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Description	

Integration of knowledge management process into digital library system: a theoretical perspective

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Integration of knowledge management process into digital library system: a theoretical perspective

Abstract

Purpose- The main purpose of the study is to develop a theoretical framework of an integrated digital library (DL) system based on knowledge management (KM) process.

Design/ methodology/approach- The study is based on viewpoints, review of existing concepts and frameworks of DL and KM, and the result of an interview of nine (9) DL practitioners world-wide. The respondents were purposively selected from the participants' lists of two international conferences held in 2008. The interview was conducted through e-mail using a short, structured, and open-ended questionnaire.

Findings- The study finds some significant overlaps between DL and KM and argues that a generic KM process of acquisition, organization, storage and retrieval, and dissemination of knowledge with receiving feedbacks can suitably be fitted in DL. Thus an integrated DL system can be consisted of digital resources, technological infrastructure, experience and expertise, DL services, and a KM process. The integration of KM can add value to developing a knowledge-based culture, management of intellectual assets, promotion of knowledge sharing, innovations in DL services, and a strong leadership position for DL.

Research limitations / implications- The research presents theoretical viewpoints of DL and KM, and the model, therefore, demands for practical investigation.

Practical implications- The study suggests the adoption of KM process in DL system to enhance its effectiveness.

Originality/value- The proposed model is an original work and theoretically, it would contribute to the advancement of academic debate in both the areas of DL and KM.

Keywords: Digital library, digital library system, knowledge management, knowledge management process, integration, theoretical perspective.

Introduction

The digital revolution of the past few decades have made a radical impact on library practices in collecting, organizing, storing, retrieving, and disseminating information globally. With the advent and widespread use of microcomputer, libraries are now transforming their information handling activities into digital format. In 1965, J.C.R. Licklider coined the phrase "library of the future" to refer to his vision of a fully computer-based library, and ten years later, F.W. Lancaster wrote of the soon-to-come "paperless library" (Harter, 1997). Nowadays, phrases like "virtual library", "electronic library", "library without walls", "Internet library", "digital library", etc. have been appeared in the literature to describe the changing face of a library in the context of the adoption of technological innovations in library practices. Although these terms are

often used interchangeably, they are distinct from one another. Being emerged in the 1990s, the concept of digital libraries (DLs) has become very popular among the disciplines of computer science, cognitive science, and library and information science (LIS). The overwhelming growth of DL has opened up new horizons in LIS, as Fox (1999) describes that the field goes far beyond supporting traditional libraries, addressing core requirements of the information age and the world of information technology, as well as new sub-areas like knowledge management and content management.

As a business concept, knowledge management (KM) emerged during the mid-nineties and received a considerable attention from many scholars and practitioners. KM has been practiced by a number of fields associated with information systems, business and management, library and information science, computer science, communications, etc. Wen (2005) describes its emergence first in the business sector, then in higher education, and now in library management. Although the emergence of KM can be traced to only last decade, Hawkins (2000) claims that for many in the academic world, KM is an old concept, a function historically performed by librarians. Broadbent (1998), on the other hand, mentions that KM is not about managing or organizing books or journals, searching the Internet for clients or arranging for the circulation of materials, rather she considers these activities as parts of KM spectrum and processes in some way. KM in its simplest sense, can be described as the management of both explicit (recorded) and tacit knowledge.

Many approaches exist on which models of both DL and KM have been built, but an integrated model of knowledge management process in digital libraries can rarely be found in the literature. Some works have focused on KM issues in DL, but they do not represent the central theme of the present work (e.g. Chen, 1999; Rydberg-Cox et al, 2000; Hicks and Tochtermann, 2001). Considering KM as a powerful tool for promoting innovations and reengineering organizational performance, the study attempts to derive a new model of DL system.

Research objectives

Knowledge management is an emerging key concern of many business organizations. The business model of KM is now being adopted by many non-profit organizations like libraries. In digital environment, the role of knowledge has become even more significant. Moreover, digital libraries perform many knowledge-based activities, and by nature, KM process is embedded in digital library system. Therefore, the aim of the study is to develop an integrated framework of a digital library system based on knowledge management process. The specific objectives are to:
- describe a framework of a DL system
- design a KM process model
- explore significant overlaps between DL and KM
- integrate KM process with DL system, and finally to
- describe major implications and benefits of the integrative framework of DL.

