with their role in the organization.

Sharing technical knowledge as a sense of personal responsibility. Personal responsibility for sharing knowledge was reported by participants who felt that sharing was their duty and an expected requirement of the job. Statements ranged from "It's the right thing to do" to "It's my job." In only one case did a respondent say that sharing was directly influenced by his culture of origin. This was reported by Raj from India. Raj made specific reference to his faith and the impact that it had on the way he works with others.

> Religion does play an important role in my cultural identity and everyday life. I pray every day to do good deeds and help others. Hinduism helps me recognize and cherish others' cultural and religious differences. An ancient Sanskrit saying implores one to do good deeds without any expectations (fruits of your labor) of any kind. I

hold that saying dear and help as many scientists as I can with my tools and provide consulting advice freely, hoping it will help them.

Raj shared that as great influence on his cultural identity, his Hindu faith directed him to help others as his contribution to a better society for all.

Researcher and author Edwin Hutchins details responsibility for tasks at one's work anthropologically as being meaningful to "society at large." In *Cognition in the Wild,* he focuses on the concept that individuals do not act alone and depicts the value of an individual's contribution to solving a problem (Hutchins, 1995). This theory is demonstrated by the responses of participants in this study as detailed in the responses below.

The most emphatic response to defining shared knowledge in the workplace came from Nicolas. He stated firmly, "one's responsibility is to make information available to others." Nicolas included that it is also his responsibility as an employee to share the knowledge that he acquires through his work, "… information that I acquire as part of the work that I do, I have to share with my team. Not everybody does this, but this is the way that I work."

Further, Nicolas was adamant that sharing was not in any way attributed to either culture of origin or culture of the organization answering, "Never!" to the interview question: How often do you feel that culture of origin effects knowledge sharing (yours as well as others)?

Like Nicolas, Raj felt that sharing was his personal responsibility and his obligation to the organization as well as the clients. In his statement, Raj provided one specific factor that motivated him to share technical knowledge. This was to help others without

expectations for in-kind response. From his statement we derive that for Raj, sharing occurs largely out of personal responsibility to fulfill his values.

Additionally, both of these individuals indicated that sharing is better for the benefit of society. This response demonstrates a sense of collectivist culture as defined by Geerte Hofstede (1980). The society of a collectivist culture places high value on family. In general, individuals from a collectivist culture take action with consideration for how it will benefit those beyond self. In a collectivist culture, greater value is placed on contribution to family than to the self. The workplace is seen as an extension of family and decisions are based on how they will benefit the organization. This contrasts the individualist culture where (in general) one's consideration to take action is first placed on how the individual will personally benefit. Hofstede defines both Greece and India as "Collectivist Cultures" (Hofstede, 2010).

Sharing technical knowledge as a means of personal gain. Knowledge sharing in the form of transferring skills to others, specifically as a means to be more productive personally, was Caleb's primary reason for sharing. He stated that he needed others to do the job along with him since he could not support the growing customer base alone.

> As a 'grunt' I needed information to do my job, and as lead I need to make information available to others so that they can do the[ir] job now.

Caleb's reference to needing others to handle the workload stayed consistent throughout the interview. His premise was that his work required sharing knowledge both with the users of his systems and with the team that he leads to enable them to answer questions posed by the users. When given the option to choose between four factors as the most motivating reason for him to share, (1. Economic/Career Gain, 2. Access to Information

and Knowledge, 3. Acknowledgement of Peers/Reputation, 4. Personal Satisfaction) Caleb selected Economic/Career gain. He was the only participant to make this choice.

Alonzo also stated that he gained personally from transferring his knowledge to others. He trains business partners who, in turn, sell the product that he represents. Alonzo's job security is based on the sales that these third party individuals make, as he explains below.

> One of the most important things we do in our organization is sell software through our partners. Unfortunately, in Colombia our partners are really just learning, so one of my objectives is to teach the important 'stuff' to our business partners so they can start selling. The other thing is that technology is growing really fast in the region I live in, that obligates our organization to hire a lot of people all the time so we have to take our time and share our knowledge to people just entering the company. The way I try to share my knowledge with partners or new hires is by showing them while I work, this means that I take a new hire to a client's location and showing him stuff he would need to learn. This is better for my productivity.

The management representative in this study also stated that sharing knowledge was, in part, required for an individual's personal gain. Lyndon explained that within his organization, if one were unwilling to share they would have limited growth in the company. When asked how individuals were expected to share knowledge at his company he explained that the are:

> Strongly Encouraged (Laughs). The reason I say that is an individual's success in any organization is dependent on how they communicate and how they share. And if an individual is reluctant or unwilling to share information with peers, colleagues,

management, employees, customers, whatever function they are in, then their ability to succeed in that organization is going to be limited.

These respondents provided three perspectives of personal motivation that impacted how they participated in, and how they benefited from technical knowledge sharing. The next influence that emerged was sharing as a sense of responsibility to fulfill one's role.

Sharing technical knowledge as an obligation of one's role or to their employer. The respondents' role in the organization also contributed to their responsibility for sharing, as was indicated by Caspar who is Director of Learning Technologies at a university in Spain. Caspar shared that, as a leader, he was expected to lead his team and that he was responsible for setting expectations through his conduct.

> I lead a team. If I share, the team shares. This type of behaviors is transmitted by your example. Leaders must lead.

This response is very direct in stating that if a leader wants his team to perform a specific function, they (the leader) must be willing to do the same.

As a project leader, Peter, from The Netherlands, also identified that beyond sharing, part of his role was to encourage sharing knowledge within his team.

> As a project manager, it is one of my main tasks to stimulate knowledge sharing within the team. This is particularly important in the type of projects I'm managing, which involve companies and research centers from across Europe working towards a common result. People are not always in "sharing mode", sometimes because that's the way they are, sometimes because they're not (yet) used to sharing knowledge with other organizations.

In his response, Peter acknowledged that individuals' willingness to share might be impeded by their readiness to share. Additionally, although the sharing that occurred on his projects may span several countries across Europe, Peter did not indicate that culture had an effect on sharing. He did point out people might not share "because that's the way that they are."

This theme illustrated the emergence of motivations that affected individual's sense of personal responsibility to share their technical knowledge with others. The next theme discusses the value individuals found from sharing their technical knowledge.

Theme 2: Value from knowledge sharing. Individuals deemed value from contributing to, and through use of, the knowledge provided from a shared resource. The act of sharing knowledge proved beneficial to individuals and to the organization. In some cases this benefit was expected and in other situations the value was a revelation that came from using the application. The benefit came directly from the knowledge provided in the resource, and as a means to learn who else in the organization may have related knowledge. These capabilities are factors that contribute to innovation and are listed in Table 11.

Table 11: ***Theme 2***

Aspects of Value Obtained Through Use of Knowledge Resource
Reciprocity
Enabling Innovation
Unexpected Value
Value to the Organization

Reciprocity. For Biljana, a researcher from Bosnia, the act of sharing invoked the anticipation for reciprocity. "It is my job to share and therefore hopefully receive, to be able to share again."

Her personal gain did not serve as a barrier to her participation nor was it the sole impetus for sharing. Further, Biljana expects to share what she has learned. In her answer she relays her direct expectation of a natural progression or continuing to transfer what one knows.

Peter, who is from Belgium, also indicated that through sharing technical knowledge he would benefit from the knowledge of others.

> The capability to impact other people in or outside of the organization with your technical knowledge and also the capability to benefit from other people's technical knowledge.

These examples of reciprocity commonly occur in the on-line computing world and are referred to both as "gift economy" (Rheingold, 1993) and "economies of cooperation" (Kollock, 2003). These terms refer to the act of offering information freely with the expectation that others will do the same. This is particularly evidenced in open-source code and applications. From this sharing, trust and communities of practice develop where contributors enjoy the reputation that is built within their communities (Kim, 2000). Individuals are relied upon as those who will share knowledge and as experts in their field.

Enabling innovation. Enhanced innovation was another value that was recognized as an outcome from sharing knowledge. Knowledge sharing provides enhanced capability for individuals to see what has been done in the past and from this create solutions for the present. Respondents in the interviews defined the capability of innovation as a benefit that they felt from having a shared knowledge resource. Peter, from Belgium, shares that the knowledge resource provided through his employer enabled innovation: "I have been able to think in new ways."

In his position as a consultant, Peter bridges the gap between customers who use a computer application and the developers who create the application. Peter relates that in his job, each customer's need is situational and potentially presents a need that he has not yet addressed. The shared knowledge resource allows Peter to see the alternative approaches taken by others and innovate a solution based on past responses to similar needs.

Robert, a Japanese/American, also spoke about innovation as an outcome of a shared knowledge resource containing the history of projects at his organization. He uses the resource provided by his employer as a means of making new contacts and learning who knows what. If Robert has a problem that hasn't been worked on yet, he can search through the resource for individuals who have worked on a similar issue. This provides a means for Robert to expand solutions for his company while providing the opportunity for him to meet new individuals.

> Ah, well it gives me exposure to a lot of different people and different roles and responsibilities - a lot of contacts are encountered. In that sense if there is knowledge to be shared, if I don't know the person, I have to find the person. So it's kind of like, well, who do I know who might have an answer to that. And you follow that kind of a trail and eventually you might get to somebody who has an answer.

Through this answer, it is evident that the knowledge resource allows Robert to increase his knowledge and expand the network of experts for a specific topic. If he wants to develop an idea, he now knows an individual with whom he can converse.

Caspar, from Spain, shared that the university where he works has various resources that are content specific. His whole organization is able to benefit from this shared

knowledge. “We have resources for the storing of many types of content and this enables/contributes to innovation within the company.”

Caspar reiterated the capacity for innovation for individuals as well as the whole organization. His opinion is substantiated by the research of others; effectiveness based on the provision of a knowledge resource shows that perceived effectiveness for individuals, as well as whole organizations, increases with access to such resources (Sabherwal & Becerra-Fernandez, 2003).

Having the knowledge shareable allows distribution of information internally as well as externally to customers. Raj, whose origin is East Indian, spoke about the benefit of sharing experiences with an external colleague through his company knowledge base.

> I had worked on an application two years ago and documented the steps that I used to get it to work on a different platform. Another colleague from another university needed this. Because it was in a central location it was of value to him. We can build upon this knowledge.

Multiple resources can be of benefit, but content demands appropriate resource management. One would not try to manage version control of computer code, for example, with an application for document management. Other justification for multiple applications may include specific access to a resource, such as email based access or security restrictions. Organizations tend to want to solve multiple needs with the same application. Efficiency gained at the loss of function for useful sharing in the long run is not cost effective. Forcing a one-size-fits-all solution may not meet the needs of those who require access to knowledge. Current technology allows interaction of data across multiple resources.

Unexpected value. Individuals will use an application in the way that is most productive for them. They may find unplanned usefulness in information that is initially created for another purpose. Damon, the manager at the research laboratory in the western U.S., brought up the fact that for him the intended value of the knowledge exceeded the unintended benefit. His team develops software and he shares how his team uses a knowledge repository beyond its primary function of version control for computer code.

> Yeah it's been a positive impact. Having the version control software itself is not so valuable, but there are a bunch of things that get lumped in with it like testing, portability tools that they call to build code on other systems. You know, I would say that indirectly it has had a very positive effect on my productivity because of all of the stuff that comes with it.

When asked to explain how he found value in the knowledge base, Nicolas, whose origin is Greek, discussed the value of sharing both successful and unsuccessful outcomes that could be useful for the next developers.

> Whether those are successful steps towards a goal or unsuccessful steps. So let's say that you are trying to find a solution to a problem, whether that is a technical problem of installing of a piece of software or the configuration or the programming problem. Like you are a software engineer, so we are trying to solve programming problems. You create a repository or resource of other people's experience who might have tried the same thing. So whether they did this in a successful way or unsuccessful in attempting to solve the problem, it is still valuable information to know.

Having the ability to foresee potential failure saves time that may be better applied to another research direction. Understanding the cause of a failure provides the opportunity to apply new technological solutions and make changes to industry.

Nicolas provided a statement that is most significant in this research. He said that the resource contains "people's experience." It is important to note that the information represents individuals' experiences, not automatically generated data.

Raj, from India, also stated that the human factor is necessary in developing a meaningful resource for sharing knowledge. He said that a resource of high value holds critical insight shared by an engineer and may give justification or more explanation to technical choices.

> We have various resources. Internally we have shared web-based repositories that take the form of source code repository and an additional knowledge base for explaining your rationale for your knowledge. Also developers and users use the information that explains the software. A key component is the critical insight that is added to the source files. We also have a wiki. For an application I would write out what changes I have made and what systems and what tools [were required]. In the future, if I need to access this information, I first go to the wiki and see how it was used last time. This helps me to do my work. I also contribute to the wiki, on FAQs and through articles and journal papers.

Individuals will use the knowledge in a repository in the way that best suits them, as Raj also shared in his response. He noted that the repositories in his organization might contain a variety of knowledge and contribute to future work.

Whether individuals use the knowledge as it was intended or not, new uses for knowledge can only occur if the knowledge is shareable in the first place. The ability to use knowledge in the way that permits uniqueness for the individual invites innovation and may lessen one's inhibition to share what they know.

Value to the organization. Each respondent was asked if the knowledge resource provided by their employer was of value to their organization and to explain how. Additionally, each was asked if their organization had business processes for using the knowledge sharing (KS) application and if these were effective. Lastly, respondents were asked if their participation was mandatory, strongly encouraged, or optional. The answers to these three questions were analyzed for their interdependence and were compared to ascertain contributing factors associated with the value of the knowledge sharing resource.

Mick works as a private consultant and, as such, does not have a shared knowledge application provided for his use. He did not contribute to this question.

In this analysis, a majority of respondents, 57%, found the knowledge sharing (KS) resources provided by their employer as valuable, used the application because it was strongly encouraged, and had effective business processes defined for using the tool. 22% percent of the respondents rated the KS as valuable and used it because it was mandatory, and they also rated the business processes for using the KS as effective. 1 respondent answered that the choice to use the KS application was optional and rated it as effective. 1 respondent stated that his employer did not provide business processes but he still rated the KS resource as valuable. Only 1 respondent rated the tool as not valuable. The explanation he gave was that there were too many resources and it was difficult to find information.

Caleb demonstrated the need for business processes to be well defined and mandated through his response to the question “How often do business processes affect your participation in knowledge sharing?” He responded, “Often to sometimes. Yes, they affect my participation. Sometimes I wouldn't be sharing unless I was told to.”

In his answer, Caleb stated candidly that without a directive to share his knowledge, he wouldn’t always share his knowledge. This substantiates the need for businesses to mandate sharing technical knowledge and to provide a resource to manage knowledge sharing.

The responses were consistent with those acquired in the pilot study. In general, individuals found the knowledge sharing application valuable when use of the resource was mandatory or strongly encouraged. The primary difference between the final research and the pilot study is that the final set of interviews included an opportunity for the respondent to rate their level of acceptance of the business processes.

The responses indicate that individuals find value in knowledge sharing resources when they are provided useful business processes denoting how to utilize the knowledge sharing applications along with edicts to use the applications. The additional step of including workers’ experience into such a resource cannot be a choice. This needs to be a clear expectation of one’s responsibility. Ultimately, business processes giving direction for how to use the application are required. Given no other instruction, individuals will use an application in the manner that is most productive for them. Taking an extra step won’t happen with consistency unless it is mandated. The knowledge resource develops as these steps are taken, and individuals then become aware of the benefit. Once the benefit is felt, they are more likely to share more of what they know.

