# AN EXPLORATION OF THE DIFFUSION OF A NEW TECHNOLOGY FROM COMMUNITIES OF PRACTICE PERSPECTIVE: WEB SERVICES TECHNOLOGIES IN DIGITAL LIBRARIES

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This study explored and described decision factors related to technology adoption. The research used diffusion of innovations and communities of practice (CoP) theoretical frameworks and a case study of Web services technology in the digital library (DL) environment to develop an understanding of the decision-making process.

A qualitative case study approach was used to investigate the research problems and data were collected through semi-structured interviews, documentary evidence (e.g., meeting minutes), and a comprehensive member check. The research conducted face-to-face and phone interviews with seven respondents with different job titles (administraive vs. technical) from five different DL programs selected based on distinctive characteristics such as size of the DL program.

Findings of the research suggested that the decision-making process is a complex process in which a number of factors are considered when making technology adoption decisions. These factors are categorized as organizational, individual, and technology specific factors. Further, data showed that DL CoPs played an important role in enabling staff members of a DL program to access up-to-date and experienced-based knowledge, provided a distributed problem solving and learning environment, facilitating informal communication and collaborative activities, and informing the decision-making process.

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# CHAPTER I

# INTRODUCTION TO THE STUDY

## 1.1. Introduction

The advent of the Internet and specifically the World Wide Web (WWW) application has changed forever the means of accessing data and information. The Internet brought new opportunities for libraries as well as dilemmas and problems such as technology choice and readiness.

Digital libraries (DL) were envisioned as network-accessible repositories in 1990s. Now, DLs extend the classical brick-and-mortar library concept, bring value to society, and transform this vision by providing more dynamic and interactive means of organizing, accessing and preserving human knowledge regardless of temporal and geographical barriers (Larsen & Watctlar, 2003; Reddy & Wladawsky-Berger, 2001).

Availability of research funding for DLs in the 1990s attracted attention from various disciplines not only library and information science and computer science but also sociology, political science, and others (Borgman, 1999). The interdisciplinary character of DL research contributed to variations in definitions of a DL.

DLs reside on inter-networked data storage and computing systems providing unparallel access to the users located anywhere on the world (Reddy & Wladawsky-Berger, 2001). The speed of technological advances in information technologies (IT) in the last ten years has enabled DLs to provide innovative resources and services to people. The information landscape is changing as a result of the revolutionary developments in

IT, incompleteness of content on Internet, ever increasing digital content along with the evolution of networked technologies and applications, lack of standards, ineffective information retrieval mechanisms, and minimal cataloging. These factors present challenges to the future of DLs (Borgman, 1999; Reddy & Wladawsky-Berger, 2001).

DL software can be distinguished in terms of the way they are developed and implemented as off-the-shelf DLs (e.g., Greenstone from University of Waikato) and custom-built DLs (e.g., California Digital Library [CDL]) ("California Digital Library," 2005, "Greenstone Digital Library," n.d.; Pasquinelli, 2002). The most popular off-the-shelf and custom built DLs are developed or supported by institutions of higher education, libraries, and federal or state agencies. For example, the Flexible Extensible Digital Object and Repository Architecture (Fedora) is a general purpose repository system developed jointly by Cornell University Information Science and the University of Virginia Library ("Fedora," 2005). Such DL software enable organizations customize the application to meet their organizational requirements such as integrating with current and emerging technologies. On the other hand, development of a custom DL takes relatively longer than adopting off-the-shelf software, since numerous critical decisions need to be made for the development of the custom application such as programming language, standards, and policies.

No matter how a DL is built, it needs to have some room to accommodate future technological innovations. Decision makers who include managers, coordinators, designers, and developers need to make important decisions at some point in time to adopt or reject an innovation including a specific technology, application, framework or idea related to DLs. Decision makers who need information about an innovation may

seek this information through both informal and formal communication channels while making such critical decisions.

### 1.2. Study Goals, Objectives, and Research Questions

This study attempts to shed a light on the decision-making process to adopt or reject a new technology in the context of DLs.

To develop an understanding of this decision-making process, the study employs adoption of Web services (WS) technology as a case study in the DL environment and the impact of Communities of Practice (CoP) as an informal communication channel parallel to the Diffusion of Innovations theory (DOI) on the decision-making process. WS technology is an open, standards-based, interoperable, and vendor-neutral platform to integrate disparate applications and systems seamlessly (Tilley *et al*., 2002).

A case study of WS provides a significant opportunity to explore roles and influence of informal communication channels on the decision-making process. Since WS technology was introduced in year 2000, it has been adopted by some of the popular DLs (e.g., Fedora, Greenstone, and CDL).

One complementary research goal, a set of objectives, and three research questions are listed below. These guided and directed the study.

#### 1.2.1. Goal

- Understand and describe decision factors related to technology adoption.

#### 1.2.2. Objectives

- Identify and characterize factors in DL technology adoption decisions.
- Characterize the influence of CoPs on decisions to adopt or reject technologies in the DL environment.

- Identify the structure, characteristics, and the roles of CoPs that influence the decision-making process when adopting technologies in the DL environment.

1.2.3. Research Questions

1. What are the key decision factors that lead decision-makers to adopt or reject WS in the DL environment?
2. What are the activities, entities, processes, motivations, and forces that influence the decision to adopt or reject WS technologies in the DL environment?
3. What are the roles played by CoPs as informal communication channels on WS adoption decisions in the DL environment?

1.3. Background and the Definition of the Terms

This section begins with reviewing diffusion of innovations (DOI) and the CoP which serve as theoretical frameworks in exploring decisions to adopt WS technologies in the DL environment. The section continues with brief introductions to DLs and WS technologies.

1.3.1. Adoption and Diffusion of New Technology

Rogers (1995) defined diffusion as a process of "an innovation communicated through certain channels among the members of a social system over time" (p. 5). As indicated in the definition, the diffusion has four elements:

1. An innovation that is an idea, practice, or object perceived as new
2. Communication channels by which messages are passed from one individual to another
3. A social system that is a set of interrelated groups sharing a common problem
4. Time in which certain decisions will be made

The adoption process, which pertains to an individual, is defined as "the mental process through which an individual passes from first hearing about an innovation to final adoption" (Rogers, 1995, p. 35).

There are five main characteristics of innovations that explain their rate of adoption (Rogers, 1995):

1. Relative Advantage
2. Compatibility
3. Complexity
4. Triability
5. Observability

Some innovations could be perceived by individuals as having greater relative advantage, compatibility, triability, observability, and less complexity, but this does not necessarily ensure the adoption of a specific innovation by individuals or some larger aggregate social unit such as an organization or a community.

In the 1940s Ryan and Gross (cited in Rogers, 1995) found that hybrid corn seed adoption among Iowa farmers follows S-shaped adoption curve. In their later studies hybrid corn seed adopters are classified in relation to the amount of time it took them to adopt the innovation. The classification of adopters based on their time of adoption constitutes the basis of DOI theory.

Rogers (1995), using numerous diffusion studies conducted in agricultural, marketing, IT, and other fields, identified the characteristics of these adopter categories developed by Ryan and Gross. These characteristics of adopters and methodologies in DOI theory are developed by looking at the adoption of innovations by individuals. The

focus of DOI on individual level of adoption is considered a limitation by some researchers (Fichman, 1992; Lai & Guynes, 1997). Many of the concepts of DOI still apply to the organizational level of adoption with some improvements and modifications addressing organizational factors such policies, the organizational chart, and decision-making processes (Czepiel, 1975; Fichman, 1992; Swanson, 1994; Zmud, 1982).

Moore (1999) relabeled Rogers' (1995) adopter categories (Innovators, Early Adopters, Early Majority, Late Majority, and Laggards) to reflect the IT adoption in organizations and introduced the concept of "Chasm" to describe the fundamental differences between Visionaries and Pragmatists in terms of their adoption characteristics. Moore's adopter categories and their relationship with Roger's (1995) adopter categories listed as below:

- Technology Enthusiasts (Innovators)
- Visionaries (Early Adopters)
- Pragmatists (Early Majority)
- Conservatives (Late Majority)
- Skeptics (Laggards)

The chasm plays a critical role in achieving critical mass (Early Majority) then to mainstream market (Early Majority, Late Majority, and Laggards). Moore argues that addressing the differences between Visionaries and Pragmatists is critical to reach mainstream markets. If a technological innovation achieves critical mass, it is more likely to dominate the market and widespread adoption of the innovation accelerates its maturation process (Fichman & Kemerer, 1993).

In addition to individual level of adoption in DOI and Moore's chasm in IT adoption at organizational level, Davis (1989) focused on two specific adoption criteria at individual level IT adoption.

Davis developed new measurement scales for two specific variables, perceived usefulness and perceived ease of use, which are considered to be fundamental determinants of user acceptance. He found that ease of use and usefulness are strongly correlated with usage behavior in terms of self-reported current usage and self-predicted future usage. The technology acceptance model (TAM) proposed by Davis focuses on these two important technology acceptance criteria (i.e., ease of use and usefulness) to answer the question of "What causes people to accept or reject information technology?" (Davis, 1989, p. 320). A major limitation in Davis' study was reliance on self-reporting than objective measurement.

Perceived ease of use parallels complexity of DOI, however compatibility and relative advantage of DOI have more broad definition than perceived usefulness (Davis, 1989).

Tornatzky and Klein (1982) found that compatibility, relative advantage, and complexity consistently influence the innovation adoption process out of ten identified innovation characteristics (e.g., cost, social status) in their meta-analysis of 75 innovation characteristics studies from various fields such as agriculture, sociology, and IT.

The adoption of a new technological development is a complex social process involving characteristics of the adopter (individual vs. organizational) and the innovation, and the social group to which the adopter belongs.

### 1.3.2. Communities of Practice

A Community of Practice (CoP) is defined as a group whose membership is voluntary and whose members strengthen their knowledge and expertise by regularly sharing information and learning based on common interests (Lesser & Storck, 2001).

Group members do not necessarily work together in the same organization or social environment, but they get together on a regular basis because they find value (e.g., social capital) in their interaction, which serves as driving force for members to continue their activities (Donaldson *et al.*, 2004). Although CoPs generally build on preexisting interpersonal networks, CoPs can be initiated, promoted, and supported by organizations themselves as long as organizations are able to benefit from them (Wenger *et al.,* 2002).

Three elements of a CoP provide a practical model to guide community development (Wenger *et al.,* 2002):

- Domain
- Community
- Practice

Domain is the topic that a CoP focuses on. Domain provides the community with a common identity by creating a common ground for its members. A well-defined domain clearly states its purpose and value to members and other stakeholders (Wenger *et al*., 2002).

Community is the people who have interest in and passion for the domain and meet face-to-face an ongoing basis. The technology (e.g., instant messaging and video conference) provided on various platforms (e.g., Internet) allows community members to have such meetings virtually regardless of geographical boundaries (Daniel *et al.*, 2003).

Commitment of the members to the domain is what makes them different than just a group of friends (Wenger *et al.,* 2002).

CoPs not only manage the shared knowledge but they also create value for both their members and organizations (Wenger *et al.,* 2002). Tacit knowledge, experience-based and subjective, encompasses expertise in the domain. CoPs are informal learning environments that provide the right tools such as conversation and apprenticeship to share and develop tacit knowledge (Wenger *et al.,* 2002).

### 1.3.3. Digital Libraries

According to Borgman (1999), DLs are viewed by library practitioners as organizations or institutions that provide resources in digital form. Researchers who have been studying information-related issues (e.g., information retrieval, databases, information seeking) view DLs as a set of electronic resources and technical tools to find, navigate, and manipulate information.

Availability of substantial research funding attracted great number of researchers from various disciplines (e.g., computer science, sociology, library and information science) to DLs in the 1990s, which resulted in variations and a lack of agreement on the definition of a DL (Borgman, 1999). DLs are positioned at the crossroads of the library and information sciences, computer science, and network information systems. According to Suleman and Fox (2001), a definition could only include the idea of accessible collection of knowledge because of variations and a lack of agreement on the definition of a DL and interdisciplinary characteristics of the DL research.

Most of the existing systems available in the early 2000s classified as DLs resulted from custom-built project-oriented software development efforts creating

variations of underlying program logic in terms of standards, scalability, and interoperability (Pasquinelli, 2002; Suleman & Fox, 2001). Although there have been accomplishments in the areas of technical and semantic interoperability (e.g., ANSI/NISO Z39.50, Open Achieves Initiative [OAI], and Dublin Core [DC] metadata) developing a standards-based common architecture for DLs, achieving interoperation across disparate and multiple disciplines, and integrating various resources and DL services remain difficult tasks to achieve (Larsen & Watctlar, 2003).

### 1.3.4. Web Services

Web services do not bring a new computing model but enhance the existing ones, such as client/server architecture (Litoiu, 2002). However, Web services offer an open, standards-based, interoperable, and vendor-neutral platform to integrate disparate applications and systems seamlessly (Tilley *et al*., 2002).

Suleman and Fox (2001) suggest that addressing interoperability at the level of individual services enhances interoperability and eases integration of various DL services as opposed to at the level of organizations which is parallel to the Web services approach (Hickey, 2003).

## 1.4. Justification for the Research and Significance of the Study

The main unit of analysis in diffusion studies has been either individuals or organizations (Rogers, 1995). As Fichman (1992) stated, one of the major limitations in DOI research is the implicit assumption of innovation adoption of individuals for their own independent use, rather than being a part of larger community of interdependent users. Diffusion studies have been carried out in both organizational and individual levels. In organizational level adoption, additional innovation characteristics are involved

in the decision-making process such as organizational structure and administrative influence (Daft, 1978; Lai & Guynes, 1997; Swanson, 1994).

CoPs embody individuals with diverse backgrounds and social structures (e.g., other CoPs, organizations), which in turn, reduce the learning curve and rework, and promote innovation by enabling them to share and disseminate both tacit and explicit knowledge (Lesser & Storck, 2001). When these benefits of CoPs are considered, their contribution to DL development efforts may be vital specifically in terms of technology decisions. In addition, most of the DL development efforts were pioneered by educational institutions and academic libraries (i.e., Fedora by the University of Virginia Library and Cornell University, Greenstone by University of Waikato) where direct monetary compensation is not the main goal. DL development efforts are mainly collaborative and attract attention from various disciplines resulting in cross-fertilization of ideas (Borgman, 1999; Kochtanek & Hein, 1999). DL conferences and workshops play key roles in enabling researchers and practitioners to engage in community building activities (Borgman, 1999).

Generally technology enthusiasts and visionaries who actively participate in group discussions in various venues (e.g., face-to-face, virtually) are members of CoPs since they are more open to change and innovations (Brown & Duguid, 1991). The literature and nature of DL development efforts (e.g., open source) suggest the existence of CoP-like structures. This study explored, described, and analyzed roles and the influence of CoPs on the decisions when adopting a new technology in DL environments.

The unit of analysis in this study is the decision to adopt or reject a new technology. To develop an understanding of this decision-making process, the study

investigated the adoption of Web services technology as a case study in the context of DLs. Having a new technology which is its early stages of adoption in the DL environment provides a significant opportunity to investigate the factors influencing the decision-making process. One weakness of the diffusion research is its reliance on recall data from respondents as to their time of adoption of an innovation (Rogers, 1995). Studying an innovation in its early stages of adoption cycle is an important factor in lowering the recall data problem.

Important decisions have been made in the past as to adopt or reject a new technology for various reasons such as providing the means of searching and accessing digital content, delivering content in more efficient and advanced manner, and social status (e.g., being a pioneer in offering new DL services) (Pasquinelli, 2002). Some of the key technologies and standards related with interoperability that have been adopted in the past in DL environments are listed below (see Appendix A for the detailed list):

- ANSI/NISO Z39.50 Protocol
- Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH)
- Open URL

In the context of DLs, roles and influence of informal communication channels on the decision-making process to adopt or reject a new technology have not been investigated before. The adoption of WS technology can be viewed as a revelatory case to the extent that it may reveal factors and issues common to other information technologies in the context of DLs. Therefore, this study may benefit decision makers in making more conscious decisions regarding adoption of technologies in the context of DLs.

## 1.5. Scope of the Study

The study limited to an investigation of decision regarding adoption of WS technologies in the DL environment. Decisions to adopt other technologies prior to WS in the DL environment were not either systematically compared against or judged as good or bad decisions. This study examines the role of CoPs as information communication channels influencing decisions made to adopt or reject WS technologies in the DL environment. A qualitative single case study conducted for this research does not provide the basis for generalizability over decisions regarding other technologies that have already been or will be adopted but it can possess analytical validity and provide an in-depth understanding about the decision-making process.

## 1.6. Summary

This chapter provided an introduction to the study and briefly explained its focus, motivations, goal, objectives, and research questions. In addition, this chapter introduced the theoretical frameworks of DOI and CoPs that guided this research in the context of DLs with a focus on a particular technology, WS.

# CHAPTER II

# REVIEW OF THE LITERATURE

## 2.1. Introduction

This chapter presents a review of the literature relevant to the topic of the research, namely, the factors influencing the decisions regarding adoption of Web services (WS) technologies in digital libraries (DLs) based on Roger's (1995) Diffusion of Innovations (DOI) and Wenger's (1998) Communities of Practice (CoPs) theories. This chapter begins by reviewing DOI theory and then continues with a discussion of CoP concepts, which serve as the theoretical frameworks for this study. The chapter continues with discussions of DLs and WS technology, which are used as the environment and technology the case study examines.

## 2.2. Theoretical Framework I: Diffusion of Innovations

Rogers (1995) argued that the study carried out by Ryan and Gross in 1943 at Iowa State University marks the origin of modern diffusion research. Ryan and Gross (cited in Rogers, 1995), from the rural sociology field, used an interview-based methodology to investigate the factors that influence adopters' thoughts and actions and the process of adoption of an innovation.

Rogers has examined and provided a synthesis of over 3000 previous studies of adoption and diffusion from various fields in his influential book, Diffusion of Innovations, first published in 1960. Roger's book provides a unified theory of diffusion of innovations (Surry, 1997).

The DOI research methodology provides required instruments, both quantitative and qualitative, to assess the rate and pattern of diffusion of an innovation and identifies various factors that facilitate or hinder adoption and implementation (Fichman, 1992). These major factors include properties of the innovation, characteristics of adopters, and the means leading to adoption. There are four main elements need to be considered while studying the diffusion of an innovation.

- Innovation
- Communication Channels
- Time
- Social System

2.2.1. Innovation

An innovation can be an idea, behavior, practice, or object perceived as new by the adopter (e.g., organization, individual). The concept of newness may be determined by the human reaction to it as well as the time passed since its discovery or first use. If the idea seems new to an individual or organization, it is considered an innovation (Daft, 1978; Rogers, 1995). Rogers' DOI theory focuses on the individual as the main unit of analysis rather than organizations (Fichman, 1992; Lai & Guynes, 1997). However, it has also been applied successfully in organizational settings (Czepiel, 1975; Gopalakrishnan & Damanpour, 1997).

DOI researchers study the characteristics of the innovation to explain the rate of adoption of an innovation. Rogers (1995) reviewed numerous diffusion studies and classified characteristics of innovations into five general categories: relative advantage, compatibility, triability, observability, and complexity (Rogers, 1995). These

characteristics of innovations become important factors in the decision-making process to adopt an innovation. Innovations with greater relative advantage, compatibility, triability, observability, and less complexity are more likely to be adopted faster than others that lack these characteristics (Rogers, 1995). However, there are structural factors (e.g., formalization and centralization) as well as other innovation characteristics (e.g., cost, profitability, social approval) influencing adoption of an innovation, and therefore Rogers' DOI model needs to be extended to accommodate such factors specifically in organizational settings (Daft, 1978; Damanpour, 1991; Leonard-Barton & Deschamps, 1988; Tornatzky & Klein, 1982). In addition, Tornatzky and Klein (1982) found that relative advantage, compatibility, and complexity have the most consistent relationships with the adoption of innovations across a wide range of industries.

*Relative Advantage*: "The degree to which an innovation is perceived as a better idea than it supersedes" (Rogers, 1995, p. 15). Social prestige, economic improvement, satisfaction, and convenience can be considered important factors in measuring the degree of relative advantage. The perception of an innovation's relative advantage may not be based on an objective evaluation as opposed to the factors listed above (Hurt *et al.*, 1977; Rogers, 1995)

*Compatibility*: "The degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of potential adopters" (Rogers, 1995, p. 15). If an innovation is not compatible with the existing norms and conditions within the social system, it is more likely that the innovation will face resistance and not be adopted as quickly as one that is perceived as compatible.

*Complexity*: "The degree to which an innovation is perceived as difficult to understand and use" (Rogers, 1995, p. 16). Innovations that require the adopter build new understandings or develop new skills will be adopted slower than ones that can be readily understood (Rogers, 1995).

*Triability*: "The degree to which an innovation may be experimented with on a limited basis" (Rogers, 1995, p. 16). Trying an innovation partially or in stages, in small scale rather than full scale implementation, allows potential adopters to reduce the uncertainty about how the innovation works, and demonstrates the possible outcomes and benefits of its use. Innovations that can be tried on a small scale will more likely be adopted faster than innovations that don't allow experimental implementations.

*Observability*: "The degree to which the results of an innovation are visible to others" (Rogers, 1995, p. 16). If the results of the innovation are apparent and easy to see others are more likely to ask for more information from the adopters, which in turn creates more discussion around the innovation resulting in faster adoption of the innovation.

According to the DOI theory, adopters make voluntary decisions to accept or reject an innovation based on the benefits they expect, however, in organizational settings such decisions may be supported by the management (Leonard-Barton & Deschamps, 1988; Zmud, 1984) or mandated (Moore & Benbasat, 1991).

Daft (1978) examined the roles of administrators and technical employees in the process leading to adoption and distinguished between administrative and technological innovations by proposing a "dual-core model of organizational innovation" in his eight-year longitudinal study of 13 high school districts. He argued that organizations can be

studied as if they are composed of two polar cores, administrative and technological cores, based on the area where an innovation occurs and showed that technological and administrative innovations don't correspond to organizational characteristics respectively. Daft (1978) defined a technological innovation as "an idea for a new product, process or services" and an administrative innovation as related to the social structure of the organization, referred to "the policies of recruitment, allocation of resources, and the structuring tasks, authority and reward" (p. 197). Daft found that both administrative and lower level employees can introduce innovations depending on the type of innovation; however administrative innovations originate at the higher levels of hierarchy and move from top to bottom as opposed to technical innovations. According to Daft (1978), skilled individuals in the technical core may have more weight on the decision to adopt or reject a technological innovation if the management core lacks expertise in the area. Zmud (1984), however, found the managerial influence stronger for technological innovations. Furthermore, technological innovations are more observable and have higher triability and are perceived more beneficial and easier to implement than administrative ones, resulting in a lag in administrative innovations that are perceived to be relatively more complex (Swanson, 1994).

Swanson (1994) focused on IT related innovations from the organizational perspective and proposed an extension to Daft's (1978) dual-core model to incorporate a functional IT core linking the technical and administrative cores. Swanson (1994) also categorized IT innovations based on their ability to support IT core (Type I), administrative core (Type II), and technical core (Type III) and mapped these categories to a tri-core model. Type I innovations, such as data administration, are restricted to the

IT core; Type II innovations, such as information centers, provide general administrative support; and Type III innovations, such as Web services, integrates IT applications and services and impacts the business as a whole.

### 2.2.2. Communication Channels

The second element of the DOI theory is communication channels which refer to the means by which an innovation or information about an innovation is passed along to others. The concept of communication channel has two units; a "source," which can be an individual or an organization that generates the message and a "channel," through which the message is transferred to a receiver (Rogers, 1995, p. 194).

Mass media channels are the most frequently used means of communication to reach and inform larger audience about an innovation and to create "awareness-knowledge" (Rogers, 1995, p. 195). Mass media channels include television, radio, and journals; these are efficient tools to let the word out and disseminate explicit knowledge (e.g., journal articles). These channels are not as useful for transferring tacit knowledge (e.g., organizational culture) that is derived from experience, incorporates beliefs and values, and is more subjective and intuitive. Mass media channels, however, may not be effective for persuading a potential adopter to accept an innovation and disseminate tacit knowledge. When it comes to adopting an innovation, most adopters need a subjective evaluation of the innovation from others who have more knowledge and are like themselves (e.g., social status), which is communicated through interpersonal channels (Moore, 1999; Rogers, 1995). The distinction between tacit and explicit knowledge is based on codability of the knowledge (e.g., the ability to be put into words). Explicit knowledge is easy to specify, document, express verbally and in print, and access. It can

be coded and transferred easily via formal channels from one location to another (e.g., one organization to another) (Persaud *et al.*, 2001). On the other hand, tacit knowledge may not be easily accessible; it is intuitive and experience based. Tacit knowledge cannot be coded and easily transferred (Nahapiet & Ghoshal, 1998); it makes data and fact more meaningful to others who lack that particular tacit knowledge (Persaud *et al.,* 2001). Tacit knowledge is more actionable knowledge, therefore more valuable as opposed to explicit knowledge (Marwick, 2001). Table 2.1 provides a comparative list of characteristics of tacit and explicit knowledge.

Table 2.1

Comparative Characteristics of Tacit and Explicit Knowledge

| Tacit Knowledge | Explicit Knowledge |
|---|---|
| ▪ Drawn from experience and is the most powerful form of knowledge<br>▪ Difficult to articulate formally<br>▪ Includes privately held insights, feelings, culture, and values<br>▪ Hard to steal and copy<br>▪ Shared only when individuals are willing to engage in social interaction | ▪ Can become obsolete quickly<br>▪ Formal articulation possible, and can be processed and stored by automated means, or other media<br>▪ Easily communicated and shared<br>▪ Formally articulated and public<br>▪ Can be copied and imitated easily<br>▪ Can be transmitted |

Adapted from Daniel *et al.* (2003).

Informal face-to-face meetings are the most typical way of building and sharing tacit knowledge. In addition, thanks to rapid developments in IT and Internet (e.g., Microsoft Net Meeting) such meetings can be organized in a virtual environment crossing the geographical boundaries of a confined physical place (Marwick, 2001).

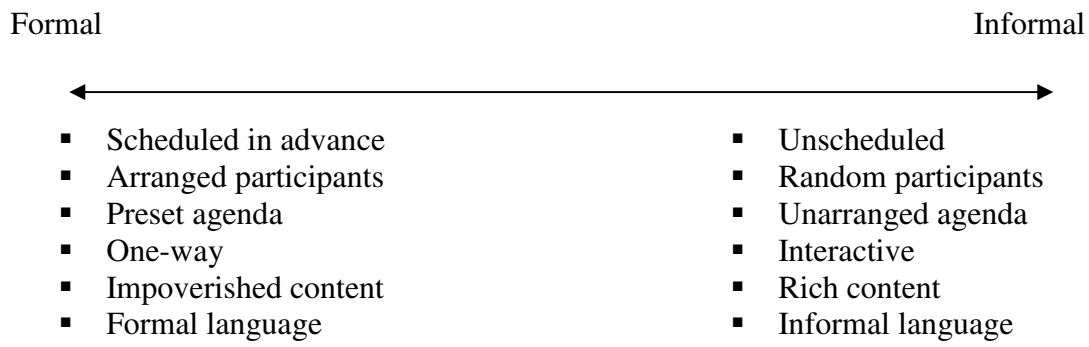
The flow of communication in an organization follows both formal and informal channels (Kraut *et al.*, 1990).

*Formal Communication Channels*: This channel is created and regulated by the management and defined in the organizational chart. Communication is coordinated based on common rules, policies and regulations, and standard procedures through memos, reports, and other standardized communications ("Establishing A Framework," n.d.; Kraut *et al.,* 1990). These formal communication tools are specified in advance, unidirectional, and relatively impoverished (Kraut *et al.,* 1990).

*Informal Communication Channels*: Informal communication is interactive, spontaneous, and rich in content and supports organizational and group coordination when the formal communication tools (e.g., rules) are not available under conditions of uncertainty ("Establishing A Framework," n.d.). Organizations are less explicit when it comes to regulating social relationships than work procedures (Kraut *et al.,* 1990). The nature of the relationship among individuals and their social status are important factors affecting formality of the communication. Informal communication channels (e.g., interpersonal) are the most effective mechanisms for transferring tacit knowledge and accelerates the knowledge searching and transferring process within a group (Fang *et al.*, n.d.; Persaud *et al.,* 2001). In addition, informal communication channels enable group members to be aware of each others' expertise. Group members can be more useful to each other if they have the knowledge of who knows what in solving problems (Cross *et al.*, 2001)

Figure 2.1 illustrates some of the variables that Kraut *et al.* (1990) identified to distinguish formal from informal communication.

*Figure 2.1.* The formality of communication.




Adapted from Kraut *et al.* (1990).

The distinction between formal and informal communication channels (Kraut *et al.,* 1990) parallels to Daft and Lengel's (1986) distinction between impoverished and rich communication channels based on the medium's capacity for prompt feedback, the number of cues and channels used, personalization, and language variety. Kraut *et al.* (1990) added the criterion of spontaneity to their criteria of bandwidth and interactivity that are important for online virtual meetings. Daft and Lengel (1986) classified media in order of decreasing richness (1) face-to-face, (2) telephone, (3) personal documents (e.g., memos), (4) impersonal written documents, and (5) numeric documents.

2.2.3. Time

Time is the third element in the DOI theory. The innovation-decision process, adopter categories, and the rate of adoption in a social system in the DOI theory includes a time dimension (Rogers, 1995). This process is composed of information-seeking and information-processing activities where the decision-making unit is motivated to develop a level of understanding (e.g., advantages versus disadvantages) about an innovation.

*The innovation-decision process*: Rogers (1995, p. 20) defines this as "the process through which an individual or other decision-making unit passes from first knowledge of

an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of new idea, and to confirmation of this decision" and proposed five stages in the process:

1. Knowledge
2. Persuasion
3. Decision
4. Implementation
5. Confirmation

1. *Knowledge Stage*:

This first stage in the innovation-decision process happens when the decision-making unit becomes aware of an innovation and develops a level of understanding of how it functions.

The existence of perceived needs or problems does not fully explain why individuals or organizations start the innovation-decision process in the first place. Sometimes potential adopters are exposed to an innovation by chance whereas some adopters actively seek such knowledge by making themselves available for such exposure in accordance with their interest and needs (Rogers, 1995).

Rogers (1995) speculated that exposure to mass media and informal communication channels such as interpersonal networks, increases the potential adopter's chance of knowing about an innovation earlier than others.

2. *Persuasion Stage*:

At the persuasion stage, the decision-making unit develops a positive or negative position about the innovation. Perceived attributes of an innovation (e.g., relative

advantage) play an important role in developing a general perception about the innovation (Rogers, 1995). In this stage, potential adopters are motivated to seek subjective evaluation information (i.e., tacit knowledge) about the innovation through informal communication channels as well as additional related information (i.e., explicit knowledge).

3. *Decision Stage*:

In this stage, the decision-making unit takes critical steps that result in a choice to adopt or reject an innovation. Adoption is a decision to embrace an innovation and rejection is a decision not to adopt. However, the decision may not be binary (adoption vs rejection). Sometimes, potential adopters may be in an intermediate decision state in which the decision is uncertain (Deffuant *et al.*, 2005).

In this stage, potential adopters continue to seek additional information about the innovation and develop an intention towards trying the innovation. Triability of an innovation on a partial basis plays a major role in this stage. Most adopters tend to try an innovation on a small scale before they make a final decision (Rogers, 1995).

4. *Implementation Stage*:

In this stage, the innovation is put into use in a larger scale on a regular basis. The innovation may be put to use gradually depending on the nature of the innovation and characteristics of the organization (e.g., size). Even though the decision to adopt the innovation has been made, it could be reversed at any point in the implementation stage. In organizational settings, implementers are usually not the ones who make such decisions but their feedback is valuable in deciding whether or not to continue to use the innovation (Fichman & Kemerer, 1993). The implementation stage ends when the

innovation is no longer perceived as a new idea and becomes a regular part of ongoing operations in the adopting unit (Rogers, 1995).