Methodology

The study is qualitative in nature, and to attain the defined objectives, an email interview of nine (9) DL practitioners was conducted along with the review of existing concepts and frameworks of both DL and KM. The interviewees were selected from the participants' lists of World Library and Information Congress: 74th IFLA General Conference and Council, 10-14 August 2008, Québec, Canada, and of Joint Conference on Digital Libraries, 16-20, June 2008, Pittsburgh, Pennsylvania, USA. Initially twenty (20) library practitioners were purposively selected based on their professional knowledge, skills and experiences in DL and KM, and personally contacted them via email. Nine persons (2 each from USA and UK, 1 each from Australia, Canada, China, India, and South Africa) were agreed to participate in the study. The interview was conducted using a short and structured questionnaire composed of ten (10) open-ended questions related to library practitioners' views on the concepts of DL and KM, and the issues concerning to the inclusion of KM in DL system. To ensure the anonymity of the interview participants, the study used a coding system for each interviewee like IP1, IP2, IP3, …..and IP9. The findings of the study were thematically analysed and interpreted.

Review of literature

Conceptualizing digital libraries

Digital libraries (DLs) can be viewed from a number of perspectives as Nurnberg et al (1995) mentions that from a database or information retrieval perspective, digital libraries may be seen as a form of federated databases; from a hypertext perspective the field of digital libraries could seem like a particular application of hypertext technology; from a wide-area information service perspective, digital libraries could appear to be one use of the World Wide Web; and from a library science perspective, digital libraries might be seen as continuing a trend toward library automation. Marchionini, Plaisant and Komlodi (2003) consider DL as the logical extension and augmentations of physical libraries in the electronic information society, while Lesk (1997) describes that DLs combine the structure and gathering of information, which libraries and archives have always done, with the digital representation that computers have made possible.

DL as defined by Oppenheim and Smithson (1999) is an information service in which all the information resources are available in computer-processable form and the functions of acquisition, storage, retrieval, access and display are carried out through the use of digital technologies. In early 1990s, Gapen conceptualized DL in a comprehensive way as: "…the concept of remote access to the contents and services of libraries and other information resources, combining an on-site collection of current and heavily used materials in both print and electronic form, with an electronic network which provides access to, and delivery from, external worldwide library and commercial information and knowledge sources" (Gapen, 1993). To broaden the scope of digital libraries, Borgman et al (1996) mentions two complementary ideas:

- "Digital libraries are a set of electronic resources and associated technical capabilities for creating searching, and using information ... they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium....and exist in distributed networks…
- Digital libraries are constructed, collected, and organized, by (and for) a

community of users, and their functional capabilities support the information needs and uses of that community…".

Rowlands and Bawden (1999) explore three domains of the digital library: informational domain, systems domain, social domain. The elements of these three domains can be reflected in the model of Yang et al (1997) which comprises of four structural levels supporting five basic kinds of functionality. The structural levels are: user interface; networks and communications; information resources; and reference service system, while the functionality includes digitization; large repositories; fast data transfer; privilege; and management. When framing digital library design space, Marchionini and Fox (1999) identified four dimensions of digital libraries: community, technology, service, and content. Fox and Urs (2002) describe building blocks of digital libraries emphasizing which parts are "digital" versus "library". Of the six parts, computing and networking belong to "digital" while collections, services, and community are related to "library", and content shares the common aspects of both the terms. A conceptual framework for digital library systems as described by Del Bimbo, Gradmann and Ioannidis (2004) consists of three major layers: contents, management, and usage. As a core system, *management* is responsible for the management of the *contents* and for providing the necessary functionality. Being the user interaction component, *usage* deals with all aspects of the interface between the users and the system.

The concept of knowledge management
Different disciplines use the term 'knowledge' to denote different things, and so defining it precisely and exactly is not so easy. According to Drucker (1999), knowledge is personal and intangible in nature, whereas information is tangible and available to anyone who cares to seek it out. Davenport and Prusak (1998) define knowledge as a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. They further mention that in organizations, knowledge often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices and norms. Within the field of KM, knowledge has broadly been categorized as *explicit* and *tacit*. Very simply, explicit knowledge is described as documented or codified knowledge while tacit knowledge is non-documented or non-codified one. According to Polanyi (1966), tacit knowledge is personal, context-specific, and therefore hard to formalize and communicate. Explicit knowledge, on the other hand, refers to knowledge that is transmittable in formal, systematic language. Nonaka (1991) also distinguishes between explicit and tacit knowledge as "Explicit knowledge is formal and systematic. For this reason it can be easily communicated and shared, in product specifications or a scientific formula or a computer program. Tacit knowledge is highly personal. It is hard to formalise and therefore difficult, if not impossible, to communicate."