In all, the respondents indicated 4 common values that were obtained through the use of a shared knowledge resource provided by their organizations': reciprocity, enabling innovation, unexpected value, and value to the organization. These contributed to the emergence of the theme. It should be noted that each of the knowledge resources were unique and did not contain the same information.

Theme 3: Degree that sharing was affected by role. Individuals expressed that they shared knowledge through the tasks that were required to do their job. These cases were categorized by individual roles in the corporation. Once understood, organizations can utilize the effect that roles have when defining business processes to ensure knowledge sharing. The degree that sharing was affected by role is illustrated in this theme though the responsibilities of role, leader's contributions, specific knowledge being shared, and the distinction of human interaction versus automated data collections. Evidence of the effect of sharing by specific role is illustrated in the descriptions given by the respondents as shown in Table 12.

Table 12: ***Role Effects on Sharing***

Role	Participant	Effect on Sharing	Proposition
Team Leader	Caleb	"As a 'grunt' I needed people to share with me so that I could do my job. Now as team leader I need others to be able to do the job.	KS is affected by the specific responsibilities of a role. Roles that demand collaboration incur KS as a natural consequence.
Team Leader	Nicolas	"Actually it is part of my role. I see it as part of my role that any information that I acquire as part of the work that I do, I have to share it with my team."	

Role	Participant	Effect on Sharing	Proposition
Researcher	Biljana	"It is my job to share."	
Project Manager	Leo	"In my environment, it [KS] is everything that I do. "It's like when two ants cross and they touch antennas. It is everything that goes on."	
Director	Caspar	"I lead a team. If I share the team shares. This type of behavior is transmitted by your example. Leaders must lead."	Leaders set expected behavior by their example. The actions of managers are transmitted to other employees.
Project Manager	Jordan	"As a project manager, it is one of my main tasks to stimulate knowledge sharing within the team."	
Consultant/Engineer	Peter	"I provide a bridge between these people and the developers."	Individuals act as intermediaries to facilitate KS between others. Translations of knowledge may be required.
Developer/Company Owner	Raj	"Clients need to assimilate and define information to users in a clear form which may be different than [when] communicating with an engineer."	The knowledge shared is dependent on the receiver.
Researcher	Mila	"I'm sharing experience, not textbook knowledge."	KS is initiated by human interaction. Human involvement is required for KS. It is more than automated data. People are required to define knowledge.
Researcher	Biljana	"Besides, the human contact is the primary enabler to share things."	

Responsibilities of role. Knowledge sharing is affected by the specific responsibilities of a role. Caleb related how his role in the organization impacted his reason for sharing knowledge. As a junior employee, he needed the knowledge of others to learn to do his job. Later as a project lead responsible for overseeing that same job, he needed to share his knowledge and skills with others so that they could do the work as well.

The knowledge that people decide to share, and with whom they share, is a personal choice. Others also explained how they felt that knowledge sharing was a requirement of their role. Nicolas emphasized that he personally felt that "all of the knowledge" he acquired while completing his work should be shared with his team. As a researcher, Biljana also indicated the responsibility of her role in sharing knowledge stating that, "It is my job to share."

For Leo, sharing was an expected and natural part of his daily job activities. As manager of training and documentation for his organization's high performance computing environment, his responsibility was to make knowledge available to others. He stated that sharing knowledge came as naturally for him as it occurs among ants. In his answer Leo also speaks of the requirement for a "prescriptive, ordered" kind of exchange to ensure that when sharing occurs it is documented. This is further indication illustrating that individuals require business processes that give direction in how to go about sharing one's knowledge.

Knowledge sharing is a natural outcome of specific roles. Nicolas states that as a team leader, it is part of his role to share information with his team. As a researcher, Biljana also stated that it is her role to share. Leo said that sharing is "everything that I do" when describing how their roles were impacted by knowledge sharing. Here the challenge does not arise from getting individuals to share their knowledge, it is more getting the knowledge

documented in a shareable fashion. Naturally occurring interactions and situations should be considered when organizations define business procedures and make their selections for knowledge sharing applications. The more closely related to an individual's work and the more enhancement to the actual work being done, the more acceptance individuals will have for using a knowledge sharing design.

Leaders set examples of expected behavior. Caspar states that, "Leaders must lead." He pointed out that if he shared, his team would share. The concept identified here is that leaders must exemplify their expected behavior. If leaders want others to share knowledge, then they will need to set the example by sharing themselves. If defined rules of operation are expected for business operations, then everyone who participates in that business process needs to adhere to them. If everyone follows suit, a general appreciation develops.

In his role as project manager, Jordan indicated that, "one of my main tasks is stimulating knowledge sharing within the team." Jordan manages projects that may span several countries in Europe. The distance alone creates an added necessity for individuals to share openly. For projects that require KS as a means to success, leaders may need to take the proactive approach of motivating their teams to share.

Nicolas stated that as a team leader he "mandates sharing among team members." In addition to sharing information in electronic repositories, he holds weekly meetings where the team shares their work status by means of face-to-face discussion. The value of face-to-face interactions on knowledge sharing cannot be overlooked. It is in the face-to-face meetings and opportunities to work together where leader's actions are observed and thus may be emulated. It is also through face-to-face interactions where trust develops. The greater the trust between individuals, the greater the sharing that can occur.

The statement “Leaders lead!” is like the adage “Walking the walk.” In the technical industry, managers are often technical experts who rose to the role of leadership as the next rung in the ladder of promotion, rather than being promoted for their experience in managing. They may not be aware of the influence of their actions. Newly implemented business processes often require change in day-to-day operations. To be effective, these processes must become intrinsic to the daily work. Leaders may not be aware of their influence on the processes being put into practice. Leaders set the bar for achievement through their actions.

Consultants as intermediaries. Sometimes, sharing knowledge is conducted as a means of facilitating communication between others. In the world of commercial off-the-shelf or “COTS” software, companies often customize their software to provide their customer with a specific service from their application. Often times there is a communication gap between the end user who needs customization and the developer who will be creating it. Differing perspectives may result in a customization that does not provide adequately for the need or meet the customer’s expectation. Additionally, customers trying to explain what they need or developers trying to describe what they are designing as a solution may frustrate both developer and end-user. Engineers who can work well with both the customer and the developer are often hired to act as intermediaries to facilitate this communication. This kind of communication demonstrates knowledge sharing by means of translation. Lin, a consultant/engineer, explained his role as follows:

> We have business partners, development teams, and we try to determine what the customer needs. I do a gap analysis and create a road map through consulting with SMEs (Subject Matter Experts) internal and external to the company. My role impacts this a lot. Basically, I am a single point of contact - I am the channel - I need

to understand the needs and supply of knowledge. I need to know the history and what has been shared and then I can deliver the data.

Like Lin, Peter facilitates transfer of knowledge. He stated, "I provide a bridge between these people and the developers." Whereas Lin operates more as a central point of contact, Peter sees his role as an agent of transfer.

The other consultant in this research is Mick who consults with many different organizations, unlike Lin and Peter who work for a single software manufacturer. Mick is hired to employ technical capability from industry directly to a company's computer system. Recall that Mick stated that his job required him to make certain that the customer understood his transfer of information as he had intended. Mick has to be certain that his recommendations are understood and implemented as he has suggested. One commonality shared among the three consultants in this study is that they each act as a conduit for information.

Knowledge shared is dependent on the recipient. Raj takes knowledge sharing in his role one step further by indicating that the KS that occurs is also dependent on the receiver of the information. As director of a research laboratory at a university, he shares information with students, and other faculty. As business owner, Raj shares information with another set of individuals, his clients. He must gauge the recipient and adjust the knowledge shared accordingly.

Knowledge sharing is the need to share technical knowledge with peers, clients, articles, peer review publications, email to engineers indicating technical issues and knowledge is tracked in wikis that we have accrued. In my role I am communicating

with each of them. For clients, I need to assimilate and define information to users in a clear form, which may be different than communicating with an engineer.

Many respondents also indicated that knowledge sharing was dependent on their company's proprietary knowledge or controlled by internal information secrecy. These factors dictate what and with whom knowledge can be shared.

Individual roles may also influence the specific knowledge that is being shared. Individuals who route information to others may have the additional responsibility of filtering information or formulating an interpretation of the information. Statements referencing one's role as a "bridge" between individuals from diverse areas in the organization or to shareholders indicate knowledge filtering. Processes such as this cannot be automated. They require human interaction. Often times, applications are sold as a means for ensuring operations of this type. The mistake that an organization can easily make is sole reliance on the application to capture the knowledge. There are many more steps that must be considered to fully actualize such use of an application for knowledge sharing, starting with people using the application in a prescribed manner.

Knowledge sharing requires human interaction. Finally, another factor that emerged from the respondents' answers was the inclusion of human interaction. Mila and Biljana, who are female researchers in Europe, shared the aspect of their roles requiring human interaction. Mila stated, "I'm sharing experience, not textbook knowledge." This requires her to share knowledge that she had acquired through first-hand experience. Biljana was also very clear about her inclusion of the human element stating, "Besides, the human contact is the primary enabler to share things." At the core of these answers is one distinction between knowledge management and information management; knowledge is identified by

people, while information can be gathered automatically. *Information* is the result of collected data and *knowledge* is one's experience. For example, through the collection of the number of failures of a widget to perform over a period of time (data), the lifetime (*information*) of the widget can be ascertained. The fact that the widget was useful to perform a specific function for the Acme Company is *knowledge*.

The value of capturing the knowledge that is shared in processes requiring human interaction cannot be overstated. This is information that an organization needs to be resilient and that individuals need to be innovative. When driven by well thought out business processes, the use of knowledge sharing applications can ensure operational success. Without functional business processes, any capture of knowledge is unpredictable.

The summary of aspects that developed the theme of "Degree that Sharing was Affected by Role" is presented below in Table 13. As roles differ, so do the subthemes or the factors that impact sharing by role. In this research, individual's roles strongly affected how knowledge was shared in an organization.

Table 13: *Theme 3*

Degree that Sharing was Affected by Role
Responsibilities of Role
Leaders Set Examples of Expected Behavior
Consultants as Intermediaries
Knowledge Shared is Dependent of the Recipient
Knowledge Sharing Requires Human Interaction

Theme 4: Impact of method on knowledge sharing. This research uncovered two unexpected aspects that have an impact on knowledge sharing: interaction and environment (as Shown in Table 14). Respondents indicated that knowledge sharing for them was

accomplished through two primary means. It was either developed as the result of unrestricted or "ad hoc" interaction, or it was implicitly shared through teaching/telling someone something. This distinction of interaction represents one-way and two-way sharing of knowledge. The environment was also mentioned as a contributing factor to knowledge sharing, specifically, as defined by a formal or informal environment for communication. The following are responses that illustrate these findings.

Table 14: ***Theme 4***

Impact on Method on Knowledge Sharing
Sharing Through 1-Way or 2-Way Interactions
Formal and Informal Environments

Sharing through one-way or two-way interactions. Damon directly identified knowledge sharing through his role as mentor. In the interview he stated that as a manager, he was seldom provided the opportunity to share technical knowledge. He sorely missed that type of interaction with his peers but he did experience technical knowledge sharing as a mentor. Mentoring interaction is more likely to be one-way. Mentors counsel and perform the role of a coach. This form of sharing is weighted more towards leading than collaborating. As a mentor, Damon's responsibility was to guide his mentees to develop their own career. Damon enjoyed the opportunity that this role provided him to share his technical experience and expertise in the field.

Alonso is an experienced employee responsible for training new hires and business partners. He applies teaching as a form of knowledge sharing. He found that teaching is the best way to share his skills with others to enable them to do their jobs. In this example, information is being shared through a pedantic, or telling, means as compared to transferring

knowledge among peers. Similarly to Damon's knowledge sharing, this is one-way communication.

Two of the respondents described "imparting" knowledge, Lyndon and Raj. Lyndon is the one individual in this study whose job role is upper management. The company where he works is in a highly technical industry and multi-cultural, as it has a global presence. Lyndon defined knowledge sharing in his role as VP of Human Resources as follows, "My role involves a lot of communication and I guess that is partly sharing knowledge and partly imparting information."

In his statement, Lyndon distinguishes imparting as teaching and sharing as a collaborative effort.

Raj also used the terms imparting and communicating scientific data as distinct forms of interaction in his definition of technical knowledge sharing. In these responses, the term "impart" is used synonymously with "teach." It is interesting to note that both of these respondents not only delineate between imparting and sharing knowledge but also participate in both forms of interaction.

Formal and informal environments. Environment is also identified as having an impact on knowledge sharing, particularly in terms of formal versus informal communications. Caspar makes a distinction between the working environment in his region of Spain and that in California.

> I think that the working style in California is similar to that of the Mediterranean; while the style of work in Northern Europe is more formal. The formality of the work implies/enables a typical relation that is too structured to facilitate or make open communication possible.

In Caspar's comparison, he implied that the culture in his work environment is informal. Also in this statement, Caspar identified that a formal environment could impede knowledge sharing. This same idea is further stated in Caspar's answer describing the effect that the culture of the organization has on knowledge sharing in his work place.

> I think that the predominant culture is the effective and efficiency. The formality in the work implies a type of relation [that is] very structured, where the open and informal connection is not produced easily.

In Caspar's description, he indicates that his work environment is focused on economical use of employee time. This is not conducive to casual collaboration or hallway banter. Combined with Caspar's description of a relatively formal work environment, one can ascertain that casual knowledge sharing would not occur with much frequency. These factors impede open communication and thus impact overall knowledge sharing.

Raj's answer also highlights the effect of formality on general communications. In his answer describing cultural impact on knowledge sharing, he compared the formalized culture within the academic system in India to that in the U.S. Raj provided an example of how students are expected to communicate with their professors.

> In India if you want to speak to a professor or manager more formality is required. You first have to send memos requesting their time. Then when you see them you address them as Sir or Madam. This is very different from the U.S.

In this response, Raj shares one difference in formality of communication style at academic institutions in the U.S. and India. The difference is really quite dramatic. Contrast a student writing a memo to request consultation in India with the typical university in the U.S. where professors have published office hours when they are available for students to drop in.

In many cases faculty in the U.S. expect students to address them on a first name basis. Raj's answer indicates that the environment created by the formality required in India also impedes communication and ultimately decreases the opportunity for knowledge sharing.

In a diametrically opposed position, Mick, the private consultant from the U.S., shared how impromptu communications can enhance technical knowledge sharing. Beyond the organizations that he consults with, Mick actively participates with an international group of technical experts developing Internet standards. This work is done in working groups comprised of individuals who are globally located and meet at conferences several times a year. They utilize email, phone, wiki and web for their distance interactions. Of equal value are the opportunities for face-to-face interactions. Mick noted the value of information shared outside of formal meetings, informally in restaurants and bars. "Actually, informal sharing at locations like bars and restaurants can be very effective. The face-to-face environment is important."

