The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0305-5728.htm

Knowledge management implementation in a library

Mapping tools and technologies to phases of the KM cycle

Naresh Kumar Agarwal
Graduate School of Library and Information Science, Simmons College, Boston, Massachusetts, USA, and

Md Anwarul Islam
School of Knowledge Science, Japan Advanced Institute of Science and Technology (JAIST), Ishikawa, Japan

Abstract

Purpose – The purpose of the study is to investigate the tools/technologies that would be of value to libraries as they implement knowledge management (KM) and to map these to different phases of the KM cycle.

Design/methodology/approach – Models of the KM cycle and theories related to information technology (IT) adoption were reviewed, along with tools/technologies for collaboration and KM. A theoretical "model for KM tools and their adoption in libraries" was arrived at.

Findings – It was found that there is no single set of tools that would be applicable to everyone or across libraries. In addition, technology is just an enabler for KM. Therefore, a comprehensive set of tools, both physical and technological, is presented.

Research limitations/implications – The paper provides a practical, one-stop place for librarians to decide on KM methods and tools based on their unique environments. The proposed model for KM tools should guide further research.

Originality/value – Most studies on KM have been outside libraries. Of all KM tool studies, there is a lack of a single paper that puts together the majority of tools/technologies (whether IT or non-IT-based) that would help library staff make informed decisions. The primary research contribution is a model for KM tools and their adoption in libraries.

Keywords Libraries, Technology acceptance model, Diffusion of innovation, KM cycle, KM tools, Technologies

Paper type Conceptual paper

When teaching KM in Fall 2012, the first author provided a long list of tools and created an assignment whereby LIS students had to pick any one tool, learn the tool over a few weeks, create a tutorial based on it and identify its relationship with the KM cycle. In another course, LIS 488 Technology for Information Professionals (across a few semesters), students had to learn technology tools and create tutorials as well. Some of the student-created technology tutorials can be seen at: http://mytechtutorials.wordpress.com/. The authors are grateful to these students from Simmons College who indirectly provided an impetus for this article.

VINE
Vol. 44 No. 3, 2014
pp. 322-344

0305-5728
DOI 10.1108/VINE-01-2014-0002

Background and Introduction

Knowledge management (KM) is a newly emerging approach aimed at addressing today's business challenges to increase efficiency and efficacy by applying various strategies, techniques and tools in their existing business processes. It has been described as a process or a set of processes (Abell and Oxbrow, 2001; Townley, 2001; White, 2004), a method of management (Shanhong, 2000), a new dimension of strategic information management (Ponelis and Fair-Wessels, 1998) or the use of organizational knowledge through sound practices of information management and organizational learning (Broadbent, 1998). Although the business model of KM is now being adopted by many non-profit organizations such as libraries, it is not as pervasive as in the business sector. In knowledge organizations such as libraries, several kinds of knowledge need to be managed:

- user knowledge (their need, who to contact and information seeking);
- resource knowledge (sources and services, where these services are available and other features of resources); and
- personnel practice knowledge (expertise available, the quality of service they provide and others).

Moreover, KM can help improve communication among library personnel and between users and service providers, between top management and staff and can promote a culture of knowledge sharing (Teng and Hwamdeh, 2002).

The only studies on library and knowledge management have focused on the relationship between KM and library (Sarrafzadeh *et al.*, 2010; Roknuzzaman and Umemoto, 2009), the need for KM in libraries (Wen, 2005), KM in academic libraries (Maponya, 2004), librarians' awareness or perceptions of KM (Siddike and Islam, 2011) and KM in state-of-the-art digital libraries (Islam and Ikeda, 2014). A big hurdle in KM implementation in libraries is a lack of clear knowledge as to how to implement KM. What tools and technologies need to be adopted? What are the set of processes and phases involved? Are the people and processes more important or technology tools and systems? Can we simply implement KM by adopting a particular KM tool or system? Most of the research and case studies of KM implementation, whether in libraries or other business organizations, show that there is no silver bullet to implementing KM (Allee, 1997). Each organization must come up with its own template for what is best suited to its needs. Rather than imposing a process or a tool on an organization, KM is about coming up with strategies, processes and tools that are most likely to be adopted and used successfully by people in the organization.

Objective of the study and theoretical considerations

Without providing a one-size-fits-all solution, this paper is an attempt to help libraries make informed decisions as they venture out to implement KM. We put together the various tools and technologies available for KM implementation, and map them to different phases of the KM cycle – ranging from knowledge capture or creation, knowledge sharing or dissemination and knowledge acquisition and application (Dalkir, 2011). These cycles encompass the different ways in which knowledge is managed, from capturing to transferring knowledge (Awad and Ghaziri, 2004).