So what is KM? Nonaka and Takeuchi (1995) define KM as the capability of an organization to create new knowledge, disseminate it throughout the organization, and embody it in products, services and systems. A comprehensive idea about KM has been given by Davenport, Delong and Beers (1998) as "…is concerned with the exploitation

and development of the knowledge assets of an organization with a view to furthering the organization's objectives. The knowledge to be managed includes both explicit, documented knowledge, and tacit, subjective knowledge. Management entails all of those processes associated with the identification, sharing and creation of knowledge. This requires systems for the creation and maintenance of knowledge repositories, and to cultivate and facilitate the sharing of knowledge and organizational learning".

According to Abell and Oxbrow (2001), knowledge management is the creation and subsequent management of an environment which encourages knowledge to be created, shared, learnt, enhanced, organized for the benefit of the organization and its customers. Skyrme (2002) has synthesized the definition of KM as the explicit and systematic management of vital knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation, in pursuit of organizational objectives. The conceptual framework of KM provided by Bouthillier and Shearer (2002) comprises of six basic steps: discovery of existing knowledge, acquisition of knowledge, creation of new knowledge, storage and organization of knowledge, sharing of knowledge, use and application of knowledge. On the other hand, Awad and Ghaziri (2004) encapsulated a KM model consisting of four steps as capturing, organizing, refining and transferring. The captured knowledge should be organized using indexing, cataloguing, filtering, codifying, etc. for its easy access and retrieval. Then knowledge should be refined, and disseminated or transferred to the concerned people for effective use.

The analysis of interview data

This section discusses about the constituent parts of DL system, KM as a process, relationship between DL and KM, and the integration of KM in DL system based on thematic analysis and interpretation of interview data.

What constitutes a DL system?
Different interviewees described digital libraries from different perspectives although the essence of the term was almost same. They argued that DL emerged as a field of computer science, and LIS community found a strong affinity with its professional practice in the virtual or digital world. For many in the academic and professional world, DL is the logical extension of traditional library system in digital environment. Regarding the component parts of digital libraries, four interviewees noted that a DL system should be a combination of digital resources, technologies, and a digital community, while two interviewees considered digital repositories for preservation of digital assets, advanced search mechanism, and a set of well structured personnel to handle digital contents as the components of digital libraries. One of the interviewees reported that a digital library includes digital resources management, workflow, storage, and electronic delivery of information services (IP8). Almost similar views were drawn by other interviewee who described DL as the preservation of electronic resources, their management and a mechanism for their electronic dissemination (IP3). The interviewee IP3, however, added two extra elements, e.g. file management system and online public access catalogue (OPAC) for a DL system. Thus a framework of a DL system may be described in terms of the following four elements: digital resources, technological infrastructure, experience and expertise, and digital library services (fig 1).
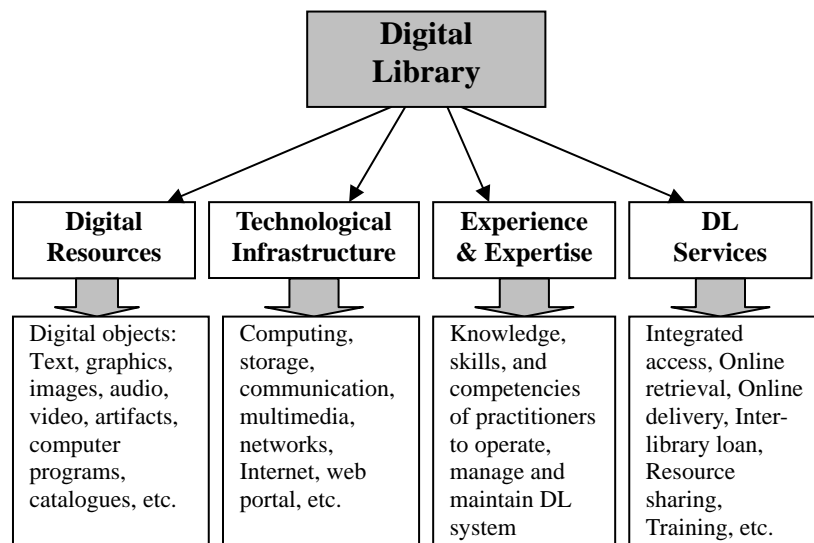
Figure 1: Components of a digital library system

Digital resources

Digital libraries contain information resources that can be encoded as sequences of bits. Most of the respondents used the terms like items, resources, contents, or materials to denote the collections of a DL. For IP6 and IP9, a DL possesses a collection of information resources as can be found in a traditional library. But the collections in a DL are in digital or electronic forms. According to them, the contents of a digital library comprise of a wide range of digital objects including text, graphics, images, audio-video, computer programs, etc. IP8 described that a DL provides user with access to a large volume of online information resources, e.g. library catalogues, textual databases, full text electronic books and journals, reports, photos, movies, music, etc. The DL resources can also be regarded as the items to be stored in a digital repository, typically consisting of data, metadata, and a digital object identifier.