The effect of spontaneous brainstorming, diagrams, or notes on napkins, and the uncompetitive environment in these surroundings are common occurrences at conferences. Informal occasions are where colleagues who generally communicate electronically take the opportunity for face-to-face communication. This communication may not be purely work related either. Casual and personal interactions allow individuals to get to know each other and develop, if not a sense of trust, a feeling of familiarity with their colleague.

Mick also brought to light the effect that organizations with extensive hierarchy were less conducive to knowledge sharing. He stated, "Sometimes depending on the organization, if they are too hierarchical that can be restrictive."

This type of structure includes formality and here Mick provides agreement with the respondents who stated that formality would negatively impact knowledge sharing.

Theme 5: Obstacles to knowledge sharing. Understanding obstacles that may impede knowledge sharing is key to the success of a knowledge based system. Once these areas are identified, adaptations can be made to address concerns through the business processes, within the application itself, and through education. In this research, answers from 10 respondents indicated obstacles that could or had put a hindrance on their knowledge sharing. Two aspects emerged from the repetitive responses: need for certainty of information shared and competition (see Table 15). The following accounts are examples from these categories.

Table 15: ***Theme 5***

Obstacles to Knowledge Sharing
Need for Certainty
Competition

Need for certainty. Individuals expressed that the importance of certainty could be an obstacle to the knowledge that they share. Those who are known in their field for their expertise are directly asked to contribute their knowledge. The information that they share reflects on their expertise and often contributes to a larger technical solution. The knowledge that they share must be reliable, and as a result, the expert needs to be confident in their response. This need for certainty emerged in the answers respondents gave to two specific questions: "Does the number of people who can see your contribution affect your sharing of technical knowledge?" and "Can you provide a circumstance in which you would be uncomfortable sharing information?"

Nicolas answered the question regarding the number of people who will see their knowledge with, “No. I don't share if I am not certain.” This response is representative of individuals sharing technical knowledge. Individuals put their credibility at risk when they share technical knowledge. The value of an idea or a solution can be easily lost if the information provided is faulty or incorrect.

Mila who answered the question “Can you provide an example of discomfort when sharing?” echoed this opinion. She reported, “Yes, if I’m not completely sure that my knowledge is correct, [or that it] is transferable.” In her answer, Mila also addressed the fact that the knowledge must be understandable to be shared. This includes presenting the knowledge clearly in a commonly understood language as well as being able to utilize the electronic format and presentation.

Respondents also reported obstacles when sharing knowledge outside of their working group or organization. This was primarily due to the increased work required of verifying the information presented. If one is sharing internally to their work group, they might use notes or slide decks. Externally published material requires a heightened level of rigor in the documentation. Depending on the publisher, this may include tenets of peer review and formality of presentation. The level of thoroughness varies on the audience and it requires more work for the individual sharing. This is specifically so if the shared knowledge was being presented to others “outside” of the day-to-day working teams, as told by Raj.

> If I know that this information will only be accessed by members of my team I may be more informal and I may explain the limitations of competitors’ products. If this information is to be shared on the Internet, I would be careful as to what I say about competitors and I would double check my facts. I would be more respectful of the

configuration and the other team. We work with several tools and some have limitations.

Raj includes the issue of filtering for content of information actually being shared so as not to disclose information that might jeopardize his customers to competitors.

In his response, Caleb also identified the necessity to verify the information being shared. He stated that as the numbers of those receiving the information go up, so does the work required to ensure the information.

> The more people you have looking at what you are sharing, the grander the scale, the more onerous the task and the more you are responsible to be very correct and more guarded, more careful that the information you are sharing is correct.

Jordan also answered that certainty was important to him when sharing with a greater number of individuals.

> If a large number of people will be receiving the information, I will spend more time polishing the information, for instance by providing background information, motivations, more precise wording, and additional figures.

When one shares knowledge, they avail themselves to scrutiny and criticism. The opportunity is also made available for them to become known by their peers and create a reputation for themselves. As professionals they want to portray themselves at their best by ensuring certainty in the information that they present.

Competition. Poor economy, unclear job futures, and internal struggle for power and prestige all contribute to competition. Alonzo, from Columbia shared a story with me that his father used to tell him. This is about many crabs in a bucket and they can't get out. They could work together to build a ladder with their bodies and help each other out of the bucket,

but they don't. As one will try to climb out the others pull him down. Alonzo identified the competition in his country of Columbia this way. He provided the following answer.

> What I can tell you from my culture is that people who have the knowledge really don't want to share it because that makes you their competition; while this isn't my case I have met many people with that mentality. In the U.S. I think people are more open to share information, they create papers, documents, tutorials, courses, on-line forums, etc and with this everybody learns. In Colombia people seldom publish documents or create spaces (online forums) to create that knowledge sharing environment.

Leo described how competition prevents knowledge sharing in the U.S. He also explained how he felt Americans were perceived by individuals living outside of the U.S.

> What stands out is reputation; Americans are known as being loud and obnoxious. This is more an individual instance than representation of the country as a whole. Americans are competitive and what stands out are the values that we promote. Americans share information, but real knowledge is hard to find. Knowledge that has merit or professional value is not shared unless under prescribed circumstances.

In this response Leo indirectly explains another reason why business processes are required for knowledge sharing. In his experience, individuals will not share knowledge unless under prescribed circumstances and he asserts that lack of sharing is due to competition.

Competition is seen as an obstacle to technical knowledge sharing. It is aided by the status of the economy and competition for jobs as well as internal competition for position and funds. In the private, for-profit company, individuals are more apt to work together

because making a profit ensures each of their jobs. In a public environment, organizations are generally funded prior to work being accomplished. In order to keep a project funded, and thus have a job to do, public employees are less willing to share; lest a competing individual out perform them and receive the funding the following year.

Understanding potential obstacles ahead of time allows for proactive measure to be instituted. Solutions for certainty can be addressed by means of business process design. Process can be designed using workflow that involves review of subject matter or simply allowing the author to designate when information is ready for release. Practices can be instilled to break down competition that prevents individuals from working together. For example the redesign of status meetings to include a format where individuals convey who contributed to a project rather than presenting accomplishments as theirs alone. Providing cultural education and the opportunity for individuals to work one-on-one with those from diverse backgrounds will help others learn how to work together. This ultimately builds trust among the employees and enables a technical knowledge sharing environment to develop.

Theme 6: Culture as it Affects Knowledge Sharing. Individuals from diverse cultures often have differing styles of communicating, which may impact knowledge sharing. Respondents in this research were asked if they felt that culture of origin affected knowledge sharing. Some reported that the culture or origin could be a hindrance. Others said that it did not have any effect. Those who answered, "Yes" were asked to provide examples of situations where culture of origin had impacted knowledge sharing. Table 16 below identifies the subthemes that emerged from the respondents' answers to develop the theme "Culture as it Affects Knowledge Sharing."

Table 16: ***Theme 6***

Culture as it Affects Knowledge Sharing
Power Distance
Gender
Language
Culture has no Effect

Power distance. One example that was given by several respondents was of interactions with individuals of Asian culture. This culture rates high in "power distance." Power distance defines the space that individuals place between their selves and figures in authority or subordinates (Hostede, 1980). Unspoken rules for engagement in societies with high power distance dictate formality and may prevent individuals from speaking their mind or discussion with certain other individuals at all. The protocol also extends a controlling influence over what one can say and still be appropriate. For example, one who talks about their accomplishments may be thought of as boastful. Also, it may be considered disrespectful for one to present a differing opinion. It is generally out of respect for others that individuals of Asian cultural descent are less likely to participate vocally in technical knowledge sharing at work. Lin gave the following statement explaining this.

> Chinese do not like to express themselves. Even if they have an opinion, they do not want to say anything because they might embarrass the individual - expressing your opinion has negative implications.

Scenarios on the academic front can also present power distance challenges between individuals of differing cultures when interacting with one another. In his role as an advisor at a research university in the Netherlands, Jordan provided an account that he had with a student from central Asia.

> A few years ago, I acted as an advisor for a M.Sc. student, who was from Uzbekistan. She very much had to get used to my way of providing feedback, which I would characterize as constructive but direct. My directness upset her a few times, but after a while we adapted to each other and then things worked out fine.

This example is a case that provided all the ingredients for challenge. The interaction here included vastly differing cultures, subordinate-supervisor interaction, gender difference and criticism. In this example, Jordan illustrated the need for individuals to be aware of the effect cultural differences can have on communication. He was able to find ways to interact that were considerate of the differences with his student. This understanding influences compassion and provides a more conducive environment for sharing one's ideas.

Gender. For some, there is also a cultural acceptance of gender roles that can take precedence over the unspoken expectations in the workplace. In the following example, Caleb related an experience that occurred at the university where he works in Canada. This situation involved his supervisor, a woman from India and her manager.

> In terms of delegation more than knowledge sharing, lots of cultural stereotypes are rooted in some kind of truth. Women from oppressed, downtrodden groups, for example, those who have castes systems, behave as well. So when sharing information it is useful to set expectations. For example, I had an East Indian manager, a woman in [a] relatively senior role leading a large number of students. Her manager commented that 'We should change this lab around.' Instead of her having the students do it, she went straight ahead and did it herself. Without asking for help. Culture played a role. If she had been raised in a place without visible roles or caste system, she wouldn't have responded that way.

Caleb includes his opinion that women from cultures that have significantly differing societal distinctions and expectations, particularly for women, produce responses from women who react in kind. His recount of the situation illustrates that despite her role as a manager, his supervisor felt that it was her personal duty to complete the work that her manager has requested. She responded as subservient to her manager and kept his request at her level rather than delegate it down the line. Caleb implies that the same chain of information exchange could occur when sharing knowledge.

Language. Individuals from the same culture of origin share more than one style of communication; they also share the words to facilitate communication. This can especially be true among individuals having technical discussions. In his response, Roger, who emigrated to the U.S. as a child with his family from Japan, explained one benefit for individuals who speak a common language.

> It depends on who they are sharing with and if the persons are conversant. If they are both from the same country, for example, then they might very well use that native language. Which makes it easier for them to both communicate in something that they are both familiar with. Sometimes in trying to communicate in English when it is a second or third or possible fourth language, people struggle for words.

Roger identified a commonly occurring communication scenario that exists in our global economy, “lost communication”. Lost communication can occur in a similar manner in the case where individuals use colloquialisms or native slang when speaking to others with a different language. An example is the use of jargon in technical discussion. An individual outside of this research, from the U.S., was speaking to Russian counterparts about designing an Internet network. She began her presentation with, “I’m going to talk today about an

example using a copper solution for a network." The Russian delegate stopped her with the statement, "We do not understand liquid copper." She was speaking about the distinction between telephone wires and ethernet for a computer network. The literal translation was confusing for the individuals who spoke English as a second language.

Culture has no effect. In all, 7 respondents identified culture in their responses as both having an effect and not; 3 of whom stated that culture did not impact knowledge sharing. Nicolas, from Greece, works at an international computer company and was emphatic that culture had no effect on his interactions with others at work.

> I do not believe that cultural identity impacts the way that people communicate with one another. I don't see people as belonging to a culture. I don't see the cultures of the individual as identifying them. Actually it is against company policy to identify people in the place of work as being from a different culture. We accept that there are people from different culture but we don't try to clarify [identify them as such].

Likewise, Mila originally from Russian did not think that culture had affected communications. When asked to identify her culture of origin she stated, "Due to my migration background, I see myself as European." Mila has lived in several countries while completing her education and internships.

Lyndon is from the United Kingdom, he also works for an international company and has lived in many different countries as a required by his employer. When asked if he thought that culture affected knowledge sharing he responded, "No, I'm not quite sure that it does. I think in the UK we are quite an open culture in terms of willingness to impart and give information."

Each of these individuals had lived and worked in several different countries. We can assume that their global experience living and working in diverse cultures enabled them to be more adaptive when sharing knowledge with individuals from other cultures and therefore they did not think that culture of origin had an impact.

Summary Analysis

Six themes emerged from the data in this analysis: sharing as sense of responsibility, value from knowledge sharing, degree that sharing was affected by role, impact of method on knowledge sharing, obstacles to knowledge sharing, and culture as it effects knowledge sharing.

The research corroborated results previously learned from the pilot research and earlier author's reports, while also offering some unexpected findings. What is known from other authors is that individuals will use a knowledge sharing application in the way that best suits them (Overdijk & van Diggelen, 2008). This includes how individuals will adapt to the provision of organizations' shared knowledge resource as well as their willingness to contribute to a shared community knowledge resource (Kim, 2000). Individuals have a perception of economy of cooperation that encourages them to share knowledge freely (Kollock, 2003), and individuals enjoy heightened perception of effectiveness from the availability of a shared knowledge resource (Sabherwal & Becerra-Fernandez, 2003).

The findings in these interviews matched previously obtained pilot results which indicated that individuals will find value in an application that they are mandated or strongly encouraged to use, when they are given effective business processes for how to utilize the application. Additionally, culture of origin does impact the way that knowledge is shared in some cultures.

New findings of factors that affect knowledge sharing include the necessity of human interaction and the impact of: formality in the working environment, competition, one's role in the organization, the need for certainty, and the idea that personal values will trump everything else. These findings illustrate that although one's role can greatly impact knowledge sharing, individual's human nature is based on values that transcend their role in the organization. The creation of communal knowledge from the accumulation of individual knowledge into a technically transferrable media is initiated through individual choice and the willingness of the individual to facilitate sharing. Lastly knowledge is information that is identified as such by the contributor.

Organizations that want to optimize use of their information systems and the process of knowledge sharing can utilize these findings as addressed in the following discussion chapter.

Chapter 5

Discussion

Sharing knowledge is not about giving people something, or getting something from them. That is only valid for information sharing. Sharing knowledge occurs when people are genuinely interested in helping one another develop new capacities for action; it is about creating learning processes. – Peter Senge

Introduction

Everyone knows something that nobody else does. This is an inescapable fact because no two individuals have the same experience. Everyone has a niche or something that they do in a way that is unique from others. An individual's knowledge is obtained through their personal experience, acquired as the result of one's chase after a passion, or as the result of pursuing a personal interest. Personal knowledge is realization that requires, at a minimum, an individual's time and interest and likely took a concentrated effort to learn. As a result of this personal commitment, individuals are not always willing to share their knowledge with others.

Although most individuals have learned their career-based knowledge while employed, in the U.S. it is generally the case that employee's rights of patent are released to their employer. Thus the organization maintains ownership of the outcome of ideas generated through the work of their employees. Organizations consider this knowledge to be a corporate asset that belongs to the company. Companies need to have an inventory of the knowledge that exists within their employee base in order to be resilient, innovative, and to remain competitive. As a resource this corporate knowledge has value to the individual employees, project teams, the collective areas of the corporation and potentially to society as

a whole. The challenge for employers is to capture this intangible asset, which can only be done when individuals share what they know.

One aspect that is unique to the emergent technical industry is the requirement for individuals to keep up with change. To do this one must apply self-determination to continue to learn and develop competencies independently. Evolving technology occurs simultaneously through the development of the individual's creativity, skills and knowledge. Additionally, businesses in emergent industry experience volatility. They are particularly vulnerable to competition, downsizing due to funding cuts, and currently, a poor economy. As a result of this unpredictability, individuals are not as willing to contribute their personal knowledge or skill proficiency to an organization that might outsource their job or cease to maintain operations.