A few considerations are important as we propose the following:

- A single set of tools for KM cannot be mandated because every library and its employees will need to decide for themselves which tools and technologies they find easy to use and useful to their current needs.
  - Davis's (1989) Technology Adoption Model (TAM), which has been tested and validated in countless studies, talks about the importance of two factors – perceived ease of use and perceived usefulness, before people decide to use a piece of technology or not. Thus, the KM tools chosen and adopted must fulfill the criteria of perceived ease of use and perceived usefulness for the majority of librarians and other stakeholders in the library. A number of factors, from prior experience to awareness to familiarity with particular tools may affect both these perceptions.
  - Different people in the library will take to KM differently. Their attitudes may range from enthusiastic to indifferent to opposed. Roger's (1995) diffusion of innovation theory classifies people into innovators, early adopters, early majority, late majority and laggards. Some people will be comfortable changing and adapting to new tools (the innovators and early adopters as per Roger's theory), while there will be others who will resist and be late to adopt KM (the laggards and the late majority as per Roger's theory). It is often a good idea to identify the innovators and early adopters in the library, and bring them into any pilot program for implementing KM in the library.

  The TAM model and Roger's theory provide the theoretical basis for this article.
- Second, technology tools keep changing, so there cannot be a permanent set of recommendations which will hold true across time. What will remain consistent is the need for knowledge creation, sharing and use in libraries.
- Third, a library needs to factor in the cost of adopting any particular set of tools or technology, i.e. buying/licensing, and the cost of maintaining. Even though open source software is considered free, it is not really free, as libraries will need to hire people (computer programmers or others) who can maintain the software, extend it, write short scripts, etc.
- Finally, but most importantly, technology is not the most important in KM implementation. Various studies have noted that KM is about people and not about tools or technology (Rah *et al.*, 2009). Technology is needed to support people's needs, and not the other way round. If KM and people are the horse, technology is the cart. We have to be careful that the cart does not pull the horse. Technology should act as a support for the processes, policies and procedures adapted to best serve people in the organization/library to meet the mission and goals of the library. Ruggles (1997b) defines tools as "technologies which support the performance of activities or actions". He defines KM tools as "technologies […] which enhance and enable knowledge generation, codification and transfer". In line with the discussion above, Ruggles cautions that "not all knowledge tools are computer-based, as paper and pen can certainly by utilized to generate, codify and transfer knowledge".

Keeping these in view, this article does not recommend any one particular approach, tool or a set of tools for KM implementation in libraries. Rather, we bring together various tools, technologies and options currently available that would be useful for different phases of the

KM cycle, should a library decide to implement KM. These include both traditional KM tools and (information) technologies, as well as open source and Web 2.0 tools. Individual libraries can then pick tools from within those that they think are easy to use, and that their employees are likely to adopt. So, depending on the technology infrastructure in the organization, the expertise of the staff, the relationships with vendors and the KM needs, the library can decide on the best approach for tools and technologies.

The mapping of the tools/technologies to phases of the KM cycle is important to ensure that technology is not the primary driver, and that technology does not drive the KM phases. Depending on the KM phase being implemented in the library and the unique library context, it can pick the right tools and technologies from a suite of options. While a few prior studies have looked at KM tools (Rollet, 2003; Tiwana, 2002; Tyndale, 2002; Jantz, 2001; Dieng and Corby, 1998; Ruggles, 1997), they are not written from the perspectives of library and information science professionals, and do not always map to phases of the KM cycle. The only attempt at a preliminary mapping was by Tyndale (2002). In addition, many of the papers were written a long time ago, and a lot of technological developments have happened in the past decade, and continue to happen.

A conceptual/theoretical research approach is adopted in this study. By having the possibilities of KM tools and technologies currently available, and having them mapped to phases of the KM cycle, we hope libraries will be in a better position to make the choices required when implementing KM. This paper is a step in that direction.

The rest of the paper is organized as follows: in the next section, we review the literature. We talk about prior studies on KM tools, the KM cycle and KM cycle models. The integrated model by Dalkir (2011), as well as theories by Davis (1989) and Rogers (1995), are adapted as lens in the study. This is followed by a brief methodology section. We then talk about the tools and technologies for KM implementation and map them to different phases of the KM cycle. This is followed by findings and discussion. Finally, we look at the limitations and future work and conclude the paper.

Literature review

A number of researchers have looked at KM tools in the context of knowledge management. Tyndale (2002) classifies technology tools in 17 areas – intranets, push technologies, etc. He classifies the tools as new versus old and maps them to knowledge creation, organization, distribution and application. Ruggles (1997, 1997b) classifies KM technologies, focusing on KM uses such as enhancing and enabling knowledge generation, coding knowledge and transferring knowledge. Rao (2005) compiles case studies of KM tools, techniques and strategies used across organizations. Rollet (2003) classifies technologies in the areas of communication, collaboration, content creation, content management, adaptation, eLearning, personal tools, artificial intelligence, networking, standards and hardware. He also makes a case for what can, and what cannot, be achieved through technology. Jantz (2001) discusses a tool called common knowledge database for managing and using informal knowledge in university libraries. Dieng and Corby (1998) provide an approach to understanding the core tools and techniques widely used in undertaking KM in an organization. Tiwana (2002) includes technologies and KM best practices of KM. Lindvall *et al.* (2002) survey the tools available to support different KM activities.