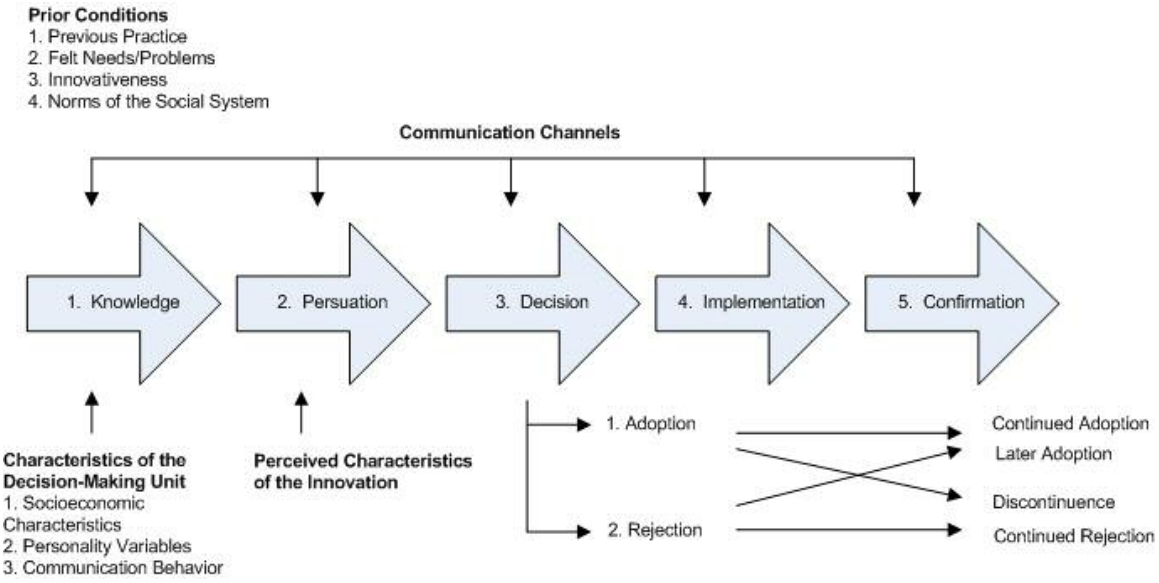
5. *Confirmation Stage*:

Although the end of the implementation stage marks the end of innovation-decision process, some decision-makers continue to seek more information about the innovation to support their position or reverse a previous decision to adopt or reject the innovation.

If the decision-makers receive conflicting and negative messages, especially through informal communication channels, they may reject the innovation that was previously adopted (Rogers, 1995). Rejecting an innovation that had been accepted previously is called discontinuance. If the innovation has not been integrated into ongoing routine operations successfully, it is more likely to lead to discontinuance.

Figure 2.2 summarizes the innovation-decision process in the DOI model.

*Figure 2.2.* A model of stages in the innovation-decision process.




Adapted from Rogers (1995).

Rogers (1995, p. 252) described innovativeness as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system." Adopter categories are the classification of the members of a system based on their innovativeness. Although the adopter categories are based on the relative time frame at which an innovation is adopted, some common characteristics among the members of a category (e.g., use of particular communication channels) can be found. Adopter categories in the DOI theory are:

1. Innovators
2. Early Adopters
3. Early Majority
4. Late Majority
5. Laggards

1. *Innovators*:

Innovators, who are not necessarily inventors, actively seek information about new ideas pertinent to their interest, area, or expertise. They utilize both formal and informal communication channels to gain knowledge about new ideas and learn more about them. Although they value subjective evaluations about the innovation from their peers, they don't depend particularly on the members of their system. They are in a position where they would rather be first to adopt the innovation by themselves and then provide feedback to the other members of the system. They are ready to take risks and suffer occasional setbacks in case the innovation fails. However, they are more motivated to try and adopt innovations because of their risk-taking and exploratory nature than the other members of a social system.

Innovators are the gatekeepers of their social system, since they are the first ones who brought the knowledge in and tried it (Rogers, 1995). Their experiences shed light on the innovation for early adopters.

2. *Early Adopters*:

Early adopters are considered those who are looked to for advice and information about the innovation. They rely mainly on subjective evaluations from innovators. They help the innovators in reducing the uncertainty about an innovation and then pass the subjective evaluation to near-peers through informal communication channels. They are the most influential group within a system and serve as a role model for the rest of a social system.

3. *Early Majority*:

The early majority holds a unique place between those very early in the adoption cycle and those comparatively late to adopt an innovation (Rogers, 1995). They serve as a link between these early and late adopters. Their innovation-decision period is relatively longer than that of innovators and early adopters.

The early majority maintains "Be not the first by which the new is tried, Nor the last to lay the old aside" mentality (Rogers, 1995).

4. *Late Majority*:

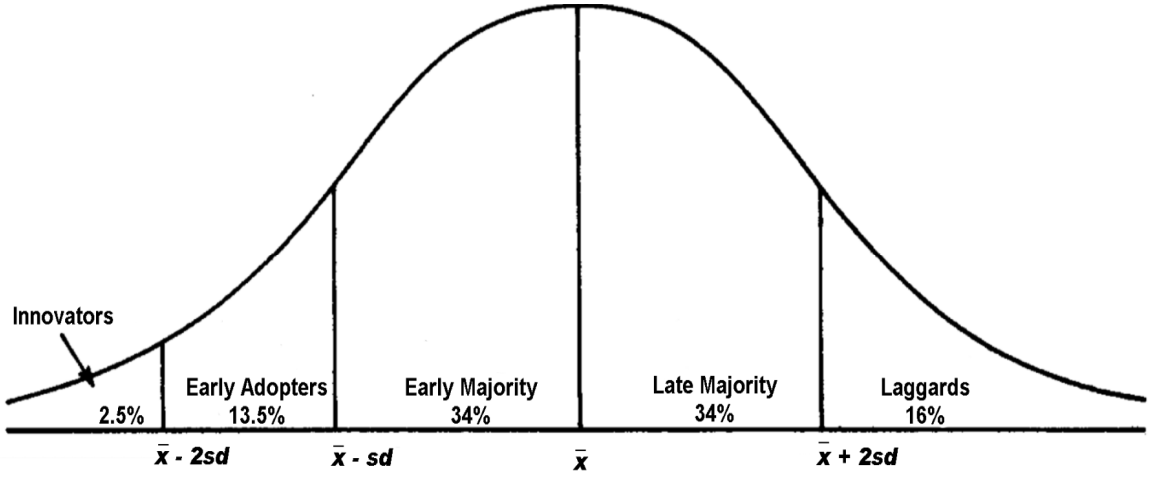
Late majority members evaluate innovations with extreme caution and skepticism. They may need to see the economic advantage and to feel the pressure from their peers to adopt the innovation.

5. *Laggards*:

Laggards are the last ones to adopt an innovation within the social system. They are on the sidelines within the social network of the system and they do not trust the other members of the system who do not have close ties with them (Rogers, 1995). They need to be absolutely sure about an innovation before adopting and their innovation-decision process is time consuming and lengthy.

Figure 2.3 illustrates the adopter categories based on innovativeness and indicates the normal frequency distribution of each group. Rogers (1995) developed the figure below by using two basic statistical parameters, mean ($\bar{x}$) time of adoption and its standard deviation (*sd*).

*Figure 2.3.* Adopter categorization on the basis of innovativeness.



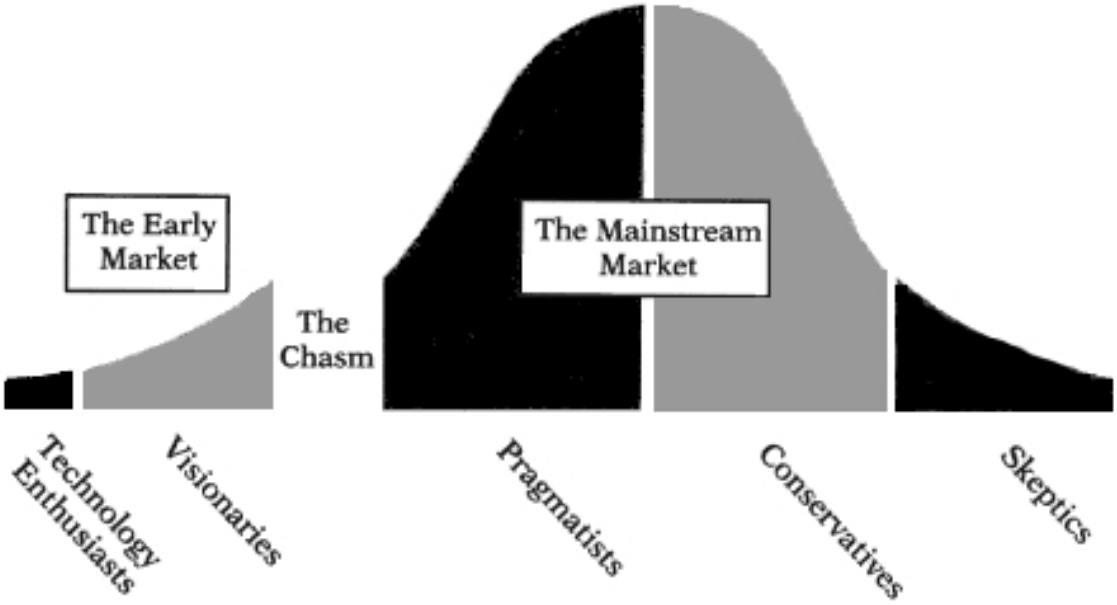

Adapted from Rogers (1995).

On the other hand, Moore (1999) relabeled the adopter categories to reflect the IT adoption in organizations and introduced the concept of chasm. Moore's adopter categories and their relationship with Rogers' (1995) adopter categories are:

- Technology Enthusiasts (Innovators)
- Visionaries (Early Adopters)
- Pragmatists (Early Majority)
- Conservatives (Late Majority)
- Skeptics (Laggards)

Moore (1999) does not draw clear boundaries between these adopter categories in terms of their adoption characteristics specifically between Visionaries and Pragmatists. Figure 2.4 below shows the Moore's adopter categories in the context of IT diffusion.

*Figure 2.4.* The chasm.




Adapted from Moore (1999).

Moore (1999) pointed out that the fundamental difference between Visionaries (early adopters) and Pragmatists (early majority) comes from their adoption characteristics. According Moore (1999), the concept of chasm represents the threshold for adoption to achieve critical mass (early majority) and thus addressing the differences

between Visionaries and Pragmatists is critical for an innovation to reach mainstream markets (early majority, late majority, and laggards). If a technological innovation achieves critical mass where adoption threshold, adopter expectations, and sponsorship behind the technology play a very critical role, it will more likely to be dominant in the market, and widespread adoption of the innovation accelerates its maturation process (Fichman & Kemerer, 1993).

In the case of a new technology adoption in organizations, economists identified several major factors that determine whether a new technology achieves a critical mass or not; these factors include: prior technology drag, investment irreversibility, sponsorship, and expectations (Fichman & Kemerer, 1993). For a newer technology to replace an existing mature technology that has already been adopted by quite number of organizations, it would need to promise to meet current and future organizational goals. In addition, the newer technology would need to offer some short-term benefits to ensure faster return on investment. These factors increase the importance of observability of an innovation (Rogers, 1995). However, earlier technology may cause a drag on the organization from moving to a newer one. There will be transition costs of adopting a new technology with relatively small user base, and because of the associated cost, only a few of them may be able to switch to a new technology. In addition, when the adoption of a new technology requires large capital commitment and/or the newer technology has higher level of incompatibility with the existing technologies, reluctance among the potential adopters grows along with the chance of being stranded.

Strong sponsorship and positive expectations are able to overpower the reluctance that might arise from prior technology drag and the risk of being stranded. These two

factors play a major role for "a new technology to overcome the head start of a prior technology" (Fichman & Kemerer, 1993). Sponsors of a new technology ease the financial burden on the early adopter by making credible commitments to develop and improve the technology. On the other hand, positive expectations about the technology that will be adopted by a larger audience in near future drive others to join.

Rate of adoption is "the relative speed with which an innovation is adopted by the members of a social system" (Rogers, 1995, p. 22). The number of adopters of an innovation in a certain period of time (e.g., within one year) is generally used to measure rate of adoption.

According to Rogers (1995), the five perceived attributes of an innovation can be used to explain the rate of the adoption along with other factors such as type of innovation-decision and communication channels. In addition, Davis' (1989) perceived usefulness and perceived ease of use of an innovation can be added to the list in explaining the rate of adoption of IT related innovations. Tornatzky and Klein (1982) argued that the perceived attributes of an innovation proposed by Rogers (1995) are too broad in terms of defining the characteristics of an innovation and identified more than ten attributes (e.g., cost, profitability, and social approval) including Rogers' (1995) that have a part in explaining the rate of adoption of an innovation in organizational settings.

In addition, Davis (1989) focused on the fundamental determinants of system use, namely, perceived usefulness and perceived ease of use, and developed measures to predict and explain use. Although definitions of perceived usefulness and perceived ease of use parallels Rogers' (1995) definitions for relative advantage and complexity respectively, these two attributes have been studied so broadly and inconsistently in the

relevant literature, which makes them confusing and difficult to interpret (Davis, 1989; Tornatzky & Klein, 1982). Perceived usefulness is described as "the degree to which a person believes that using a particular system would enhance his or her job performance"; on the other hand, perceived ease of use defined as "the degree a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320).

### 2.2.4. Social System

Rogers (1995, p. 23) defined a social system as "a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal" and the members or units of a social system may be composed of individuals, organizations, and informal groups. Sharing a common goal keeps the system together and members cooperate to a certain extent to solve common problems.

Patterned social relationships (e.g., hierarchical positions) among the members of a social system defines the social structure of a system which, in return, can facilitate or delay the diffusion of an innovation and lays out a framework for making predictions about the human behavior in a system since such structure provides regularity and stability to human behavior (Rogers, 1995).

Established behavior patterns called norms are the ruling principles of a social system, which may also influence diffusion (Rogers, 1995). In other words, norms serve as a guide or a standard for the members against which they can assess their own behavior. Norms may slow the diffusion process when an innovation doesn't comply with the norms of a social system even if the adoption of the innovation offers important benefits for the system (Raghavan & Chand, 1989). On the contrary, innovation

characteristics and other factors discussed earlier are considered in a decision if an innovation complies with the norms.

The most innovative members (i.e., innovators) of a system are often given a low status of credibility because of their risky and deviant nature (Rogers, 1995). Their attitude towards innovations limits their influence in persuading others to adopt. However, some members, especially early adopters and early majority, are able to influence others' attitudes. Such an influential and informal position is called opinion leadership (Rogers, 1995). Opinion leadership is earned and maintained by a social unit's or an individual's technical competence, social accessibility, conformity to the norms, and contribution to the social system as opposed to formal status of a social unit or an individual. Opinion leaders are very influential through informal communication in getting to their followers.

The innovation-decision can be made by an individual member of a system as well as by the entire system. The decision can be made collectively by reaching a consensus among the members of a social system or by a relatively few individuals who possess status, power, or technical expertise (Rogers, 1995).

A decision made by an individual to adopt or reject a new idea independently from other members of a system is called an optional-innovation decision (Rogers, 1995). An adoption decision may be influenced by the norms of the system and informal communication channels. In this case, the decision is made by an individual member of the system rather than the entire social system, and the individual member is fully responsible for the consequences of the decision.

Collective-innovation decisions are made by members of a system through a consensus to adopt or reject a new idea. All the units within the social system are expected to comply with the decision. However, reaching a collective decision is a time-consuming process because it is made by a consensus among the members.

Authority-innovation decisions are made by a select set of members of a social system who have authority and higher status in the organizational chart; in this decision-making process an individual member has little or no influence on the decision. In organizational settings, collective and authority-innovation decisions are more common than the optional-innovation decisions, and authority-innovation decisions result in higher rate of adoption than others (Rogers, 1995).

### 2.2.5. Summary

This section has presented the important aspects of the Rogers' DOI theory focusing on individual level of adoption along with the contributions of diffusion research in the areas of IT adoption and adoption at organizational levels. Diffusion of an innovation is a social process that is influenced by various factors such as characteristics of the innovation (e.g., relative advantage) and the decision-making unit (e.g., individual characteristics) depending on the level of adoption (individual vs organizational). The information about the innovation is communicated through formal, informal, and mass media channels in the course of the innovation-decision process. Rogers (1995) suggested that having some exposure to mass media and informal communication channels such as interpersonal networks increases a potential adopter's chance of knowing about an innovation earlier than others. The research reported here specifically focuses on CoPs which serve as an informal communication channel.

## 2.3. Theoretical Framework II: Communities of Practice

Communities of Practice (CoPs) are composed of people who share a concern, common problems, or a passion about the domain, and who want to gain more knowledge and expertise pertaining to the domain by interacting regularly (Wenger *et al.*, 2002). CoPs provide a learning environment through social participation, where participation refers to being active participants in the practice and building a sense of identity associated with the CoP to which they belong to.

The phenomenon of CoPs has been around for years but the term itself was used first by Lave and Wenger while studying apprenticeship as a learning model, and they argued that the acquisition of knowledge is a social process (Hildreth & Kimble, 2004).

Participation encompasses much more than engaging in joint activities and it means more than just working together in CoPs. Participation may involve numerous relationships such as conflictive versus harmonious and cooperative versus competitive (Wenger, 1998). Participation gives a shape to a CoP while shaping its members' experiences.

As organizations, specifically commercial ones, expand in size, geographical coverage, and complexity, knowledge has become the key to improving organizational performance and the formation of informal social groups like CoPs become a natural part of organizational life (Lesser & Storck, 2001; Wenger *et al.,* 2002). CoPs make knowledge an integral part of their ongoing activities and interactions. Interpersonal interactions play an important role especially in sharing tacit knowledge; the learning tools utilized by CoPs such as storytelling, conversation, and apprenticeship increase the efficient use of knowledge. CoPs act as a living repository for collective knowledge

through creating a value for both the members and the organizations supporting and sponsoring these social structures (Wenger *et al.,* 2002).

As discussed earlier, knowledge can be tacit as well as explicit. Sharing tacit knowledge requires personal interaction and CoPs provide such an informal learning platform through, for example, conversation and apprenticeship. Members become aware of their peers' expertise, knowledge, and skills by creating a venue for them to interact with each other. They are able to compare, verify, and benchmark their professionally developed expertise in the field against their colleagues' knowledge. When a CoP is approached from knowledge sharing point of view, there are two types of members: knowledge seekers who look for the knowledge and knowledge sources that either have the knowledge or direct the seeker to another source (Lesser & Fontaine, 2004).

In addition, CoPs have the ability to deal with a broad range of knowledge-related issues by connecting isolated professionals and expertise and linking unconnected activities pertinent to domain. The individuals that participate in CoPs and organizations that support and provide resources to them see value in CoPs for themselves. In the short run, CoPs improve the business outcomes for organizations by providing an arena for problem solving, quick answers to questions, more perspectives on issues, and improved quality of decisions. For the members, CoPs may improve their work performance by providing them with access to expertise and knowledge and helping to deal with challenges. However, in the long-run, CoPs develop organizational capabilities by letting organizations envision technological developments and take advantage of emerging market opportunities. For the members, CoPs foster professional developments by

helping members to expand their knowledge and expertise and improve professional reputation (Wenger *et al.,* 2002).

As mentioned in Chapter I, there are three crucial characteristics (i.e., domain, community, and practice) of a CoP that provide a guide to community development and distinguish a CoP from other social structures such as a project team or a neighborhood community.

### 2.3.1. Domain

Domain defines a community through a common framework and identity. It addresses the issues related with a community's purpose such as topics, issues, and benefits pertinent to its members so that a common understanding of the domain can be developed within the community. A CoP may gain legitimacy through a well-defined domain. The domain determines the boundaries and guides members about what is worth sharing and pursuing; it provides them with a direction, through which members and other stakeholders are connected to the community. A shared domain encourages members to contribute and participate, and therefore provides a sense of accountability to the knowledge that is a distilled product of collective learning.

A domain is not composed of a static set of issues, topics, and problems. It evolves along with the community (Wenger *et al.,* 2002). In any domain, as existing problems and issues are resolved new problems and challenges appear. As new members join with different perspectives, existing members replenish themselves, so that the community evolves and grows. These challenges and improvements generate fresh energy for the members and keep the CoP alive and well.

A CoP has an identity characterized by a shared domain. Commitment to the domain distinguishes a community from a group of friends or other social structures. Membership provides a sense of commitment (Wenger *et al.,* 2002). The table below summarizes the distinctions between CoPs and other social structures.

Table 2.2

Distinctions Between CoPs and Other Social Structures

| Group Types | Function | Basis of Membership | Basis of Cohesion | Duration |
|---|---|---|---|---|
| Communities of Practice | Develop members' expertise and define their place or role in the community | Self selected or assigned by the management | Commitment and identification with the expertise that forms the basis of the practice | As long as members have an interest in improving the practice and maintaining the community |
| Formal Work Teams | Perform the ongoing work that has been assigned to the team (e.g., produce and deliver a product or service) | Everyone who has been assigned to the team | Job/performance requirements and continuing, common goals | Until the work or the organization is reorganized |
| Project Teams and Task Forces | Accomplish a specific task or assignment, usually during a particular time frame | As assigned by the management | Project milestones and goals | Until the project or task has been completed |
| Informal Networks | Collect and share information of common interest | Reciprocal value and acceptance, that is, members obtain and provide information of value | Perceived value in belonging and participating | As long as people have a reason to connect and share information |

Adapted from Nickols (2000).

### 2.3.2. Community

Wenger *et al.* (2002) defined a community in the context of CoPs as a group of people who engage in joint learning activities, build relationships, and help each other regularly in pursuing their interest in the domain. Continuity in their interactions lets them develop a sense of belonging, identity, and commitment (Wenger *et al.,* 2002).

A CoP does not necessarily have to be composed of the members of a same organization or department. Communities may attract members from different parts of the same organization as well from different organizations, from the same geographical location as well as from other parts of the world. All communities are distributed to certain extent.

Interpersonal relationships are critical in community building. Knowing who knows what (Cross *et al.,* 2001) makes getting a right answer for the members easier when they are in need. In addition, interpersonal relationships enable members to overcome the initial trust issues that may arise when members engage in information sharing activities. Moreover, interpersonal interaction is an effective way of building trust, which is a precondition for genuine knowledge sharing (Persaud *et al.,* 2001).

Although a CoP provides its members with a common domain, it does not imply that members have similar backgrounds, skills, and perspectives. A kind of homogeneity may accelerate the community building efforts at the early stages but it is not a required ingredient for a community. In the long run, continuous interactions among members enable them to build common identity; they also promote diversity. Over time, members develop their own styles and approaches. They define their status within the community

by participating in discussions and developing interpersonal relationships. Having diversity in skills, ideas, and perspectives makes CoP a richer, creative learning environment for its members.

Relationships among members and structure of communities change as they increase in size. Table 2.3 summarizes these changes.

Table 2.3

Change in Communities

| Size | Type of Relationship |
|---|---|
| < 15 | Intimate |
| 15 < & < 50 | Fluid and Differentiated |
| 50 < & < 150 | Tend to break into subgroups based on topics, geographic location, etc. |
| > 150 | Subgroups with strong identities |

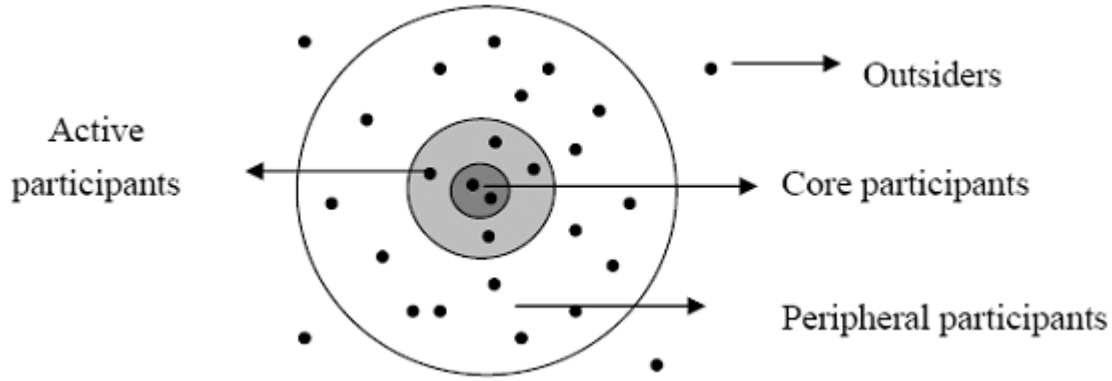
Adapted from Wenger (1998).

Although it is not an easy task to classify the relationships based on the size of the group, direct interaction among members starts to diminish as communities grow in size. In communities with fewer members, relationships are more intimate and members are able to access each other easily. As the number grows, interactions among members start to get less intimate. A community begins to break into subgroups intentionally or unintentionally when the size reaches a threshold where subgroups start to build up strong identities for themselves although they have sense of belonging to the greater community (Wenger, 2001).

Mutual engagement of members is a personal matter and therefore a source of coherence for the community (Wenger, 1998). From this aspect, participation is

voluntary, and it does not really matter how members join (i.e., self-selected or assigned) the community. As they participate in the community activities at various levels, they become the part of the community. Wenger (2001) identified four levels of participation in a CoP as shown in Figure 2.5.

*Figure 2.5.* The degrees of community participation.




Adapted from Wenger (2002).

The small group people who actively participate in activities of the community often lead and coordinate the community with topics and agendas they determine. The core group constitutes ten to fifteen percent of the whole community. The next level is the active group who attends and participates in the activities but not as regularly as the core group members. The active group is also small and constitutes fifteen to twenty percent of whole community. The majority of the CoP members is peripheral and seldom participates in the activities. Some remain peripheral because they think their state of knowledge is not relevant to the rest of the community or carries no authority, or they don't have enough time to contribute. Outsiders are not the members of the community but they may have an interest in the community.

A newcomer starts as outsider, and then can progress to becoming a fully engaged member in the CoP activities. The informal structure of CoPs enables members to travel through these levels as the topics of the community change (Wenger, 2001).

### 2.3.3. Practice

A practice is defined as the set of frameworks, tools, ideas, knowledge, and documents a community develops, shares, and maintains (Wenger *et al.,* 2002). It refers to the work its members do and their shared understandings and activities (Borgatti, 2004). Moreover, practice gradually changes as a collective product of a community. A CoP distinguishes itself from other kind of social groups that we call communities such as people who live in the same neighborhood by being organized around a practice and a domain.

The practice is oriented both to past and future. On the one hand, it explores existing knowledge that has been built up and shaped over time by the participants and embodies the history of the community. On the other hand, it looks into the latest advances in the field and thus enables members to handle new situations. In the process, they develop a shared repertoire that refers to shared collection of procedures, techniques, shortcuts, jargon, tools, symbols, concepts, and so on. In this sense, a shared repertoire supports innovation and its diffusion, because it provides a language for communicating new ideas (Wenger, 1998; Wenger *et al.,* 2002). A larger repertoire enables participants to express new ideas and pass them on to others quickly within the community (Borgatti, 2004).

### 2.3.4. Social Capital

Social capital can be defined from the CoP perspective as "the common social resource that facilitates information exchange, knowledge sharing, and knowledge construction through continuous interaction, built on trust and maintained though shared understanding" (Daniel *et al.*, 2003). It is often used as a model to explain various social issues in social groups such as city neighborhoods and is widely discussed in sociology and political science literatures (Daniel *et al.,* 2003; Lesser & Storck, 2001).

Nahapiet and Ghoshal (1998) identified three primary dimensions of social capital: the structural, the relational, and the cognitive. These can be applied to CoPs (Lesser & Storck, 2001). The structural dimension refers to "overall pattern of connections between actors" (Nahapiet & Ghoshal, 1998). In other words, it is related to the ability of members of a system to make connections with others. Through these connections, called information channels, the time and investment required to collect crucial knowledge is reduced (Nahapiet & Ghoshal, 1998). Making connections through networking is the initial step in developing social capital. Strengthening these initial contacts through interpersonal relationships refers to the relational dimension of social capital.

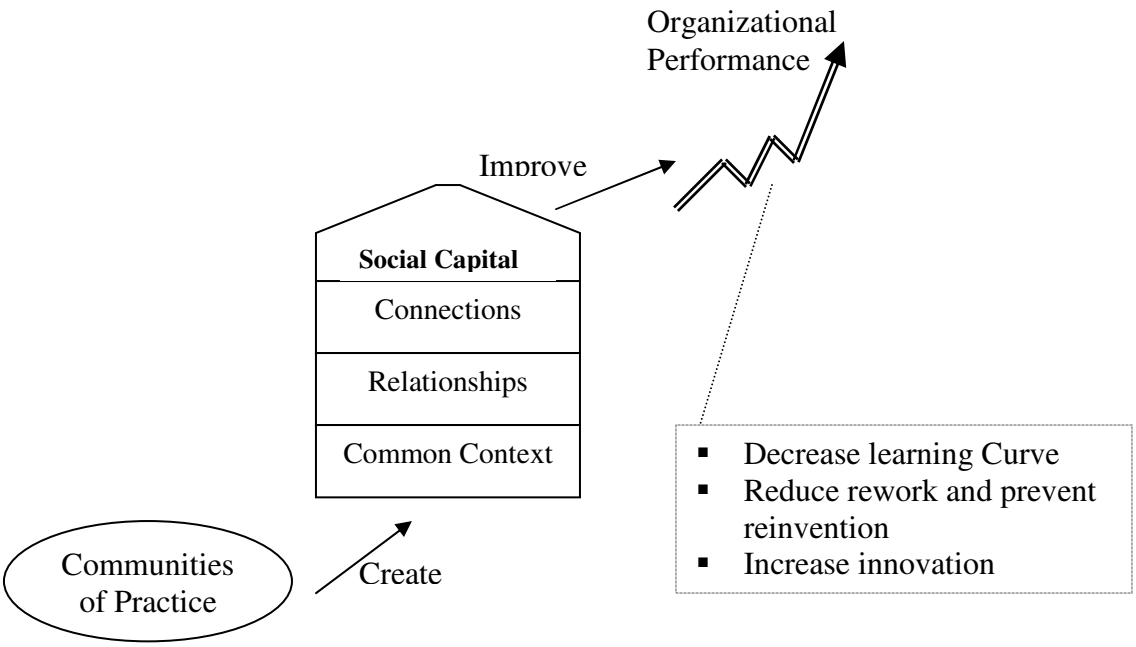
According to Nahapiet and Ghoshal (1998), there are four components of relational dimension of social capital: trust, norms, obligations, and identification. These have an important influence on the behaviors of the members of a social system. Trust refers to having confidence in others in terms of their competence, ability, reliability, and openness to new ideas in a given situation (Lesser & Storck, 2001; Nahapiet & Ghoshal, 1998). Research in this field shows that a higher degree of trust in relationships

encourages people to engage in social exchange and cooperative interaction (Nahapiet & Ghoshal, 1998; Persaud *et al.,* 2001). Norms refer to a commonly accepted set of rules that dictates individuals' behavior. They represent a degree of consensus within a group. Rogers (1995) also identified norms of a social system as an important factor influencing innovation decisions made both at individual and at organizational levels. Obligations involve a commitment or duty or motivation for engaging in a mutual relationship and activity to exchange or combine knowledge. Identification refers to the process whereby individuals consider themselves united as one with another or a social unit. Membership in a social unit is an important factor facilitating the sense of identification in a group.