Needs Addressed

The current operational demands on privately held companies addressing market competition and public organizations striving for funding have escalated management's need to seek solutions to ensure business viability. Automation has long been proclaimed as the solution that will add effectiveness and efficiency to a business operation. Consequentially, organizations invest in costly solutions in anticipation of value added results. Successful technical implementations of these systems may take years and some are never finalized. However, the technical integration is only half of the solution. The complete problem that was identified is the need for businesses to know what they know, to capture their inclusive corporate knowledge.

Organizations need to know what they know; but getting individuals to share knowledge is an elusive task. This research addresses this challenge and offers

recommendations for employers to consider when developing their knowledge sharing solutions.

This chapter offers discussion of the findings that emerged from this research, and puts forth suggestions for businesses to enable technical knowledge sharing. The discussion will first review the original 5 research questions and address if, and how, they may be of impact to the design of an application for technical knowledge sharing. Next the discussion will move to the emergent findings that developed as the research was taking place. A summary of the theoretical propositions and implications that emerged will be presented with final research conclusions, implications for practice, and discussion of future research in this area.

Research and Questions

This study was directed to answer an overarching question, "Do specific factors influence technical knowledge sharing in a research industry?" A pilot study was completed to determine if this topic warranted further research. The analysis of the pilot suggested 5 factors that could contribute to individuals sharing technical knowledge. The pilot results were subsequently used to develop the five sub-questions listed below, which were posed to respondents in this research through interview format.

1) How does one's role within the organization contribute to knowledge sharing?
2) How does one's culture of origin affect sharing technical knowledge?
3) How are technical employees' perceptions of value associated with shared knowledge resources, affected by business procedures to manage knowledge?
4) What business procedures affect individuals' participation in knowledge sharing?

5) Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?

Discussion of Methods

The driver for this research was the frustration that organizations have faced to successfully gather and share internal knowledge through IT solutions. Individuals continually resist using the applications to share knowledge though the software is considered effective by human factors standards and operational as designed. A study of individuals who regularly work with technical knowledge was necessary to understand the nature of knowledge sharing by individuals in the technical fields. The goal of this study was to construct a conceptual framework based on theoretical proposition for how to enable technical knowledge sharing interactions.

These objectives were best served by qualitative analysis. Constructivist grounded theory method (CGTM) was selected for the analysis method, as the intent was to develop a theoretical framework of a field that had little prior research. This method utilizes a well-defined structure of inductive procedures for collecting data and comparative analyses for translating the data into a resulting theory of explanation. CGTM differs from traditional grounded theory (GT) as this method encourages researchers with background in the topic to include their experience and understanding into the area of study, while inviting the researcher to develop their results in relation to the respondents. In CGTM the researcher works with the participants to develop their responses and may at times assist them in the process (Charmaz, 2006). The researcher conducting this study had first hand experience in providing technical support. In addition to the previous assignment of providing formalized

technical support, the problem for the researcher was further impacted by the competition among internal groups for control of the project.

Technical knowledge sharing itself is socio-technical in nature. That is, it is based on technical ideas generated though social interactions. CGTM is consistent with this inter-relationship allowing the researcher to gather data heuristically, construct interpretations of the analysis with the respondent, use previously conducted study and the researcher's personal experience to generate theory.

All of the participants in this research were individuals who work in technical industry. Although the work roles differed among them, each had experience with, and was able to articulate their understanding of technical knowledge sharing. Through independent interviews with individuals who work in the emergent technical fields and analyses of their responses, determination was made of the contribution specific factors have on technical knowledge sharing.

Discussion of Results

The overarching question that this research aimed to answer was "Do specific factors influence technical knowledge sharing in a research industry?" Through analysis of the answers given to the 5 research questions, 6 nearly directly associated themes emerged as common factors that contributed to technical knowledge sharing. These themes were closely aligned with the research questions and are discussed in detail in Chapter 4. The remainder of this chapter offers the findings related to this research that indicate how this study answered the research questions and provides propositions and implications of additional findings that emerged beyond the research questions.

Research questions. The research questions are posed here along with discussion of the research results and the theoretical framework that emerged from this study.

RQ1 Role within the organization. The first research question was, "How does one's role contribute to knowledge sharing?" Respondents were asked to explain how their role in the organization impacted the way that they shared knowledge. Each of the respondents answered that their role directly influenced sharing of technical knowledge. The following five aspects emerged as having an affect on knowledge sharing: 1) fulfilling one's job responsibilities, 2) ensuring that others' fulfill their responsibilities (e.g. individuals' roles as managers and team leaders), 3) the information that was actually shared, 4) who the individuals were sharing information with, and 5) the concept that sharing knowledge is dependent on human interaction. Due to the many aspects, the theme that emerged from the responses to question was, "The Degree that Sharing was Affected by Role." The theme that emerged in this analysis was very similar to the original research question.

The responses to this question elicited some very exciting ideas in this research. First, sharing to fulfill one's role was indicated by individuals who needed others to be able to do the work to that they were doing. This type of sharing was directly beneficial to the individual who was sharing the knowledge or skills. These respondents, through enabling others to do a specific job were also providing the means to do their jobs better or to concentrate on other areas of their work. In these cases there was a level of personal gain acquired from sharing knowledge in this regard.

Next, analysis showed that whether or not knowledge was shared was highly influenced by role. For example, managers indicated that they were able to lead by example,

and project leads mandated sharing by their subordinates. In several responses the answer given was "it is my job to share."

Consultants acting as conduits, facilitated knowledge sharing by directing and translating the sharing of knowledge between others. Along with this, a similar concept that emerged was through respondents who share knowledge with individuals external to the company. In the later case the knowledge shared had to be filtered for proprietary content as well as validity.

The idea of translating and filtering further fuels the distinction between information and knowledge that was identified by several respondents who stated explicitly that they were "sharing their experiences" rather than information available from other collective resources. Here the distinction between automated processes that collect data and information that was identified as human knowledge is illuminated. The last idea particularly identifies an area not widely promoted, that the gathering of knowledge cannot be automated. Herein lies one reason for the failure of many IT solutions to provide successful knowledge sharing. These solutions were designed for sharing information, not knowledge!

RQ2 Culture of origin. Research question two was, "How does one's culture of origin affect sharing technical knowledge?" The original questions for this research were designed from the findings of a pilot study. The pilot data was substantiated by literature (Hofstede, 2001; Ardichvili, et. al., 2006), and it appeared that culture of origin would have an impact on knowledge sharing. In the research interviews, additional questions were designed to assist in determining the answer to this question. Two of these that were posed are, "How often do you feel that culture affects knowledge sharing (yours as well as others)?" and "Do you feel that individuals from specific cultures share knowledge

differently than others?" The answers to both of these questions were overwhelmingly affirmative. Respondents indicated that individuals from diverse cultures shared information differently. In the three cases where respondents answered that culture did not have an effect, each had lived and worked or studied in a countries different from their culture of origin. The association is that as a result of their experience interacting with individuals from other cultures, these respondents were adaptive to cultural diversity. Thirteen respondents indicated that culture of origin did have an affect on knowledge sharing. They reported both negative and positive impacts on knowledge sharing due their personal culture of origin as well as others' differing cultures. This topic did emerge as contributing to the overall research.

RQ3 Perception of value of knowledge resource. Research question 3 was, "How are technical employees' perceptions of value associated with shared knowledge resources affected by business procedures to manage knowledge?"

The reoccurring theme of the value found in the knowledge resource emerged in the responses from twelve of the respondents. The responses indicated a range in the value individuals found in the resource. Three specific areas were repeatedly identified in the answers: reciprocity, enabling innovation, and "All the stuff that comes with it!" Reciprocity occurred through the expectation of individuals who instigated sharing their knowledge, "It is my job to share and therefore hopefully receive, to be able to share again." Reciprocity can only be experienced if there is active use of the knowledge resource through contribution as well as inquiry.

Another value that was identified is that of innovation. In their answers, respondents indicated that the information contained in the resource enabled them to be innovative. Access to historic information and being able to associate an individual with a skill were

highly valued. This response was found in both the interviews with the technical workers and the upper level manager. Innovation for the individual enables personal career growth. Innovation for the company enables successful business operations.

"All the stuff that comes with it!" was repeated by participants who found an unintended capability from the knowledge resource. The manager whose team used the knowledge resource to manage developed software code explicitly stated this. What he found was that the value extended beyond code control "Having the version control software itself is not so valuable but there are a bunch of things that get lumped in with it like testing … portability tools that they call to build systems." This was echoed by another respondents as well, "… indirectly it has had a very positive effect on my productivity because of all of the stuff that comes with it." Often applications designed with one intention are re-purposed by those who discover alternative uses for the application.

This indicates that planned return on investment for providing knowledge resources might very well be greater than initially thought. It is difficult to put a dollar value on the capabilities that shared knowledge may provide. A study indicating the perceived effectiveness of knowledge management processes for shared knowledge does indicate that the value increases from individual, group, and to the whole organization. The results indicate that the perceived effectiveness is greater for the working group (Sabherwal & Becerra-Fernandez, 2003).

In all, responses to this research question did provide direct contribution to this research. Employees find value in a knowledge resource when the use of it is required, and unintended benefits can arise through use of a knowledge resource.

RQ4 Business procedures affect on knowledge sharing. In the world of automation distinction is made between *business processes* and *business procedures*. *Processes* are the automated resources that provide the capability for knowledge sharing. In this research processes equate to resources that enable electronic management of knowledge: databases, web pages, wiki's, electronic mail. *Procedures* are the required steps that an individual must perform in order to add knowledge to the resources. This is accomplished by means of human interaction with the process by documenting incoming calls and project findings, and registering software. The information that is added is not presented in a consistent structure. Therefore, it is difficult if not impossible to extract knowledge from information. Human activity is required to identify the knowledge.

When respondents were asked to discuss the business process that affected their participation in knowledge sharing, the common response given was that these processes were specific to the application and need being addressed. In general, respondents identified repositories for project plans, software development, record of technical support, and lessons learned. The existence of business processes in the work place was reported by all but two respondents.

In this research the question posed was "What business procedures affect individuals' participation in knowledge sharing?" As the interviews progressed, it became obvious that the responses to this question alone addressed specific software applications being used. The answers did not provide data from which to determine generalizablity. This prompted the question to understand if determination could be made that business processes and procedures affected individuals' participation in knowledge sharing. To find out, a composite of questions were analyzed from which to establish: who in the organization used the

resources, if respondents found knowledge sharing effective, and if knowledge sharing capability, when provided, was of value to them (see Table 3).

Overwhelmingly what emerged from the data was that when knowledge sharing capability (process) existed and when knowledge sharing was mandated (procedures) or strongly encouraged, respondents identified the resources as effective. Individuals who used the resource in a prescribed manner using business processes identified value found from shared knowledge resources.

The responses provided to the applicable research questions posed indicated that, to ensure the use of a knowledge sharing resource, the use must be prescriptive and mandated.

RQ5 Affect of media on knowledge sharing. Research question five was "Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?" This question was posed to determine if media would affect an individuals sharing of technical knowledge. The answer overwhelmingly was "No." The result to this question would most probably differ if the research group were other than computer subject matter experts. There was one surprise in the respondents' answers, however. Nearly all stated that when sharing technical knowledge they preferred to meet face-to-face. If that option was unavailable, limited by distance for example, their second choice was to speak over the phone. Email rated the third as the preferred form of communication for sharing knowledge.

The sense that emerged in the interviews was that these individuals were less comfortable sharing knowledge in a form that could easily be duplicated and shared further than intended. This aspect emerged solidly from the responses and is included in the

obstacles theme. There were no other significant findings in the responses to this research question.

Additional Research Development

The nature of Constructivist Grounded Method Theory is the emergence of theory from data. Three additional themes emerged that were not specifically defined in the original research questions. These were: personal responsibility, environment, and obstacles. The following presents discussion of these three areas.

Personal responsibility for sharing. Beyond cultural differences, business procedures, and even getting one's work done, emerged one aspect which respondents identified as impacting technical knowledge sharing, their sense of responsibility. This was influenced by the potential for reciprocity, personal career gain, and in one case religious belief. Generally, respondents answered that this was the right thing to do.

In spite of mandates, individuals choose whether or not to share their tacit knowledge. It cannot be taken from them. The responses that indicated this aspect were particularly inspiring, illustrating that the other findings in this research were outweighed by the sheer fact that human nature trumps all. It also was inspiring to learn that individuals' values transcended personal gain and that they placed higher importance on contributing to the greater societal good.

Impact of environment. Environment emerged from the data as being a contributor to sharing technical knowledge. Formal environments proved to be restrictive and were not conducive to knowledge sharing. Directly at the opposite emerged the aspect that knowledge was being more readily shared in informal environments. Although respondents indicated that they shared formally by means of publication and presentation, sharing directly in the

work place was negatively affected by the formality of the environment. Not surprisingly individuals will often share technical knowledge in organically formed groups or while working with colleagues. For knowledge to occur there needs to be a balance between formal and informal scenario.

The respondents in this study have stated that informality, the ability for collaboration to form organically and communication to occur freely, contributes to the individual's willingness to share knowledge. At the same time, knowledge is most useful when it is accessible to the whole organization. For this accessibility to occur it is necessary to have a formally structured knowledge management.

When individuals share informally, they may not document the knowledge for later access. It they do, they will use the application that is most familiar to them. The results of are, organizations that end up with disparate information that is difficult to access.

The conundrum then is for an organization to delicately balance the formality of knowledge management with the informality required for knowledge sharing to occur freely. One way for this to occur is to make the gathering of the knowledge intrinsic to the day-to-day work routine, and to allow individuals to determine what information, when, and with whom, they will share.

This last step poses yet another difficult challenge for an organization in that while it is desirable to allow the individuals jurisdiction over dispersing the information, the organization must be assured that the information is manageable. Here business processes and procedures and individuals' day-to-day activity must be interwoven to ensure that valuable knowledge will be shared.

The other impact of the environment that emerged was whether information was being delivered, imparted or taught, or if it was being shared by means of interaction or working together. The later accepts input from all and as such invites the trust and creativity that is necessary for innovation.

Obstacles to knowledge sharing. This theme emerged from the respondent's answers throughout the interview process. Any statement that identified as a discomfort or hindrance to sharing was collected. Like other themes, this one was a composite of the answers to several different questions. What was discovered is that the obstacles to sharing are not insurmountable. Rather in many cases they are areas that are in need of improvement. An example is the impact on communications between individuals of diverse culture of origin on knowledge sharing. The general factor of impedance that was identified was "power distance." Examples in this research demonstrated that power distance explicitly impacted interactions between genders or subordinate-to-superior communications. Cultures that traditionally have high power distance in their culture are likely to have this also negatively affect knowledge sharing.

The need for certainty is another area specific to professionals in technical industry. These individuals are trained from freshman not to announce findings without proof of their conclusions. In the technical industry, publications must pass the rigor of "peer review" and validation of theory is accepted protocol for professionals in any industry. Without certainty individuals are not willing to share. Publication or advertisement of findings without verification, if incorrect, could halt an otherwise promising career. Respondents also indicated that information that was being shared outside of the immediate working groups

required greater validation and as such produced a more onerous task for the individual sharing.