The aforementioned studies have a few important weaknesses:

- They were written a few years ago. Considering the fast pace of change in technology, and the recent advent of social networking and Web 2.0 tools, many of the tools are not comprehensive or applicable anymore.
- The terms used to classify tools (Tyndale, 2002) are broad and terms are used from the software industry and not easily understandable by libraries.
- Studies such as those of Rao (2005) include case studies from businesses/industry, and are not directly applicable to libraries.
- Finally, many of the tools are not comprehensively mapped to a phase of the KM cycle, even though some of them such as Tyndale (2002) and Ruggles (1997, 1997b) attempt to do so.

KM cycle and models

While libraries have traditionally managed knowledge created by others, KM is about managing knowledge that originates within the library (Townley, 2001). KM can be seen as a cycle that encompasses various phases, such as the capture, creation, codification, sharing, access, application and reuse of knowledge within and between libraries. Dalkir (2011) reviews KM cycles identified by different researchers, implemented and validated in real-world settings. Figure 1 summarizes the phase of the KM cycle identified by Wiig (1993), Meyer and Zack (1996), Bukowitz and Williams (2000), McElroy (1999) and Awad and Ghaziri (2004).

Table I provides a different view of the KM cycle phases identified by these researchers. Across the different phases identified, the ones similar in meaning are listed in a single row.

Based on these, we can conclude that KM is an ongoing process or cycle in an organization which starts with acquiring relevant knowledge resources and continues through their proper utilization. The first part is locating, acquiring and capturing existing knowledge that is relevant to the library and creating new knowledge. The acquired knowledge is organized using taxonomies, codification, indexing, filtering, etc. The knowledge is refined and synthesized or transformed as per the needs of the library. 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 using effectively. Finally, the KM process receives feedbacks from the knowledge users regarding the extent to which it satisfies their knowledge needs. Feedbacks ensure proper utilization of knowledge with necessary modification in the system. Finally, a call is made whether any part of the knowledge is expensive to keep and can be divested.

We can simplify Table I to get eight unique phases that comprise the KM cycle.

(1) Knowledge creation.
(2) Knowledge acquisition or sourcing.
(3) Knowledge compilation or capture.
(4) Knowledge organization, refinement, transformation and storage.
(5) Knowledge dissemination, transfer and access.
(6) Knowledge learning and application.
(7) Knowledge evaluation and value realization.
(8) Knowledge reuse or divesting.

Figure 1.
Phases of the KM cycle

Wiig (2003)	Meyer and Zack (1996)	Bukowitz and Williams (2000)	McElroy (1999)	Awad and Ghaziri (2004)
Creation				
Sourcing	Acquisition	Get	Individual and group learning	
Compilation	Refinement	Use	Knowledge claim validation	Capturing
		Learn	Information acquisition	
Transformation	Store/retrieve		Knowledge validation	Organizing
			Knowledge integration	Refining
Dissemination	Distribution			Transferring
	Presentation			
Application		Contribute		
Value realization		Access		
		Build/sustain		
		Divest		

Table I.
Combining phases of the KM cycle

Dalkir's (2011) integrated KM cycle covers three overarching phases:

(1) Knowledge capture and/or creation.

(2) Knowledge sharing and dissemination.

(3) Knowledge acquisition and application (we revise this to "knowledge application and use", as acquisition could be construed to be similar to knowledge capture).

We adopt these phases of the integrated KM cycle (Figure 2) for mapping to tools in this paper.

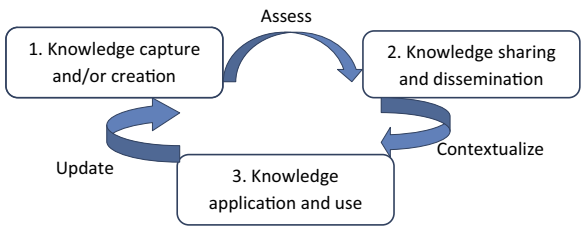
Type of knowledge applicable to libraries

White (2004) sees KM as crucial to providing dynamic and effective services to library users of the twenty-first century. Two types of knowledge would be of interest to libraries – tacit and explicit. While explicit knowledge is formal, codified and systematic (like books that libraries have always dealt with; and other documents produced within the library), tacit knowledge is personal, experience-based knowledge held by people (Nonaka, 1991) – librarians and library staff, administrators and users.

Knowledge capture and/or creation: In Figure 2, in the first phase, tacit knowledge is identified or captured, explicit knowledge is organized or coded or new knowledge is created. Knowledge creation is typically the outcome of an interactive process that will involve a number of individuals who are brought together in a project team or some other collaborative arrangement (Newell *et al.*, 2002) such as networking with other libraries, attending library events (workshops, seminars and conferences) and connecting with online communities (Shanhong, 2000). That is why, the knowledge of library operations, library users and their needs, library collection, library facilities and technological knowledge needs to be put together. As a result, new knowledge will be created which leads to the improvement and development of service to the users and functioning of the library. However, this diverse knowledge is rather dispersed across all the library sections and up the library hierarchy.

This dispersed knowledge captured or created across the library needs to be assessed, then shared and disseminated across the library (second phase in Figure 2).