The cognitive dimension is defined as "to the extent that people share a common language, this facilitates their ability to gain access to people and their information" (Nahapiet & Ghoshal, 1998). In other words, the cognitive dimension refers the development of shared context in a social unit. Creating shared narratives facilitates the transfer of tacit knowledge among the members of a social system (Lesser & Storck, 2001).

Lesser and Storck (2001) argued that social capital is a part of CoPs and gives rise to behavioral changes that have a positive influence on organizational performance. Moreover, they indicated that CoPs serve as generators of social capital by developing, promoting, and nurturing connections and relationships among practitioners regardless of their physical locations and official statuses. In turn, social capital provides a platform where a sense of trust and mutual obligation, shared common language and context constitute the foundation. Figure 2.6 shows how CoPs are linked to organizational performance through social capital.

*Figure 2.6.* The link: CoPs, social capital, and the organizational performance.




Adapted from Lesser & Storck (2001).

The case studies conducted by Lesser and Storck (2001) show that CoPs impact organizational performance by decreasing the learning curve for newcomers, responding more rapidly to customer needs and inquires, optimizing use of time, and acting as a breeding ground for new ideas.

2.3.5. Summary

This section introduced and explained structural elements of CoPs and how this framework is related to this research. This study focused specifically on CoPs as informal communication channels and their influence on decisions to adopt or reject an innovation. A shared repertoire supports innovation and its diffusion because it provides a language for communicating new ideas (Wenger, 1998; Wenger *et al.,* 2002). In parallel to factors (i.e., social system, communication channels) identified by Rogers (1995), CoPs and

social capital (e.g., conveying tacit knowledge, norms) influence decisions regarding adoption of an innovation.

## 2.4. Digital Libraries

The term digital library (DL) is an interdisciplinary concept that has different meaning from one discipline to another (Borgman, 1999; Kochtanek & Hein, 1999; Marchionini, 1998). Scholars in engineering and computer sciences fields are interested in the enabling technologies, information retrieval, and networks; on the other hand, information professionals and scholars are more concerned about the content, organization, publishing, and user behavior in the library and information sciences field (Borgman, 1999; Marchionini *et al.*, 2003). The availability of research funding to a wide array of disciplines for DL research during 1990s gave rise to conflicting definitions and perspectives while leading to the cross-fertilization of ideas and a regular exchange of information (Larsen & Watctlar, 2003). Fox (1998) selected more than ten definitions of the term digital library from the literature (see Appendix B for the detailed list); each definition contains a different set of requirements for a DL. Borgman (1999) clustered all these conflicting and different definitions into two perspectives: research-oriented and practice-oriented. The research-oriented definition focuses on the significant research problems and relationships between them; the practice-oriented one emphasizes and attempts to frame current and expected practical challenges such as evolution of libraries as institutions. In other words, some see the DLs as electronic information collections and others consider them as institutions that are logical extensions of and supplements to brick and mortar libraries. It is important to note that the concept of DL is constantly evolving and being refined through the joint activities of various disciplines such as

workshops, conferences, and scholarly writings (Borgman, 1999). A Delphi study conducted by Kochtanek and Hein (1999) coalesced on the definition of DLs as "organized collection of resources, mechanisms for browsing and searching, distributed networked environments, and sets of services objectified to meet users' needs," which is very broad definition. On the other hand, the President's Information Technology Advisory Committee (PITAC) Panel on Digital Libraries defined DLs as "the networked collections of text, documents images, sounds, scientific data and software that are core of today's Internet and tomorrow's universally accessible digital repositories of all human knowledge" (Reddy & Wladawsky-Berger, 2001).

As discussed earlier, the interdisciplinary and complex nature of DLs prevents researchers agreeing on a commonly accepted definition. The perspective taken in this study is the research-oriented definition that evolved beyond just emphasizing enabling technologies to include various aspects of data and metadata (Borgman, 1999):

> Digital libraries are a set of electronic resources and associated technical capabilities for creating, searching and using information. In this sense they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium (text, images, sounds; static or dynamic images) and exist in distributed networks. The content of digital libraries includes data, metadata that describe various aspects of the data (e.g. representation, creator, owner, reproduction rights) and metadata that consist of links or relationships to other data or metadata, whether internal or external to the digital library. (p. 234)

In general, DLs enable far broader range of users than traditional physical and organizational arrangements (e.g., libraries) to access information. Gathering, organizing, sharing, and maintaining such information resources require a flexible, scalable, and

interoperable infrastructure (Larsen & Watctlar, 2003). A vision set forth for the DLs by the President's Information Technology Advisory Committee (PITAC) Panel on Digital Libraries suggest that DLs providing the means of searching and accessing all human knowledge anytime and anywhere via Internet for all citizens (Reddy & Wladawsky-Berger, 2001). One of the key issues in accomplishing this vision is improving the ability to store and retrieve digital content across disparate and independent systems and collections by improving interoperability among these diverse DLs (Reddy & Wladawsky-Berger, 2001). Interoperability is an important issue in the situation where various system architectures, operating systems, and programming languages are required to communicate with each other. In addition, DL development efforts are closely related with the progress in general purpose technologies such as high-speed networking, security, and interoperability (Marchionini, 1998). However, the size, heterogeneity, and complexity of the today's information resources become critical factors when building DL systems because such factors create immense challenges for interoperability, or the ability to ensure seamless information exchange across multiple DLs and information resources (Akscyn & Witten, 1998; Gonçalves *et al.*, 2002; Marchionini, 1998). Marchionini (1998) addressed interoperability in two levels. The first level is the efforts to create standards for data storage and transmission, for query representation, and for vocabulary control; DLs adopt such standards and modify their content and services at the local level. However, standards development is a complex social process and requires consensus among stakeholders (Moen, 1997). This process may be time-consuming. The second level encourages individual DLs to create standards-based services that can be easily accessible and used by other DLs. In this sense, ANSI/NISO Z39.50, Open

Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), and Search/Retrieve Web Service (SRW) and Search/Retrieve URL (SRU) protocols can be considered mechanisms for mapping queries to different information resources (Arms, 2005; Hickey, 2003; Marchionini, 1998).

As underlying IT systems of DLs evolve, the vision of creating universally accessible and searchable information space evolves. The technologies used in DLs are changing at an accelerating speed. The introduction of Gopher services and WWW in the 1990s put the Internet in the center of great changes in terms information sharing, technological innovations, and commercial activities (Corrales, 2001). Now, with the help of high-speed networks and increasing computing performance, DLs provide access to information which may be available in a number of formats including high-resolution images, streaming audios and videos, and text. It would not be possible to accomplish this vision with the technologies available in the early years of WWW. For example, Z39.50 is a pre-Web technology ("Z39.50-Wikipedia," n.d.) used for searching and retrieving information from multiple databases simultaneously operating over the Internet (Moen, 1995). The Z39.50 protocol is powerful enough to provide organizations (i.e., libraries) with a robust platform to access various information resources through a single search interface in an interoperable manner ("Library of Texas," 2004). The development of SRW and SRU protocols is an attempt to update and transform the Z39.50 information retrieval protocol while preserving its functionality and power perform better in the context of the WWW and incorporates recent developments in the Web technologies such as Extensible Markup Language (XML) and Web services (WS) ("Z39.50-Wikipedia," n.d.).

### 2.4.1. Communities of Practice in Digital Libraries

The role of the CoPs has not been a focus of DL research even though some influential researchers (Borgman, 1999; Marchionini, 1998) in the field have addressed this concept directly and indirectly in discussion of DLs. A number of groups and organizations operating in DLs can be characterized as CoPs. Some of them refer to themselves as CoPs, such as the Semantic Interoperability (XML Web Services) Community of Practice ("SICoP," 2005); others prefer to call themselves communities with an interest to specific aspect of the field though their goal and activities fit the description of a CoP such as Z39.50 International Next Generation (ZING) Forum and Digital Library Federation (DLF).

The Network of Excellence on Digital Libraries (DELOS) is another example of a CoP in the DL field with a well-defined domain but itself is a network that aims to integrate and coordinate the DL research efforts carried out by the major digital library research teams in European Union (EU) ("DELOS Network," 2005).

The DL conferences, funding agencies, workshops, and professional societies (e.g., Association for Computing Machinery) play important roles both in building and cultivating the CoPs in the DL field, and such meetings serve as a breeding ground for future collaboration in DL development efforts (Borgman, 1999). In addition, the experts in the field reached a consensus that “efforts associated with development of digital libraries are primarily collaborative” in the Delphi study conducted by Kochtanek and Hein (1999, p. 253).

### 2.4.2. Summary

Although the interdisciplinary nature of DLs prevents researchers reaching consensus about the definition of DLs, this concept allows an exchange of ideas and experiences among different fields and provides researchers with a breeding ground for innovations. As DLs grow in size and number of services, the underlying technological framework becomes more critical in providing required performance and scalability (Pasquinelli, 2002). DL technologies and standards are evolving and improving as new challenges and requirements emerge and decisions regarding adoption of appropriate innovations become more critical for the DL environment.

## 2.5. Web Services

The concept of Web services (WS) has emerged as the next generation of web-based technology for exchanging information. This effort began five years ago with the submission of the SOAP 1.1 to World Wide Web Consortium (W3C) (Barefoot, 2002). WS are self-contained applications that can be described, published, invoked, and located over the Internet (or any network). Once a Web service is deployed, other applications can discover and invoke the service. WS provide a programmable interface for other applications without requiring custom programming and proprietary solutions regardless of the operating systems and programming languages to share information as opposed to providing users with a graphical user interface (Boss, 2004).

According to the W3C, a Web service is defined as a software system designed to support interoperable machine-to-machine interaction over a network by using XML for sending and receiving messages (Booth *et al.*, 2004). Simplicity and flexibility of XML made it a definitive standard for data transmission and storage. XML is an open standard

and can be accessed and processed by any tool capable of reading and writing American Standard Code for Information Interchange (ASCII) text. By definition, the only requirement for a Web service is to use XML. However the basic WS platform is composed of XML and a transport protocol. HTTP is the commonly used transport protocol on the Internet (Hickey, 2003). XML, Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL) are tools to create WS. A Web service provides the framework for creating the next generation of distributed systems by which organizations can encapsulate existing business processes, publish them as services, search for and subscribe to other services, and exchange information throughout and beyond the enterprise (Adams *et al.*, 2002). Besides recognizing heterogeneity of networked resources and applications as a fundamental ingredient, WS are independent of platform and the development environment can be packaged and published on the Internet. Also WS enable just-in-time integration and interoperability with legacy applications (Oguz & Moen, 2005).

Development of WS technologies and standards are mainly driven by large enterprises and e-commerce businesses that needed to have their information systems communicate seamlessly and effectively with each other to be competitive in their business practices. WS have emerged as a promising technology offering a flexible, reliable, and low cost way to make applications communicate with each other. There was a great need for a simple and reliable technology designed to ensure interoperability among various operating systems and programming languages based on open standards and protocols where other component-based distributing computing architectures like

Common Object Request Broker Architecture (CORBA) and Distributed Component Object Model (DCOM) fell short.

A Web service has an abstract description or an interface described in a machine processable format (specifically WSDL). Other systems interact with a Web service in a manner prescribed by the WSDL using SOAP messages, typically conveyed using transport protocols such as HTTP and Simple Mail Transfer Protocol (SMTP). In some cases WS registries can be used to discover alternative WS. The following section briefly explains the complementary tools and technologies of WS.

### 2.5.1. XML

XML is a set of rules and guidelines for describing structured data in plain text. After its standardization by W3C in 1998, XML has become the driving force behind numerous other standards (Coyle, 2002). XML is a cross-platform, software, and hardware independent tool to transmit data in plain text format allowing XML documents to be exchanged among otherwise incompatible platforms.

XML allows data and content to be packaged in a common format that is machine-readable and is able to be manipulated between similar or different application environments. XML lets applications present data, syntax, schema, and semantics when sending data. An XML Schema Definition (XSD) document or Document Type Definition (DTD) specifies elements, attribute names, and data types that can used in an XML document. The XSD lets services and clients running on various platforms semantically interoperate over a common document structure (Burner, 2003, "Web Services Gotchas," 2002). XSD is an XML based alternative to DTD to define the structure of an XML document.

2.5.2. SOAP

SOAP is a vendor neutral, programming language independent, and transport and network protocol independent communication protocol. SOAP is simple communication protocol that defines a message structure including an optional Header element and a mandatory Body element wrapped up by an Envelope (Burner, 2003). Once there is a well formed XML fragment enclosed in a minimum of SOAP elements, there is a SOAP message. XML documents can be generated easily using any kind of programming language.

A SOAP message is an XML document containing following elements:

Envelope: Identifies the XML document.

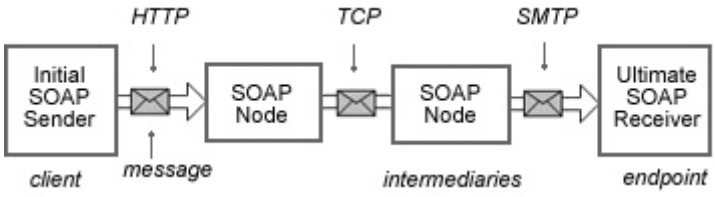
Header (optional): Header information.

Body: Contains application-specific data to be exchanged

Fault (optional): Contains error information.

The primary use of SOAP is to make different programs running on different platforms able to communicate. SOAP is widely used because it supports interoperability among many different environments and it can be used in combination with various transport protocols, for example, HTTP, SMTP, and Transmission Control Protocol (TCP), as shown in Figure 2.7.

*Figure 2.7.* SOAP messaging.




Adapted from Skonnard (2003).

SOAP is easier to implement than most of the earlier communication protocols such as Distributed Component Object Model (DCOM). The biggest advantage of SOAP is that it sends data as XML text, for example, to enable standard message formats, standard data representation, and so on. However, converting all the data into text and parsing it back into data structures at the other end may consume some portion of processing power. As SOAP implementations mature, the performance gap between SOAP and other protocols (e.g., DCOM) will likely narrow (Wolter, 2001).

A SOAP binding is set of rules defined to specify how a SOAP message is carried within or on the top of another protocol for exchanging messages. The SOAP specification provides a flexible framework to define arbitrary bindings and explicit binding for HTTP in order to ensure interoperability over various underlying network protocols (Skonnard, 2003).

### 2.5.3. WSDL

WSDL is the machine-readable language of WS. WSDL defines how applications can communicate with each other (Barefoot, 2002).

The WSDL working draft of W3C released in 2004 explains WSDL as follows (Chinnici *et al.*, 2004):

> WSDL describes a Web service in two fundamental stages: one abstract and one concrete. Within each stage, the description uses a number of constructs to promote reusability of the description and separate independent design concerns.

At an abstract level, WSDL describes a Web service in terms of the messages it sends and receives; messages are described using a type system, typically XML Schema.

At a concrete level, a binding specifies transport and wire format details for one or more interfaces. An endpoint associates a network address with a binding. And finally, a service groups together endpoints that implement a common interface.

A WSDL document uses following elements:

| Element Name | Description: |
|---|---|
| Types | : A container for abstract type definitions using XML Schema. |
| Message | : An abstract definition of the data being communicated. |
| Operation | : An abstract description of an action supported by the service. |
| Port Type (Interfaces) | : An abstract set of operations supported by one or more endpoints (ultimate receiver). |
| Binding | : A concrete protocol and data format specification for a particular port type. |
| Port | : A single endpoint defined as a combination of a binding and a network address. |
| Service | : A collection of related endpoints. |

In other words WSDL provides a map or template showing how services should be described and used by software clients (Vasudeman, 2001). WSDL plays a key role in ensuring technical level interoperability by describing how other applications can consume the service.

### 2.5.4. Universal Description, Discovery and Integration

A Universal Description, Discovery and Integration (UDDI) registry consists of three levels of information (Vasudeman, 2001):

| | |
|---|---|
| White Pages | : Name, address, phone number and other contact information. |
| Yellow Pages | : Industrial categorizations based on standard taxonomies. |
| Green Pages | : Technical information about the WS provided. |

UDDI serves as an information database of WS where organizations publish a service, and lets Web service requesters search that information to find a Web service and run it**.** Web based applications can communicate with UDDI registry via SOAP messages (Barefoot, 2002; Vasudeman, 2001).

2.5.5. WS Architecture as a Distributed Computing Technology

Distributed computing systems and software running on them can be characterized as loosely coupled or tightly coupled architectures (Grigonis, 2001; Vrenios, 2003). A Web service can be implemented based on both loosely and tightly coupled architectures. However, a loosely coupled WS is more advantageous than tightly coupled ("Web Services Gotchas," 2002).

In traditional distributed computing applications, program-to-program communications are tightly coupled. In other words, programmers need to specify where each and every application resides and how to communicate with each other. Having such a system provides more security, privacy, data-integrity, and complex transaction processing than loosely coupled architecture.

In tightly coupled systems, programmers know both endpoints and where applications reside so that security checking and maintenance can be performed easily. However, in the long run, system maintenance can be difficult and time consuming, for example, in the case of an increase in the number of applications interacting with each other ("Web Services Gotchas," 2002).

A traditional client-server application is run partly on the client, primarily responsible for presenting data to the user at the user interface, and partly on the server, which supplies data services to the user; this is called a two-tier architecture. An n-tier

architecture, also known as three-tier, provides a three-way interaction in a client-server environment where client provides a user interface, the application server is responsible for organization and application services, and database server is responsible for storing and validating the data. Typically n-tier architectures provide better application scalability, lower maintenance, and increased reuse of the components as opposed to two-tier architecture.

In a Web service, an n-tier architecture has been adopted versus two-tier structure as in a traditional client-server approach. Three main principles must be followed to make the n-tier approach for WS (Gillmor, 2001; McKusick, 2003).

First, communication efficiency is crucial in WS where many applications interact with each other. The Web uses a stateless protocol (i.e., HTTP) which means each request is treated as an independent transaction simplifying the design because servers don't need to allocate resources to deal with conversations in progress or has trouble freeing itself if the transaction breaks before it is completed ("AIPS++ Glossary," 2000). In other words, both the HTTP client and server close the Transmission Communication Protocol (TCP) connection after the data exchange is over. In a client-server model, communication between database and the application is maintained by TCP, a stateful protocol meaning limited number of clients can connect to server simultaneously. Stateful protocols may not work efficiently on the Web due to high number of requests.

Secondly, in WS, program-to-program communications are loosely coupled where an application requests another application to perform a certain task and programmers don't need to specify where to find cooperative applications and how to make those communicate with each other. If any of the applications fail, the system

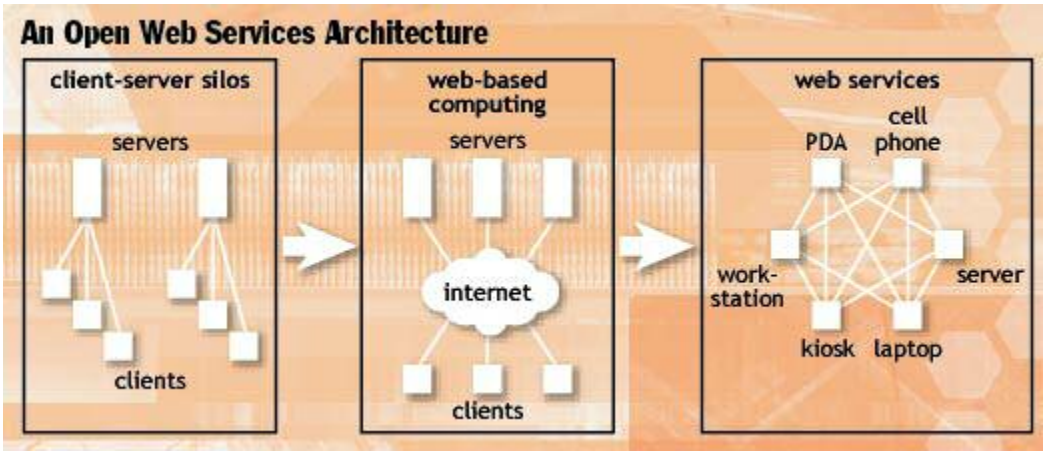
dynamically can use the registry service (i.e., UDDI) to find alternative applications to run automatically.

The third criterion to make a Web service successful is asynchrony. Some applications that are used by a Web service may not be available due to various reasons such as not being capable of handling a given load, bugs in the program, and hacker attacks. Asynchrony reduces the dependency among the components of the system by not requiring a component to wait until another one responds (Orchard, 2003). A message-based architecture built in WS makes applications perform their tasks while the system in the backend is not available. XML messaging and the SOAP protocol are able to provide both synchronous and asynchronous invocations (Gillmor, 2001; McKusick, 2003).

### 2.5.6. How do WS work?

The simplicity and extensibility of XML opened new horizons for moving data among applications across the Internet or organizational networks. In WS architecture, communicating parties can be both servers and/or clients as shown in Figure 2.8.

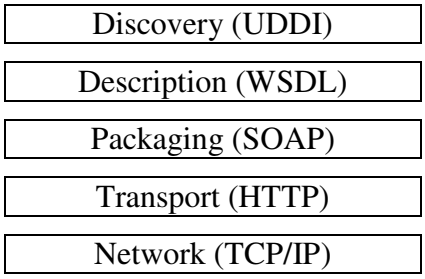
*Figure 2.8.* Open WS architecture.




Adapted from Kleijnen & Raju (2003).

Data exchange happens among applications via the standard HTTP protocol in most of the WS implementations available today. In other words, the browser sends the data via a Web form using post method to a Web service, and it receives a response in XML. The data exchange happens in the packaging layer (Fuecks, 2002) as shown in Figure 2.9.

*Figure 2.9.* WS technologies.




On the top of the data exchange (packaging) layer, the description layer provides information that describes what type of input and output the service provides at its interface as shown in Figure 2.9. In other words, this is a description of data types of the parameters (i.e., WSDL) passed to a Web service and the data passed back from the Web service so that developers can easily implement the programs accessing WS (Virk, n.d.).

Above the description layer, a discovery layer provides information that describes the nature of the service itself called UDDI, which can be a public or private site where available WS are listed for discovery.

### 2.5.7. WS in Digital Libraries

Hickey (2003) lists various ways of using WS technology in DLs from registering different types of objects and search services to navigating hierarchies and decomposing objects into simpler objects. The Search/Retrieve Web service (SRW) is a standardized

Web service built on the 20 years of experience of the Z39.50 information retrieval protocol. SRW provides an easy way to implement the protocol with the power of older and more complex Z39.50 (Sanderson, 2004). Even some libraries are replacing Z39.50 with WS technologies as the protocol of choice between library portals and online electronic resources (Boss, 2004). WS facilitate access to electronic databases, and digital libraries providing access to such resources benefit from this technology (Boss, 2004).

In addition, The Flexible and Extensible Digital Object and Repository Architecture (Fedora) system, designed by the Cornell University Information Science and The University of Virginia Library's Digital Library Research and Development Group (DLR&D) is a promising open source digital library software initiative. Fedora was originally implemented based on CORBA architecture; however the latest version of Fedora (2.0) has adopted a service oriented approach (SOA) based on WS (Introduction to Fedora, 2005). DSpace is another open source system, developed by Hewlett-Packard and MIT Libraries, to store the digital research and educational material produced by an organization or institution as a repository. Greenstone is yet another open source digital library software from New Zealand Digital Library Project at the University of Waikato that has a focus on publishing (Don *et al.*, 2005). The DELOS network pays close attention and contributes to the use of WS technologies in digital libraries. EBSCO, a publisher of a broad range of full-text and bibliographic databases, has recently introduced its WS interface to EBSCOhost, an electronic journal service for academic and corporate subscribers, forming a basis of real-time communications among library systems, portals, and all other systems in the future (Boss, 2004).

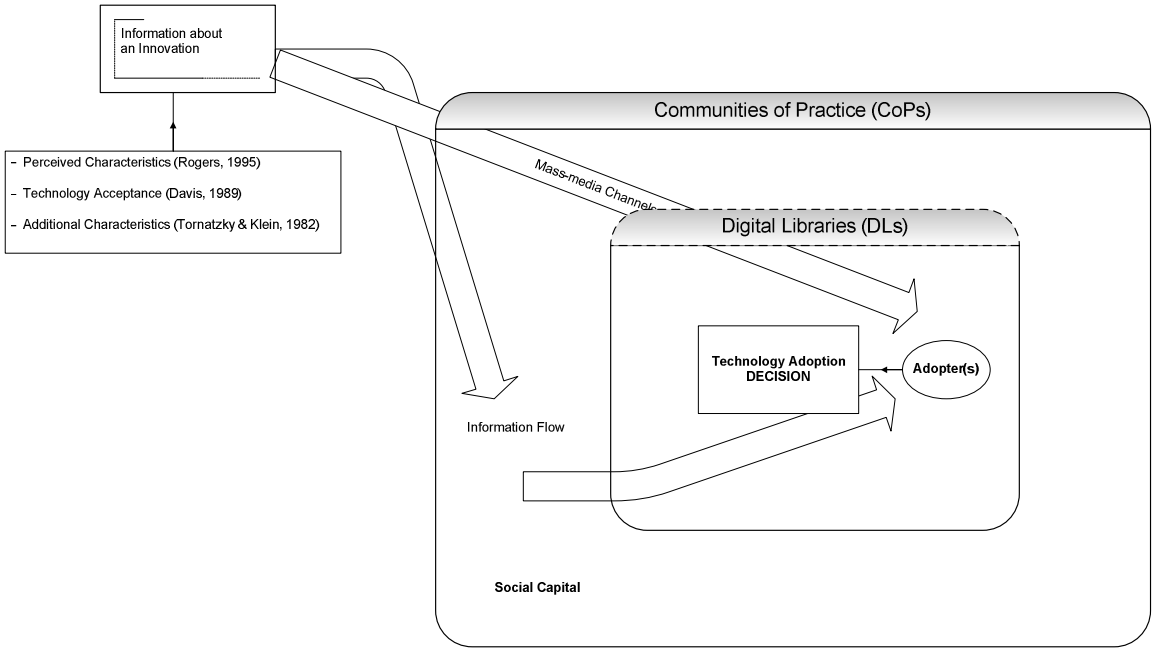
2.5.8. Summary

This section identified and discussed the important aspects of WS technologies. In addition, current use of WS technologies in DLs was discussed. The major strength of WS is its reliance on XML. Given the characteristics of WS technologies and current use in DLs and e-commerce, WS may play an important role as a technology providing interoperable standards-based access to DLs.

2.6. A Conceptual Framework for the Study: Technology Adoption Decision in the context of Digital Libraries

Figure 2.10 provides a brief summary of relationships among the theoretical frameworks employed in this research and the case study of WS technologies adoption decision in the context of DLs.

*Figure 2.10.* A conceptual framework: technology adoption decision in the context of DLs.

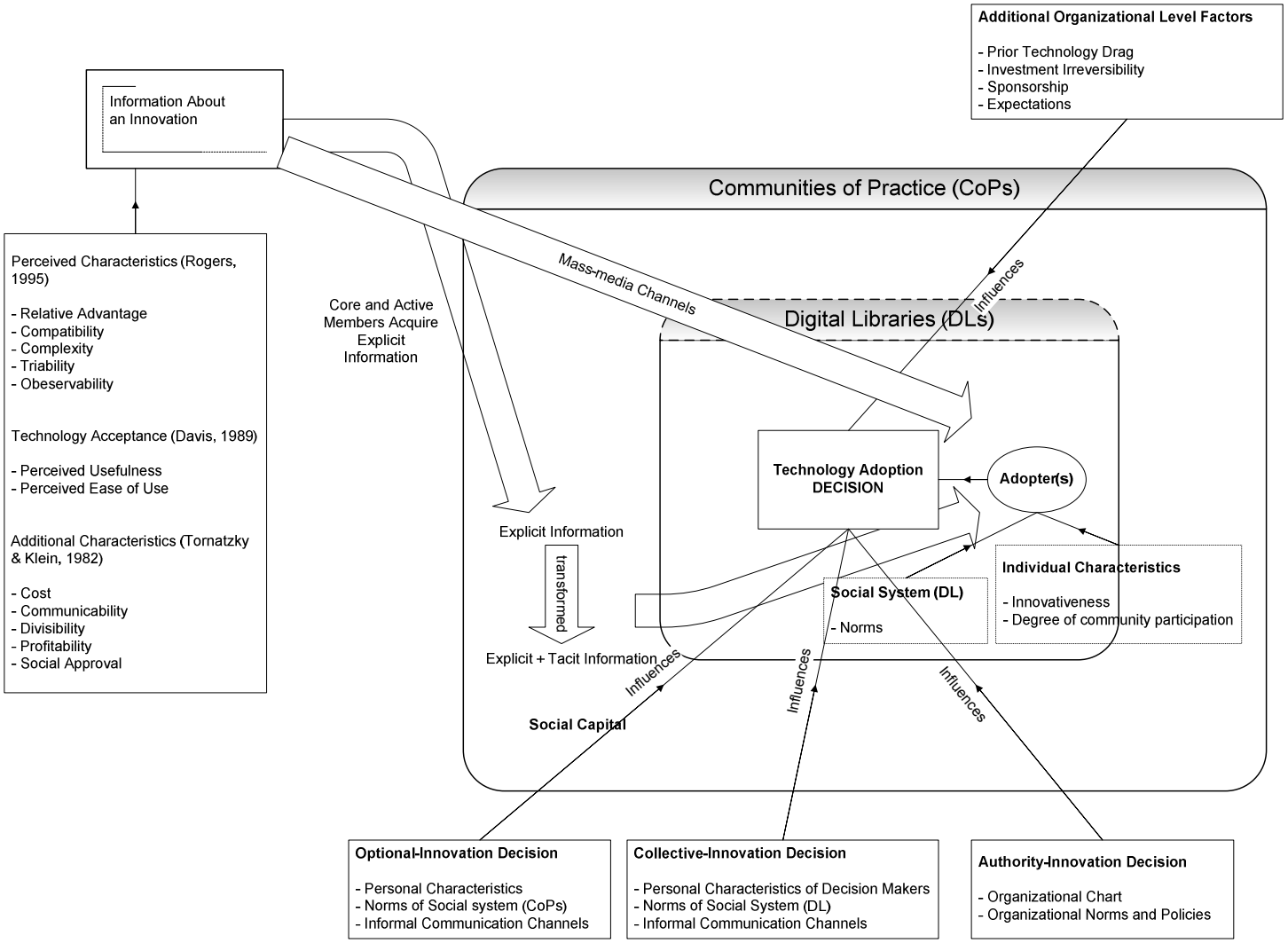


As shown in Figure 2.10, potential adopters may acquire information about an innovation through formal (e.g., mass media) and informal (e.g., inter-personal) communication channels. The information acquired through these channels may include perceived characteristics of an innovation that may play a key role as decision factors in the decision-making process. This study does not assume that decision makers in DLs belong to a CoP. Based on the given features of CoPs and the interdisciplinary nature of DL research suggest that some social groups in DLs can be characterized as CoPs.

Rogers (1995) identifies three types of innovation decisions which are optional, collective, and authority innovation decisions. The optional-innovation decisions are made at individual level and they are made under the influence of personal characteristics of individual, norms of the informal social system that he or she is a part of, and informal communication channels including CoPs and interpersonal communications. In addition, the potential adopter may obtain information about the innovation through mass media channels and CoPs. However, the degree of participation and innovativeness of the adopter are important factors influencing the adoption decisions. For example, core and active members of a CoP who resemble innovators and early adopters are more open to adopt new technologies as opposed to ones on the sidelines and outside of a CoP who resemble late adopters and laggards in terms of adoption characteristics. The characteristics of the innovation play a critical role when making adoption decision. These early adopters, including innovators of a CoP, nurture and put the explicit information that they received through mass media channels into application and then enrich the explicit information with their experiences and feedbacks. Figure 2.11

provides a detailed view of the conceptual framework including these potential factors that may influence technology adoption decisions in DL.