The last common obstacle that was identified was competition. The current economic crises, companies outsourcing positions, and internal competition among employees were reported as contributing factors.

An additional finding was that internal competition was more prevalent among respondents in public organizations versus those in private industry. The reason assumed is that the objective in private industry is to make a profit. This invites others to work together for the organization. Subsidized organizations tend to instill competition among their employees by the mere nature of funding. Employees must compete for the funds to proceed with a project. This process makes them more likely to feel the need to stand apart from their peers.

Summary of Propositions

As previously discussed, the emergent findings in this research defined 6 themes. The themes are presented in summary in this section along with an illustration of the finding and the proposed implications for adaptation that an organization may consider to implement to ensure technical knowledge sharing.

Overwhelmingly, individuals' identified that they shared their knowledge out of personal choice (see Table 17). Sharing is an individual's choice and it is based on their personal value. To facilitate knowledge sharing, an organization can adopt a goal or mission of sharing as "the right thing to do" to encourage participation. Individuals will also share for personal gain. If an application includes a way to facilitate this in its design, it is more apt to be used. Lastly participants indicated that they shared as a fulfillment of their role at work.

Organizations can include business processes and tasks by role as part of the job definition to encourage technical knowledge sharing.

Table 17: ***Theme 1 Propositions***

Theme 1. Sharing as a Sense of Responsibility		
Findings	Illustrations	Implications
Individuals share out of personal value.	"Religion does play an important role… and I help as many scientists as I can …" "… one's responsibility is to make information available to others. … Not everybody does this, but this is the way I work."	A company goal or mission directed to knowledge sharing as the "right thing to do" will encourage individuals to participate.
Findings	Illustrations	Implications
Individuals share when they see potential for personal gain.	"… as lead I need to make information available to others so they can do the job." [Re: Sharing with new hires.] "This is better for my productivity."	Designers and trainers need to consider how individuals can personally benefit when they plan for or teach how a knowledge resource can be used.
Individuals share technical knowledge as an obligation of one's role or to their employer	"If I share, the team shares. … Leaders must lead." As a project manager, it is one of my main tasks to stimulate knowledge sharing within the team"	Incorporating techniques for "sharing by role" within an organization will ensure use of a knowledge resource. E.g. Project Leaders mandate contribution of project documentation, managers share weekly "news notes" on accomplishments, company "spotlight" for individual contributions.

Theme 2 illustrates the value that individuals find in a knowledge resource (shown in Table 18). Individuals will use an application if they find value in it. This poses a quandary when initially releasing an application, as it most likely will not yet contain a large amount of

individual's input or knowledge. One approach to address this problem is for the organization to mandate use of the application and to acknowledge the information that is contained within as valuable. Through the inclusion of business processes that operate dependent on the knowledge resource and that deliver valuable information will also ensure use. Including the ability for individuals to customize the application for their needs is an attractive option for those individuals with technical expertise. One technical approach to increase initial data is to make secondary resources available from within the resource that is planned as a primary source. This creates a "common location" feel to the application and allows individuals to access information that they have used in the past. Additionally if individuals receive acknowledgement for using the application this provides additional validity for the value of their contribution as well as for the knowledge resource.

Table 18: ***Theme 2 Propositions***

Theme 2: Value from Knowledge Sharing		
Findings	Illustrations	Implications
Intended values gained from sharing technical knowledge include reciprocity and reuse capability.	"It is my job to share and therefore hopefully receive, to be able to share again." " … capability to impact other people … and benefit from other people's technical knowledge."	Organizations that implement shared knowledge resources can advertise the expected value of the resource to encourage use within their organizations.
Intended values gained from sharing technical knowledge include increased productivity by enabling innovation and reduction of redundancy of work.	" … We can build upon this knowledge." " …it made me aware for instance of other activities that are going on in the company which might be relevant.." " … I have been able to think in new ways."	Individuals will benefit and value of shared knowledge and when it is presented in a tangible form that they can make use of.

Table 18 Continued

Theme 2: Value from Knowledge Sharing		
Findings	Illustrations	Implications
Unexpected value was experienced through use of the knowledge resource.	" … indirectly it has had a positive effect … because of all of the stuff that comes with it."	Design for use of the knowledge resource needs to include flexibility for enhanced handling of the information.
Value comes from sharing successful and unsuccessful work in a knowledge resource.	"… a repository or resource of other people's experience … whether they did this is a successful way or unsuccessful … it is still valuable …"	Consistent business processes capture all outcomes and ensure retention of corporate history and information integrity.
Use of the knowledge resource must be mandated.	"… I wouldn't be sharing unless I was told to."	Business processes must be defined and mandated for use to occur.

In theme 3, respondents acknowledged that they used knowledge resources in relation to their role in an organization (see Table 19). This may impact the actual information that they share as well as with whom they share it. Individuals also identified knowledge as personal experience or understanding. This concept introduced the differentiation between information and knowledge in this research.

Table 19: ***Theme 3 Propositions***

Theme 3: Degree that Sharing was Affected by Role		
Findings	Illustrations	Implications
Individual's role contributes to how a knowledge resource will be used.	"… part of my role [is] that any information that I acquire as part of the work that I do, I have to share it." "It is my job to share." "My role impacts this a lot. … I am the channel."	Organizations can ensure use by implementing business processes at all levels of employee participation.
Intended recipients impact shared knowledge.	"For clients I need to assimilate and define information… different than communicating with an engineer."	Knowledge is delivered depending on the recipient may require access restriction and filtering.
Sharing knowledge is not the same as sharing documented information.	"I'm sharing experience, not textbook knowledge."	Knowledge sharing requires human interaction to denote knowledge from information.

Knowledge sharing occurs in both collaborative and pedantic exchanges and is affected by formal and informal environments as detailed in the proposition for theme 4 (see Table 20). Respondents reported that formal environments were an impediment to technical knowledge sharing. Individuals are much more likely to share what they know in informal or naturally occurring groups. Sharing in informal situations outside of the workplace was noted as being particularly valuable for sharing technical knowledge.

Table 20: ***Theme 4 Propositions***

Theme 4: Impact on Method on Knowledge Sharing		
Findings	Illustrations	Implications
Participants made a distinction between one-way and two-way sharing.	"My role involves a lot of communication … partly sharing knowledge and partly imparting information."	Knowledge is shared through pedantic and collaborative interchanges.
The environment, including location, and style of interaction impacts knowledge sharing.	"The formality of the work implies/enables a typical relation that is too structured to facilitate or make open communication possible." "…informal sharing at locations like bars and restaurants can be very effective. The face-to-face environment is very important."	Environment needs to be considered and planned to enable knowledge sharing.

Obstacles that were reported by respondents as affecting knowledge sharing were given in terms of: need for certainty, controlling the content and the breadth of the sharing, and competition, as shown in the propositions for theme 5 (see Table 21). In the technical arena, individuals post opinion as suggestion for others to follow based on their technical discovery. If they share something that is not correct it may jeopardize their chance of being trusted by their colleagues in the future. Information is shared based on the recipient and may require access control to the content particularly if it is proprietary in nature. Internal competition has an adverse affect on knowledge sharing within an organization. Individuals competing for funds, position, and acknowledgement are more likely to hold their knowledge within than to share it for the benefit of others.

Table 21: ***Theme 5 Propositions***

Theme 5: Obstacles to Knowledge Sharing		
Findings	Illustrations	Implications
Technical professionals want to be certain of the technical knowledge that they are sharing.	"I do not share if I am not certain." "… if I am not completely sure that my knowledge is correct, is transferrable."	For installations of knowledge sharing applications, contributor's need for certainty is necessary.
Reach of knowledge information necessitates control of content.	"The more people you have looking at what you are sharing, the grander the scale, the more onerous the task and the more you are responsible to be very correct and more guarded, the more careful that the information that you are sharing is correct."	Contributors need to be able to control the knowledge that they are contributing, including the ability to make changes to the content.
People need to know who will be accessing the information.	"If I know that this information will only be accessed by members of my team I may be more informal ... If this information is to be shared on the internet I would be careful as to … and I would double check my facts." "The issue is that I don't want to put in something that everyone will see that is not approved by others."	Contributions vary based on who is accessing the knowledge that they share. This can be accomplished by providing access control of the content.

Competition is an impediment to knowledge sharing.	"What I can tell you from my culture is that people who have the knowledge really don't want to share it because that makes you their competition." "Americans are competitive … [they] share information, but real knowledge is hard to find"	A corporate knowledge resource cannot be built if internal competition is encouraged.

Culture of origin emerged as theme 6 in this research as individuals felt very strongly both in it having and not having an effect (shown in Table 22). This was most evident in cultures with high power distance divisions and effected knowledge sharing in terms of gender and hierarchy of position within the organization. Differing language was also mentioned as an impediment to sharing knowledge by having an adverse effect on communication. In each of the situations the problems identified can easily be negated through attention to awareness and by training.

Of the fifteen respondents, 3 stated that culture of origin did not affect knowledge sharing. Each of these individuals had lived and worked in counties outside of their country of origin and it was felt that their global experience had an effect on their ability to share individuals of varying culture of origin.

Table 22: ***Theme 6 Propositions***

Theme 6: Culture of Origin		
Findings	Illustrations	Proposition
Power distance differences affect knowledge sharing between differing cultures, gender, and in supervisor subordinate relationships.	"… do not express themselves … expressing yourself has negative implications." "… after a while we adapted to each other and then things worked out fine." Example of female manager who completed a menial task herself rather than delegate it.	Differing communication styles and expectations for interaction can be included in sensitivity training.
Individuals with the same native language can communicate with each other more assuredly.	" … If they are both from the same country for example then they might very well use that native language. Which makes it easier for them to both communicate in something that they are both familiar with."	Language can be a barrier. It is necessary to use terms that are well understood and to avoid colloquialisms and jargon.

Conclusion and Significance to Field

The findings that emerge in this inquiry were based on the analysis of data resulting from two studies, a pilot and the final research. The themes that emerged indicate the opinions of experts in the technical industry who were selected for the express purpose of distinguishing the factors that contribute to technical knowledge sharing in the computing industry.

From the six themes that emerged there are four sub-themes that standout as unexpected findings in this research and seem particularly important for industry to consider.

These are: 1) the requirement of human activity in the process of knowledge sharing, 2) the unexpected value that comes from use of a knowledge resource, 3) the personal responsibility that inspires individuals to share knowledge as a contribution to the greater good of the organization, and 4) the impact of competition on knowledge sharing.

The value of human contribution can be summed up in the answer given by one respondent, "I am sharing experience not textbook knowledge." To illustrate this a distinction between information management and knowledge management is offered. The current knowledge pyramid consists of four levels: data, information, knowledge, and wisdom (see Figure 9). This model while incorporated by many researchers over years (E.g., Ajmal & Koskinen, 2008; Davenport & Prusack, 1998), is not claimed as being created by any one author.

Figure 9. **Data, Information, Knowledge, Wisdom Model; Author Unknown**

This knowledge pyramid has been used to explain knowledge management solutions, which indicate that data beget information from which knowledge is derived. The findings in this research dispute that explanation. Respondents in this research provided answers through which emerged the understanding that knowledge cannot be derived or filtered automatically from information. Knowledge must be identified and designated as such by an individual. I propose that this is why IT solutions implemented by organizations are not more successful.

Knowledge cannot be automated as the DIKW pyramid implies. I offer this conclusion graphically through an enhanced version of the DIKW model that emerged from this research in Figure 10.

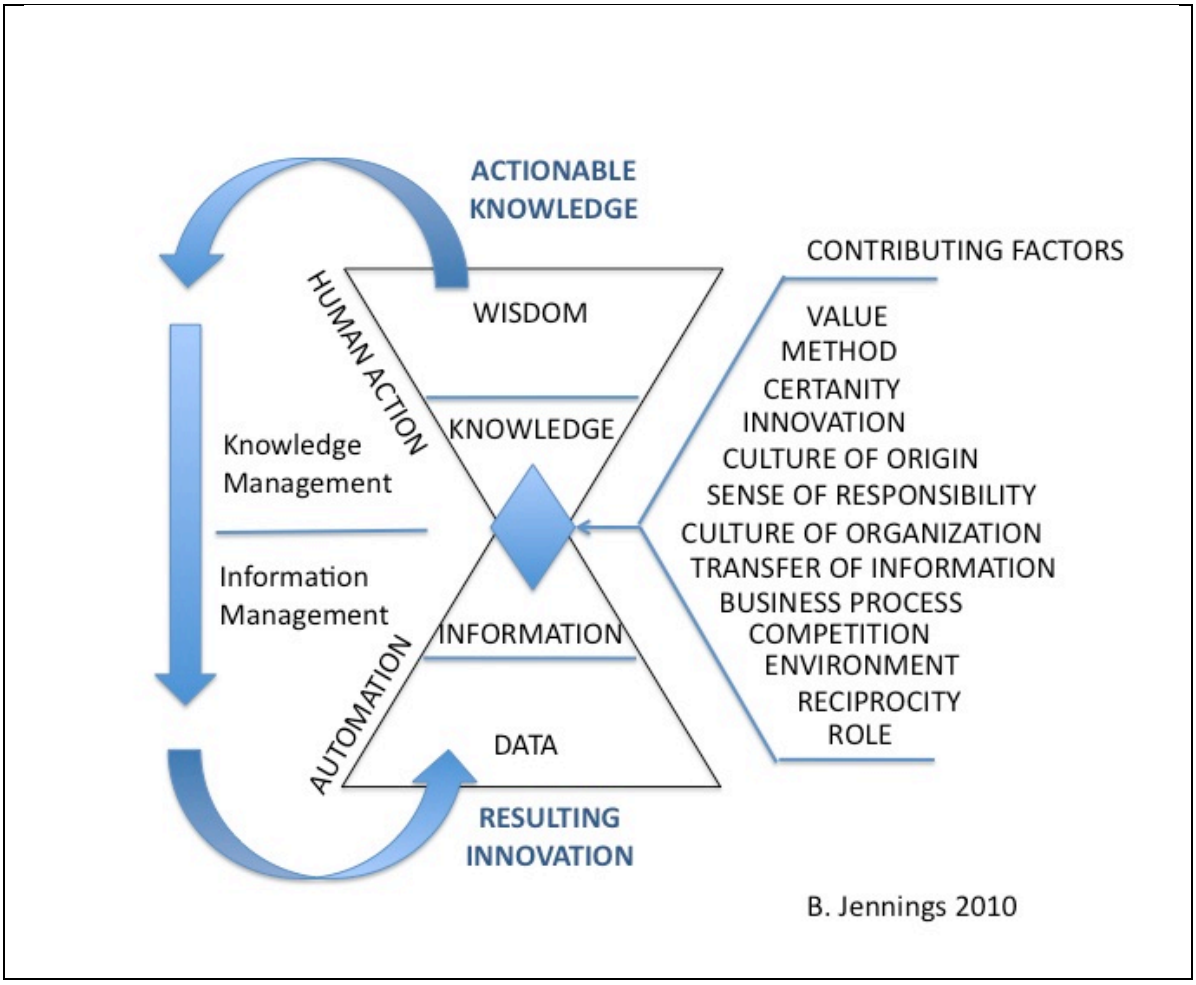


Figure 10. **Data-Wisdom Transformation Model**

This model includes the four stages of data, information, knowledge, and wisdom as presented in the DIKW model, with differences. Presented as the Data-Wisdom Transformation Model (DWTM), the representation has a different graphical shape, and indicates an additional separation of the layers. The anvil shape was chosen over the pyramid to indicate the amount of data that occurs at the four individual layers. The pyramid model

suggests that less information results at the pinnacle of filtered information. The anvil indicates that the largest amount of content occurs in the data and wisdom levels. Data being the automatically captured "raw" information and wisdom the result of data transitioned through the levels of information, and knowledge. Actionable knowledge is the knowledge resulting from wisdom that is known to govern or direct the choices of an organization. It is the knowledge that is used to make decisions that effect and represent the whole of an organization (Argyris, 1993). The results of actionable knowledge can be returned to the model as data and the knowledge process begins anew.