Knowledge is then contextualized in each department of the library or to each library employee or user to be understood and used (third phase in Figure 2). This stage then feeds back into the first one to update the knowledge (Dalkir, 2011).



Source: Adapted from Dalkir (2011)

Figure 2.
A revised integrated KM cycle

Integrated library systems, while prevalent for a long time, are largely controlled by vendors, and often inadequate due to the growth of electronic and digital resources (Wang and Dawes, 2012), changed expectations regarding interfaces (Andrew, 2009) and changing user demand (Breeding, 2006), as well as transformation of libraries in knowledge-based society to capture the range of knowledge needs that different areas of the area have. Thus, along with an integrated library system or a library automation system, libraries will need to supplement and include other technology tools that can capture their knowledge needs adequately.

We use the revised integrated KM cycle adapted from Dalkir (2011), as well as Davis's (1989) and Roger's (1995) theories on technology adoption/diffusion, as a theoretical lens in this study, and apply it to the context of KM and KM tool adoption in libraries.

Methodology

Klein and Myers (1999) provided a set of principles for conducting and evaluating interpretive field studies in information systems. While the methodology adopted in this paper was largely theoretical, a few key underpinnings from Klein and Myers are applicable to this paper. First, a theoretical base was established from prior literature. Second, existing tools and technologies applicable to KM were reviewed. Third, these tools and technologies were mapped to various phases of the KM cycle. While a particular tool could be applicable in different phases of the KM cycle, an attempt was made to find the phase that the tool was best matched for. Fourth, non-information technology (IT) tools were included to make the cycle complete. Finally, the theoretical model adopted was extended to come up with key findings from the paper. The use of the theoretical model to understand specific tools and their usage follows the fundamental principle of the Hermeneutic Circle, as well as the principle of abstraction and generalization as per Klein and Myers (1999).

KM tools and technologies for KM application

In the tables, we review a wide range of technology (IT-based) and non-technology tools and techniques currently in use in KM or across disciplines that would be applicable to the three phases of the KM cycle identified in Figure 2. The choice of tools for each phase must be specific to the library or department implementing KM and must be consistent with its goals and strategy. Of the tools listed, most of them are free or open source, while some are paid or have paid features. In addition, when considering a free product, libraries need to consider the cost of maintenance and the degree of support provided, and look out for any hidden costs. In helping to identify the tools and the categories within them (both IT and non-IT based), Good (2012, 2013), Young (2010), Dalkir (2011), Leask *et al.* (2008) were important studies, supplemented by other Web sites and blogs. Many of the descriptions of the tools are taken from or adapted from these sources as well. Many of these tools and techniques represent those that have been successfully adopted across organizations in their KM initiatives, as well as new possibilities brought about by technological advancements.

The six tables are classified into the three phases of the integrated KM cycle of Figure 2. Each phase has two tables – one for non-IT-based tools, and the other for IT or technology based tools. The three tables on non-IT-based tools list the tool or method,

what it does and how it applies to KM in libraries. The three tables on IT-based tables list the overarching technology category, what it does, examples of current tools in that category, as well as how those apply to KM in libraries. While specific examples of tools would evolve and change with time, the technology categories and non-IT-based tools or methods are expected to remain relevant for years to come. In each table, the tool categories or methods are listed in an alphabetical order, and not in any particular importance or hierarchy.

Cycle 1: creation and capture

Tables II and III include the non-IT- and IT-based tools for capturing tacit and explicit knowledge or creating new knowledge in libraries. In the rightmost column of the two tables, we refine the category of "knowledge capture and/or creation" further to knowledge codification, capture, creation, acquisition, sourcing, compilation or organization (terms used in Figure 1 and Table I) to describe the application of each tool more precisely.

Cycle 2: sharing and dissemination

Tables IV and V include the non-IT- and IT-based tools for knowledge sharing, transfer, access and dissemination across the library.

Cycle 3: application and use

Tables VI and VII include the non-IT- and IT-based tools for learning and knowledge acquisition, application and use in the library.

Findings and discussion

We have looked at tools and techniques for knowledge creation/capture, sharing/dissemination and application/use – both technology-based solutions, as well as those that do not necessarily rely on technology.

A few findings emerge:

- It was found that there is no single set of tools that would be applicable to everyone or across libraries. Depending on technology adoption (Davis, 1989), diffusion (Rogers, 1995) and individual personalities, people will use the information created, captured or shared differently. Tools such as myers-briggs type indicator (MBTI) (Table VI) help individuals assess their own behavior when accessing and using information.
- In addition, technology is just an enabler for KM. Only technology tools are not enough. A combination of physical environment and technology-enabled tools is necessary. For each phase of the KM cycle, we have provided a comprehensive summary of both technology- and non-technology-based tools.
- Technology changes rapidly. While specific examples of tools would change over time, the broader technology categories, as well as the non-IT tools will remain relevant for many years.
- Even among the technology tools listed, the ways to access them are changing. An increasing number tools will be used in mobile and tablet environments (Apple iOS, Google Android or Windows-based devices). We would recommend librarians to pick tools that have mobile support, as they are more likely to be adopted and used in different ways.