*Figure 2.11.* A conceptual framework in detail.



Collective and authority innovation decisions are common in organizations. Authority-innovation decisions are made by relatively a few individuals who possess power, status, or technical expertise and compliance and compatibility of decisions with existing organizational (i.e., academic library or DL) rules, policies, and norms are significant factors affecting the decision. In addition, prior technology drag, sponsorship, investment irreversibility, expectations, and perceived characteristics of innovations are taken into consideration when making authority-innovation decisions. In collective-innovation decisions, information acquired through informal communication channels is taken into consideration when making decisions since the decisions are made through consensus among members of a social system (i.e., DL).

The decision-making process involves characteristics of the technology (e.g., relative advantage, cost) that will be adopted, dynamics of community-wide adoption (e.g., critical mass, sponsorship, and adopter expectations), and organizational policies along with the personal characteristics of decision-makers. In this sense, Rogers' DOI model with contributions from organizational level of IT adoption (Daft, 1978; Davis, 1989; Swanson, 1994; Tornatzky & Klein, 1982) and CoPs provide a valuable framework to assess the decision-making process with a case study of the WS adoption in DLs.

## 2.7. Summary of Literature and Implications for the Study

DLs were envisioned as network-accessible repositories a decade ago; now they are transforming the information landscape by improving and changing the means of knowledge access, creation, use, and discovery across disciplines (Larsen & Watctlar, 2003). However, the development and widespread deployment of more intelligent knowledge environments that not only support scholarly inquiry and communication but

that are open, accessible to all, and transparent in their operation remains as a fundamental challenge for DL practitioners and researchers. The DLs have features and services impossible in traditional brick-and-mortar libraries.

As technologies rapidly change the information landscape is transformed, DLs find themselves dealing with the issues of technology adoption decisions to exploit this dynamically changing technology environment to meet their users' needs and expectations. Therefore understanding the decision-making process regarding adoption of WS technologies in the context of DLs is important.

# CHAPTER III

# METHODS

## 3.1. Introduction

This study employed a qualitative case study design that supported the exploratory and descriptive nature of the research. This research attempted to explore and describe factors, activities, processes, and forces involved in the decision-making process to adopt or reject the use of Web services (WS) technologies in digital library (DL) environments and contributions of Communities of Practice (CoPs) as informal communication channels to this process. The study used the case study of decision-making related to WS technologies in the context of DLs as a method of investigation to understand the decision factors related to technology adoption.

This chapter discusses the research strategy, data sources and collection activities, data management and analysis, credibility and trustworthiness of the study and limitations that qualify the study's findings.

## 3.2. The Research Strategy: Qualitative and Case Study

The research strategy consisted of two components: a qualitative methodology and a case study. This strategy provided a framework of methods and data that would yield answers to the three research questions:

RQ1. What are the key decision factors that lead decision-makers to adopt or reject WS in the DL environment?

RQ2. What are the activities, entities, processes, motivations, and forces that influence the decision to adopt or reject WS technologies in the DL environment?

RQ3. What are the roles played by CoPs as informal communication channels on WS adoption decisions in the DL environment?

The following sections discuss the qualitative methodology and case study components of the research strategy.

### 3.2.1. Qualitative Research

Patton (2002) suggests that qualitative methods "permit inquiry into selected issues in great depth with careful attention to detail, context, and nuance" (p. 227). A qualitative approach facilitated an in-depth and detailed study of decision-making process related to WS adoption while acknowledging the complexity of social processes involved in decision-making.

The exploratory and descriptive nature of the study justified the use of a qualitative research approach that allows discovery and description of the social processes involved in decision-making. In addition, the following identifies some basic characteristics of a qualitative study and their relationship with this research (Creswell, 1994).

- *Research was descriptive*: Qualitative research focuses on identifying and describing a phenomenon in great detail and in the language of respondents (Patton, 2002; Trochim, 2002). Qualitative data "capture and communicate someone else's experience of the world in his or her own words" (Patton,

2002, p. 47). The research aimed to describe the decision factors regarding adoption of WS technologies in the context of DLs.

- *Research focused on the process that is occurring*: Qualitative research is concerned with complexities and dynamics of the process. This study focused on what type questions about the decision-making process to adopt or reject WS technologies in DL environments such as: What are the activities, entities, processes, motivations, and forces that influence the decision as to adopt or reject WS technologies in DL environments?
- *Research focused on respondents' perceptions and experiences*: Adoption of an innovation is a social process. The literature review revealed a number of innovation characteristics, organizational factors, and informal communities that play critical roles in shaping and influencing decision-makers' perceptions, values, and experiences with an innovation. Since the research was exploratory and descriptive in nature, the respondents' points of view, perceptions, and their thoughts about what is happening and their experiences needed to be revealed without predetermining those points of view to understand adoption and innovation and the decision-making process.
- *Research had an interpretive character*: Any social phenomenon has different meanings and those meanings are constructed by the individuals who experience them (Hoepfl, 1997). The researcher attempted to make sense of the data while preserving perspectives and meanings of the respondents to explore and describe the nature of motivations, activities, forces, and processes involved in decision making and draw conclusions. Interview data,

documentary evidence, and member check data were interpreted to reflect the phenomenon from respondents' perspectives and to foster understanding of the phenomenon.

- *The research process was inductive*: Discovering patterns, themes, and categories in the collected data is referred to as inductive analysis (Patton, 2002). Inductive analysis was used to sort the data into codes, codes into categories, and categories into themes. As the researcher interacted with the data, findings emerged out of data. Thus exploring and discovering common patterns, themes, and categories in the data to develop an understanding about the phenomenon reflected an inductive approach. The researcher established links between the research objectives and findings derived from the data (see Chapters II and V). Further, the researcher revised the preliminary conceptual framework based on the findings which reflected motivations, activities, forces, and processes found in the raw data.

Although quantitative methods have been predominant in information technology (IT) adoption research (Choudrie & Dwivedi, 2005), this study aimed to develop a better understanding of decision factors influencing adoption of WS technologies in the context of DLs. However, the research questions used what type questions to explore and describe decision factors as opposed to quantitative approach which uses why type of questions to compare groups or build relationships between identified variables (Creswell, 1994). Thus qualitative methods are more appropriate in situations where quantitative methods are not able to provide the depth and detailed description and understanding of the phenomenon.

### 3.2.2. A Case Study

Marshall and Rossman (1999) suggested that "studies focusing on society, and culture, whether a group, a program, or an organization, typically espouse some sort of case study as an overall strategy" (p. 61). This qualitative study used the adoption of WS technologies in DL environments as a case study to explore and describe factors, activities, processes, and forces involved in the decision-making process.

A case study approach aims at describing a phenomenon "in depth and detail, holistically, and in context" regardless of the unit of analysis as opposed to providing an empirical generalization from a sample (Patton, 2002, p. 55). Yin (1994, p. 13) described a case study as an empirical inquiry that:

- Investigates a contemporary phenomenon within its real-life context, especially when
- The boundaries between phenomenon and context are not clearly evident.

The decision-making process in DLs is a complex social phenomenon where a number activities, entities, processes, motivations, and forces at play. Yin (1994, p. 3) argued that "the need for case studies arises out of the desire to understand complex social phenomenon" and case study allows "an investigation to retain the holistic and meaningful characteristics of real-life events" where phenomenon and its context are not always perceived and studied separately as opposed to quantitative approaches (e.g., experiments and surveys). A qualitative case study approach allowed the exploration of the decision-making process to adopt or reject WS technologies as a complex social phenomenon.

The lack of scientific generalizability is a common drawback of a single-case study (Yin, 1994), since the sample population does not represent the whole population. This study did not intent to provide an empirical generalization from a sample to a population but to understand and describe a complex social process from purposefully selected respondents who are knowledgeable about the area.

## 3.3. Research Design

This study employed a case study, qualitative research approach to collect and analyze data to answer the study's three research questions. In-depth information about this complex social process involving decision-makers was acquired through semi-structured interviews and documentary evidence (e.g., meeting minutes and reports). The interview respondents and academic libraries that they are associated with were selected based on specific criteria.

First, the researcher conducted an extensive literature review in the areas of diffusion studies, CoP and social learning, DLs, and XML based technologies, specifically WS (see Chapter II), and incorporated his own knowledge and expertise in these areas into the study design.

Semi-structured interviews allowed the researcher to explore the decision-makers' perspective, which yielded very useful information to understand and describe the phenomenon. The interviews served as the primary source of data. Semi-structured interviews use a set of pre-established questions that serve as a guide during the interview session. The interview guide ensured that same questions were asked of all respondents, yielding data that focused on the research questions. This interview technique enabled the researcher to acquire more and detailed descriptions about the phenomenon by allowing

respondents' individual perspectives and experiences to emerge when interviewing (Patton, 2002). In contrast to semi-structured interviews, structured interviews may overlook some key information since they typically do not allow the researcher to explore comments from the respondents for further clarification or to allow new topics to be discussed. Semi-structured interviews are a good technique where it is important to allow new information, ideas, and perceptions to emerge in the course of the interviews. ("Interviews: How to conduct them," n.d.). Respondents and DL programs were selected based on their distinctive characteristics (see Appendix C for the list) in terms of the current status of the decision (e.g., adopt, reject), role (e.g., designer, manager), experience, and size of the program to maximize sample variation.

Secondly, documentary evidence was incorporated to complement the interview data and provide additional insights and clarifications. Documentary evidence included wide range of documents from websites of the DL programs to publications and presentations [co]-authored by respondents.

Further, a comprehensive member check was conducted which allowed the researcher to obtain additional information from respondents and to have study findings reviewed by them.

The qualitative approach as opposed to quantitative studies generally focused on relatively small samples selected purposely. Purposeful sampling allows the researcher to select individuals to interview who are "information rich" with respect to the goal of the research, which in turn yields "insights and in-depth understanding" about the phenomenon "rather than empirical generalizations" (Patton, 2002, p. 230). Purposeful sampling enabled the researcher to learn about the phenomenon in detail from others'

perspectives by having relatively a small number of respondents who had special knowledge and perspectives about the case (Gall *et al.*, 1999).

The credibility and trustworthiness of a qualitative case study are very important considerations for the researcher since credibility and trustworthiness help "persuade his or her audiences (including self) that the findings of an inquiry are worth paying attention to, worth taking account of" (Lincoln & Guba, 1985, p. 290). Patton (2002) suggested that "the validity, meaningfulness, and insights generated from qualitative inquiry have more to do with information richness" (p. 245). Section 3.6 describes the activities used to improve the credibility and trustworthiness of the study by the researcher.

## 3.4. Data Sources and Data Collection Activities

Interviewing enabled the researcher to acquire information about another person's perspective and to collect information from them about the phenomenon that the researcher cannot directly observe (Patton, 2002). In addition, documentary evidence including meeting minutes or reports that reflected opinions or declarations about decisions made were requested from respondents. In addition, presentations and publications (co-)authored by respondents and DL programs' web sites were also included in the documentary evidence. The documentary evidence was used to complement and clarify certain points in the interview data and to validate and support respondents' statements.

### 3.4. 1. Semi-Structured Interviews

Interviews allowed the researcher to collect data through direct interaction with individuals being studied (Gall *et al.*, 1999). Interviewing aimed to "capture how those being interviewed view their world, to learn their terminology and judgments, and to

capture complexities of their individual perceptions and experiences" (Patton, 2002, p. 348). Yin (1994) argued that interviewing was one of the most important data collection source for a case study since "most case studies are about human affairs" (p. 85).

The researcher developed an interview protocol (see Appendix D) to guide semi-structured interviews with respondents. The University of North Texas (UNT) Institutional Review Board (IRB) examined and approved the study for the use of human subjects (see Appendix E for the IRB approval letter). The researcher conducted interviews with eight individuals at five different DL programs across the country including managers, coordinators, and developers who were involved in DL related projects and participated in the decision-making process to adopt or reject WS technologies. One of the interviews was not included in the analysis (see Chapter IV) because of respondent's higher administrative status and he/she was not able to provide answers for WS adoption decision process. However, his/her responses corroborated another respondent from the same program in terms of administrative influence in decision-making processes and work structure of the program.

Purposeful sampling, specifically maximum variation sampling, was employed when selecting key informants who had the best knowledge, expertise, and overview about the topic of the research (Patton, 2002; Varkevisser *et al.*, 2003). The maximum variation sampling aimed at "capturing and describing the central themes that cut cross great deal of variation" (Patton, 2002, p. 234).

The respondents were from DL programs at the California Digital Library (CDL), University of North Texas (UNT), University of Texas at Dallas (UTD), University of Texas at Austin (UT Austin), and a university in the American Southeast (ASE). The

respondent who did not want to have the name of the DL program disclosed described the program as a member of Association of Research Libraries (ARL) in the American Southeast. Some of the participating libraries are members of various influential organizations in the DL field including Digital Library Federation (DLF), ARL, and Coalition for Networked Information (CNI). Table 3.1 shows the number of respondents from each participating DL program and membership of these university libraries/DL programs' membership in non-profit organizations in the field (see Appendix C for detailed information).

Table 3.1
Participating DL Programs, Number of Respondents, and Membership Status in Nonprofit Organizations in the Field

| DL Programs | Number of Respondents | DLF | CNI | ARL |
|---|---|---|---|---|
| CDL | 1 | Yes | Yes | No |
| UNT | 2 | No | Yes | No |
| UTD | 2 | No | No | No |
| UT Austin | 1 | Yes | Yes | Yes |
| ASE* | 1 | No | Yes | Yes |

* signifies the undisclosed DL program

During the interviews, the researcher asked questions to explore and understand respondent's perception of the phenomenon without imposing any of the researcher's perceptions which contributed to reliability and reduced bias (Marshall & Rossman, 1999). Furthermore, Patton (2002) argued that "collecting the same information from each person poses no credibility problem when each person is understood as a unique

informant with a unique perspective" (p. 347). In addition, semi-structured interviews followed an interview guide which facilitated analysis and organization of data by making responses easy to find and compare while allowing the researcher to pursue related topics or issues with respect to the topic that were not anticipated when the interview guide was developed (Gall *et al.*, 1999; Patton, 2002).

The researcher conducted a set of preliminary interviews to pretest the interview instrument. Interview questions were refined, reworded, and reordered as suggested. The pretest ensured all the interview questions were understandable by respondents while allowing them "to respond in their own words and to express their own perspectives" (Patton, 2002, p. 348) and the resulting data relevant to the research questions.

3.4.1.1. Characteristics of the Digital Library Programs

Specifically in academic libraries, digital library projects and initiatives of various library departments were likely to be coordinated and managed under a digital library program. However, the terms DLs , DL programs, and DL projects are used synonymously in the literature to refer to such units (Greenstein & Thorin, 2002; Samuel *et al.*, 2005). In addition, all respondents worked in what are called DL programs (Greenstein & Thorin, 2002). DL programs are generally managed as separate departments, initiatives, or units within the academic library. The CDL differed from other DL programs participating in this study because it is "a library in its own right" (Greenstein & Thorin, 2002, p. 3). In the context of this research, the term of DL programs was used to refer to these departments, units, or structures such as CDL.

Greenstein and Thorin (2002) conducted a study to investigate how digital library programs of the Digital Library Federation (DLF) member libraries were initiated,

influences that shaped the development, current status of programs and funding, and expected possible challenges. They identified, based on survey data, several characteristics DLF member DL programs. The researcher used the size and age of the DL program as key criteria when selecting DL programs for this study. The size and age DL program appeared to be important factors influencing DL programs' orientation, as they transform from small scale and experimental structures to more mature ones.

1. *Age of the DL program*: The first DL initiatives began in the 1990s. Age of the DL program was determined based on the year when the first DL project was started. Greenstein and Thorin's (2002) study suggested that as DL programs get older and more mature, they transform from an experimental and small scale initiative to a more operational one. They make informed decisions regarding their focus and orientation, relationships with surrounding academic units and others, and organization of the program. Table 3.2 shows the list of DL programs participating in the case study and when the first DL project started in these programs (see Appendix C for additional details in the five DL programs participating in this research).

Table 3.2

Initiation of First DL Projects at Participating DL Programs

| DL Programs | Year |
|---|---|
| CDL | 1997 |
| UNT | 1997 |
| UTD | 2003 |
| UT Austin | 1992 |
| ASE* | 2002 |

*signifies the undisclosed DL program

2. *Orientation of the DL program*: Orientation refers to the focus of the DL program. UNT, UTD, and ASE primarily focused on digitizing existing documents in their collections and providing online access to them. Some focused mainly on "providing systems environments and infrastructure capable of managing digital assets as may be acquired or used within the host institution" (Greenstein & Thorin, 2002, p. 2) while engaging in digitization activities (e.g., CDL and UT Austin).
3. *Organization of the DL program*: The organization of the program referred to the organizational form in terms of management style and structure of the program. The CDL is considered to be a confederal organization because other libraries contribute to the DL (e.g., content). Although CDL was initiated and hosted by the University of California system, CDL was "a library in its own right" (Greenstein & Thorin, 2002, p. 3).

4. *Relationships with surrounding academic departments and units*: This relationship refers to closeness of the DL to other departments or schools (e.g., Library and Information Sciences [LIS]) and units (e.g., IT department) in terms of sharing resources and experiences. All participating DL programs had access to IT department resources available on campus. However not all DL programs had access to LIS departments at their institutions. Table 3.3 shows the list of participating DL programs with LIS departments or schools at their institutions.

Table 3.3
Participating DL Programs and LIS

| DL Programs | LIS dept./school on campus |
|---|---|
| CDL | Yes |
| UNT | Yes |
| UTD | No |
| UT Austin | Yes |
| ASE* | No |

The researcher used these distinctive characteristics to select the DL programs. Interview participants were selected from these DL programs based on criteria discussed in the previous section to maximize the sample variation.

3.4.1.2. Respondents

As discussed in Chapter II, the most popular off-the-shelf and custom-built DLs have been developed and released by the institutions of higher education where partnership among several disciplines (e.g., computer science and information sciences)

and academic libraries have made great contributions to the field in the past and continue to lead, shape, and contribute to the field. Such institutions relied heavily on external funding to continue to maintain existing DL projects and to initiate new ones, which require them to compete to secure funding. This process fueled the innovation and creativity in the field (Greenstein & Thorin, 2002). Because of the important roles of academic libraries in DL development efforts, the researcher developed a list of potential interview candidates associated with academic libraries and new candidates were added to the list as respondents suggested other potential candidates. Selection criteria for interview candidates included:

- Extent of knowledge of WS technologies (e.g., did the individual have any information about the advantages and disadvantages of WS and applicability of WS to DL environments)
- Participation in decision-making process to adopt or reject WS technologies (e.g., did the individual have any influence on the decision-making process to adopt or reject WS, was the individual a part of the decision-making process)
- Affiliation with academic libraries in institutions of higher education.

The selected respondents were contacted via email, phone, or face-to-face and asked if they would consider participating in this study. Upon their approval, the Interview Protocol (see Appendix D) and brief information about the research were provided for their reference. Appointments were arranged both through email and by phone. The purposeful sampling brought together six males and one female from five DL programs. Respondents' professional ranks ranged from assistant dean for digital and information technologies to library systems programmer. In terms of their responsibilities, three of

them were in administrative positions (e.g., assistant dean for digital and information technologies), another three held technical positions with administrative responsibilities (e.g., digital projects manager), and one of them was a programmer. Years of experience of the respondents with DL library related projects ranged from eleven years to as low as a year and a half and overall average years of experience were approximately seven years. Some of the respondents were responsible for initiating DL projects in their institutions. The researchers already knew some of the respondents personally and others were contacted with the help of a faculty member at School of Library and Information Sciences at UNT.

The researcher contacted respondents several times prior to interviews in person and through email and asked respondents whether they were knowledgeable about WS and participated in the decision-making. Three respondents were from DL programs where WS were already adopted and in use. The researcher assumed that they were knowledgeable and participated in the decision-making because of their responsibilities in their programs. All respondents were provided with information explaining the purpose of the research and WS technologies and they agreed to participate. In addition, interview data confirmed that two of these respondents were knowledgeable about WS and took part in the decision-making process. Data from one interview wasn't included in data analysis because of the respondent's lack of knowledge about WS adoption process and interview didn't yield any specifics about decision factors regarding WS adoption.

Patton (2002) set no rules for the sample size in qualitative inquiry by arguing that "the validity, meaningfulness, and the insights generated from qualitative inquiry have more to do with the information richness of the cases selected and the

observational/analytical capabilities of the researcher than with sample size" (p. 245). The researcher stopped conducting interviews when data saturation was reached to meet the research goal, that is, to understand and describe decision factors related to technology adoption (Hoepfl, 1997). Data saturation is defined as the point in a data collection process where new information becomes redundant (Bogdan & Biklen, 1992). The researcher started to notice certain themes (see Chapter IV) appear consistently (e.g., management style and structure of the DL program, focus and orientation of the DL program, and participation in communities) as he completed the fourth interview. When the following two interviews appeared to be consistent with the earlier ones, the researcher decided to cease the data collection process through interviews. Guest *et al.*'s (2006) findings suggest that six to twelve interviews could be enough to meet research objectives where purposeful sampling is carefully carried out to include information rich individuals.

All of the interviews were digitally recorded with respondents' permission. They were also asked for permission to use direct quotes from the interviews. To protect their privacy, their names are not disclosed with direct quotes or paraphrases of their words in Chapter IV. The researcher transcribed the verbatim from recorded interviews and had respondents review and approve transcripts. Although verbatim transcription was done, the member check process was important in terms of allowing respondents to correct acronyms, offer additional information, and make minor corrections and establishing credibility as suggested by Lincoln and Guba (1989).

### 3.4.2. Documentary Evidence

Yin (1994, p. 81) argued that "the most important use of documents is to corroborate and augment evidence from other sources" for case studies. Documentary evidence served as a secondary data source and was used to validate and complement the interview data. Using WS technologies, as a case study, that is in its early stages of adoption in DL field reduced the level of recall error in the interview data. However, the challenge of obtaining complete and reliable information from interview respondents about an innovation that was adopted or rejected in the past remained. Some respondents could not remember when they first heard about WS. Although the researcher requested respondents to provide documentation such as meeting minutes and reports relevant to decision-making process involving WS technologies, not all did. The key criterion for selecting documentary evidence was its authority (e.g., official reports, meeting minutes, official DL program websites, or papers [co-]authored by respondents). A document's relevance to decision-making process and/or WS adoption was secondary criterion. The researcher collected some of the documentary evidence from DL programs' websites, publications or presentations (co-)authored by respondents, and grant applications and in some cases those documents were older than three years or were not related with the decision-making process (see Appendix F for the list of documentary evidence).

### 3.4.3. Comprehensive Member Check

Lincoln and Guba (1985) states that purpose of comprehensive member check is "not only to test for factual and interpretive accuracy but also to provide evidence of credibility - the trustworthiness criterion analogous to internal validity in conventional studies" (p. 373). This final verification process allowed respondents to evaluate the

researcher's interpretation of findings and analysis of data from their perspectives (Lincoln & Guba, 1985; Patton, 2002). Following Lincoln and Guba's guidelines each respondent was provided with a list of research findings with brief explanations in the form of a web page and asked to comment on them. This web page also included an information packet consisting of latest drafts of Chapter IV, Results and Findings, and Chapter V, Discussions and Conclusions, at the time of the study for their reference in case more information was needed (see Appendix G for the comprehensive member check document). The researcher made follow-up calls and emails to make sure all respondents responded.

3.5. Data Management and Analysis

The interview data were analyzed using inductive analysis, which included processes of finding important themes and patterns in the data that can be used to explain the phenomenon (Gall *et al.*, 1999). In general, qualitative data collection methods can generate massive amount of data, and making sense of large amounts of textual data becomes an important challenge (Patton, 2002). The researcher used the following set of procedures to code and categorize the interview data for interpretational analysis as suggested by Gall *et al.* (1999):

1. Prepared a data repository to store interview data
2. Numbered each line of text sequentially then divide into meaningful segments
3. Developed meaningful categories to code the data
4. Coded each segment by any and all categories that apply to it
5. Cumulated all coded segments by a given category

The researcher continuously reviewed and revised “the category scheme until all the data could be classified within the scheme with no redundancy of categories” to “clarify the meaning of each category, create sharp distinctions between categories,” and reveal the most important categories to the case study (Gall *et al*., 1999, p. 299).

Documentary evidence provided additional and clarifying information supplemental to the data collected through interviews. Further, a comprehensive member check was conducted to ensure study findings reflected respondents’ perceptions and opinions. This process also allowed respondents to provide additional information, however the member check process did not result in substantial additional information.

### 3.5.1. Analysis of Semi-Structured Interviews

Digitally recorded interviews were transferred to a computer and transcribed verbatim using Transcriber software program ("Transcriber," 2005). Later, the transcribed interview data were entered into the Atlas.ti software program. This program was used to store and facilitate the analysis of the transcribed interview data including segmenting transcripts into smaller pieces and defining codes and categories ("ATLAS.ti," 2005). The networking feature of the software allowed the researcher visually connect the codes, categories, and their descriptions to provide an audit trail for the analysis. An audit trail is a documentation of the research process and representative samples of this documentation included as figures (Figures 3.1 and 3.2) and appendixes (Appendixes D, G, H, F) in this chapter. As Patton (2002) suggested the qualitative analysis software programs do not analyze data but “facilitate data storage, coding, retrieval, comparing, and linking” (p. 442). The researcher was responsible for the analysis, coding, and categorization.

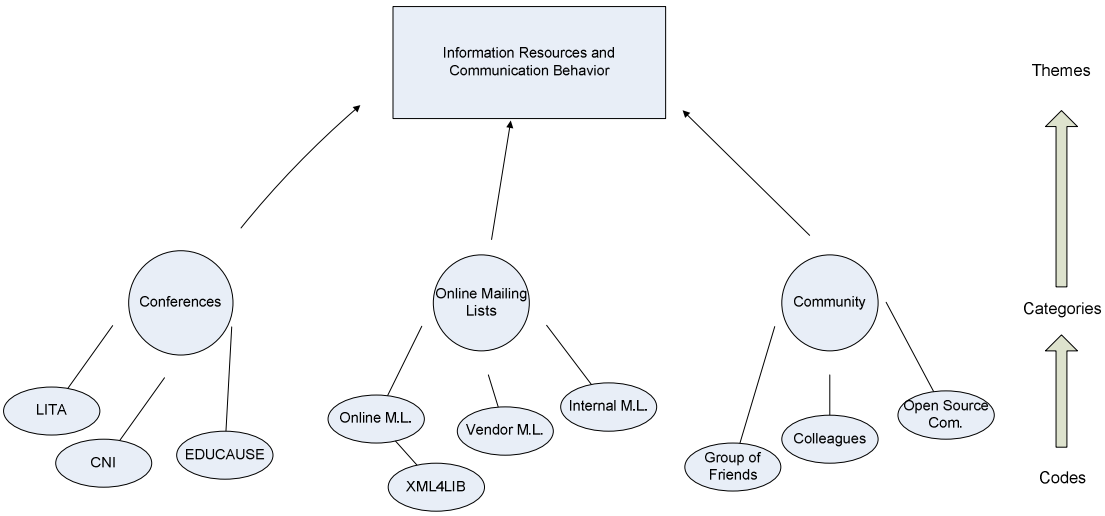
Patton (2002) also argued that "qualitative analysis is typically inductive in early stages, especially when developing codebook for content analysis" (p. 453). The process of reducing the qualitative data and evaluation of discovered categories, patterns, or themes in respondents' answers is characterized as content analysis (Patton, 2002).

Data coding is an important part of qualitative data analysis process to "organize and make sense of textual data" (Basit, 2003, p. 143). Development of coding categories was guided by research questions of the study (Neuman, 1991). The coding or labeling process began when the researcher started pre-testing the interview protocol. The researcher took notes (key phrases, terms) during the interviews, and these notes were used when data were analyzed, and they were helpful to develop meaningful coding categories.

After loading the interview data into Atlas.ti, the researcher read through transcripts. A word frequency count was performed to look at most commonly occurring keywords; these provided a set of possible codes or coding categories that could be used in the analysis such as conferences and manpower. Although interviews were semi-structured, the researcher generally maintained the order of questions during interviews. The coding process involved constant revisions and reviews. Following Newman's (1991) guidelines, the researcher performed an initial pass by coding answers to each question from interviews. In this phase, the researcher assigned code(s) to words, sentences, or paragraphs. Codes are labels or abbreviations assigned to certain segments of the interview transcripts including phrases, words, sentences, or a whole paragraph (Marshall & Rossman, 1999; Neuman, 1991). Developing themes or coding categories were not the main objective in this phase but rather the focus was to break the data down

to smaller pieces for further revision and analysis. A category or sub-theme is defined as an abstract cognitive structure that represents the meaning of a group of codes (Schumacker & McMillan, 1993). In the context of this research, themes represent a higher level of abstract structures than categories and served as code families for clustered set of categories. Eisner (1991) defined themes as the "recurring messages construed from the events observed" (p. 189). After the initial coding, the researcher performed a second pass through the data and assessed the commonality and differences among all instances of each code. Additional codes also emerged during this process. The researcher looked for categories that could cluster and consolidated codes based on similar characteristics and patterns including causes and consequences, conditions, interactions, strategies, and processes. Such codes were either grouped together under an existing and more general code or assigned a new code that would represent a set of codes. On the other hand, some codes were divided into sub-codes. The researcher organized all codes into a structure by separating them into major codes and sub-codes. Themes started emerge from the data. The researcher identified the major codes, categories, and themes that represented the data best. The process of developing themes from categories and categories from codes is schematically represented in Figure 3.1.

*Figure 3.1.* Theme building process.

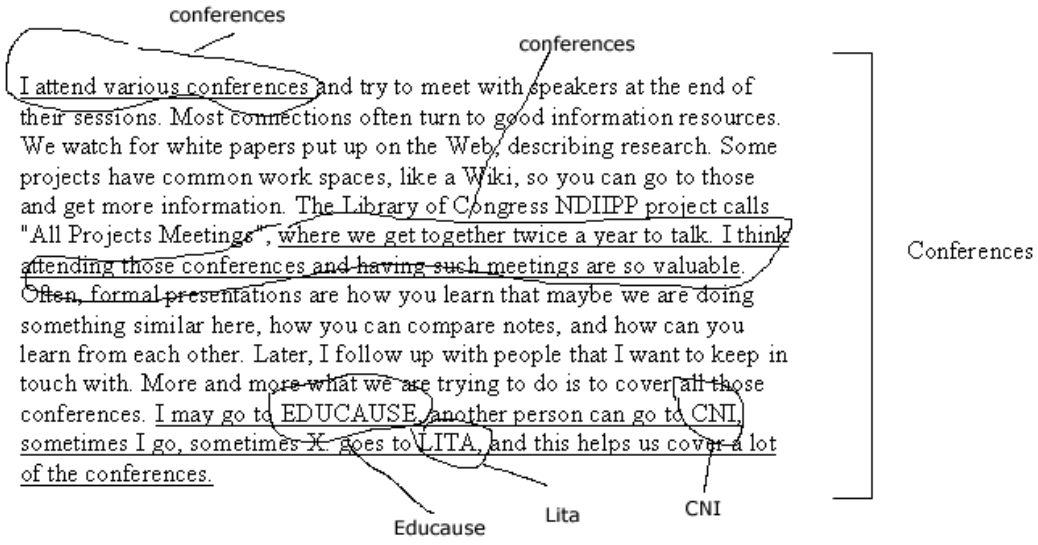



Adapted from Eisner (1991).