The arrows to the left indicate that the results of actionable knowledge can be reused in the data layer of the model. Thus demonstrating continuity as organized information moves through all the phases**,** indicating the continuous process capability of the model.

Within the 4 layers, the bottom level that is titled "data", represents data that is automatically generated. This is generally machine generated and often it is gathered automatically from other resources. Without analysis or manipulation, it is not meaningful.

The second level, "information", is data that has been electronically manipulated into a meaningful representation. Operational metrics is an example of the content that is represented at this level. Based on the number of "hits" or access attempts logged to a website (data), the business can determine who the online customers are (information). As indicated in the model, the data and information levels represent automatically collected data and belong to the information management half of the model.

The knowledge level is next in the sequence. This is information that has been designated by a human as knowledge. It is most generally that which has evolved out of an experience. Common examples of knowledge are lessons learned and best practices for

performing specific procedures. Using the last example given for metrics gathered from website access, the following scenario illustrates knowledge transitioned from information. From the metrics collected (data), the interests of the customer accessing the site (information) can be derived. Knowing this information the business could apply targeted advertisement (knowledge) to the website.

The top level, wisdom, represents knowledge from which further action can be taken or actionable knowledge. This is the area that represents capability for innovation. Repurposing of knowledge is an example of wisdom that was shared from participants in the study. When speaking about the value of a software code registry, Damon said that the resource was valuable for code development, but what was of the most value to him was "…all the stuff that comes with it!" He indicated several uses for the data other than that which it was initially designed for. Another unintended use that emerged was the ability for Robert to learn who in the company had worked on similar projects in addition to those that he was involved with, thus possibly providing additional resources for subject matter expertise. This information allows individuals to be more productive by starting their work from where others have left off and can save time in through by lessening redundancy. These are examples of actionable knowledge.

In addition, the DWTM model illustrates the process that results in wisdom returning to the data state demonstrating the capability for continuous transformation. As data resulting from the applied knowledge are collected, it is then used to begin the transformation process over again. What were data can be transformed into wisdom and subsequently useful as data again. This continuum also recognizes the change in data from tacit to explicit states, as knowledge must be shared for it to be acted upon by others. It is through the provision of

knowledge that innovation may occur. As indicated in the model, the levels of knowledge and wisdom require human activity or participation.

On the far right of the anvil are the many factors that emerged in this research as contributing to technical knowledge sharing. Some are facilitators and others impediments to the process. Both of which must be considered to enable a successful solution for sharing knowledge that individuals and their organizations can benefit from. I propose that the failure of an organization to experience fully functional knowledge sharing is the result of not giving the necessary consideration to one of the areas depicted.

Another surprise that emerged in this research was the unintended value that is associated with technical knowledge sharing. Having a resource to manage knowledge that can also serve as a supply of corporate knowledge is immeasurably beneficial to build resilience, enable innovation and ultimately enhance the future of a company. Individuals indicated that the value that they enjoyed from the resource included unintended benefits. "All the stuff that comes with it!" Knowledge provides insight to capability, subject matter experts, and technical history. Organizations need to know what they know in order to truly understand their capabilities to continue to grow.

Individuals' sense of personal responsibility for sharing knowledge also emerged in this research. The individual who cultivated it holds the knowledge. This knowledge is not valuable to anyone else until it is in a shareable form. The respondents in this research indicated that for them, sharing is dependent on one's willingness, certainty, and sense of personal responsibility. None of which can be automated or forced. Organizations that want to implement successful knowledge sharing solutions are more assured to have successful

solutions if they give recognition to individuals who share what they know and have learned with others.

Lastly the impact of competition to individuals and the organization was an unanticipated finding in the research. Individuals stated that they were hesitant to share with others who they saw as their competition. One of the respondents from a public organization said that it was difficult to find real knowledge being shared in his organization as each group had different resources and that "Americans are competitive … Knowledge that has merit or professional value is not shared unless under prescribed circumstances." This statement indicates that within his organization, individuals are reluctant to share valuable information.

Internal competition appears to be greater in public organizations than private. From personal experience I offer that this is due to the funding models. Private companies profit by saving on costs and as such have an incentive to work together and share information internally. Public organizations are funded ahead of the completion of the work and employees are penalized if they do not use all of the allotted funds. The funded model separates employees into individual work units and creates internal competition that invites individuals to compete with one another rather than work together. Additionally in the private sector, bonuses, perks, and monetary rewards are commonplace for successful projects. Incentives such as these are outside of the funded model and rarely if ever occur. These can be offered to employees in private industry as an incentive or remuneration for sharing their knowledge or working together.

The significance of these findings is that identification of the factors that individuals value in knowledge sharing subsequently provides direction for an organization to consider when implementing an IT solution. Providing business processes that enable individuals to

find value in their use of the knowledge sharing application benefits the individual and ultimately the organization as a whole. It is the use of the application that ultimately determines its success and contribution to the organization.

Implications for Practice

The findings in this research demonstrate the need for organizations to give consideration to the human element when designing business processes for knowledge management. IT solutions are commonly thrown at the problem through implementations that are costly and time consuming to put into practice. A plethora of information and recommendations exist that describe how to design logic for use (Nickerson & Zenger, 2004; Nonaka & Takeuchi, 1995) but they do not explain how to design an application to ensure that it will be used. Consideration of the human element surpasses human computer interface issues but is not answered entirely by social networking solutions. This problem in creating knowledge resources requires understanding how to motivate individuals to share and how to capture the results of the sharing.

While the aspect of motivation was not an area of focus in this study, the value of captured knowledge was. This research demonstrates that individuals value meaningful knowledge resources; and knowledge resources become meaningful when they are used. The missing element in the mix is the creation of shared knowledge, not only to encourage employees to do this but for its capture and documentation to occur as well.

Employers can give this an assist by making knowledge sharing commonplace in day-to-day activity. As the desired behavior is exemplified, so it will be practiced. For example, a managers' brief corporate announcement of project status can also highlight accomplishments and identify those responsible for seeing them through. Recognition in

daily or weekly news releases serves as motivation and electronic announcements provide documentation.

An example that can be implemented within projects is for leads to invite their teams to participate in face-to-face briefings of work being done, in the presence of a scribe. This regular update of project progress, success as well as failure, creates an environment for sharing. It places individuals in proximity that they may otherwise not be in and the note taker performs the necessary data capture. Further inclusion of this information into a shareable resource can prevent redundancy and enhance innovation. The motivation for the employee is "all the other stuff" that occurs in focused sessions that are brief and productive. The meetings must be kept moving along and should be in casual round table discussion format not formal presentation.

Stepping this up to the organization wide sharing level, businesses could consider implementing *pecha-kucha*, an idea for knowledge sharing that is currently flourishing world-wide. Japanese for "chit-chat", *pecha-kucha* was created by Astrid Klein and Mark Dytham, young architects and space designers. This is a forum where individuals are invited to present any idea or topic in a format of 20 slides, each shown for not more than 20 seconds. Events take place in any venue from classroom to bar room. The idea is to provide an informal environment for sharing and to keep the ideas moving at a fast pace. While the time limit presents a creative challenge, the open topic creates an exciting and uncompetitive environment.

As indicated in the analysis, individuals will share knowledge dependent on their willingness, certainty, and sense of personal responsibility. These factors can be included in IT solutions by means of integration in the process and procedure design for capturing

knowledge. Acknowledgment of contributions and contributors is a small gesture that may increase one's willingness to share knowledge. A measure as simple as providing the individual with permissions to change their contribution or decide with whom it will be shared will allow an individual a sense of control. This control provides a sense of security in knowing that they decide when to release their knowledge when they are certain of it.

The ultimate effect in sharing, however, is one's sense of personal responsibility. That being said, it is truly up to the individual if they will share or not. An organization can employ motivational factors such as acknowledgement and recognition of individuals' contributions.

Future Research

We are in the era of the knowledge workers, individuals who work with and create knowledge daily. With more jobs being outsourced or distributed globally, and an economy that forces businesses to operate under increasingly restrictive budgets, this is also a time that bestows a lessening of job security for many employees. Fewer people expected to accomplish more work, results in greater amounts of knowledge being held by a correspondingly smaller number of workers. Moreover, knowledge gained through service experience becomes held tightly as personal capital and is less frequently contributed back as the corporate asset of shared employee knowledge.

Employers also face new challenges in the development and retention of organizational knowledge. Recent concerns have emerged specifically due to the rise of baby boomer talent reaching retirement age. Internal knowledge sharing is on the decrease due to employment uncertainty created by the current economic trends and the outsourcing of jobs.

The U.S. Census Bureau indicates that there are approximately 78 million baby boomers, individuals born between 1946 and 1969. On January 1, 2011, the first of the baby boomers turned 65, the age anticipated for retirement in the U.S. For the next 19 years, potentially 10,000 individuals a day will turn 65 and thus be eligible for retirement.

For employers, this fact represents a potential loss in organizational knowledge and they are scrambling to learn what their existing workforce knows before they retire. This late attempt to gather knowledge from career employees is impeded by psychological and tangible concerns. For an organizational representative to approach a senior employee who has worked for the company a number of years and ask them to share what they know about the business or operations is unrealistic. At best, there will not be enough time to gather all of the knowledge that the individual may be willing to share. At worst, it is disrespectful to assume that someone can share all the knowledge they have obtained in their career through a few conversations.

This need for knowledge gathering presents an area for future research. It is essential for organizations to know what their employees know and for their employees to share the knowledge that they learn as it is acquired. The knowledge sharing process needs to be part of the business process management (BPM) at the onset of their employment not just as they are walking out of the door. Organizations need to consider how to gather knowledge intrinsically through business processes that inspire knowledge sharing in day-to-day work activities.

Management consultant, Chris Boudreaux suggests that employees will share knowledge when it is part of their job (2011). Boudreaux offers examples through 5 practical business processes: 1) establish knowledge sharing as part of the job, 2) reward people for

performing above expectations, 3) publicly thank the best contributors, 4) create a challenge for the management team by providing prioritized knowledge sharing activities and recognizing when these are met, and 5) recognize that knowledge management is content management that needs to be managed if it is going to be useful (Boudreaux, 2011).

In this section I offer three areas identified in the findings of this research and corresponding questions for proposed future research.

Proposed Question for Future Research 1: What business process management (BPM) procedures are useful as ongoing methods to ensure that knowledge sharing is intrinsic to the day-to-day operations by operational role?

One of the findings of this research was that business processes are necessary to ensure that employee's knowledge is shared in a manageable way. Researchers suggest that individuals will share knowledge when they are motivated to do so (Hutchins, 1995; Davenport & Prusack, 1998). Organizations often rely on incentives to motivate their employees to share knowledge. The incentives used are diverse and so are the outcomes. Two common incentive types are financial (hard) rewards, and acknowledgements and personal development (soft) rewards.

In a study of financial rewards, researchers Cockrell, Stone and Wier determined that such incentives may contribute three types of influence on knowledge sharing among professionals in an organization: useful, harmful, and masked. Referring to Janus, the two faced Roman god , this team of researchers present findings on how financial incentives may have a dual nature in results among accounting processionals (Cockrell, Stone and Wier, 2009). They extend earlier research on economic and psychological theories to determine the influence on useful and harmful knowledge sharing.

It has also been suggested that rewards may have unintended consequences (Boudreaux, 2011). Systems that reward employees for specific activities can be "gamed" or manipulated by employees who target their activities to give the appearance of achieving the intended outcome. For example, employees who are rewarded for the number of contributions that they make to a shared knowledge base can make minor alterations to previous entries and count them as new. Additionally, Boudreaux suggests that providing incentives for specific activities can indirectly degrade the value of work that is not incentivized (2011).

It is essential for organizations to understand and benefit from the impact that motivational methods may have on their organization and to utilize them to create a knowledge sharing environment within the organization.

Proposed Question for Future Research 2: What are the comparative results of the different incentives for knowledge sharing?

Findings of this study concur with previous research demonstrating that individuals share knowledge in communities of practice when they find that it is beneficial for them to do so (Allen, James, & Gamlen, 2007; Nonaka & Toyama, 2007; Huysman & Wuld, 2006; and Davenport & Prusack, 1998). That is not to say that organizations can easily create successful communities of practice. Etienne Wenger advances this notion in his research indicating that successful communities of practice are those that are informally and organically formed by mutual consent of the members (Wenger, 1998a).

Further research published on communities of practice discusses how these group situations are ideal opportunities for individuals to share tacit knowledge (Irick, 2007). Successful COPs are developed by knowledge seeking individuals (Wenger, 1998), Irick

provides suggestions for managers to nurture and support the idea of group sharing as opportunities for individuals to problem solve and contribute to the innovation of an organization. Through this type of support, managers are performing the role of knowledge brokers to encourage the practice and develop the talent of knowledge sharing in the organization from the time that an employee enters into employment. This research offers insights on how organizations support for communities of practice in turn can enable gathering of knowledge from all employees at all levels of their career (Irick, 2007).

Proposed Question for Future Research 3: How can managers use their role to influence and support communities of practice as a part of the tacit knowledge sharing and gathering for the organization on the whole?

This research effort has indicated that recognition of individual's contribution is essential to creating an environment of knowledge sharing for the organization as a whole. To ensure successful knowledge sharing, it must be practiced at the core of the business processes and by everyone in the organization.

References

Ajmal, M., & Koskinen, K. (2008). Knowledge transfer in project based organizations: An organizational perspective. *Project Management Journal*, *39*(1), 7-15.

Allen, J., James, A., & Gamlen, P. (2007). Formal versus informal networks in R & D: A case study using social network analysis. *R&D Management, 37*(3), 179-196.

Appleyard, M. (1996). How does knowledge flow? Interfirm patterns in the semiconductor industry. *Strategic Management Journal (Special Winter Issue) 17*, 137-154.

Ardichvili, A., Maurer, M., Li, W., Wentling, T., & Stuedemann, R. (2006). Cultural influences on knowledge sharing through online communities of practice. *Journal of Knowledge Management*, *10*(1), 94-107.

Argyris, C. (1993) Actionable knowledge: Design causality in the service of consequential theory. *Journal of Applied Behavior Science*, *32*(4), 390-408.

Baron, R. A., & Markham, G. D. (2003). Beyond social capital: The role of entrepreneurs' social competence in their financial success. *Journal of Business Venturing*, *18*, 41-60.

Baskerville, R., & Pries-Heje, J. (1999). Grounded action research: A method for understanding IT in practice. *Accounting Management and Information Technologies, 9*(1), 1-23.

Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R. (2004) *Knowledge Management: Challenges, Solutions, and Technologies.* Publisher: Prentice Hall.

Boudreaux, C. (2011). Knowledge Sharing Happens When you Make it Part of the Job. Retrieved from http://socialmediagovernance.com/blog/governance/knowldge-gets-shared-when-sharing-is-part-of-the-job, 03/28/2011.

Brown, J. S., & Duguid, P. (1991). Organizational learning and community-of-practice: Towards a unified view of working, learning and innovation. [Special issue]. *Organizational Science*, *2*(1), 40-57. Organizational Learning: Papers In honor of (and by) James G. March.

Burton, Y. C., & Bailey, T. (2000). Knowledge sharing within organizations: Linking art, theory, scenarios and professional experience. *Proceedings of the 4th Annual Knowledge Management World 2000 Conference and Exposition*, Santa Clara, CA.

Carroll, J. C. (Ed.) (1998). *Minimalism beyond the Nurnberg funnel*. Cambridge, MA: Massachusetts Institute of Technology Press.

Charette, R. (2010). Toyota's Sudden Acceleration Problems: What Did It Know and When Did It Know It*? IEEE Spectrum*. January 29, 2010. Retrieved from http://spectrum.ieee.org/riskfactor/computing/it/toyota-sudden-acceleration-problems-what-did-it-know-and-when-did-it-know-it-

Charmaz, K. (1991). *Good days, bad days: The self in chronic illness and time*. New Brunswick, NJ: Rutgers University Press.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Thousand Oaks, CA: Sage Publications, Inc.

Cockrell, R., Stone, D., & Wier, B. (2009). *The Janus-Faces Influence of Financial Incentives o Knowledge Sharing.* Wilfrid Laurier School of Business and Economics,

Waterloo, Ontario, Canadd. Retrieved from http://www.wlu.ca/docsnpubs.php?grp_id=1683

Coleman, G., & O'Connor, R. (2007). Using grounded theory to understand software process improvement: A study of Irish software product companies. *Information & Software Technology, 49*(6), 654-667.

Conway, S., & Silgar, C. (2002). *Unlocking knowledge assets.* Redmond, WA: Microsoft Press.

D&R Headline News (2007). SystemC in 2007: User groups thriving. *SystemC and ESL in 2007: Everyone's Talking the Same Language.* Retrieved from http://www.design-resue.com/news/15667/systemc-esl-2007-everyone-talike-same-language.html

Davenport, T. (2005). *The benefits of business process standards.* Harvard Business School Working Knowledge for Business Leaders Archive. Retrieved from http://hbswk.hbs.edu/archive/4895.html

Davenport, T. & Prusack, L. (1998). *Working knowledge: How organizations manage what they know*. Boston, MA: Harvard Business School Press.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 318-341.

Dwyer, N. & Suthers, D. D. (2006). Consistent practices in artifact-mediated collaboration. *International Journal of Computer-Supported Collaborative Learning*, *1*(4), 481-511.

Dyer, J. H. & Noebeka, K. (2000). Creating and managing a high-performance knowledge-sharing network: The Toyota case. *Strategic Management Journal*, *21*, 345-367.

Elsey, B. & Fujiwara, A. (2000). Kaizen and technology transfer instructors as work-based learning facilitators in overseas transplants: A case study. *Journal of Workplace Learning*, *12*(8), 333-342.

Esteves, J., Ramos, I., & Carvalho, J. (2002). *Use of grounded theory in information systems area: An exploratory analysis.* Conference Paper from the European Conference on Research Methodology for Business and Management, University of Reading, Reading, UK.

Eybe, H. & Schmidt, H-J. (2001). Quality criteria and exemplary papers in chemistry education research. *International Journal of Science Education*, *23*(2), 209-225.

Glionna, J. M. & Masters, C. (2010). Toyota recalls undermine Japanese confidence in an industrial titan. *Los Angeles Times.* January 29, 2010. Retrieved from: http://articles.latimes.com/2010/jan/29/world/la-fg-japan-toyota29-2010jan29.

Glaser, B. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, CA: The Sociology Press.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago: Aldine Publishing Co.

Hall, E. & Hall, M. R. (1989). *Understanding cultural differences.* Tarmouth, ME: Intercultural Press.

Hofstede, G. (1980). *Geert Hofstede analysis*. Retrieved from http://www.cyborlink.com/besite/hofstede.htm

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations*. Thousand Oaks, CA: Sage Publications.

Hofstede, G. (2010). Cultural dimensions. *ITIM International*. Retrieved from http://www.geert-hofstede.com/index.shtml

Hood, J. (2006). Orthodoxy vs. power: The defining traits of grounded theory. In A. Bryant & K. Charmaz (Eds.), *The sage handbook of grounded theory,* 302-328. Thousand Oaks, CA: Sage Publications.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: Massachusetts Institute of Technology Press.

Huysman, M. & Wulf, V. (2006). IT to support knowledge sharing in communities: Towards a social capital analysis. *Journal of Information Technology*, *21*(1), 40–51.

Irick, M. (2007). Managing Tacit Knowledge in Organizations. *Journal of Knowledge Management Practice,* Vol. 8, No. 3, September 2007.

Jones, M. & Alony, I. (2007). The cultural impact of information systems – Through the eyes of Hofstede: A critical journey. *Issues in Informing Science and Information Technology, 4*, 407-419. Informing Science Institute.

Kaplan, S. (2000). Building Communities - Strategies for Collaborative Learning. *American Society for Training and Development*. Retrieved from http://www.learningcircuits.org/2002/aug2002/kaplan.html

Kim, A. (2000). *Community building on the Web: Secret strategies for successful communities.* Berkeley: Peachpit Press.

Kollock, P. (2003). The economies of online cooperation. In M. A. Smith & P. Kollock (Eds.). *Communities in cyberspace* (pp. 220-239). New York: Routledge.

Krell, B. & Wiseman, T. (2004). *Knowledge management standards at TELUS information technology infrastructure*. Proceedings at Qualcon 2004, Adelaide, South Australia.

Leonard, D. & Sensiper, S. (1998). The role of tacit knowledge in group innovation. *California Management Review*, *40*(3), 112-132.

Lutz, K., Isenberger, L. & Zevenberger, A. (2008, February). *Can six sigma & CMMI get along?* Conference Proceedings in SEPG 2008, North America, sepg1439, Tampa, FL.

Naidu, S. (2003). Designing instruction for e-learning environments. In M. G. Moore & W. Anderson (Eds.). *Handbook of distance education* (pp. 349-365). Mahwah, NJ: Lawrence Earlhaum Associates, Inc.

Nickerson, J. A. & Zenger, T. R. (2004). A knowledge-based theory of the firm: The problem-solving perspective. *Organization Science*, *15*(6), 617-632.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organizations Science, 5*(1), 14-37.

Nonaka, I. (1998). Building a foundation for knowledge creation. *California Management Review, 40*(3), 40-54.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge creating company*. New York: Oxford University Press.

Nonaka, I., & Toyama, R. (2007). Why do firms differ? The theory of the knowledge-creating firm. In K Ichijo & I Nonaka (Eds.), *Knowledge creation and management, new challenges for managers* (pp. 13-31). New York: Oxford Press, Inc.

Nowak, A., Szamrej, J., & Latané, B. (1995). From private attitude to public opinion: A dynamic theory of social impact. *Psychological Review*, *97*(3), 362-376.

Orlikowski, W. (1993). CASE tools as organizational change: Investigating incremental and radical changes in systems development. *Management Information Systems Quarterly, 17*(3), 309-340.

Overdijk, M., & van Diggelen, W. (2008). Appropriation of a shared workspace: Organizing principles and their application. *International Journal of Computer-Supported Collaborative Learning, 3*(3), 165–192.

Peloquin, J. J. (2001). *An Essay on Knowledge as a Corporate Asset.* Retrieved from http://cog.kent.edu/Author/Peloquin.htm.

Piantanida, M., Tananis, C., & Grubs, M. (2002). *Claiming grounded theory for practice-based dissertation research: A think piece.* Roundtable discussion at the 2002 Conference on Interdisciplinary Qualitative Studies, Athens, GA.

Pieterse, J. (2006). Enterprise design strategy: Aligning IT & business practices. *Information Technology Professional IT Community*. Retrieved from http://it.toolbox.com/blogs/enterprise-design/the-future-of-sociotechno-processing-12929

Pollard, D. (2006). *How to save the world. Social networking: Why are conversations and collaboration tools so underused?* Retrieved from http://blogs.salon.com/0002007/20006/08/27.html#a1624

Rheingold, H. (2003). *Smart mobs. The next social revolution*. Cambridge, MA: Perseus Publishing.

Sabherwal, R. & Becerra-Fernandez, I. (2003). An empirical study of the effect of knowledge management processes at individual, group, and organizational levels. *Decision Sciences*, *34*(3), 225-260. Oxford, UK: Blackwell Publishing.

Salancik, G. & Pfeffer, J. (1978). A social information processing approach to job attitudes and task design. *Administrative Science Quarterly*, *23*(2), 224-253.

Salisbury, M. (2003). Putting theory into practice to build knowledge management systems. *Journal of Knowledge Management*, *7*(2), 128-141.

Salisbury, M. & Plass, J. (2001). A conceptual framework for a knowledge management system. *Human Resource Development International, 4*(4), 451-464.

Salomon, G. (1993). *Distributed cognitions*. Cambridge, UK: Cambridge University Press.

Saveri, A., Rheingold, H., & Vian, A. (2008). Technologies of cooperation: A socio-technical framework for robust 4G. *Technology and Society Magazine, IEEE*, *32*(2), 11-23.

Scholl, W., König, C., Meyer, B., & Heisig, P. (2004). The future of knowledge management: An international Delphi study. *Journal of Knowledge Management*, *8*(2), 19-35.

Silver, D. & Shakshuki, E. (2002, January 19). *Knowledge Management: Integrating Perspectives*. Acadia University, NS, Canada.

Smits, M. & de Moor, A. (2004). Measuring knowledge management effectiveness in communities of practice. *Proceedings of the 37th Annual Hawaii International Conference on System Sciences*, Big Island, HI.

Strauss, A. & Corbin, J. (1990). *Basics of qualitative research: grounded theory, procedures and techniques.* Newbury Park, CA: Sage Publications.

Szulanski, G. (2003). *Sticky knowledge barriers to knowing in the firm.* London: SAGE Publications, LTD.

Tapscott, D., & Williams, A. (2006). *Wikinomics. How mass communication changes everything*. London: Penguin Group.

The Associated Press (2010). *Carmaker's reputation imperiled.* Bridgewater State University. Retrieved from http://www.patriotledger.com/business/x402456621/Carmaker-s-reputation-imperiled

Tsai, W. (2002). Social structure of "competition" within a multi organization: Coordination, competition, and intraorganizational knowledge sharing. *Organization Science*, *13*(2), 179-190.

Urquhart, C. (2007). The evolving nature of the grounded theory method: The case of the information systems discipline. In A. Bryant & K. Charmaz (Eds.), *The sage handbook of grounded theory* (pp. 311-331) Thousand Oaks, CA: Sage Publications.

Vecchio, D. & Kyte, A. (2008, February 12). *Key issues for IT modernization*. Gartner, Inc. Publication ID Number G00155224. Retrieved from http://mediaproducts.gartner.com/reprints/hds/article9/article9.html

Wenger, E. (1998a). *Communities of practice learning, meaning, and identity.* Cambridge, UK: Cambridge University Press.

Wenger, E. (1998b) Communities of Practice: Learning as a Social System. *Systems Thinker,* 9(5). Retrieved from http://www.co-i-l.com/coil/knowledge-garden/cop/lss.shtml.

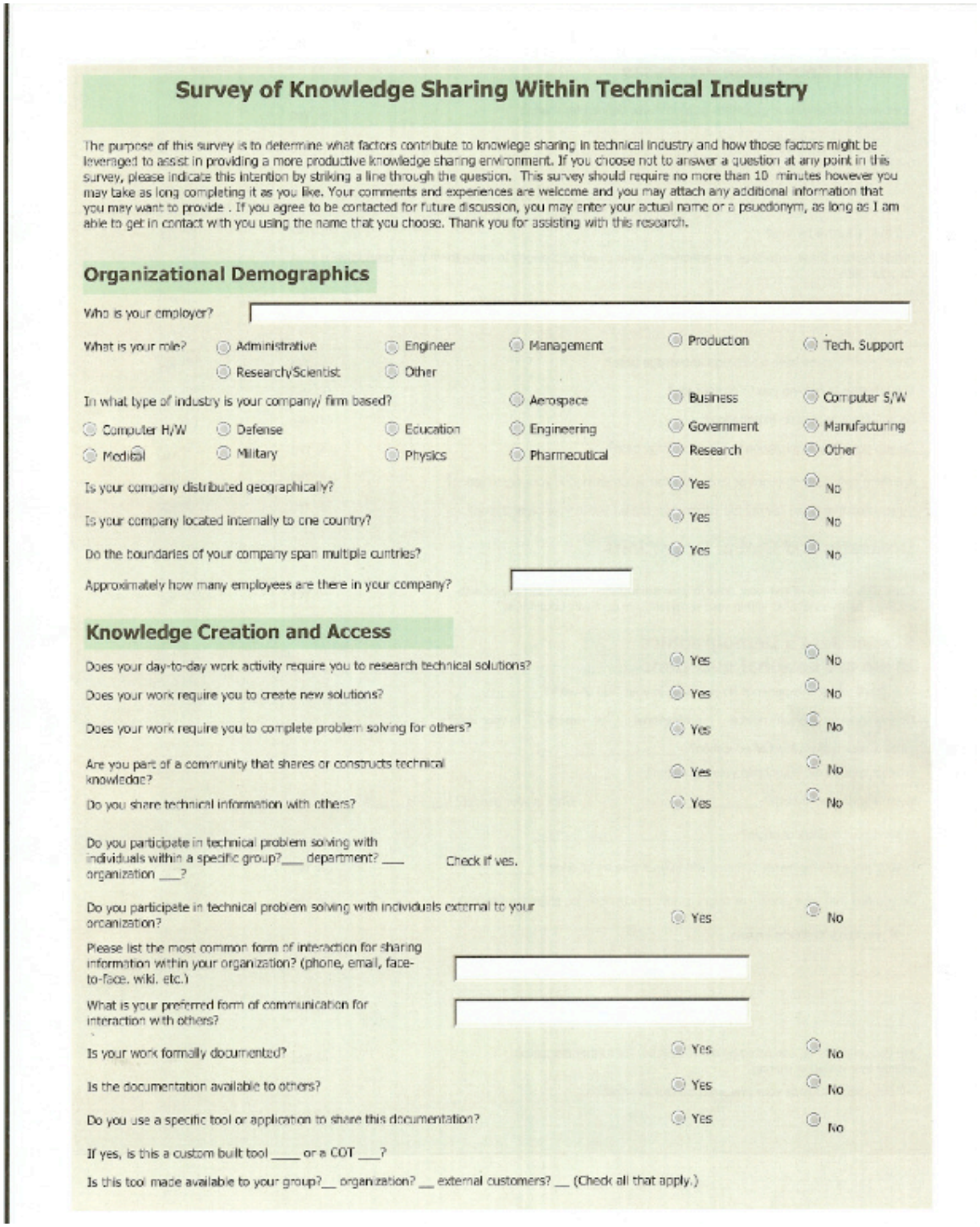
Wenger, E. (2004). Knowledge management as a doughnut: Shaping your knowledge strategy through communities of practice. *Ivey Business Journal Online*. January/February, 2004. Obtained through Illiad.