Technological infrastructure

Digital libraries integrate computing, storage and communication technologies together with many other tools and techniques to operate and maintain networked digital information system. Some interviewees (IP1, IP4, IP9) argued that not all DLs are online, but they all are built on a sophisticated technological infrastructure which may include: different machineries, software programs and procedures including digital multimedia technologies, web-based hyper media and hyper text, Internet/Intranet, user and system interface, online public access catalog (OPAC), full text search engines, relational databases, electronic document management system, etc. Technology promotes the system functions like acquisition, conversion, processing, storing, and providing universal access to digital information. The interviewee IP7 noted that the technical infrastructure of a DL can support the construction of online information services for research, teaching, and learning, including services that enable the libraries to effectively share their materials and provide greater access to digital content.

Experience and expertise

Along with sound technological infrastructure, human factors are also given priority in designing, developing, organizing, managing, maintaining, and operating DL system. Experience and expertise of a DL refer to knowledge, skills, competencies, and capabilities of librarians and other human resources to deal with digital resources, digital technologies, system design, and service promotion. One of the respondents reported from his own experience that "we appointed a DL team composed of new skills set and we also trained some existing manpower with business knowledge. The new workforce skills together with existing manpower's promotional skills dramatically changed their organizational environment, and the library as a whole now has the ability to manage complex DL technologies, community and services" (IP4). Therefore, IP2 and IP5 suggested a set of technical, organizational, managerial, behavioral, and inter-personal knowledge and skills required to have the DL practitioners and experts to cope with digital environment effectively.

Digital library services

In a digital library system, people, process and technology work together to satisfy end user's need for information anytime, anywhere. DL services interact with digital resources, knowledge organization systems and users. In line with Hill et al's (2002) description, one respondent quoted that "…generally, DL services support a number of functions like acquisition and processing of digital collections, providing users with search and retrieval facilities for easy access to digital resources, and finally the evaluation of DL system" (IP6). The result of the interview data suggests that the services of a DL may include: integrated access to online information sources; online retrieval of information: accessing, browsing, and searching facilities; electronic access to bibliographic databases (both in-house and external); electronic access to full text journals and books; electronic reference services; inter-library loan service: online requesting for documents; networking and resources sharing; electronic publishing; end-user training for using DL, etc. Thus in a digital environment, library clients have greater choice of information resources, more advanced and timely accessibility, and the opportunity to utilize information effectively.

Knowledge management as a process

The review of KM concept indicates that KM is an ongoing process in an organization which starts with acquiring relevant knowledge resources and continues through its proper utilization. All of the interviewees agreed to this notion of KM although there were some variations in their understanding and perception of KM. As for example, one respondent reported that KM is a "business process involving a range of practices used by an organisation to locate, create, represent, and distribute knowledge assets of that organization" (IP7). Two other respondents described KM as "not only a process but also a method, technique and above all a discipline that deals with the production, organization, storage, dissemination, utilization and evaluation of knowledge in order to achieve organizational goals" (IP1 & IP8). KM denotes not only the management of knowledge itself but also the subsequent management of its environment. In line of this concept, IP2 defined KM as "the process of creating an environment in an organization for ensuring knowledge flow, learning and sharing of knowledge assets, and the

assessment of knowledge utilization for further development". Our analysis suggests that KM is a dynamic and continuous social process that involves acquisition, organization, storage and retrieval, and dissemination of knowledge resources to user group with relevant feedback to achieve institutional goals (fig 2), which is also supported by existing literature.
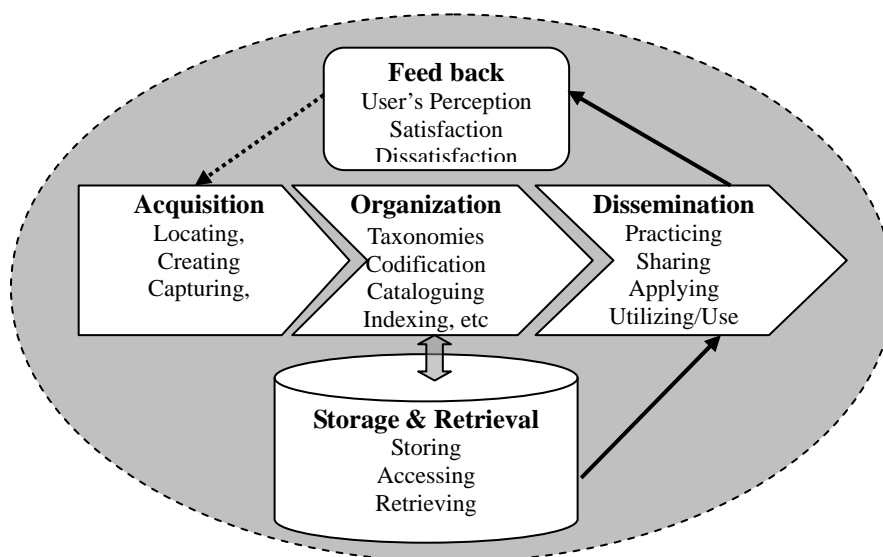