Lastly, the researcher performed a third and final pass through the data and reviewed major themes and categories. The researcher looked at connections between size and age of a DL program and themes such as management style and structure. Major themes guided the analysis. Themes were reorganized and several new themes were developed. For example, one of the major themes was the information resources and communication behaviors, and the researcher developed another theme which specifically addressed characteristics of these information resources to understand forces and motivations that led the respondents to venues discussed in the original theme.

The Atlas.ti software was used when coding interview transcripts to accelerate this process. The list of codes was collected in a codebook (see Appendix H) and it was revised continuously to ensure assigned codes and categories reflected the themes found in interview transcripts. Figure 3.2 illustrates a sample coded segment of the interview data where EDUCAUSE, LITA, CNI, and conferences were labeled as codes. Later all of these underlined segments were marked as a category called conferences.

*Figure 3.2.* Sample coded segment of interview data (codes and categories).




To improve the reliability of coding process, the researcher contacted another individual with coding experience who reviewed the coded interview transcript. This review process was informal and no major modifications were suggested. Since the researcher was the only person who coded all the data, an intercoder reliability testing was not performed. Intercoder reliability testing measures the level of agreement between multiple coders in terms of their application of codes to data (Kurasaki, 2000).

3.5.2. Analysis of Documentary Evidence

Some documentary evidence was provided by respondents in electronic format. The rest was collected by the researcher from participating DL programs' and academic libraries' websites. Papers and presentations [co-]authored by respondents were collected from official websites of various conferences. Collected documentary evidence had a high credibility since they included official reports, meeting minutes, DL programs' official websites, grant applications, and papers [co-]authored by respondents. Documentary evidence amounted to approximately 200 pages. All the documentary

evidence was kept in paper format and assigned with particular identification numbers linking them to the interview data collected from same DL program.

The documentary evidence from each location was chronologically ordered and examined in connection with the interview transcripts. While developing the chronology, the researcher examined the documents in detail. Specifically, meeting minutes and reports as documentary evidence provided complementary information regarding the decision-making process in terms of participation and administrative role in the process. DL programs' websites were used in understanding the hierarchical structure in these programs and in developing demographic information of participating programs. Grant documents and papers and presentations [co-]authored were specifically helpful in further understanding the technological benefits offered by WS. Salient points from documentary evidence are included in Chapter IV. Although the amount of documentary evidence was limited, it complemented the interview data. A sample list of documentary evidence is available in Appendix F.

### 3.5.1. Analysis of Comprehensive Member Check

The researcher compiled a list research findings based on the results of interview data and documentary evidence analysis presented in Chapter IV. A list of study findings was developed after the completion of Chapter IV and sent to respondents via email. This email contained a link to comprehensive member check web form (see Appendix G). The form included brief explanations for findings along with links to the draft results and findings sections of the study. The researcher approached the analysis of comprehensive member check from verification of study findings perspective. Responses from respondents were collected and a table of responses for each finding was created to

compare them easily. Further, these responses were also compared against interview transcripts to identify discrepancies if any. Additional information collected through this process has been incorporated into relevant sections of Chapters IV and V.

### 3.6. Credibility and Trustworthiness of the Study

Lincoln and Guba (1985) addressed the notion of trustworthiness with a simple question: "How can an inquirer persuade his or her audiences that research findings of an inquiry are worth paying attention to" (p. 290). Gall *et al.* (1999) argued that case study methods and findings should not be judged by the criteria of validity, reliability, and generalizability which imply a quantitative research methodology. Instead, they suggested that case studies employing a qualitative approach, as in this study, should "use criteria that are meant to demonstrate the credibility and trustworthiness of their findings and methods" (Gall *et al.*, 1999, p. 303). The qualitative approach allowed the researcher, research participants and readers to have "their own unique interpretation of the meaning and the value of a case study" (Gall *et al.*, 1999, p. 303). Further, Gall *et al.* (1999) suggested a set of criteria and grouped them into three main categories to judge the credibility and trustworthiness of a qualitative case study:

- Sensitivity to readers' needs
- Use of sound research methods
- Thoroughness of data collection and analysis.

In addition, applicability of a qualitative case study findings and conclusions to the reader's his/her own setting contributes to trustworthiness of the study (Denzin & Lincoln, 1994; Lincoln & Guba, 1985). The following list identifies some of the suggested criteria and discusses how this research addressed them:

1. Sensitivity to readers' needs
    a. *Strong chain of evidence*: The researcher provided the complete documentation of the research process used in the case study. The data sources and methods of recording raw data and analysis processes are discussed in this chapter. The researcher provided an audit trail to make chain of evidence explicit (see Figures 3.1 and 3.2 and Appendixes D, G, H, F). Strong chain of evidence enables the reader to "follow the derivation of the case study findings from the initial research questions and its use in the researcher's interpretations" and contributes to overall validity of the study (Gall *et al.,* 1999, p. 304).
    b. *Usefulness*: The researcher introduced the significance of the study in Chapter I. The researcher's experience in the DL field enabled him to collect data from individuals who yielded detailed information about the phenomenon contributing to the usefulness of the research.
2. Use of sound research methods
    a. *Triangulation*: This research used multiple data sources and data collection methods to answer the study's research questions and to check findings of the study. This process is called triangulation. The researcher used semi-structured interview data as a primary data source and verified to the extent possible, respondents' answers against collected documentary evidence. The comprehensive member check was carried out at the end of the research to confirm and get feedback on overall research findings from the interview respondents. Collecting data from various sources (i.e., semi-structured

interviews, documentary evidence, and comprehensive member check) and checking them against each other to assess and refine the findings let the researcher triangulate the data sources which in turn enhanced the reliability and trustfulness of the study.

b. *Member checking*: The researcher made interview transcripts available to respondents to review and approve their statements for accuracy and completeness and findings after each interview is completed. Further, the comprehensive member check process allowed respondents to review overall research findings, provide additional input, and make suggestions. The member check was an important process to ensure and researcher's interpretation of the data and findings of the study reflect perspectives held by respondents (Gall *et al.*, 2003).

3. Thoroughness of data collection and analysis

   a. *Contextual completeness*: Qualitative interviews allowed the researcher to learn more about the unit of analysis from respondents' perspectives such as their own experiences and feelings about the decision-making process. The data collected from respondents were rich in terms of tacit knowledge which, eventually, is reflected in the case study findings. Gall *et al.* (1999) argued that case study findings that reflect tacit knowledge are "more complete and, thus credible" (p. 307). Respondents' extensive DL related work experience and scholarly contributions were significant indicators of their state of knowledge.

4. Transferability

The researcher collected data from multiple sources, provided an audit trail, and presented a detailed description of the decision-making process regarding adoption of WS technologies in DLs in Chapters IV and V "to enable someone interested in making a transfer to reach a conclusion about whether the transfer can be contemplated as a possibility" (Lincoln & Guba, 1985, p. 316).

## 3.7. Limitations

The researcher was optimistic about minimizing possible recall errors in this study where adoption of WS technologies in the DL environment was a recent phenomenon. In several instances, however, respondents were not able to remember when they had learned about the technology. Since the study focused on the decision factors rather than identifying adopter categories, this did not pose a significant threat to data collection and analysis activities. However, it might suggest that respondents might have failed to identify some of the decision factors. Yet, respondents were provided with study results and findings and were asked to review them.

The researcher attempted to communicate with several respondents to clarify certain aspects of the interview and carry out member check after conducting the interviews; however these respondents did not reply. Although the interviews were transcribed verbatim, some minor errors such as acronyms might have been included in the data. The documentary evidence was utilized as supplemental to interview data and reduced the need to contact these respondents.

## 3.8. Summary

This chapter discussed the primary components of the study including the research strategy, research design, data collection, management, and analysis. The

rationale that warrants a qualitative case study and possible drawbacks and challenges when conducting this research were addressed. The data collection methods used in this research produced large amount of textual data and various software applications were introduced to organize and accelerate data collection, storage, and analysis processes in this study.

# CHAPTER IV

# RESULTS AND FINDINGS

## 4.1. Introduction

This chapter presents results and findings from data collection and analysis activities. It discusses themes that emerged in the analysis of the data collected during face-to-face and phone interviews with seven decision makers at five different academic libraries' digital library (DL) programs. Documentary evidence available from these DL programs provided complementary and supporting data for the themes. A comprehensive member check process allowed respondents to review findings of the study and make additional contributions.

## 4.2. Themes and Results

During the content analysis of the data collected, the researcher continuously reviewed and revised emerging themes. After the initial identification of major themes, the researcher consolidated a number of themes based on common characteristics as described in Chapter III. Eight themes emerged from the interview data (see Chapter III for additional information about the data collection and analysis, and how the interview questions related to the study's research questions, goals, and objectives). The themes that emerged from the data analysis are:

1. Management style and structure of the DL program
2. Focus and orientation of the DL program
3. Relationship with surrounding academic units and external entities

4. Information resources and communication behaviors
5. Characteristics of information resources
6. Participation in communities
7. Technology adoption decision
8. Factors and Web services

This section addresses each theme through a detailed discussion of the meaning and implication of the theme for the research study. All discussions are based on the data collected through the interviews and the documentary evidence.

4.2.1. Management Style and Structure of the DL Program

The first, and one of the most fundamental themes that emerged from the interviews, focused on the management style and structure of DL programs. This theme was very important in understanding the organizational structures, information seeking behavior of DL staff, and the decision-making process. As discussed in Chapter II, management style and structure of an organization influences the characteristics of decision makers and the decision-making process, the norms of the organization, and the use of formal and informal communications channels by decision makers.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories are:

- *Matrix Structure*: Refers to work structure in place at DL programs that allows participation of individuals from different units or programs in projects.
- *Hierarchical Structure*: Refers to organization of employees at various levels as described in the organization chart.

- *Flat Structure*: Refers to organization of employees with few layers of management structure.
- *Loose Structure*: Refers to flexible management structure which ignores hierarchical distinctions in knowledge sharing and makes temporary employee management possible.
- *Functional Units*: Refers to different units or program areas within a DL program
- *Informal Channels*: Refers to communication mechanisms through which information conveyed.

All academic libraries structured their DL programs as a unit or department as programs grew. Only one of the DL programs was structured as a separate library within a university system. Large DL programs consisted of several functional units or areas such as technology, user services, and digitization. One respondent discussed the size of his/her DL program as having about 80 DL staff and stated: "… [the DL program] is organized into a variety of program areas. One, probably the largest, is technology…There are other large areas such as user services, publishing, building front-end, and preservation," and another respondent described the size of his/her DL program as having over 60 DL staff, and added: "Just a few years ago, we were a small group, [and now] six, seven, or eight years later… we are not only responsible for just Web projects, but responsible for whether somebody's computer works or not. That is broad spectrum of responsibilities." Documentary evidence collected from DL programs' websites (see Appendix F for list of sample documentary evidence) corroborated the interview data in terms of specific information about structure and responsibilities of

these units. It appears that these units were structured as subdivisions and their staff included professional librarians, programmers, student assistants, and a manager or supervisor who oversees the staff within the unit and reports to the DL program administrator. Staffing varied depending on the responsibilities of the unit. One respondent discussed his/her unit in the DL program as having about 30 staff and stated: "In terms of governance… there is a small cabinet [board] that reports to [the University Librarian] including myself, the head of user services, and head of licensed content." Another respondent from a different DL program commented about the governance of the program as having more than one administrator in a unit and mentioned: "Each of the functional units has at least 2 supervisors per unit. They kind of manage the supervision of the unit." The structure of the relatively larger DL programs seemed similar to each other in terms of consisting of several groups or units that have different responsibilities in the program. It appears that the number of these units and their responsibilities varied from one DL program to another as they grew in size.

On the other hand, DL programs that are relatively small in size were structured as a unit or area within the library. Instead of having several subdivisions to handle various tasks within the unit, they had staff with various expertise such as a metadata expert, programmer/database analyst, and web developer. One respondent commented: "… we have myself as the manager and [I] report to the head of ITS [Information Technology Services]. Right below me there would be one programmer who is in charge of doing any modifications to our software or for helping us to write scripts or tools that are needed for managing our data. A.B. is a librarian and our metadata specialist for the library."

The DL programs have executed variety of DL related work activities that were categorized as projects. Supporting comments from different respondents included: "We are establishing [a] large project in the digitization of Latin American materials that are not being digitized by the Google 5 Libraries," and "[The DL] project essentially involves archiving images and attaching metadata to the images." A DL project may involve a number of different internal and external parties. In addition to a number of the DL staff, personnel from various departments of the library, faculty, and experts were generally involved in these projects, which enhanced collaboration. One respondent commented: "… all departments were very eager to get the digital library project live and we had the input from reference people… We had cataloging people involved… the library systems department worked on infrastructure and design of the system." Another respondent from a different DL program added "… my group is composed of three different units to help build collaboration within the IT [Information Technologies] units [including DL program as a unit] in the libraries… Trying to pull those three groups together has been interesting… We have to work together." Additionally, another respondent from a different DL program discussed his/her involvement in DL projects as working together with faculty in the school, as well as with other institutions. He/she went on to state: "I was involved in a lot of cross-faculty, school collaborations, and even inter-university collaborations." Moreover, documentary evidence indicated that some of the DL programs participating in this study have already worked together in various forms. For example, one DL program subcontracted to another for work on certain aspect of project since the subcontracted DL program had the needed expertise. There were also

cases where some of these DL programs applied for external grants and worked on DL development projects as partners.

On the other hand, one respondent from a large DL program acknowledged the need to facilitate communication among these functional units as well as partners involved in DL projects as their program grew in size and stated: "We are going to set up another unit, project management, and that unit will be responsible for enabling communication among various units… this is next step in evolution of management in our library that helps to facilitate the communication process as we grow."

When respondents were asked about the organizational structure of the DL program, all of them made similar comments describing their programs as hierarchically structured. However, the majority of respondents acknowledged that they have incorporated more flexible structures in practice. Representative comments to this by two different respondents were "That [organizational structure in practice] is kind of a loose structure" and "Among the [DL] staff, there is a flat structure." Loose structure was described as having flexibility in hiring temporary employees when needed and neglecting hierarchical distinctions among staff within the unit when sharing knowledge and providing input to ongoing projects. As for flat structure, it was characterized as having staff with different job titles (e.g., database administrator, a network administrator, a web developer), who hierarchically were at the same level. A representative comment would be: "Within that [technology implementation] tier there is a database administrator, a network administrator… Below that tier is a student technician tier…" It appears that these flexible structures exist alongside with the hierarchical structures. One respondent from a different and relatively larger DL program

explained this relationship "…reporting [to project management] is fairly traditional and hierarchical but in practice we are project-based and extensively matrixed. So, most people report on day-to-day basis to project management." It appeared that DL programs adopted a project-driven direction and these projects involved people from different units of the DL programs, as well as from outside of the DL programs. When these characteristics (e.g., project-driven, loose structure, involvement of various units) of management style and structure of the DL programs are accounted for, another significant category in this theme was developed as the matrix work structure incorporated by the DL programs. Documentary evidence (i.e., grant report) from one of the respondent's DL program characterized itself as a matrixed organization that is divided into "functional divisions whose staff and capacities could be combined as appropriate to meet project and program needs." Furthermore, documentary evidence indicated that "… it [the delivery of projects] requires aligned effort across a variety of functional units (e.g., ingest, programming, support services, web design and development, assessment). In this [matrixed] organizational model, communication is paramount." In connection with earlier comments and documentary evidence, it appears that bringing in people from different functional units, not limited to units of the DL programs, provided a social environment where knowledge is exchanged and shared, collaborative work and communication were crucial (see the theme, Relationship with surrounding academic units and external partners, for more information) to meet project and program needs.

The DL programs were organized into a variety of functional units. It appears that matrixed organizational structure positively influenced informal communication and

collaboration among staff in the DL environment. Project-driven foci add another perspective and support this position. Although DL programs are structured in traditional and hierarchical ways, in reality they all encouraged informal communication among staff and incorporated a flexible structure which facilitated collaboration.

Management style and organizational structure, as a theme discussed in this section, provided information that contributes to answering, in part, the second and third research questions. Organizational characteristics and structure, specifically a matrix work structure, appeared to play a central role in knowledge sharing, collaboration, and members' communication behavior in conjunction with other themes (e.g., Focus and orientation of the DL program, Relationship with surrounding academic units and external partners) discussed later in this chapter.

4.2.2. Focus and Orientation of the DL Program

Another important theme that emerged from the interview data was that of focus and orientation of the DL program. This theme was important in understanding the information seeking behavior of the respondents which contributed to the decision-making process as discussed in Chapter II and of characterizing the use of information resources and interaction with others (e.g., other members of the DL program, faculty, and DL communities) as discussed in other themes below. Interview data and documentary evidence suggested that the focus of the DL program was described as the primary line(s) of work carried out by the program and orientation was described as a DL program's direction towards research versus production work.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Production work*: Involves activities and services related to transforming analog materials into digital format and making these materials and born-digital resources available online.
- *Applied research*: Refers to DL programs' research activities oriented towards producing practical solutions for their existing problems.
- *Best practices model*: Refers to learning activities from other DL programs' experiences and successful applications of DL related technologies and standards.

It appeared that these DL programs focused on a number of areas including digitally reformatting analog items (e.g., newspapers, pictures), preserving digital content, providing software and user services, supporting scholarly publishing, and providing access to digital content. Although a majority of the respondents indicated that the digitization of analog items and distributing them online as their programs' primary focus, one respondent from a relatively large DL program stressed "providing [DL related] software services and user services" to other libraries within the university system as a primary focus of his/her DL program and another respondent from a mid-size DL program discussed his/her program mainly focused on "preserving born-digital content" as well as digitization of analog materials.

In addition to digitization and preservation of digital content as focal areas, the majority of DL programs had an interest in emerging areas such as scholarly publishing and multimedia (i.e., audio and video) content. Representative comments from respondents at different DL programs included "Another area would be publishing support services, supporting open scholarly communication and publishing" and

"innovative projects… with regards to [delivering] audio and video [content online]." Another respondent from a different DL program stated their interest in making his/her institution's scholarly output available online and stated "we started to use an institutional repository application."

Regardless of focus and size of DL programs, respondents made concurring statements that the DL programs were orientated towards carrying out more production work as opposed to research. Production work generally consisted of digitization and preservation activities. It also appeared that emerging areas such as scholarly publishing are also included as part of production work. One respondent defined production work as: "Production [work] gets material out there and you have something [so] that others can start using." One respondent from a relatively large DL program discussed the orientation of his/her DL program as handling more practical works and stated: "We [DL program] are [a] production group. We are not research oriented. We don't have the luxury of being a research institution… We can't do that [research] anymore." Another respondent from a relatively large DL program made a similar comment: "we are very much a production shop… the work that we do is oriented toward production systems." Another respondent from a mid-size DL program acknowledged the intention of his/her DL program as engaging in more research activities and mentioned: "We have always wanted to build ourselves as a research department [focusing on DL related issues], but we have done more production and practical work. We haven't had a lot of time to do researching."

Respondents also talked about several factors that were preventing them from undertaking research activities. It appeared that increasing workload, deadline-oriented projects, growing demand for DL services, and budgetary constraints were important

factors influencing the research and development efforts in the DL field. Respondents from relatively larger institutions discussed their current heavy workload as an important barrier. One respondent stated: “We have so many projects and demand to take care of and work for dissemination of those that there is not much time for research.” Another respondent discussed the low level of return on his/her DL programs’ investment as a factor and stated: “We don't typically undertake significant research for its own sake. Less research has paid off in terms of development of the program or development of new areas.” Another respondent from a mid-size DL program raised availability of financial resources as an important concern: “… we don't have enough financial resources to fund an initiative that would cost a lot of money.”

On the other hand, the form of research carried out in DL programs was designed for the purpose of producing results that may be applied to real world situations they confronted. There were comments centering on “applied research” as the major type of research in DL programs. Respondents from different DL programs made concurring statements regarding their tendency towards applied research such as “… we’d tend to think of ourselves undertaking mostly applied research,” and “… we need solutions that fit and work with the current system.” These two comments indicate the presence of applied research activities. Another respondent from a different DL program specifically acknowledged that his/her DL program benefited from applied research and stated: “What we have learned in the research part of our work has [been] applied to projects.”

In addition to the “applied research” model, it appeared that DL programs were looking to other DL programs in the pursuit of “best practices” in the field and/or to learn from their experiences. One respondent commented: “… looking across the nation or

North America, preferably Ivy League [schools' DL programs], and following best practices models," and recognized his/her intention to go beyond the best practices model and stated: "Even though I am working on a 'best practices model', I still would like to do things [with DL related technologies] that are more innovative." Another respondent from a different DL program stated "… it is important [that] we are trying to meet all the national standards for best practices [in the DL field]." Another respondent from a different DL program indicated that his/her DL program closely followed other DL programs including "California Digital Library [and] University of Michigan."

The theme of focus and orientation of the DL program discussed in this section provided information that addresses, in part, the second research question. Specifically, focus and orientation of the DL program serves as an important force guiding respondents' information seeking behavior, knowledge sharing activities, and program's goal and priorities in terms of projects in conjunction with following themes (i.e., relationships with surrounding academic units and external partners, information resources and communication behaviors).

### 4.2.3. Relationships with Surrounding Academic Units and External Entities

The third theme that emerged from the interviews was the DL programs' relationships with surrounding academic units and information services such as an information technology (IT) department, a library and information sciences school, and with external entities that are outside of their surrounding academic settings. This theme was important in understanding and characterizing respondents' interaction with others, including inter-departmental connections and those outside of the organization (i.e., university) in the context of Communities of Practice (CoPs).

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Content Acquisition*: Refers to one of motivations of DL programs to have relationships with surrounding academic units.
- *Partnership*: Refers to strategic and active relationships established not only with surrounding academic units but also with external entities.
- *Consulting/Obtain Information*: Refers to one of the motivations of members of DL programs to establish relationships with surrounding academic units and external entities.
- *Complexity*: Refers to complex nature of relationships with surrounding academic units and external entities due to involvement of number of units or groups.

All participating DL programs made concurring statements on having good ties with surrounding academic departments and information services, including other library departments, IT department, library and information school, and faculty. DL programs benefited from such connections not only by accessing their expertise but also by acquiring their content and collections. One respondent said that his/her DL program was working closely with other library departments which own collections (e.g, music) and stated: "They [other library departments] are the ones with collections. We need to work with them and they need to let us do the digitization. The Government Documents [department] has tons of materials … we have worked with them a lot."

One respondent pointed out his/her DL program's connections with other university system libraries as "long standing relationships" and described this as a complex relationship:

> This [relationship with surrounding academic units and information services] is somewhat complex, I guess. Because it varies considerably. First, with [other university system] libraries we have long standing relations. There is variety of committees and so forth, and [through] which [university] libraries staff can interact with the [DL program] staff. There are some programs in which there is great coordination of strategic development and partnering. There is an increasing degree of partnership with IT groups across the [university system]. We [DL program] started to consider the delivery of services and scholarly communication more generally in academic support and educational support when we were beginning to engage with IT department.

Foundations for these connections were also established in campus-wide or cross-campus committees. One respondent noted that members of his/her DL program participated in campus-wide or cross-campus committees that enabled them "to obtain some insight rationalization and provide strategic direction for IT development and coordination." Another respondent from a different DL program explained that his/her DL program's relationship with surrounding departments and information services included building connections to offer his/her program's services and facilitated work with them. He/she added: "… this is [the] first year where we have been talking to others to say we have services to offer."

These collaborative activities and connections, including access to other departments' or unit's collections and expertise, appeared to be maintained through

"library liaisons" or "project managers." One respondent noted the importance of the project manager position and activities of his/her DL program staff in maintaining such connections with other departments and stated: "Main contact with other departments about projects is by means of project managers. And of course, we have contacts with other departments through bibliographers, librarians." Another respondent from a different DL program discussed the importance of library liaisons maintaining such connections and stated: "As for faculty and other departments on campus, our connections with other departments [except the library and information science school] are maintained through library liaisons. … we do work with other faculty on projects.. [as] advisors and consultants." Another respondent from a different DL program pointed out that his/her DL program benefited both financially and intellectually as his/her program interacted with the IT department. He/she stated: "For example, the IT department suggested that we buy a SANS [Storage Area Networks System] so that we don't have to buy new servers as our collections grow, which saved us a lot of time and money… We learn from them as we work on some things together and as we ask for information or [their] advice."

Relationships between DL programs and resident library and information science schools (LIS) such as at the University of North Texas, University of California at Berkeley, and University of Texas at Austin appeared much closer and stronger than that of other academic units. Members of DL programs often took part in teaching tasks at these schools and hired LIS students as interns, full-time, or part-time employees. One respondent discussed proximity to a library school as an important factor in fostering his/her DL program's relationship with LIS and stated: "My boss … is currently teaching

a class at [LIS] and that is something that would probably be repeated. I personally initiated an internship program in which we would bring in [LIS] students for summer or semester oriented work that would help both parties." Another respondent from a different DL program continued: "[The] head of our digitization unit is adjunct faculty here at [LIS] and teaches a digitization class. And [the] manager of digitization also teaches occasionally in her area at [LIS] program." In addition, the same respondent indicated that his/her DL program and LIS at the university were awarded a grant: "We had a grant with the [LIS], which was a project... to develop a curriculum in digitization. We have a pretty strong tie with the [LIS]." Another respondent from a different DL program made concurring comments: "Right now, we hire a lot of our [LIS] students and teach a lot of classes and do a lot of lectures [at LIS]. We have four of [LIS] graduates [employed] in the department."

Some of the participating academic libraries were members of various organizations which have an influence on DL related issues including use of DL technologies, digital preservation, and DL development activities. Participation in these organizations provided venues for DL programs to share their work and connect with other DL programs. These organizations include the Association of Research Libraries (ARL), Digital Library Federation (DLF), and Coalition for Networked Information (CNI). The DLF promotes work on DL structures, standards, preservation, and use; CNI is interested in various areas critical to present and future of DLs; and ARL is one of the sponsor organizations of CNI and its member institutions are very active in the field. Further, these organizations engage in collaborative activities with each other in pursuit of their missions and goals. Respondents from different DL programs made concurring

statements that DL programs benefited from their participation in such organizations and encouraged their staff to participate. One respondent described his/her DL program's participation in both CNI and DLF as a very active participant and stated: "We typically send a large number of staff to DLF forums, and we try to represent the work that we are doing here, and we certainly gain considerably from our participation in that community [and] learning what other people are doing and attempting to take advantage of it. CNI is the same; we are an active contributor there. We work and hope to provide some initiatives in terms digital library development or scholarly information development activities." Another respondent from a different DL program discussed his/her program's participation in CNI as oriented towards learning about latest trends and developments in the field.

In addition, one respondent talked about his/her DL program's participation in the open source community and stated: "We currently provide some of our software to the [DL] community through Sourceforge [the world's largest development and download repository of open source code and applications]…"

Relationship with surrounding academic units and external entities as a theme provided information that contributes to answering, in part, the second research questions. This discussion also indicated that the data provided evidence of entities (e.g., LIS, nonprofit organizations) that contributed to formation of informal communities that can be characterized as CoPs (see section 2.3 for a discussion of characteristics of CoPs). Further, collegial activities that were made possible through these relationships with other academic units and external entities appeared to play a central role in formation and continuation of these informal communities. In addition, such relationships in connection

with focus and orientation of the DL program influenced the use of information resources and communication behaviors of respondents.

4.2.4. Information Resources and Communication Behaviors

The fourth theme that emerged from interviews was related to information resources and respondents' communication behaviors. This theme was important in understanding the venues that were used to access the latest information and respondents' communication behaviors in the context of CoPs.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Community:* Refers to social structures where members of DL programs interact with each other, share knowledge, and generate solution to their common problems.
- *Online Tools*: Refers to tools available on the Internet including blogs, wikis, and mailing lists.
- *Conferences*: Refers to professional meetings that respondents attended. These meetings were generally organized by nonprofit associations.

Respondents sought information about new technological developments through a diverse array of information resources, both face-to-face and virtually. Such connections appeared to be established through various platforms (e.g., conferences, mailing lists) and maintained and improved not only through synchronous channels (e.g., by phone, face-to-face, instant messaging) but through asynchronous channels (e.g., mailing lists, project wikis, blogs, journals) regardless of geographical boundaries. Relationships with surrounding academic units and information services, as well as external entities,

constituted a significant component of information access and sharing for the DL programs as discussed earlier. The respondents were in agreement that talking and sharing with colleagues was essential for their work.

Attending national and international conferences were the most commonly used venues to obtain new information and served as a breeding ground for building personal contacts with their colleagues. These collegial activities were regarded by respondents as communal activities. In addition to organizations mentioned in the preceding theme, respondents identified two additional organizations. EDUCAUSE promotes the intelligent use of technology for advancing higher education. The Library and Information Technology Association (LITA) not only serves to its members but entire library and information science community to promote, develop, and aid in the implementation of library and information technology. One respondent voiced this view: "I attend various conferences and try to meet with speakers at the end of their sessions. Most connections often turn into good information resources." Another respondent from a different DL program discussed the importance of administrative support in the pursuit of information about new technological developments and mentioned: "… [search for the information about latest technological developments] was through [attending] a lot of conferences, training, national conferences." Preexisting personal contacts and the connections established in various venues with other institutions, organizations, and DL initiatives appeared to be very important for information access and sharing purposes. One respondent discussed the importance of collegial activity in accessing current information and commented: "I think the staff here is fairly well connected to a variety of digital library programs and initiatives. I think there is a significant number of

professional ties and through those networks there is tremendous amount of information acquisition and sharing."

In addition, online mailing lists, discussion boards, blogs, instant messaging, and other tools for communicating online with colleagues were vital for building and maintaining online communities for faster information access and sharing. One respondent commented "There are some of us who, I think, engage primarily [DL] communities through mailing lists, discussions, or privately maintained email conversations. I think there are others who engage significantly through IM [instant messaging] conversations or IRC [internet relay chat] chat mechanisms." Another respondent from a different DL program explained that participation of his/her DL program's staff in such online mailing lists was related to job responsibilities of staff and technologies employed by the DL program. He/she stated: "… within the department almost everyone subscribed to various list serves. C.D. is focusing on preservation and metadata; I look at a lot of digital library systems that are out there, work with those [DL systems], and large scale metadata programs. For example, I am on METS, MODS, Fedora, DSpace, DL Access, and Greenstone [mailing lists]. I am on all of the big digital asset management systems, workgroups, and XML4Lib [mailing lists]." Another respondent from a small size DL program discussed the size of his/her DL program as an important factor for his/her reliance mainly on vendor-specific mailing lists as a primary information source when it comes to acquiring new information about technological developments and problem solving and stated "We usually seek [DL related] information on vendor-specific discussion lists... If it is not a vendor specific problem, we seek answers from other discussion boards through Digital Library Federation or the people

that we met at conferences. I have learned a lot from the people who I meet at conferences."

Another respondent mentioned that his/her DL program closely monitors information released by other DL programs about their completed and ongoing projects for faster access to specific information and stated: "We watch for white papers [that were] put up on the Web, describing research. Some projects have common work spaces, like a Wiki, so you can go to those and get more information." Another respondent from a different DL program discussed the production work orientation of the program as a determining factor in their use of information sources and stated: "I don't think any senior team members read blogs. Technical guys will look at the trade literature, pay attention to specific technologies. Myself [I] follow D-Lib [an electronic publication with a primary focus on digital library research and development] and I can't say that I go to that all the time… Occasionally, this is one of the places that I reference. I usually like to talk to people." The same respondent added: "Our chief systems engineer, he is very interested in technology, and application programming. He is constantly reading trade literature on storage systems."

One respondent discussed the importance of geographical proximity to high-tech companies for his/her DL program as a significant information source when it comes to obtaining information about the latest technological developments related with DL and stated: "So there is a significant amount of activity taking place in what is known as Silicon Valley… And there is quite a bit of [information] sharing among for profit companies that would be [in] IR [information retrieval] space and information management space."