Non-IT methods and tools	What it does	Application for KM in libraries
Abstract concept representation/mental models	A mental model is a symbolic or qualitative representation of something in the real world. It is how human minds process and make sense of their complex environments. A cognitive map is a powerful way of coding this captured knowledge	Codification: employees can share common mental models about competition, survival, users and other important aspects of decision-making
Action learning	A continuous process of learning and reflection that happens with the support of a group or set of colleagues, working on real issues, with the intention of getting things done (McGill and Brockbank, 2004)	Capture: as learning institutions, libraries should support action learning for skill improvement, development of learning and knowledge sharing
Ad hoc sessions	Formed to address a particular issue based on a member's call for help or other informal employee interactions	Capture: *Ad hoc*, informal interactions among employees or between staff and users are crucial in project success, including in digital library projects
After action review (AAR)	A technique to evaluate and capture lessons learned upon completion of a project	Capture: AAR can be carried out at the end of digitization, library automation or other projects or activities. It helps to make 'tacit' knowledge 'explicit'
Brainstorming	A simple way to help a group of people generate new and unusual ideas	Creation: useful for gaining insight on patrons, ways to create innovative library services and to reward library employees for knowledge capture
Guest speakers	Presents an opportunity to bring a fresh perspective or point of view–seminar or workshop	Capture: the library community meets at regular intervals. Inviting guest speakers leads to tacit knowledge exchange
Knowledge exchange/exit interviews	A structured process to capture an individual's knowledge, experiences and contacts before they move on	Capture: works well when there is risk of losing knowledge because of a staff member leaving an organization or a team or project and when hiring interns
Knowledge café	A way to have a group discussion, to reflect and to develop and share any thoughts/insights that will emerge in a non-confrontational way	Creation: these are about learning, bringing users together to listen and participate in open and creative conversations on topics that interest them. They help focus the library's knowledge, strengthen its networks, help a community of practice to get started and regularize knowledge sharing

(*continued*)

Table II.
Non-IT tools that best facilitate knowledge creation and capture

Non-IT methods and tools	What it does	Application for KM in libraries
Knowledge marketplace	Could be seen as a 'dating service' for knowledge. It identifies what people know and what they need to know on a particular subject, then connects them appropriately	Capture: it facilitates events or technology platforms to enable connections between library experts who have identified gaps in their knowledge in library areas, and those who have relevant knowledge and expertise which they can share
Learning and idea capture/learning from others	A key aspect of KM, at the personal and team levels, is to more "collectively and systematically" capture the learning and ideas that are taking place	Capture: libraries can do this to be more creative, generate more ideas, learn faster and turn its new learning into better knowledge to share, apply and exploit
Learning history	Learning histories (Roth and Kleiner, 2000) are useful in capturing tacit knowledge, especially in group settings	Capture: it could serve to describe what happened, why it happened, how the library reacted and what current library members should learn from this experience. These insights will help increase the library's reflective capacity
Peer assist	Direct knowledge transfer from individuals to others	Acquisition or sourcing: it is used by a project team to solicit assistance from peers and subject matter experts from those in the library field regarding a significant issue the team is facing
Road maps	Problem-solving meetings that are scheduled, convened and follow an agenda	Capture: helps libraries solve day-to-day problems in a public forum between librarians, users and management; often leads to the development of guidelines/standards for continuous process/service improvement

Table II.

- Some tools are applicable to more than one phase of the KM cycle. Therefore, we choose the KM cycle phase that a particular tool would be best suited for.
- We recommend librarians to pick 1-3 technology tools from each phase. The more tools that a library adopts, more would be the learning required for all employees. Additional support would also be needed. Therefore, a smaller number is recommended – whether this number is 1, 2, 3 or 4 will depend on individual library needs. This is because, tools, after all, are only enablers. The library would not want its employees to get mired in the learning curve of too many tools. To arrive at chosen tools, the library needs to survey its employees to ascertain their comfort level, preferences and the tools they might already be using.