Figure 2: Knowledge management process model

Acquisition involves locating and capturing existing knowledge and creating new knowledge. The acquired knowledge is organized using taxonomies, codification, indexing, filtering, etc. The processed knowledge is preserved for permanent storage, and a retrieval mechanism is used for its easy access. Then knowledge is disseminated to the concerned people for sharing, applying, utilizing, and use effectively. Finally, the KM process receives feedbacks from the knowledge users as regard to the extent of satisfying their knowledge needs. Feedbacks ensure proper utilization of knowledge with necessary modification in the system.

Significant overlaps between DL and KM
Considering certain characteristics of current DL systems, Ioannidis (2006) virtually remarks that DLs are now on their way to becoming 'Knowledge Commons'. In reply to a question of relationship between DL and KM, most respondents reported that DL and KM are two different fields although they bear some significant overlapping traits. As a sub-field of both computer science and library science, DL is technology-oriented and it deals with articulated or explicit knowledge. KM on the other hand, is business and human-centric and it deals with both explicit and tacit knowledge. The respondents, however, explored some of the overlapping areas where DL and KM have opportunity to contribute to each other (fig 3).
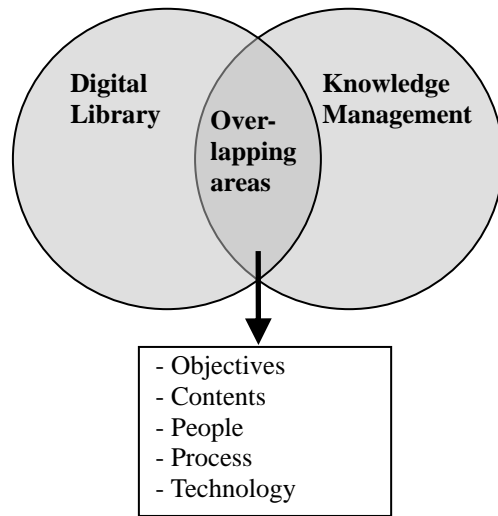
Figure 3: Significant overlaps between DL and KM

Objectives. The main objective of both DL and KM is as same as to provide users with access to knowledge resources. Being concentrated on information management function, DL system is largely technical, and service-oriented, while KM is mostly people-centred. Besides human approach, KM possesses information, technology, and management perspectives that can also be the basis for DL system.

Contents. Data, information, and knowledge are the main resources in DL as well as in KM. DL emphasizes on digitally coded articulated or explicit knowledge while KM focuses on both tacit and explicit knowledge either in digital or in physical form. The tacit dimension of KM can contribute to DL in developing mechanism for converting, storing and sharing knowledge of internal staff of DL.

People. People are the key actors in the organisational processes and the main users of information and/or knowledge systems. People with the proper blend of technical, managerial, behavioral, cognitive, and interpersonal skills can play significant role in designing, operating, and maintaining a DL and a KM system. End users need to be trained and skilled in both the cases.

Process. KM encompasses a number of sub-processes like knowledge creation process, knowledge collection and storage process, content management process, knowledge update process etc. Both KM and DL can share almost same mechanism of life cycle process of information/knowledge. They follow the same procedure of acquisition, processing, organization, storage, retrieval and dissemination of information and/or knowledge for its proper utilization.

Technology. DL system integrates a wide range of computing and communication technologies including more advanced and fast processing digital technologies, digital repositories, information retrieval engines, document management system, electronic publishing system, web-based technologies like Internet, intranets, extranets, etc. These

technologies are more or less concerned to KM system along with groupware, collaborative tools, knowledge portals, knowledge creation technologies, etc. Some important tools and techniques like indexing, taxonomies, codification, metadata, data mining, database management, knowledge mapping techniques, etc. are being used in DL and in KM for the management of contents and their retrieval.