In addition to those online communities, one of the DL programs was actively involved in community building efforts to disseminate and systematically share information. The respondent discussed that his/her staff used to be very active in such community building activities when his/her DL program was smaller in size and stated: "We had a community of people here on campus who shared information… We systematically shared information through committee work and setting up groups. We established committees and then we would set up ways to disseminate that to other people." Documentary evidence (i.e., meeting minutes) provided by another DL program revealed that DL staff were interested in creating a community to promote the institution-wide participation of faculty and staff in an institutional repository system introduced by the library.

Information resources and communication behaviors of the respondents as a theme provided information that addresses, in part, the second research question. Through this discussion, the data provided evidence of activities (e.g., conferences, mailing lists) that lead to formation and cultivation of informal communities in conjunction with the previous theme. Further, this theme provided evidence about respondents' communication behaviors and information acquisition and sharing activities; these contribute to identification of motivations and forces impacting the decision-making process in conjunction with ideas discussed in the focus and orientation theme.

#### 4.2.5. Characteristics of Information Resources

The fifth theme that emerged from interviews was the characteristics of information resources utilized by respondents. This theme was important, in connection

with the previous theme, in understanding the characteristics of venues used to access the latest technological developments in the context of communities of practice.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Innovativeness*: Refers to ideas that are perceived as new and novel.
- *Originality*: Refers to ideas that are perceived unconventional.
- *Up-to-date*: Refers to ideas that are perceived current.
- *Experience-based*: Refers to ideas that are created based on an experience
- *Informal Connections*: Refers to relationships relying on informal communication mechanisms.

One respondent pointed out "innovativeness and originality" as important characteristics of his/her information resources and acknowledged quick access to information as another important characteristic: "I need faster ways of getting information. Some information is out of date by the time it gets published in a print journal… We have got to find better ways to get very up-to-date information." Another respondent from a different DL program similarly discussed speed of access as an important characteristic and added: "I think they [technical staff] are more knowledgeable and keep themselves updated. In addition, it is not possible for me to know and read everything. If I know someone who has the knowledge, I would be able to access that particular information instantly. You don't have to read whole book and you are getting a part of it... We share our knowledge and experience." Another respondent from the same DL program added: "I am able to obtain first-hand and experience-based information from these message boards." A respondent's comment discussed in the previous theme also indicated the connection of

meeting people at conferences and subsequent information access: "I attend various conferences and try to meet with speakers at the end of their sessions. Most connections often turn to good information resources. We watch for white papers put up on the Web, describing research. Some projects have common work spaces, like a Wiki, so you can go to those and get more information" also demonstrates the importance of experienced-based knowledge since these documents (e.g., white papers) provide detailed information about projects and reflects researchers' experiences.

A respondent from a different DL program also discussed the importance of "innovativeness and originality" of information resources for his/her DL program in terms of the extent these information resources provide academically robust higher-end models for his/her DL systems and stated: "I am a new generation web developer who looks at advertising, gaming, and other kind of heterodox areas that we can bring into the academic library."

Respondents' interactions with others appeared to be maintained informally and the organizational structure of DL programs encouraged informal communication. Informality in communicating with others is one of the key characteristics of CoPs (see section 2.3 for a discussion of characteristics of CoPs). In connection with earlier themes, respondents interacted with their colleagues who were part of their own DL programs, as well as people from libraries, other university units, or external institutions and organizations to advance and share their knowledge and contribute to the field. The degree of informality in these interactions appeared to be related, in part, with ideas previously discussed in the themes of management style and structure of the DL program and information resources and communication behaviors. One respondent discussed

his/her restructuring efforts to facilitate collaboration among his/her DL staff and stated: "Each of the three units had a unit manager, and they also talk a lot more among themselves informally." At another DL program, a respondent discussed that informal communication constituted an important part of technology assessment process. A respondent from a different DL program discussed the information sharing process in his/her DL program with both internal and external contacts as informally maintained and added: "… it [information exchange] is also significantly informal as well, in a sense that we may have both professional and personal relationships with primary actors at variety of institutions. And there is significant information sharing. Out of that, there are more formal relationships."

Characteristics of information resources used by respondents provided additional information in understanding respondents' information seeking behavior and motivations for using these resources. This addresses, in part, the second research question in terms of understanding respondents' motivations in using these resources. Further, this theme, in connection with ideas discussed in the previous theme, sheds more light on characteristics of communities that are important in understanding their contribution to the decision-making process as discussed in the next theme.

4.2.6. Participation in Communities

The sixth theme that emerged from interviews was the respondents' degree of participation in communities relevant to their DL work. This theme was important, in connection with previous themes, in developing an understanding of roles played by CoPs in the decision-making process.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Motivating Factors*: Refers to factors that motivate respondents' participation in CoP activities including sharing ideas and contributing to the field.
- *Collaboration*: Refers to shared efforts of members of a CoP in DL projects. Since these members may be part of the same DL program, organization, other DL programs, or non-profit organizations, these efforts may go beyond personal level collaborative activities.
- *Sense of Belonging*: Refers to respondents' perceptions that members and their problems matter to one another.
- *Participation (active member vs. sideliner)*: Refers to respondents' frequency of participation in activities of a CoP.

As discussed in earlier themes, respondents indicated that they utilized variety of information sources, generally relied on informal communication channels, and also they were involved in community building activities.

One respondent discussed the importance of the DL communities that he/she was part of and how that improved his/her work. He/she stated: "They act as a kind of distributors of current thoughts and problems that they are running into. And to the most part, a lot of people are hitting the same problems. The community is involved in this and fixes things." Another respondent from a different DL program characterized DL communities as places where he/she gets "together, share ideas, solve problems, and contribute to the field" with his/her colleagues. The same respondent viewed participation in discussions as an important element in developing a strong sense of belonging to such

communities and mentioned: “I answer questions posted on the boards occasionally as they arise if I know the answer and I try to read all messages regularly. In my opinion, you need to provide answers so that you may get answers when you have questions.” Another respondent from a different DL program similarly recognized his/her sense of belonging to communities that he/she participated in and added: “We understand that by asking them questions, we are asking for their time and advice. So, we always try to respond to their requests.” A respondent from a different DL program discussed his/her DL program’s participation in the open source community and stated “I think we need to contribute more aggressively to OSS [Open Source Software].”

Another important component was the respondents’ degree of participation in these communities. As they participate in communal activities they become part of the community (see section 2.3.2 for a discussion of participation in CoPs). In connection with earlier statements of this theme, one respondent indicated that his/her DL program’s participation in such discussions varied as his/her topic of interest appears and mentioned: “I pretty much act as a lurker. I just take in the information and use it. In a lot of those, we are not that well-versed, so we cannot really offer a lot of opinions… For specific questions where if we know that we have answers, then we contribute.” Another respondent from the same DL program made concurring comments and stated: “In some cases we are very active, in other cases we are less active.” A respondent from a different DL program discussed his/her position in such communities as “mostly receiver” because of his/her lack of experience in the field and stated: “It [participating in communities] influences my work because it saves a lot of time.”

Respondents' perception about their participation in communities provided information that addresses, in part, the third research question. The data provided evidence of respondents' expectations from communities and their impact on respondents' work. Further, data indicated that information acquired through communities appeared to be put into application by respondents, which suggests communities' impact on the decision-making process at different levels as discussed in the next theme.

### 4.2.7. Technology Adoption Decision

The seventh theme that emerged from interviews was respondents' technology adoption decisions. This theme was important in understanding the forces and factors at play in technology adoption decision-making process in DLs participated in the study.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Evolving Environment*: Refers to gradual changes taking place in the DL environment as technologies, user needs, and expectations of DL members and users evolve.
- *Optional-Innovation Decision*: Refers to a decision made by an individual member of the DL program.
- *Collective-Innovation Decision*: Refers to a decision made by members of the DL program through reaching a consensus.
- *Authority-Innovation Decision*: Refers to a decision made by a few members of the DL program who are in administrative positions.

- *Validate with Others (outside of the DL program)*: Refers to administrative personnel's external confirmatory information seeking process regarding a technical decision made in the program.

Respondents were in agreement that their DL programs have adopted and continue to adopt a variety of technologies to meet industry standards and users' expectations as DL technologies and services provided by DLs evolve. One respondent noted the evolving nature of the environment and its influence on the decision-making process and stated: "…the infrastructure that we put in place… now it needs to be cared for. We are the generation working with the evolution of digital library, so as libraries try to adopt the new environment they are pressed to bring in the necessary resources. There is real struggle going on in libraries for [finding additional] resources to digitize and build digital collections." Another respondent from a different DL program acknowledged the evolving nature of the environment and mentioned: "We are looking at new evolving technologies to enhance our digital library technologies." A respondent from a different DL program also recognized demand for services provided by his/her DL program dramatically increased over the last three years and attributed this to the evolving nature of the environment: "… we started with four servers…[currently,] we have twelve in-house servers and three external servers. Most of those additions, maybe 70 to 80% of those additions, have been with regards to digital library collections. That area has very much increased and evolved."

Respondents at administrative positions were in agreement that they relied generally on the recommendations of their technical staff when making technology

adoption decisions. One respondent discussed his/her reliance on technical staff for technology related decisions and stated:

> I think it is more a matter of trusting them on day to day, individual things… I take their [technical staff] advice readily on such things [technology related]... what software to buy or what software that we need to integrate, I listen to them. However, on questions like 'are we going to set up a major newspaper scanning system?' I listen to them and then make a decision about such major programs. Most of the time, I would take their advice.

Another respondent from a different DL program similarly argued: "I have to have high confidence in people [technical staff] who are bringing in those [technology related] recommendations."

Additionally, these respondents also noted that they have to rely on their staff when making technical decision because their current role (i.e., administrative) required them to conduct more administrative oversight and make administrative decisions such as direction of the DL program. One respondent discussed that his/her role evolved and thus his/her position in the decision-making as the DL program grew over time and stated: "… my role has moved into one [administrative] where I have to be able to rely on their recommendations." Another respondent from a different DL program stressed his/her role as more influential in non-technical decisions and stated: "… the direction of the program, where we are going, that is where, I think, I have more influence. I consider that as my chief role and responsibility - where the direction of the program is going."

Comments from administrative personnel on their confidence in technical staff when it comes to making technical decisions led to another important category in this

theme, which is collective decision-making (see section 2.2.4 for a discussion of the types of decision-making). Recognizing the influence of technical staff in technology related decisions, one respondent in a technical position with administrative responsibilities stated "… we make such decisions [technology related] collectively." Another respondent from a different DL program also acknowledged that the number of people involved in collective decision-making process varied depending on level of effect of a technology to be adopted on the DL program and mentioned: "…higher up the stack we definitely involve a larger number of people from a larger number of units. Lower down the stack, they [decisions] tend to get made in the technology group primarily by senior management." On the other hand, another respondent from a different DL program discussed possibility of having an authority-innovation decision (see section 2.2.4 for a discussion of the types of decision-making) getting made as opposed to a collective one if there was "a deadlock in the end" when trying to make a decision.

In connection with the theme of management style and structure of the DL program, one respondent in a technical position with administrative responsibilities discussed that despite the management style of his/her DL program as micro-management, he/she was still able to influence the administration on technical decisions:

> I would consider myself as a catalyst. Sometimes quick decisions towards adoption are not taken because of overt recommendations… All of a sudden, the catalyst of that technology seems to work, even if the people were explicitly against the adopting the technology or verbally said 'no'…

In addition to collective-innovation and authority-innovation decision-making when adopting new technologies in the DL environment, several respondents from

different DL programs stated that they make optional-innovation decisions (see section 2.2.4 for a discussion of the types of decision-making) from time to time if that technology would not play a critical role in the DL system. One respondent from a different DL program also discussed that he/she was able to make his/her own technology decisions occasionally if the technology is in question was non-mission critical for the DL system. He/she gave the WS adoption decision as an example: "… we are in the middle of a project and I am thinking of authenticating our background [access] through web services." On the other hand, the same respondent made another comment on the type of decision-making involved: "Most of technological decisions are made by me and [the] library systems manager. And we make such decisions collectively. If any questions arise, we could go to upper level management otherwise we make decisions [by ourselves]." The following comment from another respondent represents his/her optional decision-making for a specific DL technology in the past: "One example that I was quick to adopt was "open search" which is protocol for basic searching."

Although technical staff in DL programs were able to influence the decision-making process in terms of technology decisions, one respondent at an administrative position argued that he/she tends to verify the information provided by technical staff prior to making final decision and stated: "I have to have a way to validate those recommendations… validating certain views that we have, we think it is a good idea, ITS [Information Technology Services] thinks it is a good idea, and my colleagues over in liberal arts think it is a good idea." It appears that CoPs have a role to play in validating decisions. On the other hand, another respondent from a different DL program discussed the importance of obtaining information through formal channels such as print

journals as a mechanism to verify the quality of information obtained informally and stressed to importance of using multiple information sources when making technology adoption decisions: “However, you need to balance what you heard or learned through your friends or other people with formal information [that is] on the journals for example… I don't necessarily trust what I learned through informal communication channels. When it comes to adopting new technology or standard, I always tend to collect information from different channels and combine them to get the best out of it.” The same respondent explained why he/she regarded informal communication channels as useful: “On the other hand, there are some cases where specific software or application involved and if I know that person has already resolved the problem before. I just follow that person, since I believe he is experienced.” It appears that he/she ranked quality of knowledge acquired through these channels based on trust and perceived status of the person who conveyed.

Respondents’ technology adoption decisions as a theme discussed in this section provided information that addresses, in part, first and second research questions. The data provided evidence of factors and forces at play in the decision-making process. Specifically, informal communication channels were used as information access and sharing mechanisms, including CoPs in the decision-making process.

#### 4.2.8. Factors and Web Services

The last theme that emerged from interviews were perceived factors leading to adoption or non-adoption of WS technologies in the DL environment. This theme was important in understanding the factors associated with WS technologies that influenced the decision-making process.

There were varied comments concerning perceived benefits and advantages of Web services technologies, how WS assists DL systems, factors leading to adoption or non-adoption of WS.

A set of categories were identified in this theme based on the interview data and documentary evidence. The categories were:

- *Financial Concerns*: Refers to availability of financial resources to fund (e.g., licensing, training) new initiatives and cost of supporting or maintaining existing ones.
- *Human Capital*: Refers to staff size and members' expertise, skills, and extent of knowledge.
- *Technology Readiness*: Refers to compatibility of existing technological infrastructure with new technologies
- *Technological Superiority*: Refers to benefits and advantages of WS technologies.

The interview data indicated that majority of the respondents heard about WS in its early years. Comments from respondents include: "Five years ago [2001]. Right when it came out," "… when I got my job [2002]," "Approximately three years ago [2003]," and "I heard about Web services when I was in library school… in 2002 or 2003." On the other hand, two respondents from different DL programs were not able to remember, "I have no idea. Several years ago" and "… [I heard about it] sometime ago."

Although respondents heard about the technology at different points in time, there were concurring positive statements about the technology when asked about their initial

perceptions of WS including: “I was surprised,” “Very impressed,” “It sounded very good technology…,” and “It sounds good.”

However, respondents who had already adopted and were still using the technology mentioned that a variety of factors contributed to the decision-making process to adopt WS. These factors included financial concerns, human capital, technological characteristics of WS, technological readiness, and perceived benefits from using the technology.

Respondents had similar comments regarding cost as an important factor when assessing a technology. One respondent stressed the importance of overall cost of adoption and stated: “… we generally have evolved into a unit which is very concerned what things are going to cost. We need to know all, not only implementation cost but also ongoing cost.” Another respondent from a different DL program argued a similar perspective: “Is the technology free or open source? If it is going to cost us, is it going to cost us for one time or yearly licensing?” Another respondent from a different DL program stated similarly: “… we evaluate options in terms of their overall cost profile.” Another respondent from a different DL program discussed his/her DL program’s limited financial resources as an important factor and stated: “… we don't have enough financial resources to fund an initiative that would cost a lot of money.” Another respondent from the same DL program followed the same view with more general statement: “Costs are always an issue.”

Respondents voiced similar concerns, regardless of size of their DL program, about importance human capital in terms of number of employees, expertise, and knowledge when it comes to adopting, implementing, and maintaining a technology. One

respondent discussed the size of his/her DL program (a small program in terms of staff size): “I want to have something that works and does not require too much manpower which is limited here.” Another respondent also recognized his/her DL programs’ limitation with regards to human capital and mentioned: “There is only so much that can be done with a single programmer and then how do you balance moving forward implementing changes and reaching a point where it requires major rewriting of the code.” Another respondent from the same DL program also discussed “manpower” as an important factor and went on to address additional factors associated with manpower: “A lot of our options involve free software but knowledge and expertise are factors there. So that [expertise] has to be a factor. In summary, the factors of cost, manpower, [and] expertise must be weighed with benefits that could be gained with the implementation of new technology.”

Another respondent mentioned that complexity of the technology in terms its components and the required manpower as a major deciding factor and stated: “… what are the moving parts and who has to make it move? Usually, the more moving parts there are and the more partners who have to move those parts, how complicated it is actually to get it going.”

Respondents’ comments varied about the technological characteristics of WS. One respondent raised his/her concerns about reliability of external WS and acknowledged platform independence of WS and mentioned: “If I want to subscribe [UDDI] to anybody else's service, I need to think how reliable that service is. Because most of [our] transactions are [running] 24/7. If their [external WS providers’] server is down, it will be difficult to provide support [for our users]. In addition, interoperability

was another important advantage… It was platform independent and we have applications running on various platforms." Although this respondent was a programmer and had experience with WS, he/she discussed the size and resources of his/her DL program as being small and limited, and went on to state: "… if our vendor asks us to use Web services, we could use it." Another respondent whose DL program had already adopted WS several years ago discussed more specific characteristics of the technology: "It became clear that we needed to move to an architecture which supports on the one hand higher addressability, greater modularity, more uniformity, and development while at the same time often permitting us to engage in more rapid development of services, of functionality, and of applications." Documentary evidence (see Appendix F) from the respondent's DL program indicated that his/her DL program adopted WS as building blocks of "an open, services oriented technical architecture." A service could be any library service encapsulated in automated systems such as indexing, ingest, and account management and "a service can delivered to a user interface." In addition, these services could be used by "other applications or intermediate consumers, which built applications from one or more services." Having DL applications themselves "consumer of services, assembling their functionality from different components" and "building up applications from simpler parts [services]" increased the modularity and flexibility of DL environments as they become "more complex and interconnected."

The level of technological readiness was another important category in this theme. Technological readiness was related to degree of compatibility of DL programs' existing technological infrastructure with new technologies. The level of technological readiness appeared to be important for triability, speed of adoption, and implementation of a new

technology. One respondent argued his/her current digital infrastructure as compatible with current technologies and stated: “Any trial involves major reworking of a system, if your data is not in a format that you can easily adapt it into another format that is one hindrance that we’ve had. We are at a point now after about two years working on our digital infrastructure where we can really start making changes. Then we can do a lot of prototyping, changes because we have all of our data in one format. So it is easy to say that we are going to try this and place it over prototype area and try it.” The same respondent recognized that his/her DL program needed to start experimenting with WS, and he/she made references to budgetary concerns and heavy workload for not adopting WS yet. He/she stated: “We are going to look at a small Fedora implementation which is all Web services. I know we have to get our feet wet and I don't know where they [WS] fit. We could use web services at this point to let other people interact with our system and we don't really have an idea of how people want to interact with our system.” Another respondent from a different DL program indicated that trying WS in a small scale was a part of overall assessment process and stated:”… our systems engineer tried Web services; he installed and looked at it. There is usually a very thorough kind of investigation.” A respondent from a different DL program acknowledged trial of a new technology and recognized “speed of adoption” as an important decision factor and stated: “How quick we actually can move from looking at this technology to implementation.”

One respondent discussed his/her DL program’s technology assessment process briefly where efficiency improvement in provided services was critical and mentioned: “Is it going to provide a function or set of functions that furthers our ability to provide

services? If it does, that is the main thing. If it does not do that, no matter who is using it, it is a luxury." Another respondent discussed scalability as a decision factor due to growth in content size and delivery mechanisms of the DL program over the last five years and stated: "… digital libraries were at the point of realizing that some of the delivery mechanisms for its content that it had developed over the last or the preceding five years [grew to extent in which], we were not capable of scaling to meet the size of the content pool." The same respondent added the growing expectations of the user community and members of the program, inadequate data sharing, and poor use of internal sources as important factors influenced the decision to adopt WS. Documentary evidence (see Appendix F) suggested that a modular approach with WS allowed developers at his/her DL program to engage in "more rapid development of services, of functionalities, and of applications." Additionally, the same respondent indicated that "willingness" was another important factor and that is why his technical staff were actively searching for a technology like WS to resolve the problems they have been experiencing with growing content size and reliable access to services provided. He/she stated: "… things were broken and we had to move to an alternative architectural paradigm. So, willingness to move [to a WS-based infrastructure] was quite present." As discussed in other themes, several respondents from different DL programs also recognized their willingness to adopt WS; however they weren't able to do so due to various reasons including budgetary concerns, lack of expertise, and personnel.

Perceived factors leading to adoption or non-adoption of WS in the DL environment as a theme discussed in this section provided information that addresses, in part, the first and second research questions. The data provided evidence of

organizational and technology-specific factors at play in the decision-making process. Specifically, technical features associated with WS provided justification for adoption coupled with other factors and forces as discussed in earlier themes.

4.3. Comprehensive Member Check

The researcher identified a number of findings from the themes discussed above. These findings were made available to respondents for their review and comment. Additional narrative for each finding was also included (see Appendix G for the comprehensive member check tool). All of the respondents participated in comprehensive member check and provided their opinions. Respondents unanimously agreed on the findings. These findings were:

1. *Organizational characteristics (e.g., work structure and management style) of a DL program have an influence on technology related decisions*.

   One respondent suggested that accomplishing a matrixed work structure in terms of having members of different units work in the same project is a time consuming process because of the time needed to communicate, plan, and implement the project. Another suggested an alternative wording for narrative of the finding which has been incorporated in discussions of findings in Chapter V.

2. *Digital Library Communities of Practice play an important role in enabling staff members of a DL program to access up-to-date and experienced-based knowledge, providing a distributed problem-solving and learning platform, facilitating informal communication and collaborative activities among DL programs as well as informing the decision-making process*.

   One respondent argued that there are a number of "technical veterans" who are members of such communities and most of them could be found in vendor related mailing lists. Another respondent suggested that limitations in membership in certain communities such as DLF actually limit their influence and role in enabling members of a DL program to access up-to-date information and experienced-based knowledge.

3. *Focus and direction of the DL program impacts its members' selection of technical information resources, shape their information-seeking behavior, and, in turn, influence the decision-making process*.

   One respondent suggested that missions and objectives of the DL program influence values of the program and his/her DL program perceived missions and objectives as an integral part of the decision-making process. Another respondent recognized the impact of needs of the entire organization on technology decisions.

4. *Surrounding academic units (e.g., IT unit, Library and Information Science Schools/Departments, Computer Science department) and external partners (e.g., DLF, CNI, other DL programs) serve as important knowledge resources and facilitate formation of informal learning communities. Knowledge acquired through them informs the decision-making process*.

   One respondent suggested that conferences or meetings such as CIL (Computers in Libraries), ALA (American Library Association), and JCDL (Joint Conference on Digital Libraries) also serve as information sources in addition to conferences such as CNI or DLF as discussed in Chapter IV, since DL related topics and technologies are discussed in these meetings.

5. *Technical characteristics (e.g., interoperability, open standards), compatibility with existing technical infrastructure, applicability to existing DL projects, total cost of ownership (e.g., licensing, maintenance cost), technical expertise in the DL program (e.g., staffing, training, learning curve), and success of a pilot project are key decision factors influencing adoption Web services technologies in the DL environment*.

   One respondent acknowledged the importance of technical characteristics in the decision-making and further suggested that the human aspect (e.g., technical expertise) is more important in the decision-making since the human aspect is very important in facilitating the implementation process. Another

respondent added exposure to other WS initiatives outside of the organization as a factor.

## 4.4. Summary

This chapter presented the themes that emerged from the analysis of interviews conducted with administrators and technical personnel who were involved in the decision-making process at five academic libraries' DL programs. Documentary evidence was included as complementary data to the interview data. Overall study findings from these themes were presented back to the respondents for their feedback as part of a comprehensive member check. The data collected through face-to-face and phone interviews, documentary evidence, and comprehensive member check provided in-depth information to answer research questions posed in this study and indicated that the decision-making process to adopt WS was a complex process involving various factors and participants.

# CHAPTER V

# DISCUSSION AND CONCLUSIONS

## 5.1. Introduction

The primary goal of the study was to understand and describe decision factors related to technology adoption in the context of digital libraries (DL) from a communities of practice (CoP) perspective. To develop an understanding of decision-making process, this study employed adoption of Web services (WS) technologies as a case study and proposed three research questions:

RQ1. What are the key decision factors that lead decision-makers to adopt or reject WS in the DL environment?

RQ2. What are the activities, entities, processes, motivations, and forces that influence the decision to adopt or reject WS technologies in the DL environment?

RQ3. What are the roles played by CoPs as informal communication channels on WS adoption decisions in the DL environment?

This chapter starts with a discussion of how research findings relate to the literature and continues with conclusions that answer the research questions. At the end of the chapter implications of this study for future research is discussed.

## 5.2. Findings of the Study and Discussion

Data collected through semi-structured interviews, documentary evidence, and comprehensive member-check were gathered and analyzed to answer the research questions. Analysis of the data revealed a number of factors, forces, and processes that

influenced technology adoption decisions in the DL environment. This section discusses the findings of the study and connects them to theoretical frameworks (i.e., Diffusion of Innovations [DOI], and CoP) and literature discussed in Chapter II. Based on the results discussed in Chapter IV, additional relevant literature from knowledge management, business administration, and library management fields are also included in this chapter.

*Finding 1:*

*Organizational characteristics (e.g., work structure and management style) of a DL program have an influence on technology related decisions.*

Although DL programs studied in this research are structured hierarchically as traditional organizations, these DLs incorporated a more flexible structure by applying low emphasis on work rules and procedures which, in turn, appeared to facilitate informal communication with their internal and external colleagues, improve openness of a program's staff to new ideas, and promote collaborative activities. Data suggested that this finding supports Damapour's (2001) conclusion regarding existence of a nonsignificant association between formalization and adoption of innovations at the organizational level. He assessed the extent of flexibility of structures in an organization as an important organizational level determinant under the category of formalization influencing innovation.

In addition, DL programs are divided into various functional units and each of these units was responsible for different aspects of the program. Further, their responsibilities expanded from building digital collections to troubleshooting computer problems as DL programs grew. Data indicated that this finding supports Damanpour's (2001) results. He (2001) evaluated such structures of having subunits under the umbrella

of a larger group as another organizational level determinant under the category of functional differentiation and found a positive association between functional differentiation and adoption of innovations. Furthermore, respondents' comments suggested a connection among DLs' flexible structure and functional differentiation leading to a matrixed work structure, that allowed DLs to draw people from different units of the program, external partners, and faculty members together face-to-face and virtually to take part in different stages of DL projects. The project-based nature of DL programs appeared to contribute to the matrixed work structure of DL programs; projects generally required involvement of various units in the program as well as others. Cohen and Prusak (2001) argued that engaging in collaborative projects involving people from different units, specifically a matrixed work structure, created a social venue for respondents to communicate and share information informally with their colleagues, with the result of improving their skills and knowledge, and informing the decision-making process.

Another aspect of the management style in addition to flexible and matrixed work structures are administrative attitude toward change. Interview data indicated that regardless of DL program administrators' background (i.e., technical vs. non-technical), DL administrators appeared to have a tendency to rely on information and recommendations provided by his/her technical staff when making technology related decisions. Data indicated that competence, reliability, ability, and openness to new ideas of their technical staff as discussed in the literature (Lesser & Storck, 2001; Nahapiet & Ghoshal, 1998) were major confidence building factors for DL administrators. On the other hand, administrators' role in creating such a climate where recommendations and

inputs from staff low in the organizational hierarchy are appreciated was essential to be able to follow trends in the field and make informed decisions. Furthermore, respondents in technical positions corroborated these accounts and discussed how they were able to participate in the decision-making process when making technological decisions. Data suggested that DL administrators' roles were significant in creating an environment where such decisions could be made collectively. This finding appears to be consistent with findings of Leonard-Barton and Deschamps (1987) who found managerial influence was an important factor in promoting use of innovations in an organization. Similarly, Damanpour (2001) assessed administrative attitude toward change as managerial attitude toward change and found a positive relationship between managerial attitude toward change and adoption of innovations. Data indicated that DL administrators did not seek recommendations from technical staff regarding administrative decisions such as direction of the DL program but did for technical decisions. Roles of administrators and technical staff in the decision-making process appeared to be consistent with Daft's (1978) "dual-core model of organizational innovation" which suggested organizations can be studied as if they are composed of two polar cores, administrative and technological cores, based on the area where an innovation occurs. Furthermore, Daft (1978) suggested that skilled technical staff may have more weight in such decisions if administrative level staff lack expertise in the area. However, data indicated that DL administrators regardless of their background consulted with their staff and preferred to make technology related decisions collectively.

On the other hand, administrative influence on technical decisions was strong and such decisions were often made at the administrative level only in one of the DLs studied

in this research. Authority-innovation decisions involves relatively few members of a social unit who have authority and higher status in the organizational chart (Rogers, 1995). Influence of individual staff members in such decisions was generally minimal. Although participation of respondents in technical positions in the making of such decisions was very limited, data suggested that they were able to influence technical decisions made at administrative level, especially, in adaptation and implementation processes of these decisions. Their feedback regarding pros and cons of the technology played an important role in adoption or rejection of technical decisions during adaptation and implementation stages of the innovation-decision process. This finding appears be consistent with Rogers' (1995) innovation-decision process model (see section 2.2.3 for a discussion of the innovation-decision process) and Fichman & Kemerer's (1993) findings which suggested implementers' (i.e., technical staff) feedback is valuable in deciding whether or not to reverse an adoption decision in the implementation stage. On the other hand, this finding seemed to contradict Daft's (1978) dual-core model (see section 2.2.1 for a discussion of the dual-core model) in terms of decision-making where technical core (administrative vs. technical cores) may have more weight in technological innovation decisions. However, it was consistent with Zmud's (1984) findings where he found managerial influence is stronger for technological innovations.

In connection with a matrixed work structure and collective decision-making at DL programs, interview data suggested that DL programs incorporated a flexible management style which accepted input from staff and enabled them to contribute to resolution of work-related problems and the decision-making in technology related issues. Informal communication mechanisms appeared to be highly utilized. Such

management style can be characterized as a participative management style (Marchant, 1982; Oosthuizen & Toit, 1999). Trust, specifically DL administrators' confidence in their staff, was also another important component of the participative management, since they believed that technical staff had the knowledge or skills to contribute (Marchant, 1982). However, the level of participation in management and decision-making was limited to technical issues as discussed earlier. One respondent specifically mentioned during the interview that management style changed as administrators of the DL program changed, and library management literature appeared to corroborate his/her experiences (Eden, 2001; Marchant, 1982; Oosthuizen & Toit, 1999). Furthermore, interview data suggested that respondents' degree of participation varied from one DL program to another. Level of participation is defined as "the extent to which employees [formally and informally] influence final decisions" (Oosthuizen & Toit, 1999, p. 214). Data suggested that size, age, and structure of the program and attitude of administrative personnel were factors influencing level of participation of technical staff in decision-making process. DL programs were generally initiated as an effort to capitalize on advantages of the Internet by providing traditional library services online. These initiatives usually began as small scale DL projects. DL programs become more functionally articulated with different functional units emerging to address different aspects of the program as it grew over time. Administrators' management styles played an important role in mediating the internal climate in terms of coordinating efforts, resolving conflicts, and paying attention to staff' feedback as size (i.e., number of staff) of the program along with number of projects undertaken increased.