Table III. Technology tools that best facilitate knowledge creation and capture

Technology category	What it does	Tool name	Application for KM in libraries
Co-browsing, screen sharing and remote support	Two or more people browsing the web at the same time; helping another person situated remotely by accessing his/her screen	Firefly, GoInstant, LiveLook, Skype screen sharing, GoToMeeting, TeamViewer, Join.me, Netviewer, Twiddla	Acquisition or sourcing: e.g. Join.me is used by librarians to help patrons resolve their password and login issues, to demonstrate search strategies or to problems downloading pdfs
Collaborative visual reviewing	Instead of emailing different versions of a document back and forth, team members can visually review documents, and all comment on a single read-only copy online	A.nnotate, Diigo, Uptogo, ConceptShare, Creately, Review Studio (former Cozimo), Notable, GroupZap, Google Drive, PDF-XChange Viewer/Editor (annotate PDFs)	Compilation or capture: e.g. Diigo helps in research, sharing and collaboration in many library activities
Collaborative writing	Projects where written works are created by multiple people together (collaboratively) rather than individually	Mixedlnk, Wridea, Editorially, Draft, Google Docs/Drive	Creation: help increase efficiency in creating storing, sharing document, bookmarks and citations: e.g. Google Docs/Drive can help library staff collaborate
Document sharing–Wikis	Helps to *create* and *share* work online and access *documents* from anywhere	Wikis, Pbwiki, Wikispaces, Google Docs/Drive, Scribd, Issuu, Docstoc, MS SharePoint, Typewith.me	Creation: Wikis can be used by library staff to archive documents and have places where multiple employees could upload/update
Knowledge community/profile capturing	Web sites for profiling based on expertise and/or answering questions posed by visitors	Quora, K-comm.tk (Agarwal and Poo, 2008; Lek *et al.*, 2009), Yahoo Answers, Wiki Answers	Capture: e.g. K-Comm helps capture the tacit knowledge held by individual library employees in various domains–from the sublime to the mundane. Helps provide a sense of community where everyone is an expert

(*continued*)

Table III.

Technology category	What it does	Tool name	Application for KM in libraries
Mindmapping and diagramming	A diagram used to visually outline information	Freemind, The Brain, Mind42, XMind, Webspiration, Bubbl, Mindmeister, Mindjet, MS Visio	Capture: useful for libraries to developing maps that chart information, thought processes, library's maps, contact information, meeting notes, project planning, SWOT analysis and future plans
Social content	Helps the Internet community tag content in Web sites, share metadata and organize web links	Del.icio.us, Blog, RSS, Tagging (Folksonomy), Diig, Diigo, StumbleUpon	Acquisition or sourcing and organization: e.g. Del.icio.us can help find other librarians/folks interested in the same knowledge field, libraries and discover their library-related links (add www.ala.org as one of your links, then find other people who are ALA fans)
Video recording	Useful for recording and editing video sessions of interviews, talks and presentations	Video camera, Tripod, Video editing (Pinnacle Studio, Adobe Premiere Elements, Lightworks)	Capture: libraries can record interviews of employees who are leaving, as well as talks and sessions held
White boarding	Placement of shared files on an on-screen shared notebook or whiteboard	Skrbl, Vyew, CoSketch Groupboard, Conceptboard	Creation: with collaborative features such as white boarding, desktop sharing, recording and video: e.g. Groupboard can be used to teach remote library members basic Internet and computer skills, while engaging participants with interactive lessons

Non-IT methods and tools	What it does	Application for KM in libraries
Embed KM in organizational HR	Encourages KM behaviors and overall cultural change. Appropriate rewards and incentives are put in place for knowledge sharing behavior within ALL roles	Library staff are rewarded to share e.g. incentivizing finding and adapting solutions from out with the library
Collaborative physical workspace	A place where human interactions such as face-to-face discussion and dialogues take place	Information commons and learning commons are collaborative spaces within the library that go beyond the interactions in the reference and circulation desks. Three levels of interactions need to be facilitated: librarian–patron; librarian–librarian; and patron–patron
Community of practice	A group of people who share a common interest working together over an extended period to explore ways of working in a specific area of knowledge	Librarians often exhibit different levels of expertise. If librarians interact to share their knowledge within a community of practice, then that practice becomes more effective for the entire community
Directory of experts, e.g. yellow pages, skill mining	Communities connect people. These connections are often used to develop yellow pages or an expertise location system	An expertise directory provides a map to subject matter experts in various fields of the library
Social network analysis (SNA)/sociograms	Organizational networks and sociograms help map the flow of knowledge in an organization	Using SNA, libraries can map relationships between people to identify knowledge flows: Who do people seek information and knowledge from? Who do they share their knowledge with?
Storytelling	Conveying events in words, images and sounds, often by improvisation or embellishment; useful for sharing experiential and tacit knowledge	Libraries can use structured sessions to elicit stories of experience and share knowledge of lessons learned and best practices pertaining to specific tasks or scenarios

Table IV.
Non-IT tools that best facilitate knowledge sharing and dissemination

- Libraries will need to decide between free versus paid tools. Free or open source does not mean free. Libraries need to consider maintenance and training costs. After that, they would need to decide (based on budgets or human resources) whether they would go with proprietary (paid; supported by other companies) or free, open-source tools, where in-house manpower will have greater role.