The integration of KM process into DL system
The significant finding of the study is that the majority of the respondents positively argued for the integration of KM into DL system, while two respondents opined that KM would not bring any value to DL (IP2 and IP5). According to them, DL itself works as a KM system, and a well-planned and well-designed DL can provide DL community with access to digital knowledge resources. For the positivists, although KM belongs to the domain of LIS, it has been rediscovered by the business community, and hence, DL community should reconsider KM as a blessing for them. They also noted that certainly a well-planned and visionary KM project can promote decent library practices in digital environment.

In a question of how KM process can be integrated into DL system, four interviewees suggested a pragmatic approach of utilizing existing DL system including its knowledge resources, technologies, people and the process. Therefore, considering the broad perspective and potential benefits of KM, it is suggested the incorporation of KM process into DL system, which ultimately would upgrade the existing DL framework consisting of five elements, e.g. digital resources, digital technologies, experience and expertise, DL services, and knowledge management. The centrally designed KM refers to the process of management and maintenance of DL knowledge assets using a life cycle process of acquisition, organization, storage and retrieval, dissemination of knowledge, and receiving appropriate feedback from DL community. Therefore, the integrated model depicted on fig 4 shows a generic KM process inside DL system consisting of the following five steps:

Acquisition of knowledge
Acquisition of knowledge is the starting point of KM in digital library for building digital collections. It refers to the process of acquiring digital library knowledge resources including technologies, human expertise, and services for DL community. The task of acquisition includes: identification of digital library knowledge resources-both explicit and tacit, creation of new knowledge, conversion of knowledge from traditional to digital format, gathering resources from the web, etc. As a continuous process, capturing of knowledge involves the gathering significant knowledge from published works (books, journals, manuals, reports, etc.), internal and commercial files and databases; from the heads of individual experts working in the digital environment; and from other valuable sources (IP1).
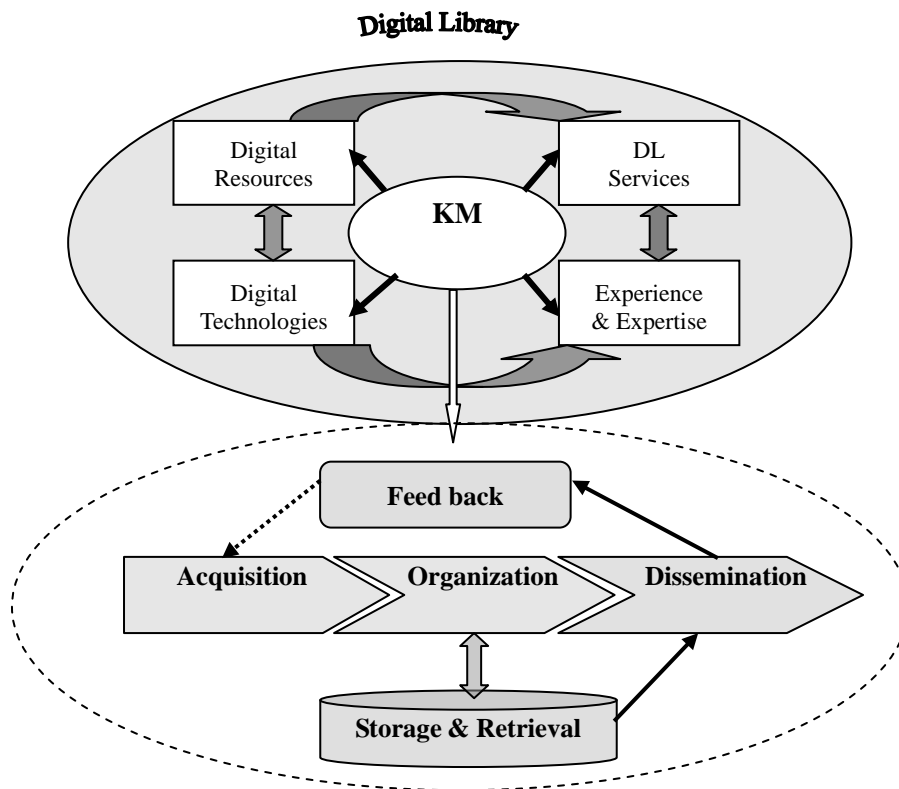
Figure 4: An integrated DL model based on KM process

Organization of knowledge

Knowledge organization systems include a variety of schemes that organize, manage, and retrieve information and/or knowledge. The respondents identified a number of long-standing tools and systems for knowledge organization in the digital environment including records and content management systems, classification and categorization schemes, taxonomies, thesauri, abstracting and indexing databases, citation indexes, semantic networks, ontologies, online public access catalog (OPAC), institutional and subject repositories, web search engines, web tools like wikis and blogs, etc.- most of which have been supported by Rowley and Hartley (2008). IP4 mentioned that the organization of knowledge eventually builds the knowledge base of DL by converting tacit knowledge to explicit knowledge in a usable form, and by providing means of codifying, categorizing, indexing, and accessing explicit knowledge.