DL administrators were inclined to pay special attention to recommendations from their technical staff and accept their input when making technological decisions. On the other hand, they sought external perspectives and confirmation from trusted peers outside of their own DL program regarding the quality of information being offered by the technical staff. This suggests that DL administrators wanted to make sure they were making the right decision while not straying away from trends and best practices in the field into realm of unrealistic endeavors. This also provided evidence that DL administrators' personal characteristics played an important role in the decision-making process. DL administrators' approach for seeking external opinion during decision-making resembled characteristics of early majority in Rogers' (1995) adopter categories and pragmatists in Moore's (1999) adopter categories.

This approach appeared to be consistent with the DL programs' position with regards to applied research. Interview data indicated that DL programs were mainly interested in carrying out applied research that enabled them to adopt technologies or standards that would work and cost less. In other words, it seemed that they were trying to learn more about who is behind the technology, current adopters and their experience, and what others are thinking about the technology including the ones outside of their DL programs. Data also suggested that CoPs were part of this additional and confirmatory information seeking process since peers contacted for additional information were often part of the same community. DL administrators appeared to trust those individuals' technical competence and appreciated their contribution to the community and social accessibility rather than their formal status. It seemed similar to what Rogers (1995) described as opinion leadership, which is an influential and informal position held by

such individuals. Opinion leadership is earned and maintained by a social unit's or an individual's technical competence, social accessibility, conformity to the norms, and contribution to the social system as opposed to its formal status. Opinion leaders were regarded as more influential through informal communication (Rogers, 1995). Formal means of communication channels such as academic journals were among the sources used to validate information recommended by technical staff as well.

Furthermore, management style and work structure of the DL program appeared to influence information seeking behavior of technical staff and their contribution to decision-making process since "empowerment and participation make employees feel significant, committed to learning, team spirited and excited about their work" (Oosthuizen & Toit, 1999).

This finding addressed, in part, first and second research questions of the study. Evidence suggested that there were number of organizational characteristics at play and informed decision-making process. Specifically, management style in the DL programs including participative and authoritative management styles and matrixed work structure were dominant forces in DL programs. Management style and work structure informed the decision-making process from influencing staff members' information seeking-behavior (see Finding 3) to their interaction with colleagues (see Finding 4).

*Finding 2:*

*Digital Library communities of practice play an important role in enabling staff members of a DL program to access up-to-date and experienced-based knowledge, providing a distributed problem-solving and learning platform, facilitating informal communication and collaborative activities among DL programs, and informing the decision-making process.*

As discussed in Chapter II (see section 2.4.1 for a discussion of CoPs in DL field), there were a number of social structures (e.g., organizations) formed in DL field which could be characterized as CoPs although these formations, generally informal, did not call themselves as CoPs. Data provided corroborating evidence by laying out characteristics of such formations in the DL field.

Findings 3 and 4 are also closely associated with this finding in term of explaining staff members' perceptions about CoPs in the DL field and their impact on the decision-making process. Data revealed that DL programs' staff utilized a number of information resources including CoPs in pursuit of meeting their programs' goals and acquiring information about the latest technological developments in the field. Respondents were generally focused on the quality and reliability of information they were able to acquire through CoPs. Access to up-to-date and experience-based knowledge was very important for members to accomplish their tasks especially when working on deadline-oriented projects. CoPs served as a communication platform where they were able to obtain information that had already been reviewed, processed, or tried by other members of the community. Discussions in such communities were perceived by respondents as a part of review process to improve the quality of information. Furthermore, the richness of

experience-based content in these discussions was another important characteristic for respondents. Following these discussions was specifically helpful for respondents in terms of knowing who are knowledgeable and influential and has the expertise in the community. Based on Rogers' (1995) definition, such a position in a social system is referred as opinion leadership and Wenger (2001) classified them as core and active members of a community with respect to their participation and contribution. Although respondents rarely contributed to these discussions, they knew who to contact if needed thanks to these discussions and other activities (e.g., conferences). This finding appears to be consistent with Cross *et al.*'s (2001) findings; they argued that if members of a social structure have the knowledge of who knows what, other members can be more useful for them in solving problems.

As discussed below in Finding 4, interview data revealed that respondents relied heavily on online resources and tools for knowledge generation, sharing, and transfer. The internet provided them with a number of communication tools to initiate new connections, maintain existing ones, and facilitate their participation in CoPs. As discussed in Chapter II (see section 2.3.2 for a discussion of participation in CoPs), being a part of CoP does not necessarily require individual members to meet face-to-face with other members; such meetings and communications could be held and maintained virtually. Interview data suggested that members of CoPs in the DL environment were geographically dispersed and meetings and communications in these CoPs were generally carried out online. Staff members took advantage of conferences and other non-profit organizations meetings to get together face-to-face and discuss issues of interest. In addition, site visits and telephone contacts also served as means of communication

among members. CoPs formed on-campus or in the DL program with colleagues who could an be reached easily both face-to-face and virtually (e.g., local intranet), were also part of information resources and learning environments utilized by respondents. Those involved in on-campus interactions may also be members of a broader CoP. Wenger (2001) argued that a CoP may have a number of subgroups as it grows in size and becomes geographically dispersed (see section 2.3.2 for a discussion of characteristics of CoPs). On-campus CoPs were generally built on existing relationships with colleagues through committee work or collaborative activities with surrounding academic and business units. Extensive use of information technologies and the Internet in DLs enabled individual members of a program to easily connect with other technology enthusiasts on campus or at organizations with close geographical proximity to form CoPs.

Experience-based knowledge is considered one of the key characteristics of tacit knowledge that reflects beliefs, opinions, and insights. Although tacit knowledge cannot be articulated or put into words easily, a shared repertoire developed in CoPs facilitates communication of tacit knowledge. Respondents attached particular attention this aspect of CoPs which provided a venue to access such a content-rich set of knowledge through personal interactions and shared repertoire. As discussed in Chapter II (see section 2.3), learning is a social process and exchange of tacit knowledge is much more challenging than dealing with explicit knowledge, which can be articulated in words and put into documents.

There were several references to the size of DL programs being a factor influencing formation and use of CoPs. As DL programs grew in size, administrators did not pay particular attention to promoting formation of CoPs within the program despite

their potential benefits to the program. Participation in CoPs is voluntary and data suggested that connections in locally networked, physically located (face-to-face), and virtual CoPs are initiated and maintained by individual members' personal efforts. Individual members at different DL programs utilized CoPs differently to the extent it would help to meet program goals, monitor trends in the field, and solve problems. DL administrators recognized connectedness of their members with colleagues internally and externally and welcomed knowledge acquired through CoPs. In connection with Finding 1, CoPs had an impact on the decision-making process where participative management style was in place.

This finding addressed, in part, the third research question of the study. CoPs played an important role by enabling DL members to access information and especially, experience-based knowledge. Although respondents only occasionally contributed to discussions and activities of CoPs, they developed a sense of belonging and commitment to these informal structures. CoPs improve the quality of information generated, shared, and transformed and enable cross-fertilization of ideas by interaction.

*Finding 3:*

*Focus and direction of the DL program impact its members' selection of technical information resources, shape their information-seeking behavior, and, in turn, influence the decision-making process.*

DL programs were generally initiated as small scale projects in 1990s to capitalize on the benefits offered by the Internet to provide traditional library services online. Such projects have gradually grown into programs, where a program is a unit or department within the library and dedicated to the production, maintenance, delivery, and

preservation of wide range of digital resources. Although DL programs' focus on digitization of analog materials and providing access to those materials hasn't changed over the years, their focus has expanded to include preserving cultural heritage materials and providing support for scholarly publishing. Greenstein and Thorin (2002) found that DLs focused initially on digitization efforts and expanded their focus as the role of DLs changed and users' needs evolved.

Staff members of DL programs utilized a number of diverse online and print technical information resources including trade and academic journals, online discussion/message boards, blogs, instant messaging, colleagues, conferences, and CoPs in search for information about latest developments in the field and solutions to day-to-day problems. Use and selection of such information sources varied from one program to another. Interview data indicated that focus and direction of the program were important factors shaping the use and selection of these diverse resources since its staff was striving to accomplish the goals of the program mandated by its administrators or parent institution. As discussed in Finding 1, DL administrators had a tendency to make authority decisions regarding administrative issues including direction of the program, management style, and work structure. Direction of the DL program was closely associated with goals of the program.

DL programs' preference for applied research over basic research was an important outcome of their focus and direction. DL programs chose to engage primarily in applied research the results of which can be directly applied to their work and yield more practical solutions compared to basic research and its results. Staff activities involving knowledge creation, transfer, and sharing, and other social interactions with

their colleagues in and outside of the program were impacted by the focus on applied research. All respondents indicated that their use of online and offline communications were oriented towards attaining program goals, completing projects in hand, and meeting their users' demands. DLs' orientation toward engaging mainly in applied research was an important factor limiting and steering information-seeking behavior of their members. Focus and direction of the program guided respondents' selection of information sources, use of these sources, and their degree of participation in CoPs where they acquire theoretical and practical knowledge and contribute to the field. Morrison (2002) argued that clarity of organizational goals and expectations are closely related with the person's motivation to learn and gain competence which, in turn, guides his/her information-seeking behavior. For example, data indicated that DL programs' orientation toward applied research was closely associated with focus of the program, and staff members adjusted their knowledge acquisition and sharing activities to better serve and meet their responsibilities and program goals.

Focus and direction of the DL program influence and shape organizational culture which impacted staff's use and selection of technical information resources. The term organizational culture as used here (also referred as organizational subculture), relates to individual members' perceptions of a shared belief system within the DL program; this provided a context for social interactions through norms and values in the form of guiding principles for its staff (Abdullah & Othman, 2005; De Long & Fahey, 2000; DeTienne *et al.*, 2004; Liedtka, 1991). Norms refer to commonly accepted set of rules in an organization that dictates individuals' behavior, and they have an important influence on behaviors of the members of a social system (Lesser & Storck, 2001; Nahapiet &

Ghoshal, 1998). Values are ideas, beliefs, and standards of behavior of members to attain organizational goals (De Long & Fahey, 2000; Liedtka, 1991). Focus and direction of the DL program contributed to its staff's perceptions of norms and values of the program which, in turn, influenced information-seeking behavior of its members. Liedtka (1991) argued that organizational norms and values that influence individual members' perceptions often reflect a position taken by senior management and/or by one's immediate supervisor. Furthermore DeTienne *et al*. (2004) argued that norms and values that constitutes organizational culture influence actions and communications of individual members; this includes knowledge creation, transfer, and sharing.

In addition to administrative influence discussed in Finding1, data suggested that DL administrators not only encouraged their staff to closely monitor trends in the field, attend specific conferences, and build informal connections with other DL programs but also valued their feedback and input when making technology-related decisions. For example in one DL Program, technical staff were not allowed to attend certain conferences that they used to regularly attend due to limitations put in place by the new administration and changes were made regarding direction of the program. Eventually, such administrative influence impacted the program's organizational culture which, in turn, informed and shaped information-seeking behavior of members of the program. Chin-Loy (2003) argued that organizational culture influences management style, decision-making, and employee relations and behavior patterns.

This finding addressed, in part, second and third research questions of the study. In connection with the Finding 1, evidence suggested that information seeking behavior of members of DL programs were significantly impacted and informed by focus and

direction of the program. Values and norms of DL programs influenced their members' use and selection of technical information sources including CoPs and in turn the decision-making process was informed by knowledge acquired through these sources.

*Finding 4:*

*Surrounding academic units (e.g., IT unit, Library and Information Science Schools/Departments, Computer Science department) and external partners (e.g., DLF, CNI, other DL programs) serve as important knowledge resources and facilitate formation of informal learning communities. Knowledge acquired through them informs the decision-making process.*

Relationships with surrounding academic units and external entities contributed to CoP activities that respondents were involved in. These relationships were motivated by various objectives including knowledge sharing, learning from others, following latest trends and developments in the field, content acquisition, or collaborative activities. The respondents' degree of participation in activities of CoPs appeared to be influenced and driven by the focus and orientation of the DL program. The DL programs' focus towards carrying out more production work, engaging in applied research, and matrixed work structure influenced respondents' relationships with surrounding academic units and external entities especially in the context of members' information-seeking and communication behavior. Respondents indicated that CoPs provided them with a rich and creative learning environment where they were able to gain considerably from diverse skills, ideas, and perspectives available in CoPs to meet organizational goals as discussed in the CoP literature (Wenger, 2001). In addition, data indicated that respondents knew where to go and who to speak with when specific information needed or they run into

problems. This provides an evidence for existence of interpersonal relationships among their peers. Cross *et al*. (2001) argued that existence of interpersonal relationships is critical in CoP building. Respondents chose to participate in CoP activities not only because of their commitment and sense of belonging but they appreciated the value of knowledge acquired and how it impacted their work. Cohen and Prusak (2001) argued that fostering informal communication, engaging in collaborative activities, and knowledge sharing were essential to meet organizational goals.

As discussed in Findings 1 and 2, respondents relied on broad range of information resources. Data indicated that several characteristics of information resources overlap with important characteristics of CoPs such as quick access to knowledge, originality in ideas, and experience-based knowledge (see section 2.3 for a discussion of characteristics of CoPs). Further, data suggested that CoPs were viewed as repositories for collective knowledge where respondents could access original, innovative, and experience-based knowledge. Respondents utilized a rich mix of communication mechanisms including face-to-face, e-mail, instant messaging, and online discussion boards to convey collective knowledge in CoPs, maintain existing connections, and initiate new ones with their colleagues regardless of their geographical locations. Marwick (2001) argued that these communication mechanisms play important roles in sharing specifically tacit knowledge (e.g., experienced-based knowledge) (see section 2.2.2 for a discussion of communication mechanisms).

According to Wenger (2001), a majority of CoP members rarely participates in discussions and stays peripheral to discussions in the community. Respondents only occasionally contributed to discussions in the community for various reasons; for

example some members thought his/her state of knowledge was not relevant or not sufficient to make contribution, and therefore influenced decisions to participate actively. Wenger *et al.* (2002) argued that the sense of belonging and commitment of members are important characteristics of a CoP and required ingredients for continuity of a community. Although data indicated that respondents only occasionally contributed to discussions in CoPs, they indicated that they felt obligated to help others and contribute to field from time to time since they have benefited from their interaction with CoPs in the past and expect to benefit in future too. Some respondents were contacted by members of other DL programs who happened to part of same CoP to advance their knowledge and learn from their experiences. Members' commitment and sense of being part of something that they appreciate and benefit their organization was a clear indication of their intention to maintain interaction with their peers. Daniel *et al.* (2003) argued that information exchange, knowledge sharing, and knowledge construction are facilitated through continuous interaction among members of a CoP (see section 2.3.4 for a discussion of social capital).

As discussed in Finding 3, DL administrators sought external opinions and confirmation from trusted individuals and colleagues prior to finalizing technology-related questions, issues, or decisions. Respondents, who were not in administrative positions, were also able to make non-mission critical technical decisions occasionally and they also pursued external opinion. Both administrators and technical respondents often chose to consult with trusted colleagues, believed their competence, met occasionally, and chatted about their daily work. Wenger (2001) characterized such social interactions as CoPs. Furthermore, data suggested that closeness (i.e., physical

proximity) and openness of members of a program to others including other academic units facilitate formation of CoPs. Several academic units including schools of Library and Information Science (LIS), the IT unit, or other departments at the library were generally involved in DL projects directly as partners or indirectly providing support and guidance as needed. For example, LIS schools often provided the partnering DL program with expertise of their faculty, and students as interns or employees.

Respondents identified external partners as other DL programs, non-profit organizations such as Digital Library Federation (DLF), and academic units at other educational institutions. The DL programs' strategic and active relationships with these parties qualified them as partners (see section 4.2.3 for a discussion of external partners). Furthermore, conferences, meetings, and other activities organized by non-profit organizations such as DLF also provided a venue for members meet with their colleagues and build connections which benefited their DL programs. Data suggested that in DL programs where a collective decision-making process was in place regarding technology-adoption, participation of DL staff in such conferences and meetings was encouraged.

This finding addressed, in part, the second and third research questions of the study. In connection with Finding 3, evidence suggested that members of DL programs interacted with their colleagues who were not only in close proximity but in other parts of the world through a number of activities. Knowledge acquired through these activities was critical in accomplishing organizational goals. Further, these activities contributed to cultivation and formation of CoPs.

*Finding 5:*

*Technical characteristics (e.g., interoperability, open standards), compatibility with existing technical infrastructure, applicability to existing DL projects, total cost of ownership (e.g., licensing, maintenance cost), technical expertise in the DL program (e.g., staffing, training, learning curve), and success of a pilot project are key decision factors influencing adoption Web services technologies in the DL environment.*

Interview data and documentary evidence revealed a number of factors that influenced and informed the decision-making process. These factors can be grouped into the following categories:

- Organizational
- Individual
- Technical

Some of the organizational factors discussed include management style, focus and direction of the program, size and age of the program, and organizational culture. Organizational factors were closely associated with the organization itself and might be indirectly impacted by a program's staff, for example. Data suggested that administrative personnel had an influence on some of organizational factors. Other factors could be regarded as more individual characteristics of members in terms of their information-seeking and communication behavior. Individual factors appeared to be at play, however their impact on decision-making might vary from one technology to another depending on role of the technology (i.e., mission critical vs. non-mission critical) in the DL program. This finding addresses organizational (e.g., financial concerns, staffing, and technology readiness), individual (e.g., skill-set, past experience, and perceived

usefulness) and technology-specific (e.g., granularity, interoperability, and open standards) factors in the DLs in the context of decision-making.

Respondents identified financial concerns as a critical factor in guiding technology adoption decisions, and these concerns included: initial cost, ongoing cost, payoff, budgetary restrictions, and funding requirements. However the extent of influence of these factors on Web services adoption decisions appeared to vary from one DL program to another depending on the DL program's expectations from the technology, needs, focus, and direction. These expectations and needs were closely related with size and age of the program. Data suggested that as programs grew in size over time, so did their collections, responsibilities, and user expectations. For example, although respondents formed positive opinions regarding open source software, they were aware that lack of necessary skills in the program would be an important factor when getting a project initiated and providing technical support if they chose to use open source software. In addition, acquiring necessary technology skills through hiring new staff members and additional training were also factors impacting cost. Lack of technical expertise as a decision factor appeared to reflect importance of Davis' (1989) ease of use, Tornatzky and Klein's (1982) ease of operation, and Rogers' (1995) complexity as innovation characteristics since adopters' technical background and skills were closely associated with perception of these characteristics. Interview data also revealed that feedback provided by technical staff during trial and implementation stages of a technology could reverse or slow an adoption decision.

Technology readiness of the DL program was another organizational factor appeared to have an influence in the decision-making process. Technology readiness had

two aspects: a human aspect (e.g., expertise, staffing); and the technological compatibility of WS technologies with existing technical infrastructure (i.e., hardware, software, and standards). In addition, technology readiness was also closely associated with availability of financial resources in case a hardware or software upgrade was needed. Respondents noted that compatibility of WS technologies with their existing technological infrastructure was an important factor that informed the decision-making. Tornatzky and Klein (1982) found compatibility as one of the most addressed innovation attributes. Compatibility also refers to consistency of an innovation with existing values and norms of the DL program, as discussed in Findings 1 and 3. Furthermore, technology readiness was also important factor for triability purposes. Small scale experiments were generally conducted in DL programs prior to making an adoption decision.

Interview data revealed that one respondent made an individual level WS adoption decision and was planning to use WS in a non-mission critical application. His/her personal positive experience with WS, his existing skill-set, potential benefits for his work (i.e., Davis' [1985] perceived usefulness), and having easy access to experienced-based knowledge through CoPs appeared to influence his perception and lower his learning curve. Technology–specific factors such as interoperability, modularity, flexibility, and WS subscription service were also decision factors in this case. In other DL programs where WS had already been adopted, adoption decisions were made collectively and WS were used for major applications. Both organizational and technology-specific factors were taken into consideration.

Another important decision factor was technology-specific benefits offered by WS including interoperability, modularity, and open standards. WS provides an

interoperable platform and is built on open standards (e.g., XML) where programs written in different programming languages and running on different operating systems are able to communicate with each other based on open standards and protocols (see section 2.5.5 for a discussion of the WS architecture). Interview data and documentary evidence suggested that interoperability was an important factor since WS would not require major changes in existing technical infrastructure. In addition to interoperability, respondents identified a number of technology-specific factors (see section 4.2.8 for a discussion of technology-specific factors):

- *Modularity and Flexibility*: Ability to act as building blocks to create distributed applications through reuse of existing applications that can be published and accessed over the internet or intranets.
- *Rapid Deployment of Services*: Development time for new applications or services is greatly reduced through use of standard interfaces (e.g., WSDL) and open standards.
- *Scalability*: Ability to handle growing amount of usage loads (e.g., web caching, load balancing).
- *WS Subscription Service (UDDI)*: A registry services for WS and allows other WS applications automatically discover services and use them.

Small DL programs often looked to older and bigger DL programs when it came to adopting new technologies and standards. Their limited financial resources, staff, and skill set were important barriers preventing them from taking initiatives that might be risky for them. These initiatives included technologies or standards that haven't been tried or are in early stages of adoption in other DL programs. They chose to rely on

experiences of other DL programs so that they were less likely to fail and run into unexpected problems. As for bigger programs participating in the study, it appeared that they sometimes wanted to be the first or early adopters of some technologies in the DL environment to set an example for other programs. Though setting an example for other DL programs or wanting to be an early adopter wasn't a key decision factor, it was one of the factors occasionally taken into consideration in decision-making processes.

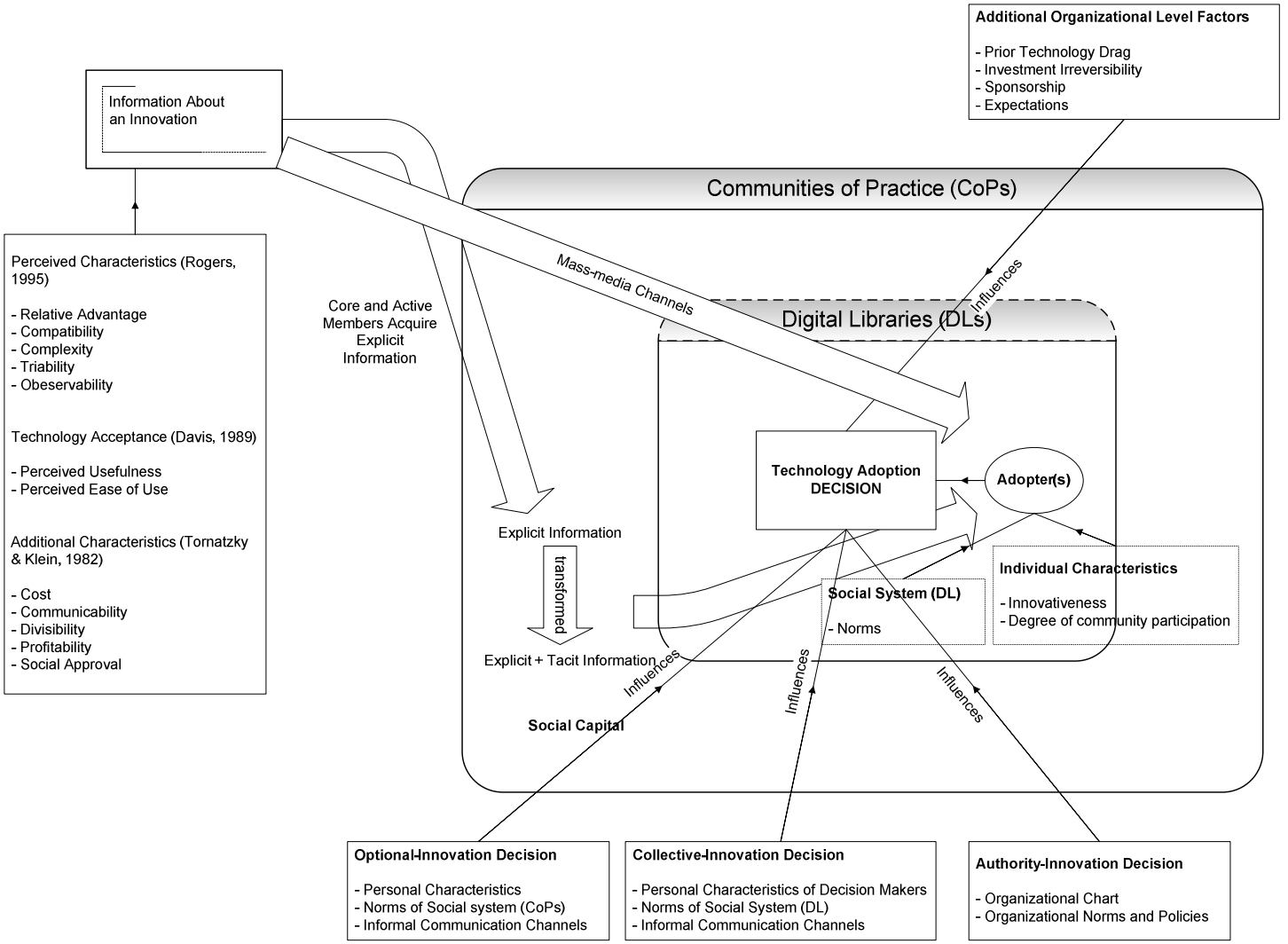
This finding addressed first research question of the study by focusing on specific factors that lead decision-makers to adopt or reject WS in the DL environment. Management style and work structure in DL programs, organizational culture, surrounding academic units, external partners, and CoPs played important roles by influencing information-seeking behavior of DL members and providing access to vital knowledge to meet programs' goals and objectives. However, additional technology-specific and organizational factors eventually determined the decision to adopt or reject WS in the DL environment.

5.2. Revised Conceptual Framework

A preliminary conceptual framework, Figure 2.11, was presented in Ch II, that described the relationships among two theoretical frameworks (Diffusion of Innovations and Communities of Practice theories) employed in this research. The literature review revealed a number of factors at organizational, individual, and technical levels that could influence decision-making process for WS technologies adoption in the DL environment as described in Figure 2.11 (reproduced here). These factors included: Rogers' (1995) perceived innovation characteristics; Tornatzky and Klein's (1982) innovation characteristics, and organizational norms and policies as factors at organizational level;

Davis' (1989) determinants of system use; informal communication channels; and norms of the social system (CoPs).

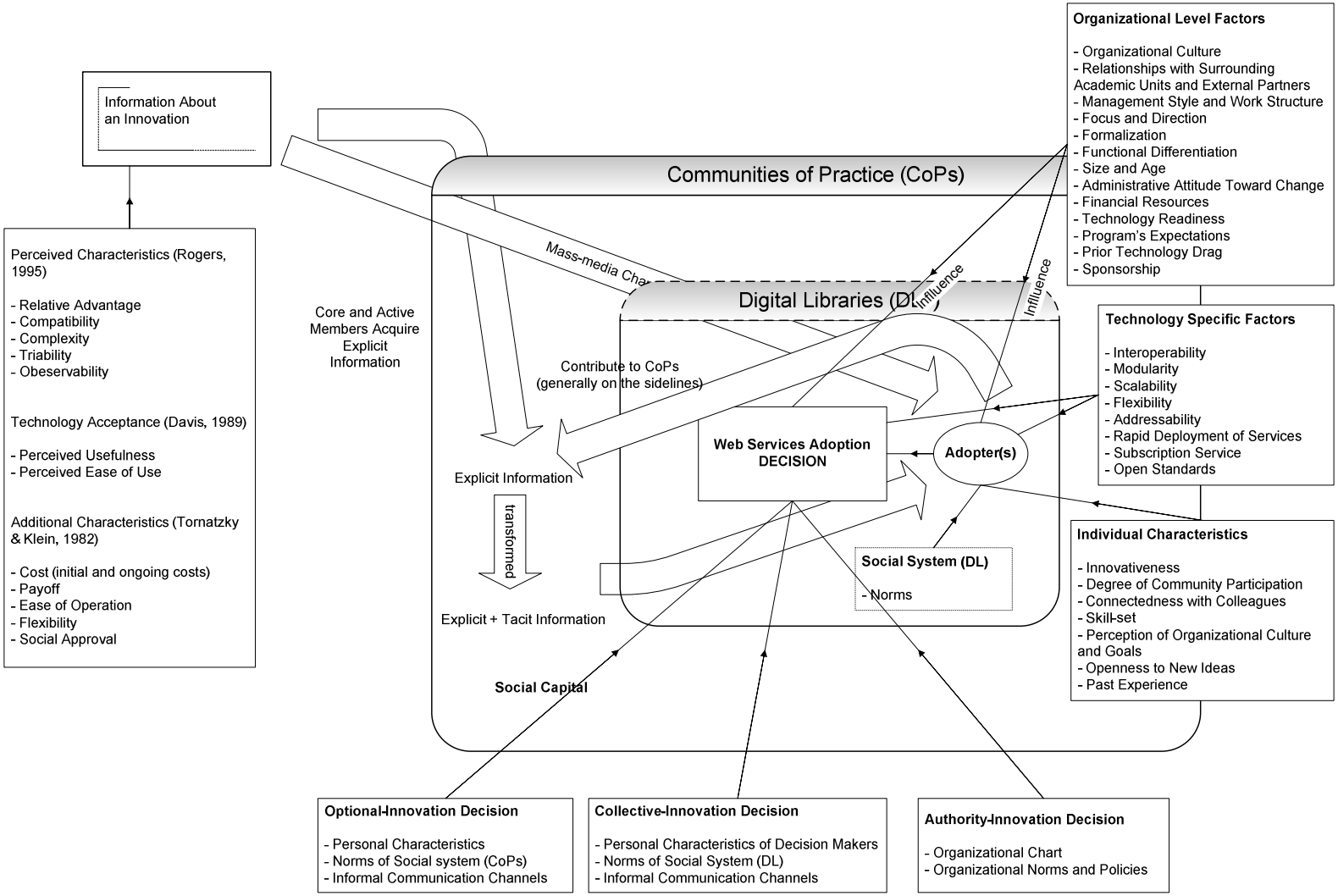
*Figure 2.11.* A conceptual framework in detail.



Analysis of interview data and documentary evidence and informed by relevant literature revealed factors that informed and influenced WS adoption decisions in the DL environment. These factors were grouped at organizational, individual, and technical levels. Data also provided evidence for a number of innovation characteristics suggested by Davis (1989), Rogers (1995), and Tornatzky and Klein (1982) such as relative advantage, compatibility, complexity, triability, perceived ease of use, cost, and social approval in addition to the factors included in the three groups listed above. Characteristics of DL programs that appeared to influence the decision-making process and categorized as organizational factors included: organizational culture, program's relationships with surrounding academic units and external partners, management style and work structure, focus and direction of a program, formalization (e.g., flexibility in hierarchal order), functional differentiation in a program, size and age of a program, administrative attitude toward change, financial resources, technology readiness (e.g., expertise, technology infrastructure), and program's expectations (e.g., user needs). These organizational level factors appeared to play a critical role especially in influencing members' information-seeking and communication behaviors. Individual level factors included: members' connectedness with their colleagues, skill-set (e.g., competence), participation in CoPs, perception of organizational culture and goals, and openness to new ideas. A number of key aspects of WS technologies have been discussed in Chapter II (see section 2.5 for a discussion of WS technologies), which can be identified as technical level factors. These factors included: interoperability, modularity, scalability, flexibility, addressability, rapid deployment of services, subscription service, and open-

standards base of WS. Figure 5.1 presents a revised conceptual framework for the study, with the revisions informed by the results and findings from this research.