More generally, the results of this study reinforce the recently accumulated evidence (Tyndale, 2002; Ruggles, 1997, 1997b) that KM cycle and its tools can be applied in libraries. Findings of this study contribute to fill the gap existing in the literature by

Table V. Technology tools that best facilitate knowledge sharing and dissemination

Technology category	What it does	Tool name	Application for KM in libraries
File sharing	Distributing or providing access to information stored digitally as files	Dropbox, Skydox, clip2net, MediaFire, 4shared, Google Drive, SkyDrive, box.com	e.g. Libraries could use Dropbox or Google Drive to organize and share files pertaining to meetings or committee work. They could also assign different file permissions and make folders transparent outside a committee
Group communication/private social network for the organization	A software platform that implements some form of group communication; teams can connect online	Yammer, Socialcast, Teambox, Hipchat, Chatter, Socialcast, Everyme, Nextt, Ning, Groupsite, Meetup	e.g. Socialcast or Ning helps library teams (even when dispersed geographically) to interact socially (less formal than email) by making knowledge and updates accessible to their peers through a news feed. They can also build their own communities
Instant messaging/chat	Real-time text transmission over the Internet	Adium, Pidgin, Meebo, Yahoo, Windows Live, eBuddy, Google Talk, Trillian, Digsby, Nimbuzz; Todaysmeet (backchanneling)	e.g. Many libraries are using Meebo as a KM tool for reference services (Ou *et al.*, 2011)
Intranet/portal	An internal computer network to share information, operational systems or computing services within an organization	Igloo, Interact-Intranet, Moxie software, Podio, X-Wiki	Mphidi and Snyman (2004) lists intranet among the most effective KM tools for libraries. Igloo, e.g., is a modern intranet that helps bring together content and conversation
Large audience webinars – > 100 participants	A web-based seminar, lecture, presentation or workshop given over the web using web presentation tools	GatherPlace, Adobe Connect, GoToWebinar, OmNovia, BigMarker	e.g. GoToWebinar can be used by librarians to disseminate best practices, or to update their skills by participating in webinars offered by others without leaving their work desks

(continued)

Technology category	What it does	Tool name	Application for KM in libraries
Social networking	Platform to build social networks or relations among people who share interests, activities, backgrounds or real-life connections	Facebook, Twitter, LinkedIn, Google+, Myspace, Academia, ResearchGate, CiteULike	Libraries need to have a presence on Facebook and Twitter to reach out to their patrons
Video conferencing	Allows two or more people in different locations to communicate and collaborate visually	GoToMeeting, Click Meeting, Skype, Adobe Connect, OoVoo, Goober, Google Hangouts	e.g. GoToMeeting can be used by libraries to have discussions or presentations of up to 26 people
Virtual three-dimensional immersive collaboration	Collaboration between virtual teams via technology-mediated communication and using personalized avatars	SecondLife, Tixeo, I-maginer, Teleplace	Many libraries have a presence in SecondLife. Libraries can use it to provide a virtual tool of their facilities
Audio conferencing using Voice-over-IP (VoIP)	Works similar to a traditional conference call using analog phones	Infinite Conferencing, WebEx, Conference Calling, OoVoo, AccuConference (see reviews at TopTenReviews, 2014), Google Talk, Voxox, Skype	Libraries can use OoVoo, e.g. to communicate with colleagues across locations (on best-practices such as digitizing an oversized rare book or any other topic) or to record a reference interview to improve user experience
Web conferencing	Allows conferencing events to be shared with remote locations	Infinite conference, InterCall, Readytalk, GoToMeeting, iLinc	e.g. ReadyTalk facilitates collaboration and sharing with external librarians or partners. It provides recording and customization options for international library conferences
Web/multimedia presenting	Helps create and share presentation online	SlideShare, SlideRocket, Prezi, Empressr, VoiceThread, Zoho Show	E.g. VoiceThread allows a library to share materials with patrons, allowing them to comment in voice/video/text to foster a sense of community

Table V.

Non-IT methods and tools	What it does	Application for KM in libraries
Cognitive styles and Myers–Briggs Type Indicator (MBTI)	Personality assessment test for employees to find out their personality type. Individual personalities affect the way people acquire and apply knowledge	Library staff can understand and better predict their personal preferences and behavior when accessing and using information
Knowledge audit	Understanding the knowledge environment of an organization or project to identify and deal with knowledge gaps	For continuous improvement, libraries need to understand the gap in their desired and existing knowledge
Personalization and profiling	Using continually adjusted user profiles to match content or services to individuals	Rather than one-size-fits-all library Web sites, users can be provided with personalization and profiling options
Taxonomy	Helps organize information, documents and libraries in a consistent manner	Many libraries organize their knowledge assets using taxonomies to aid in effective navigation and retrieval
Learning reviews	Used by a project team to aid team and individual learning during the work process	Team members working on library projects can continuously learn while carrying out the project

Table VI.
Non-IT tools that best facilitate knowledge application and use

bringing together a comprehensive listing of tools and their possible application in libraries in a single paper.

To summarize the findings, we present a model for KM tools and their adoption in libraries.

Figure 3 captures the key features of the integrated knowledge cycle model by Dalkir (2011). The tools for knowledge capture and/or creation (Tables II and III), the tools for knowledge sharing and transfer (Tables IV and V) and the tools for knowledge application and use (Tables VI and VII) form the key pieces of the model. Individuals' perceived usefulness and perceived ease of use of these tools (as per TAM – Davis, 1989) will play a major role whether particular tools are adopted/used and successful. In addition, people who self-identify as innovators and early adopters (as per the diffusion of innovation theory – Rogers, 1995) are more likely to adopt changes easily, and should be part of the pilot program when adopting KM and KM tools in libraries. A librarian or a team assesses and transfers the captured or created knowledge, contextualizes it to one's unique needs and updates it to form a continuous knowledge cycle, supported by technology. All of this must happen to support the wider organizational functions of the library such as circulation, reference, inter-library loan, customer service, etc., and help enhance its larger goals such as service, survival, growth, innovation and satisfaction.