Storage and retrieval of knowledge

The organized knowledge is stored in the organizational repositories for preservation as well as multiple uses. For the purpose of knowledge distribution and sharing, a number of tools and techniques are used to facilitating the retrieval process. Taxonomies, knowledge mapping, data mining, metadata, browsing, searching, etc. are some of the popular tools used in KM. These tools are also familiar in DL for structuring and retrieval of digital information, mainly explicit in nature. Therefore, the application of KM in DL can support the storage and retrieval process not only for explicit knowledge

but also tacit knowledge. IP3 noted that "KM may share various computational techniques including linguistics analysis, machine learning, knowledge repositories, and human– computer interaction with DL to support DL people with access to digital knowledge resources. While explicit or documented knowledge can simply be converted into digital form and can best be kept in digital files and databases, tacit knowledge might need to be packaged in a more indirect form like a story telling video etc. Since the tacit knowledge is hard to articulate, agent-based retrieval systems may be used to capture the interests and or knowledge of DL staff and users".

Dissemination of knowledge
The next step of KM process in DL is to disseminate right knowledge to the right people at right time. The dissemination of knowledge refers to those activities and processes associated with the flow of artifacts from one agent to another. The transferred knowledge is then practiced, shared, applied, utilized and used to attain library's ultimate goals of satisfying users' needs, developing research activities, creating new knowledge, promoting library functions, and building up a knowledge culture. The organizations do not just build knowledge for their sake but they ensure that it is utilized. Their motto is 'Putting knowledge to work' (Kumar and Singh, 2000). According to a respondent "the organizational success, quality, and competitiveness largely depend on the dissemination or transfer of knowledge by means different approaches and services. In a digital environment, knowledge can be transferred in the form of a number knowledge-based services and products including e-mail, electronic publications, presentations, websites, online discussion forums, video-conferencing and collaboration tools, etc (IP1).

Feed back
The final step of KM process is to receive responses or feedbacks from the end-users as regard to the extent of satisfying their knowledge needs. Feedbacks may also take the form of comments or suggestions on a particular service or system. Users' feedbacks or responses can be obtained through e-mail, web-enabled digital forms, etc. The feedbacks thus received are analyzed and evaluated to refine, readjust, or redesign the system or service, if necessary. Most respondents have argued that feed back mechanism is an integral part of existing library and information system, and DL practitioners have rich experience in this area. Therefore, the value of feed back for KM could also be derived by its proper integration and implication in DL system. Some of the important functions of feedback system, as described by IP3 are as follows, most of which were supported by IP6 and IP9:
- the assessment of existing knowledge resources and services
- identification of knowledge needs
- integration of new knowledge and services
- modification of existing system
- replacing outdated knowledge
- evaluation of knowledge
- continuous improvement
- providing knowledge in a best possible way to satisfy DL community

Implications and benefits of the integrative approach
This is a model building study, and therefore, the model has not been empirically tested or verified. The interview data supports the integration of KM process into DL system, and hence, it is expected that theoretically, the model would contribute to the advancement of academic debate and scholarship in the areas of DL and KM. As we noted earlier that two of the respondents did not support the integration of KM into DL, they, the rest of the respondents, however, expected a number of benefits and implications of integrated DL system.

Strategic planning
Launching a KM-oriented DL system requires a strategic and business plan based on an effective group decision making process. The strategic plan for KM initiatives would contribute to make strategies and decisions on information/knowledge resource allocation and organization, execute strategies, and business process analysis including strengths, weakness, opportunities and threats (IP6). Another participant, IP9 described that KM strategic plan for DL may include the development of database tools for supporting KM initiatives, coordination and distribution of digital knowledge construction, human resources development, financial asset management, intellectual property rights management, socio-economic-political and technological issues.