*Figure 5.1.* Revised conceptual framework in detail.



Data suggested three types of innovation decisions identified by Rogers (1995) were operative in the DL environment. Two of the participating DL programs have already adopted WS in their DL environments and adoption decisions were made collectively. Two other DL programs were in process of adopting WS at the time of data collection; the decision-making process in one of them appeared to be collective. However, in the other DL program the decision-making process was at the individual level (optional-innovation decision). Data indicated that utilization of WS functionality in the DL environment was an important factor impacting the type of decision made. WS technologies were used or about to be used in key applications in DL programs where collective decision-making was in place. On the other hand, utilization of WS technologies was minimal in a DL program where an optional-innovation decision was made. One DL program has not made an adoption decision yet because of strong administrative influence on technology decision. Although members of the DL program had knowledge of WS, technology decisions were authoritatively made by the DL administration. Technical staff's influence was very limited in the decision-making process.

The revised conceptual model helped the researcher structure the data found analysis in a format which may help the reader see this very complex landscape and understand this complex social process. Further, the revised model provided evidence that Rogers' DOI model needs to be complemented with organizational level factors identified by other researchers such as Daft (1978), Davis (1989), and Tornatzky and Klein (1992) to understand and describe diffusion of innovations in organizational settings.

## 5.3. Answers to Research Questions

Based on the findings discussed in this chapter, this section contains answers to research questions posed by the study.

*Research Question 1:*

*What are the key decision factors that lead decision-makers to adopt or reject WS in the DL environment?*

All of the factors revealed in this study appeared to have a direct or indirect influence at various levels on WS adoption or rejection decisions. A number of organizational, individual, and technical level factors emerged as influencing decision-makers and adoption decisions. Data suggested that availability of financial resources, focus and direction, size and age, collection size, users' and programs' expectations, administrative attitude toward change, and technology readiness were important factors influencing decision-makers. Especially when making an optional-innovation decision, a potential adopter' existing technical skill-set and connectedness with his/her colleagues were key factors. At the technical level, interoperability, modularity, scalability, flexibility, addressability, rapid deployment of services, subscription services, and the open standards base of WS were key decision factors leading decision-makers to adopt or reject WS in the DL environment.

*Research Question 2:*

*What are the activities, entities, processes, motivations, and forces that influence the decision as to adopt or reject WS technologies in the DL environment?*

Interview data and documentary evidence showed that there were number of activities that members of DL programs participated in, entities that provided them with guidance, processes that helped them develop an understanding of WS, motivations that encouraged or discouraged them towards WS technologies, and forces that informed and guided their information seeking and communication behaviors. These activities, entities, processes, and forces were in play when making a decision to adopt or reject WS technologies in the DL environment.

Activities that informed the decision-making process and in which DL members participated included CoP discussions, meetings, conferences, and workshops. Entities in the DL environment generally included CoPs, surrounding academic units and external partners, funding agencies, and the program itself. Decision-makers included members and senior administrative staff and the number of participants in the decision-making varied depending on the type of innovation decision made. DL members utilized variety of resources during their information-seeking processes. In addition, a feedback process where DL administrators received additional input both from their own technical staff and others (e.g., CoPs) outside of their own program, was another important process influenced WS adoption decisions. Application of WS technologies in a small scale project also served as a proof of concept and informed the decision-making. Project and program goals, willingness to adopt, social approval, perceived usefulness,

innovativeness, sponsorship, and peer-support appeared to be key motivations that influenced and guided decision-makers. The forces that influenced the decision-making process included management style and work structure, technological trends in the field, availability of financial resources, size and age of the program, functional differentiation, program's culture, formalization, administrative attitude toward change, and prior technology drag.

*Research Question 3:*

*What are the roles played by CoPs as informal communication channels on WS adoption decisions in the DL environment?*

DL staff engaged in activities of CoPs to advance their own knowledge, improve their work processes, produce solutions to problems, share their experiences, and contribute to field. Data revealed that one of the most valued characteristics of CoPs was the ability to provide their members with a gateway to experience-based knowledge.

CoPs attracted individuals with diverse backgrounds and skills from all around the world regardless of their geographical locations and provided an informal learning platform for their members. These CoPs were generally built and maintained in an online environment and occasionally supported with face-to-face interactions. In addition to these distributed virtual CoPs, there were other CoPs, which may be subgroups of a broader CoP, that were locally networked and physically located. Participation of members in discussions in CoPs enabled these online communities to cultivate and nurture knowledge acquired thorough experience, print or other online resources and, in turn, these discussions enhanced members' understanding of the technology. In other words, this mediating process gave rise to cross-fertilization of ideas and appeared to

improve credibility of the knowledge generated and housed in CoPs. CoPs provided a living repository for the knowledge generated within the community while they were also perceived as places where up-to-date and quality information could be acquired. CoPs were also used to verify information acquired from different sources.

CoPs played a significant role for DL members when they were searching new knowledge in pursuit of meeting their programs' goals. Data suggested that although DL staff utilized variety of technical information sources, CoPs provided an unparalleled access to tacit knowledge (i.e., experienced-based knowledge) as well as explicit knowledge. CoPs promoted sharing and dissemination of tacit and explicit knowledge, which in turn informed the decision-making process.

## 5.4. Implications for Future Research

This study provided evidence that CoPs as informal communication channels and other factors (i.e., organizational, individual, and technical) influence and inform the WS adoption decisions in the context of DLs.

Since the study employed a qualitative case study approach that supported the exploratory and descriptive nature of the research, results and findings of the study are not intended to be statistically generalizable to other technology adoption cases. Detailed description in the narrative may assist the reader of this case study research to determine applicability of findings in his/her own setting. Although factors impacting the decision-making process such as organizational and individual level factors could be considered as revelatory (i.e., exemplary), a large scale quantitative study with larger sample pool aimed at measuring impact of factors revealed in this study would yield generalizable results and add new dimensions to the understanding of decision-making process in the

DL environment. In addition, measuring the impact of CoPs on the decision-making process would also provide new knowledge and generalizable results to help understand roles of CoPs better in this process.

The findings suggested that stakeholders including funding agencies and users had an influence on the decision-making process. A study focusing on the analysis of stakeholders' impact on the decision-making process in DLs would contribute to the understanding of this complex social process.

Respondents cited lack of financial resources and staff as important barriers preventing them from taking on innovative initiatives. Knowledge could be gained by studying how DLs are assessing the economics of these new technologies in the DL environment. Data provided some evidence that although DLs are very enthusiastic about open source software, they clearly recognized that this software has its own risks.

The information landscape is transformed as technology rapidly changes and DLs often find themselves in a critical position to make a decision whether to adopt or reject emerging technologies. This study revealed a number of factors (e.g., organizational) influencing the decision-making process, that might apply other technology adoption decisions. Additional research necessary to address what DL programs should do in order to balance the needs of DLs (e.g., user needs and expectations, programs' goals) and exploit dynamically changing technology environment, and thus findings of this study can inform this additional research.

## 5.5. Summary

This research was an exploratory and descriptive study to shed a light on the decision-making process to adopt or reject a new technology in the context of DLs and

the unit of analysis was the decision to adopt or reject a new technology. The researcher had assumed that a case study of WS would provide a significant opportunity to explore roles and influence of CoPs to understand and describe decision factors related with technology adoption.

The researcher collected and analyzed pertinent data including interview transcripts, documentary evidence, and comprehensive member check to answer the study's research questions.

The complexity of the decision-making process and the variety of factors that informed and influenced this process are reflected in Chapters IV and V. The literature review (Chapter II) suggested this is a complex process (see Figure 2.11), and the findings informed and provided details about the complexity. The theoretical frameworks selected for this study proved useful to achieve the goal of the study. Further, the research included additional relevant literature to support findings of the study. The researcher attempted to provide a complete account of decision factors related with technology adoption in the DL environment. An outcome of this study suggests that an exploratory and descriptive study such as this is an important step towards understanding the decision-making process as technologies rapidly change in the DL environment. The study provides an adequate foundation for further research on the impact of organizational, individual, and technology-specific factors on decision-making processes in the DL environment.

# APPENDIX A

## DIGITAL LIBRARY TECHNOLOGIES & STANDARDS

This appendix provides a list of various digital library technologies and standards adopted and used to develop, implement, and improve digital library systems ("Digital Library Technologies," 2004).

1. Digital Library Software
    1.1. The Flexible Extensible Digital Object and Repository Architecture (Fedora) <http://www.fedora.info/>
    1.2. Greenstone Digital Library Software <http://www.greenstone.org />
    1.3. The D-Space Digital Repository System <http://www.dspace.org/>
    1.4. EPrints <http://www.eprints.org/>
2. Metadata
    2.1. Dublin Core
    2.2. Metadata Encoding and Transfer Schema (METS) <http://www.loc.gov/standards/mets/>
    2.3. Metadata Object Description Language (MODS) <http://www.loc.gov/standards/mods/>
    2.4. Encoded Archival Description (EAD) Format <http://www.loc.gov/standards/ead/>
    2.5. Open Archives Initiative (OAI) <http://www.openarchives.org/>

2.6. SFX and Open-URL <http://www.exlibrisgroup.com/sfx_openurl.htm>

3. eXtensible Markup Language (XML)

   3.1. XML Protocol <http://www.w3.org/XML/>

4. Server and Storage Software

   4.1. Apache HTTP Server <http://httpd.apache.org/>

   4.2. MySQL Database Server <http://www.mysql.com/>

   4.3. Lightweight Directory Access Protocol (LDAP) Directory Server

5. Programming Environment

   5.1. PHP Hypertext Preprocessor (PHP) <http://www.php.net/>

   5.2. Java Platform <http://java.sun.com/>

   5.3. Web Services <http://www.w3.org/2002/ws/>

## APPENDIX B

## VARIATIONS IN DEFINITIONS OF A DIGITAL LIBRARY

Fox (1998) collected a number of definitions of the term, “digital library,” from the literature. Each definition reflects different approaches and community perspectives on "digital libraries."

1. The new digital libraries will have features not possible in traditional libraries, thereby extending the concept of library far beyond physical boundaries. They will provide innovative resources and services. One example is the ability to interact with information: rather than presenting a reader with a table of numbers, digital libraries allow users to choose from a variety of ways to view and work with the numbers, including graphical representations that they can explore. With the extensive use of hypertext links to interconnect information, digital libraries enable users to find related digital materials on a particular topic.
2. Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use a by a defined community or set of communities.
3. Digital libraries are complex data/information/knowledge (hereafter information) systems that help: satisfy the information needs of users (societies), provide information services (scenarios), organize information in usable ways (structures),

manage the location of information (spaces), and communicate information with users and their agents (streams).

4. Digital library work occurs in the context of a complex design space shaped by four dimensions: community, technology, services and content.
5. The field of digital libraries deals with augmenting human civilization through the application of digital technology to the information problems addressed by institutions such as libraries, archives, museums, schools, publishers and other information agencies. Work on digital libraries focuses on integrating services and better serving human needs, through holistic treatment irrespective of interface, location, time, language and system. Although substantial collections may be created solely for the use of individuals, we consider sharable resources one of the defining characteristics of libraries. Libraries connect people and information; digital libraries amplify and augment these connections.
6. The Digital Library is:
    - The collection of services
    - And the collection of information objects
    - That support users in dealing with information objects
    - And the organization and presentation of those objects
    - Available directly or indirectly
    - Via electronic/digital means.
7. Digital library is a concept that has different meanings in different communities. To the engineering and computer science community, digital library is a metaphor for the new kinds of distributed data base services that manage unstructured

multimedia data. To the political and business communities, the term represents a new marketplace for the world's information resources and services. To futurist communities, digital libraries represent the manifestation of Wells' World Brain. The perspective taken here is rooted in an information science tradition.

8. An organized data base of digital information objects in varying formats maintained to provide unmediated ease of access to a user community, with these further characteristics:
    - An overall access tool (e.g. a catalog) provides search and retrieval capability over the entire data base;
    - Organized technical procedures exist through which the library management adds objects to the data base and removes them according to a coherent and accessible collections policy.
9. Digital libraries are a set of electronic resources and associated technical capabilities for creating, searching, and using information. In this sense they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium (text, images, sounds; static or dynamic images) and exist in distributed networks. The content of digital libraries includes data, metadata that describe various aspects of the data (e.g., representation, creator, owner, reproduction rights), and metadata that consist of links or relationships to other data or metadata, whether internal or external to the digital library.
10. Digital libraries are constructed -- collected and organized -- by a community of users, and their functional capabilities support the information needs and uses of

that community. They are a component of communities in which individuals and groups interact with each other, using data, information, and knowledge resources and systems. In this sense they are an extension, enhancement, and integration of a variety of information institutions as physical places where resources are selected, collected, organized, preserved, and accessed in support of a user community. These information institutions include, among others, libraries, museums, archives, and schools, but digital libraries also extend and serve other community settings, including classrooms, offices, laboratories, homes, and public spaces.

11. Systems providing a community of users with coherent access to a large, organized repository of information and knowledge.
12. Systems providing a community of users with coherent access to a large, organized repository of information and knowledge. This organization of information is characterized by the absence of prior detailed knowledge of the uses of the information. The ability of the user to access, reorganize, and utilize this repository is enriched by the capabilities of digital technology.
13. A library that has been extended and enhanced by the application of digital technology. Important aspects of the digital library that may be extended and enhanced include:
    - Collections of the library
    - Organization and management of the collections
    - Access of the library items and the processing of the information contained in the items

- Communication of information about the items.

14. The generic name for federated structures that provide humans both intellectual and physical access to the huge and growing worldwide networks of information encoded in multimedia digital formats.
15. A digital library is a distributed technology environment which dramatically reduces barriers to the creation, dissemination, manipulation, storage, integration, and reuse of information by individuals and groups.
16. A digital library is a machine readable representation of materials which might be found in a university library together with organizing information intended to help users find specific information. A digital library service is an assemblage of digital computing, storage, and communication machinery together with the software needed to reprise, emulate, and extend the services provided by conventional libraries based on paper and other material means of collecting, storing, cataloging, finding, and disseminating information.

## APPENDIX C

## PARTICIPATING DIGITAL LIBRARY PROGRAMS

Demographic information of participating digital library programs.

1. California Digital Library
    - Personnel in the Digital Library Program: 77
    - First Digital Library project started: 1997
    - Number of respondents: 1
    - Respondent's average years of experience: 10
    - Web Services Adoption: 2003
    - Membership: DLF, CNI
2. University of Texas at Austin
    - Personnel in the Digital Library Program: 66
    - First Digital Library project started: 1992
    - Number of respondents: 1
    - Respondent's average years of experience: 11
    - Web Services Adoption: 2003
    - Membership: DLF, CNI, ARL
3. University of Texas at Dallas
    - Personnel in the Digital Library Program: 2
    - First Digital Library project started: 2003
    - Number of respondents: 2

- Respondent's average years of experience: 3
- Web Services Adoption: In progress
- Membership: -

4. University of North Texas
   - Personnel in the Digital Library Program: 8
   - First Digital Library project started: 1997
   - Number of respondents: 2
   - Respondent's average years of experience: 7
   - Web Services Adoption: In progress
   - Membership: CNI
5. The undisclosed university in the American South East
   - Personnel: 8
   - Digital Library projects started: 2002
   - Number of respondents: 1
   - Respondent's average years of experience: 4
   - Web Services Adoption: Not adopted yet.
   - Membership: CNI, ARL

# APPENDIX D

## INTERVIEW PROTOCOL

This appendix contains the semi-structured interview protocol that was used by the researcher when conducting interviews to understand and describe decision factors related with technology adoption in the digital library environment.

Semi-structured interviews up to forty five minutes in length will allow the researcher to explore the phenomenon in depth and answer the research questions posed by the study.

Semi-Structured Interview Guide

"Thank you for agreeing to participate in this research study. I will record our conversation with a digital audio recorder with your permission. The recording of the interview will be transcribed and you will be provided with a copy of the transcript to review and correct possible discrepancies, if there is any. Your answers will be considered confidential and your identity will not be disclosed without your consent."

*Background Information about Interviewee*

- Date:
- Name:
- What is your job title?
- What primary functions does your job involve?
- When first digital library related project was started in your library?
- What is the main focus of your digital library program?

- How your digital library organized? (e.g., confederally or independent unit of library)
- How would you describe your library's relationship with surrounding departments in digital library projects?
- How do you describe involvement of your organization in digital library related projects?

*General Questions related to Decision-Making Process*

I'd like to understand how you seek information about new technological developments related with digital libraries both face-to-face and virtually within the boundaries of your organization and outside. How does it work?

- What is degree of formality of your interactions?
- What are the important characteristics of your information sources?
- Do you think that you belong to a form of informal information sharing and learning community?
- What is your position in the community?
- What is the purpose of the community or communities you belong to?
- How does the knowledge that you obtain through the community influence your work?

I'd like to focus specifically on Web services technologies in the context of digital libraries.

1. When and how did you hear about Web services first?
2. What were the advantages and disadvantages of the technology?

3. How did the decision get made to adopt or reject the use of WS technologies in digital library projects?
4. What were the important factors influencing the decision?
5. What was your role in the decision-making process?

APPENDIX E

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH (IRB)

UNT
UNIVERSITY OF NORTH TEXAS
DISCOVER THE POWER OF IDEAS

Office of Research Services

March 8, 2006

Fatih Oguz
School of Library and Information Sciences
University of North Texas

Institutional Review Board for the Protection of Human Subjects in Research (IRB)
RE: Human Subject Application #06-028

Dear Mr. Oguz:

The UNT IRB has received your request to modify your study titled "Web Services Technologies in Digital Libraries: An Exploration of the Diffusion of a New Technology from Communities of Practice Perspective." As required by federal law and regulations governing the use of human subjects in research projects, the UNT IRB has examined the requested modifications. The modifications to this study are hereby approved for the use of human subjects. **Approval for this project is February 16, 2006 through February 15, 2007.**

It is your responsibility according to U.S. Department of Health and Human Services regulations to submit annual and terminal progress reports to the IRB for this project. Please mark your calendar accordingly. The IRB must also review this project prior to any other modifications made. **Federal policy 21 CFR 56.109(e) stipulates that IRB approval is for one year only.**

Please contact Shelia Bourns, Research Compliance Administrator, at (940) 565-3940, or Boyd Herndon, Director of Research Compliance, at (940) 565-3941, if you wish to make changes or need additional information.

Sincerely,

Shelia Bourns

For: Scott Simpkins, Ph.D.
Chair
Institutional Review Board

SS/sb

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APPENDIX F

SAMPLE LIST OF DOCUMENTARY EVIDENCE

Documentary evidence is utilized as complementary to the interview data. Documentary evidence included meetings minutes and reports, digital library (DL) programs' websites, presentations and publications authored by DL members, and reports submitted to funding agencies by participating DL programs.

- Minutes for five meetings held in 2006 (January - April) provided by the DL program at University of North Texas
- Minutes for a meeting held in November 2005 provided by the DL program at University of Texas at Dallas
- Minutes for seventeen meetings held in 2002 and 2003 provided by the DL program at the university in the American Southeast (ASE). Name of this institution has not been disclosed as requested by the respondent.
- UNT Libraries: Digital Projects Units – About. Retrieved July 12, 2006 from http://www.library.unt.edu/digitalprojects/about/about.htm
- UNT Libraries: Digital Projects Units – History. Retrieved July 12, 2006 from http://www.library.unt.edu/digitalprojects/about/history.htm
- UNT Libraries: Digital Projects Units – Contacts. Retrieved July 12, 2006 from http://www.library.unt.edu/digitalprojects/about/contacts.htm

- UNT Libraries: Digital Projects Units – Contacts. Retrieved July 12, 2006 from http://www.library.unt.edu/digitalprojects/documentation/publication.htm
- CDL: Overview & Mission. Retrieved July 12, 2006 from http://www.cdlib.org/glance/overview.html
- CDL: Organization. Retrieved July 12, 2006 from http://www.cdlib.org/glance/organization.html
- CDL: Programs. Retrieved July 12, 2006 from http://www.cdlib.org/programs/index.html
- Inside CDL: Strategic Technology, Architecture, and Standards Working Group. Retrieved July 12, 2006 from http://www.cdlib.org/inside/groups/stas/index.html
- Digital Library Building Blocks: Empowering Libraries in an Increasingly Competitive Online Information Space. Retrieved August 14, 2006 from http://www.cni.org/tfms/2005a.spring/abstracts/presentations/cni_greenstein_digital.ppt
- CDL's OAI Harvest Architecture Development. Retrieved August 14, 2006 from http://www.cdlib.org/inside/projects/amwest/dlf200504_oaiArch_landis.pdf
- Rethinking How We Provide. Bibliographic Services for the University of California. Retrieved August 14, 2006 from http://libraries.universityofcalifornia.edu/sopag/BSTF/Final.pdf

- Preserving Digital Materials. Final IMLS Report from the CDL. Retrieved August 14, 2006 from http://www.cdlib.org/inside/projects/preservation/IMLS_pres_repo_report_05.pdf
- California Digital Library. The Costs of Containment. Frameworks and the Web. Retrieved August 14, 2006 from http://www.ukoln.ac.uk/events/bl-jisc-conference-2006/presentations/p-brantley.ppt
- California Digital Library. Deploying Services, Not Libraries. Retrieved August 14, 2006 from http://seminar.deff.dk/presentations/brantley1.ppt
- University of Texas Libraries Executive Staff. Retrieved April 5, 2006 from http://www.lib.utexas.edu/vprovost/exec_staff.html
- UT Library Online – Digital Library Projects. Retrieved July 12, 2006 http://www.lib.utexas.edu/dlp/search.html?search_for=dlsd&submit.x=209&submit.y=8
- Digital Library Technologies, Protocols, and Best Practices at UT Austin.. Retrieved December 10, 2005, from http://www.lib.utsystem.edu/libraries/projects.html

APPENDIX G

COMPREHENSIVE MEMBER CHECK TOOL

A comprehensive member check tool was sent to research participants via e-mail on January 19, 2007. Respondents were provided with latest drafts of Chapters IV, Results and Findings, and Chapter V, Discussion and Conclusions, at the time in case further information might be needed. Respondents were given fifteen days to respond.

**Finding 1:**

*Organizational characteristics (e.g., work structure and management style) of a DL program have an influence on technology related decisions.*

**Description:**

"DL programs incorporated a flexible management style which appreciated input from staff and empowered them to contribute to resolution of work-related problems. DLs' flexible structure and functional differentiation within programs lead to a matrixed work structure, which allowed DLs draw people from different units of the program, external partners, and faculty members together face-to-face and virtually to take part in different stages of DL projects. A matrixed work structure created a social venue for respondents to communicate and share information informally with their colleagues which improved their skills, knowledge, and contributed to decision-making process."

**Comment:**

**Finding 2:**

*Focus and direction of the DL program impacts its members' selection of technical information resources, shape their information-seeking behavior, and, in turn, influence the decision-making process.*

**Description:**

"Focus and direction of the DL program contributed to its individual members' perceptions of norms and values of the program which, in turn, influenced its members' information-seeking behavior. Technology decisions were made by members of the

program, however number of participants involved in decision-making and their degree of participation vary depending on the nature of the decision."

**Comment**:

**Finding 3:**

*Surrounding academic units (e.g., IT unit, Library and Information Science Schools/Departments, Computer Science department) and external partners (e.g., DLF, CNI, other DL programs) serve as important knowledge resources and facilitate formation of informal learning communities. Knowledge acquired through them informs the decision-making process.*

**Description:**

"DL programs use wide array of information sources to access information about latest technological developments such as colleagues, conferences, mailing lists, DL related organizations (e.g., CNI, DLF), and other DL programs. Such resources facilitate formation of informal learning communities which serve as an important information source providing access to, specifically, experienced-based knowledge and contribute to the decision-making process."

**Comment**:

**Finding 4:**

*Digital Library Communities of Practice play a significant role in enabling members of a DL program to access up-to-date and experienced-based knowledge, providing a distributed problem-solving and learning platform, facilitating informal communication and collaborative activities among DL programs as well as informing the decision-making process.*

**Description:**

"DL communities provide a platform where members of DL programs get together with their colleagues, share ideas, help each other, engage in collaborative activities, and contribute the field. Knowledge acquired through these communities contributes to the decision-making process."

**Comment**:

**Finding 5:**

*Technical characteristics (e.g., interoperability, open standards), compatibility with existing technical infrastructure, applicability to existing DL projects, total cost of ownership (e.g., licensing, maintenance cost), technical expertise in the DL program (e.g., staffing, training, learning curve), and success of a pilot project are key decision factors influencing adoption Web services technologies in the DL environment.*

**Comment**:

Your Name: (optional)

Send Form Reset

# APPENDIX H

## CODEBOOK

This appendix contains the codebook developed based on the coding of semi-structured interviews. A coding system has been developed inductively to organize the data. This appendix includes themes which represent coding families and organizing categories into which a set of individual codes are consolidated. The first list is labels for coding families, categories, and individual codes. The second list contains working definition for organizing categories.

Management Style and Structure of the Digital Library (DL) Program

- MSS: Matrix Structure
  - Consensus Building
  - Project Management
- MSS: Hierarchical Structure
  - Follow the Leader
  - Administrative Oversight
  - Micromanagement
- MSS: Flat Structure
- MSS: Loose Structure
- MSS: Functional Units
  - User Services Unit
  - Licensed Content Unit
  - Technology Unit
  - Digitization Unit
- MSS: Informal Channels

Focus and Orientation of the DL Program

- FO: Production Work
  - Digitization
  - Preservation
  - Reformatting
  - Content Production
  - Providing Access to Resource
  - Providing Software Services
  - Bibliographic Services
- FO: Applied Research
- FO: Best Practices Model
  - Innovative
  - Meeting National Standards

Relationship with Surrounding Academic Units and External Entities

- RAUEE: Content Acquisition
  - Outreach
- RAUEE: Partnership
  - Liaisons
  - LIS Programs
  - Strategic Development & Partnership
  - Collaboration
- RAUEE: Consulting/ Obtain Information
  - Advising

    - Consulting
    - Obtain Information
- RAUEE: Complexity

Information Resources and Communication Behaviors

- IRCB: Community
    - Colleagues
    - Committee Work
    - Groups of Friends
    - Open Source Community
    - Tech Companies
- IRCB: Online Tools
    - Blogs
    - Internal Mailing Lists
    - Vendor Mailing Lists
    - Online Mailing Lists
    - Project Wikis
    - White Papers
    - Online Search
    - Instant Messaging
- IRCB: Conferences
    - LITA
    - CNI
    - EDUCAUSE
    - DLF

Characteristics of Information Resources

- CIR: Innovativeness
- CIR: Originality
- CIR: Up-to-date
    - Latest Information
- CIR: Experience-based
    - Feedback from Actual Users
- CIR: Informal Connections
    - Personal Contacts
    - Through Friends

Participation in Communities

- PC: Motivating Factors
    - Knowledge Sharing
    - Access to Experience-based Knowledge
    - Solve Problems
    - Contribute to the Field
- PC: Collaboration
- PC: Sense of Belonging
- PC: Participation
    - Active Member
    - Sideliner

Technology Adoption Decision

- TAD: Evolving Field
    - Resources Needed to Meet Demand
- TAD: Optional-Innovation Decision
    - Adoption decision for non-mission critical tasks
    - Ease of Use
- TAD: Collective-Innovation Decision
    - Confidence in Technical Staff
- TAD: Authority-Innovation Decision
    - Administrative Decisions
    - Conflict Resolution
- TAD: Validate with Others
    - Informal Communication Channels
    - Colleagues

Factors and Web Services

- FWS: Financial Concerns
    - Cost (licensing, maintenance, etc.)
    - Funding Requirements
    - Training
- FWS: Human Capital
    - Staff
    - Expertise
    - Skill Set
    - Relevant Knowledge

- FWS: Technology Readiness
  - Compatibility
  - Moving Parts
- FWS: Technological Superiority
  - UDDI
  - Interoperability
  - Addressability
  - Flexibility
  - Modularity
  - Uniformity
  - Open Standards
  - Scalability

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Management Style and Structure of the Digital Library (DL) Program

- MSS: Matrix Structure: References to work structure that is project-based and permits members from various functional units to work on the same project.
- MSS: Hierarchical Structure: References to traditional organizational structure.
- MSS: Flat Structure: References to few or less layers of management structure.
- MSS: Loose Structure: References to flexibility in temporary employee management and insignificance of hierarchical distinction in information sharing.
- MSS: Functional Units: References to units or program areas in a DL program.
- MSS: Informal Channels: References to interpersonal information sharing mechanism and refers to face-to-face interactions of members regardless of their rank.

Focus and Orientation of the DL Program

- FO: Production Work: References to activities and services that are related with transforming analog materials and making these and born-digital materials available online (e.g., digitization, preservation, bibliographic services).
- FO: Applied Research: References to research activities geared towards getting quick results that could be applied to existing DL applications or projects.
- FO: Best Practices Model: References to activities of learning from other DL programs' experiences.

Relationship with Surrounding Academic Units and External Entities

- RAUEE: Content Acquisition: References to one of purposes and benefits of building relationships with surrounding academic units.

- RAUEE: Partnership: References to strategic and active relationships built with academic units and external entities.

- RAUEE: Consulting/Obtain Information: References to nature of information sharing activities

- RAUEE: Complexity: References to complex structure of the relationships due to involvement of various groups and units.

Information Resources and Communication Behaviors

- IRCB: Community: References to a form of social structure serving as an information resource. These information sources can be characterized as communities of practice since through these communities members share their knowledge and experiences, interact regularly, and solve common problems,

- IRCB: Online Tools: References to online discussion groups that use automated e-mail distribution systems. These tools also include blogs and wikis.

- IRCB: Conferences: References to prearranged professional meetings for consultation, information exchange, or discussion.

Characteristics of Information Resources

- CIR: Innovativeness: References to ideas communicated through certain information sources, which are perceived as novel and new.

- CIR: Originality: References to ideas communicated through certain information sources, which are perceived unconventional.

- CIR: Up-to-date: References to ideas that are perceived as current.

- CIR: Experience-based: References to ideas that are generated result of an experience.

- CIR: Informal Connections: References to connections that are maintained through interpersonal relationships informally regardless of ones' position in an organizational structure.

Participation in Communities

- PC: Motivating Factors: Describes factors that motivate individuals to participation in communities. These factors include sharing ideas and contributing to the field.

- PC: Collaboration: Describes an advanced stage of collegial activity which may also involve DL programs beyond sharing ideas.

- PC: Contribute to the Field: References to respondents' contribution to the collective knowledge in the field through community activities.

- PC: Sense of Belonging: Describes respondents' perceptions regarding being part of a community. Members show mutual concern for each other and their problems.
- PC: Participation: Reference to respondents' degree of participation in activities of CoPs.

Technology Adoption Decision

- TAD: Evolving Environment: Statements relating to gradual changes in the DL environment as user needs and technologies evolve.

- TAD: Optional-Innovation Decision: Description of decision-making process at individual (personal) level.

- TAD: Collective-Innovation Decision: Description of the decision-making process that allows DL members to participate in.

- TAD: Authority-Innovation Decision: Description of the decision-making process involves a few individuals who are administrative positions.

- TAD: Validate with Others: A process of seeking external opinion which is carried out by administrative staff. It takes place after making a collective-innovation decision regarding mission-critical technologies.

Factors and Web Services

- FWS: Financial Concerns: Describes financial issues impacting the decision-making process. These issues are also related to availability of financial resources.

- FWS: Human Capital: References to set of skills, education, experience, and training possessed by members, specifically technical staff, of DL programs.

- FWS: Technology Readiness: References to maturity of technological infrastructure of DL programs prior to incorporating Web services technologies into a system.

- FWS: Technological Superiority: References to benefits and advantages of WS technologies over existing ones.

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