Appendices

Appendix A

Questionnaire Pilot Survey

Administered November 2007



Survey of Knowledge Sharing Within Technical Industry

The purpose of this survey is to determine what factors contribute to knowlege sharing in technical industry and how those factors might be leveraged to assist in providing a more productive knowledge sharing environment. If you choose not to answer a question at any point in this survey, please indicate this intention by striking a line through the question. This survey should require no more than 10 minutes however you may take as long completing it as you like. Your comments and experiences are welcome and you may attach any additional information that you may want to provide . If you agree to be contacted for future discussion, you may enter your actual name or a psuedonym, as long as I am able to get in contact with you using the name that you choose. Thank you for assisting with this research.

Organizational Demographics

Who is your employer?

What is your role? Administrative Engineer Management Production Tech. Support Research/Scientist Other

In what type of industry is your company/ firm based? Aerospace Business Computer S/W Computer H/W Defense Education Engineering Government Manufacturing Medical Military Physics Pharmeceutical Research Other

Is your company distributed geographically? Yes No

Is your company located internally to one country? Yes No

Do the boundaries of your company span multiple cuntries? Yes No

Approximately how many employees are there in your company?

Knowledge Creation and Access

Does your day-to-day work activity require you to research technical solutions? Yes No

Does your work require you to create new solutions? Yes No

Does your work require you to complete problem solving for others? Yes No

Are you part of a community that shares or constructs technical knowledge? Yes No

Do you share technical information with others? Yes No

Do you participate in technical problem solving with individuals within a specific group?___ department? ___ organization ___? Check if yes.

Do you participate in technical problem solving with individuals external to your organization? Yes No

Please list the most common form of interaction for sharing information within your organization? (phone, email, face-to-face, wiki, etc.)

What is your preferred form of communication for interaction with others?

Is your work formally documented? Yes No

Is the documentation available to others? Yes No

Do you use a specific tool or application to share this documentation? Yes No

If yes, is this a custom built tool ____ or a COT ___?

Is this tool made available to your group?__ organization? __ external customers? __ (Check all that apply.)

Internal Knowledge Processes

Does your company have processes or procedures defined for sharing information? ○ Yes ○ No

Can you briefly describe them?

Are they effective for you? ○ Yes ○ No

Please list how these processes are effective or what could be changed to make them more productive for your use?

Does your company have a technical knowledge base? ○ Yes ○ No

Is it effective in helping you to do your job? ○ Yes ○ No

Do you use it to look up information? ○ Yes ○ No

Do you contribute information to the knowledge base? ○ Yes ○ No

Are there security restrictions or limits on information sharing in your organization? ○ Yes ○ No

Do you find that these restrict the information shared within your organization? ○ Yes ○ No

Domestic and Global Operations

Does 50% or more of the work done in your organization occur internally or with business partners located within your organization's domestic boundaries? ○ Yes ○ No

Respondent's Demographics - these are optional questions

How many years of experience do you have in your field of work? _____

Do you consider yourself: novice ___ professional ___ or expert ___ in your field?

What is your highest level of education? _____

In what country did you obtain your education?

What is your year of birth? _____ What is your gender? ___F ___M

What is your country of origin? _____

Is your place of employment located within your country of origin? _____ ○ Yes ○ No

Do you feel that your country or origin contributes to how you share knowledge? ○ Yes ○ No

-- If yes, can you please explain.

Are you willing to be contacted by the researcher for further discussion related to knowledge sharing? ○ Yes ○ No

--If yes, please provide your preferred contact information.

Appendix B

Interview Questions for Participants

(Research Questions in BOLD Provided for Reviewers)

Participant Name:

*Age Range: 21-25 26-30 31-35 36-40 41-45 46-50 51-55 56-60 >60

*Level of Education:

---

*Optional

Can you please share your definition of technical knowledge sharing?

Participant's Role in Company

How does one's role within the organization contribute to knowledge sharing?

What is your role within the organization?

How does your role impact the way that you share knowledge?

How often do you share knowledge as a result of your role?

Often Sometimes Seldom Never

Cultural Impact

How does one's culture of origin affect sharing technical knowledge sharing?

What is your country of origin?

Can you please describe your cultural identity?

Is the predominate culture of the organization that your work for the same as your culture of origin?

Y N

-If no, what is the predominate culture of the organization that you work for?

How often do you feel that culture affects knowledge sharing (yours as well as others)?

Often Sometimes Seldom Never

Do you feel that individual's from specific cultures share knowledge differently than others?

Y N

- If Yes, can you identify such a culture and give an example of a knowledge sharing experience?

General Participation in Knowledge Sharing

In what context do you contribute to technical knowledge that is shared within your organization? (Repositories, Knowledge Base, Case History)

How often do you voluntarily share technical knowledge with:

Peers?	Often	Sometimes	Seldom	Never
Internal to your work group?	Often	Sometimes	Seldom	Never
Other groups within your organization?	Often	Sometimes	Seldom	Never
That your whole organization can see?	Often	Sometimes	Seldom	Never
With a restricted audience?	Often	Sometimes	Seldom	Never
With your management?	Often	Sometimes	Seldom	Never
On the shared Internet?	Often	Sometimes	Seldom	Never
Others in organizations external to your own?	Often	Sometimes	Seldom	Never
Technical Conferences?	Often	Sometimes	Seldom	Never

When others approach you for your technical knowledge, you are comfortable sharing? Y N

Can you provide a circumstance in which you would be uncomfortable sharing information?

What method do you employ when you need information? (e.g., email, phone, face-to-face, web, wiki)

How often do business processes affect your participation in knowledge sharing?

Often Sometimes Seldom Never

Does the number of people who can see your contribution affect your sharing of technical knowledge?

Y N

- If Yes, can you explain?

Do you share your work while it is in development, after it is completed, or both?

D C B

Are you more inclined to share information if you can do so anonymously?

Y N

Preferred Media for Sharing

Does type of media provided for interaction influence individuals' involvement in sharing technical knowledge?

How frequently do you use the following synchronous media methods to share information?

Face-to-Face	Often Sometimes Seldom Never
Voice phone	Often Sometimes Seldom Never
Skype	Often Sometimes Seldom Never
Teleconference	Often Sometimes Seldom Never
Other electronic media	Often Sometimes Seldom Never

How frequently do you utilize the following asynchronous methods for knowledge sharing:

Email	Often Sometimes Seldom Never
Wiki	Often Sometimes Seldom Never
Blog	Often Sometimes Seldom Never
Knowledge Base or application such as: SourceForge, TRAC, SharePoint, etc.	Often Sometimes Seldom Never

Does your organization have a preferred method for sharing knowledge? (For example: email, voice mail, wiki, face-to-face)

Y N

-If Yes, can you describe it?

Do you prefer other methods for sharing information?

Y N

-If Yes, can you describe it?

Business Processes

What business procedures affect individuals' participation in knowledge sharing?

Does the organization where you are currently employed have shared knowledge resources?

Y N

-If Yes, can you explain what type of information is expected to be shared? For example:

Technical project plans – a project management application

Code development – tool for version control or shared modules

Technical support – case experience/history

Best Practice/Lessons Learned – database or shared repository (e.g., SharePoint)

Are there business procedures associated with these processes?

Y N

- If Yes, How effective are these business procedures?

Very Effective Effective Somewhat Effective Not Effective

Is your contribution to these resources: mandated, strongly encouraged, or optional:

Mandated Strongly Encouraged Optional

How are technical employees' perceptions of value associated with shared knowledge resources, affected by business procedure to manage knowledge?

Are the knowledge resources that your employer provides valuable to you?

Y N

Does your work group benefit from these knowledge resources?

Y N

Do you feel that having these shared knowledge resources is of value to your company?

Y N

-Can you explain?

If you feel that these shared knowledge resources are not valuable how would your improve them?

If you feel that these business procedures are not effective, how would you improve them?

Appendix C

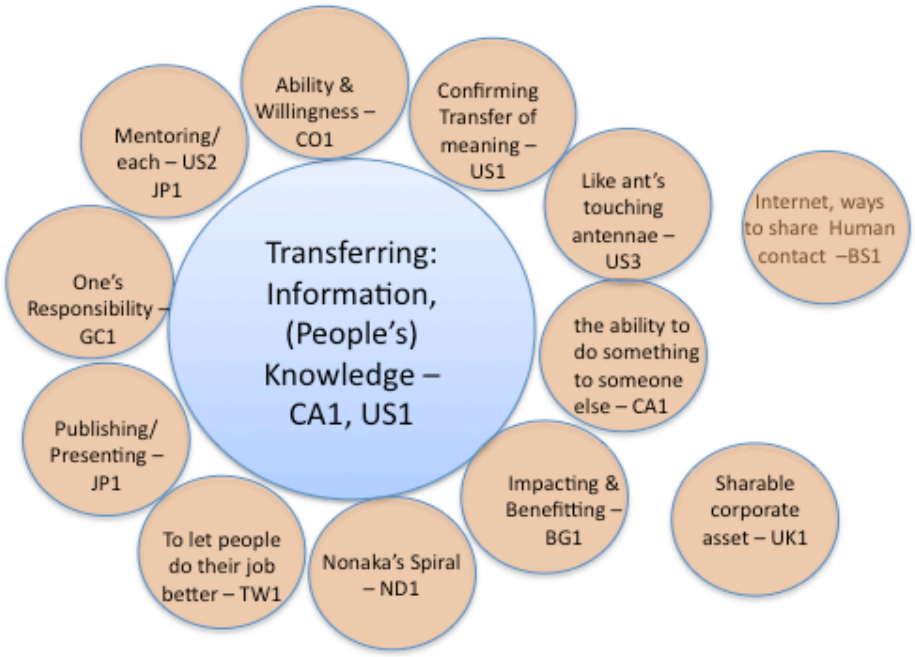
Axial Coding Results

M.1		METHOD	
M.1.1	US1,IN1,SP1,BS1,US3, TW1, US2	Informal	
M.1.2	CA1,US1, US2, CO1, RU1, NL1	Preference for Face-to-Face	
M.1.3	IN1, RU1, UK1	Sharing dependent on delivery	
M.1.4	UK1, IN1, US2	Sharing dependent on receiver	
M.1.5	RU1, GC1, NL1	Standard method	
M.1.6	SP1, TW1	Tools	
M.1.7	CA1,RU1, UK1, JP1, NL1	Method used when [the]need information	
M.1.8	RU1, US1, US3, TW1, NL1	Depends on locality of individual	
M.1.9	UK1	Depends on information sharing	
N.1		NECESSITY	
N.1.1	US3, CA1, CO1, BG1, JP1	To do my job	
N.1.2	CO1, CA1	Transfer skills	
N.1.3	BS, GC1, JP1	Transfer experience	
N.1.4	UK1, IN1	Sharing with customers	
N.1.5	CO1, JP1, TW1	Teaching	Tw1 - to let others do their job
N.1.6	GC1, US3, BS1	Mandated Sharing	
N.1.7	IN1,SP1,CO1, TW1, BG1, ND, JP1, UK1, RU1	Highly Encouraged	
	US2,CA1	Optional	
O.1		KEY OBSTACLES - HINDRANCES	
O.1.1	IN1, US2, SP1	Formal	
O.1.2	CO, US2, GC1	Competition	
O.1.3		Culture	
O.1.4	US1, CA1, US2, BG1, TW1, CO1	*Culture does affect*	
O.1.5	UK1, RU1	Global Business Effect	
O.1.6	GC1, IN1, RU1, US1	Need for certainty	
O.1.7	GC1, RU1, UK1	*Culture does not affect.*	
O.1.8	NL1	Uncomfortable sharing	
O.1.9	UK1, CO1, CA1	Not Willing To Share	
O.1.10	TW1, IN1, UK1	Need to control breadth of sharing	
R.1		RESPONSIBILITY	
R.1.1	US2, JP1	Mentoring	

R.1.11	IN1,UK1	Imparting
R.1.10	UK1, CA1	To make information available to others
R.1.2	US3, BG1, TW1	It is the job
R.1.3	GC1	Knowledge [learned] is not mine
R.1.4	CO1, TW1, CA1, US2, US1	Transfer information
R.1.5	BS1, NL1, BG1, TW1, US3	It is my job
R.1.6	NL1	Sharing with colleagues - Method
R.1.7	SP1	Leaders Set Example
R.1.8	SP1, NL1, GC1, IN1	Leaders Share
R.1.9	US1	Confirmation
R1.12	GC1, RU1	Share experience (not book learning)
R.1.12	UK1, NL1, BG1, TW1	Resp. due to Role
V.1		VALUE
V.1.1	CA1, UK1, BS1 BG1,	Enabling
V.1.10	CO1	Shared knowledge resource not of value
V.1.11	CA1, JP1	Opportunity
V.1.12	BG1, UK1	Enabliing Innovation
V.1.2	CA1	Economic gain
V.1.3	JP1, BG1	Impact of shared knowledge on individual
V.1.4	UK1	Impact on the Organization
V.1.5	JP1, SP1, GC1	Self Interest - acknowledgement of peers
V.1.6	US2, IN1,GC1,	Stuff that comes with it!
V.1.7	BS1, BG1	Reciprocity
V.1.8	CO1	Motivation
V.1.9	RU1, BG1, JP1, IN1, TW1, CO1	Value of shared knowledge to the organization
V.1.13	RU1, TW1, CO1	BP of value The results not the process
V.1.14	UK1, BG1	Value to Org
V.1.15	JP1	Learning what others know
		CULTURE
C.1	RU1, UK1, GC1	Individual culture is Global - does not effect
C.1.2	GC1	Individuals not culture
C.1.3	SP1	Culture of organization
C.1.4	JP1, NL1, BG1, TW1, CA1	Culture does have Effect

Appendix D

Sample Concept Map



What is going on here?

Responsibility/Duty – Mentoring, publishing, one's responsibility

Transfer – Interactive, Social, Feedback, Confirmation, ants touching antennae

Job Aid/Business Process – Do the job better, Ability for someone else to do what you do

Internet Access/Applications (Tools) – Ways to share

Human Contact Required – Human contact primary enabler, peers

Appendix E

Sample Memo

Knowledge Sharing as a Social responsibility – February 14, 2010

Need to ask – Do you share technical knowledge? – This can possible by inferred through the response to question 14

So the data so far tells me that technical knowledge is a social responsibility. It may be motivated by personal or organizational factors. The idea of "social" indicates that interaction is required. This is further supported by individual's preference to share information face to face.

Although up to now the tool has not been considered a contributing factor, I think that it may have an effect. The question that comes to mind is if individuals are using a tool that affords them human contact – synchronous sharing vs asynchronous – just adding information to a repository without any other human validation …….

To take idea one step further it is implied that processes for business collecting/sharing technical knowledge should include human interaction – the social angle if they are going to be used successfully.

People overwhelmingly prefer synchronous to asynchronous sharing

Reference SP1