Developing a knowledge-based culture
KM process in DL can contribute to the development of knowledge warehouses of the library by acquiring, capturing, and creating appropriate knowledge resources. KM establishes a unified knowledge framework in the library within which the knowledge currently available in multiple formats can be collected, converted, organized and disseminated, and thus making them available to those who need these, where and when they need these. IP8 remarked that "practicing KM creates a knowledge-based culture and environment which is conductive to more effective knowledge creation, transfer, and utilization. This transforms DL into a more efficient knowledge sharing organization for its community establishing a knowledge link within and outside the library".

Management of intellectual assets
Intellectual capital involves human capital, customer capital, structural capital and business intelligence capital (Al-Hawamdeh, 2003). DL possesses a number of human resources having experience and expertise in the field. The expert knowledge, skills, and experiences can be transformed into intellectual capital or assets of library which should be managed and utilized for the benefit of the users, and for internal operation and future use of DL system. An interviewee, IP7 asserted that "practicing KM assists in developing an organizational culture and environment for capturing, managing, and updating these intellectual assets, and making them easily accessible for sharing and utilizing". Expert knowledge should be developed and upgraded through continuing education, training programs, sharing practice, etc. for handling technologies and the system, and for providing better services.

Promotion of knowledge sharing

DL has its own strategy and process of disseminating and transferring articulated knowledge items to its user community, and some LIS people perceive this process as knowledge sharing. In this sense, knowledge sharing is not a new for DL, but as IP5 and IP8 mentioned it is much more than knowledge dissemination process of DL. Knowledge sharing is seen as a central concept of KM, which focuses more attention on tacit knowledge. The tacit knowledge can be communicated through interaction, collaboration and conversations in communities/networks of practice. The introduction of KM provides DL an opportunity to promote a collaborative, innovative, and knowledge-sharing culture. According to IP3, "an organizational culture can help human resources to share or transfer their knowledge and experiences through seminars, workshops, tutoring, mentoring systems, etc". The experience and expertise of other libraries can be shared under the existing library cooperation, networking and resources sharing programs.

Knowledge innovations in DL services

The dynamic growth of knowledge resources and increasing individual demands for specific knowledge item have raised challenges for a digital library in providing innovative and efficient knowledge services. An effective KM practice would help DL to plan and design DL services tailored to the interest and need for specific knowledge of end-users (IP1). Lee (2005) mentions that information about each user can be obtained by analyzing the records of user registration, surveys, circulation and interlibrary loans, frequently asked reference questions, and the use of e-journal and digital resources, etc. Users' needs and their satisfaction can be collected through periodic users' surveys, and the findings may assist in planning and redesigning innovative library services.

A strong leadership position

KM provides a strong leadership skills, competencies, training and development. IP4 opined that "KM leadership can increase the ability of DL to achieve organizational efficiency, identify opportunities, communicate best strategies, manage intellectual capital, facilitate organizational learning, develop continuous leadership process, sustain in competitions, and to maximize organizational potentials".

Conclusions and future work

Considering the amazing success of commercial web search engines, Lagoze et al (2005) have raised a question: In the age of Google, what is a digital library anymore, anyway? The authors further remark that DL becomes a context for information collaboration and accumulation – much more than just a place to find information and access it. In fact, DL in the present context, has introduced a number of important issues including the management of digital library contents, developing appropriate search and access mechanisms, management of knowledge, and so on (IP8). Both KM and DL are closely allied in their objectives of satisfying users' needs, fundamental concepts of content management, and the process of work. They are content-centric as well as technology-oriented, but KM emphasizes more on human aspects. However, they should not compete with one another; rather they are complement to each other.

In view of this perspective, the study develops an integrated framework of a DL system that can be evolved through the process of KM. As can be found from the study, the framework consists of two separate models: one is digital library model and the other is knowledge management process model. All of the elements of a DL system have their own knowledge aspects, and as an integral part of DL, KM is embedded in DL system at any time and in any part. KM as a generic process refers to the acquisition, organization, storage and retrieval, dissemination of knowledge, and receiving relevant feed for further modification and adjustment. The KM process can suitably fit in DL environment, and hence, it is suggested to adopt this process for promoting DL a knowledge-enabled and knowledge-driven organization.

The model is expected to support in innovation, organization, sharing and socialization of knowledge and to enhance the effectiveness of DL system with proper utilization of both recorded knowledge and experience and expertise of the library. Digital libraries thereby can be transformed into a more efficient knowledge sharing organization for its community establishing a knowledge link or knowledge networking within and outside the library. Thus the study encourages DL practitioners to adopt KM process on which the entire digital library system can be designed, operated and maintained, and ultimately, values can be derived from the system. The theoretical ideas presented in this article need to be tested and justified in practical environment. Therefore, the researchers hope to verify the proposed model in their future work.

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