Table VII. Technology tools that best facilitate knowledge application and use

Technology category	What it does	Tool name	Application for KM in libraries
Content management	Creating solutions to manage all content created by the organization/library	WordPress, Drupal, Joomla, Plone, MS Sharepoint Server, Squiz Matrix (see other tools at CMS Critic, 2013)	Libraries are adopting Drupal, WordPress, Joomla or Plone for easy content management
Event scheduling	Finding a common time when everyone can make it; carried out when planning an event	Google Calendar, Doodle, Genbook, TimeToMeet, Appointment-plus, MeetingMaker, EventBrite	E.g. Doodle helps in finding a suitable time for an event (meeting, conference, trip, etc.)
Expertise locator	Connecting people with knowledge needs to experts	Who's who, LinkedIn, Science Citation Index	Useful to librarians as knowing "who knows what" is often more valuable than knowing "how to do"
Project management	Plan, organize and manage resource pools and develop resource estimates	Basecamp, Freedcamp Todoyu, Clarizen, Genius project, AtTask, Project Insight, Daptive PPM, Tenrox, Project manager	Useful for projects such as creating a digital library, creating a multi-subject reference guide, preparing for teen reading week, etc.
Work grouping/team collaboration workspaces	Groups of users can easily access a set of related sheets, reports and templates	Smartsheet, AutoCAD, Wizehive, WebOffice, Onehub, Ubidesk, IBM Lotus Quickr, Teamlab	E.g. Ubidesk is fast and secure, and provides tools for knowledge creation, collaboration and sharing

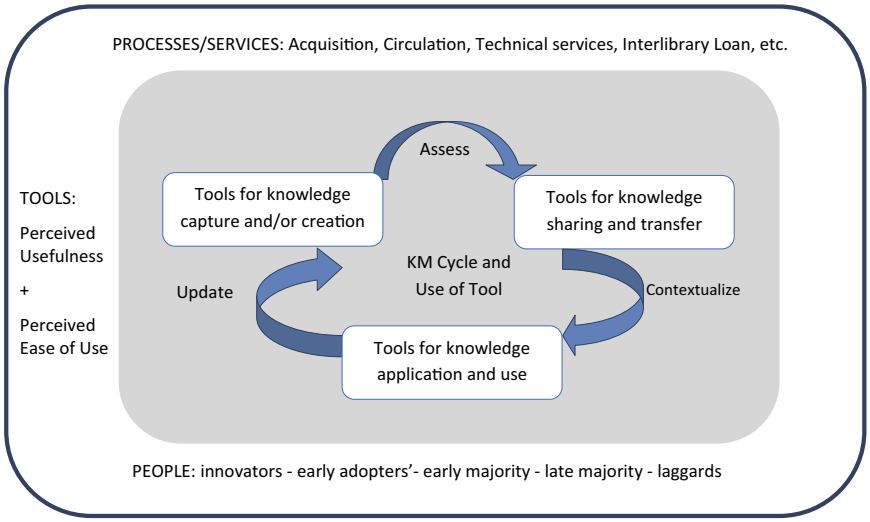


Figure 3.
Model for KM tools and their adoption in libraries

Concluding remarks, limitations and future work

The proposed model for KM tools and their adoption in libraries should help further research in this area. The six tables and this model should help guide the practical implementation of KM in libraries.

The following are the limitations of the study. First, technology tools will keep changing. Therefore, individual examples listed, while applicable for the next two to five years, might change in the longer term, and will need to be supplemented with newer developments. Second, the directories of tools, as well as the proposed model, will need to be tested against actual adoption and use by librarians. The theoretical considerations presented in this article are not tested but rather based on conceptualization. Thus, while we expect the paper to be highly useful, it must withstand the test against actual intention to use and usage.

In a future work, we will examine how integrated library systems need to evolve to take advantage of KM, and also gather qualitative and quantitative data to test the model.

References

Abell, A. and Oxbrow, N. (2001), *Competing With Knowledge: The Information Professionals in the Knowledge Management Age*, Library Association Publishing, London.

Agarwal, N.K. and Poo, D.C.C. (2008), "Capturing tacit knowledge across different domains: Knowledge Community (K-Comm)", in Mitra, A. (Ed), *International Journal of Business Information Systems (IJBIS)*, Vol. 3 No. 6, pp. 668-685.

Allee, V. (1997), "Twelve principles of knowledge management", *Training and Development*, Vol. 51 No. 11, pp. 71-74.

Andrew, P. (2009), "21st century library systems", *Journal of Library Administration*, Vol. 49 No. 6, pp. 641-650.

Awad, E.M. and Ghaziri, H.M. (2004), *Knowledge Management*, Pearson, NJ.

Breeding, M. (2006), "Web services and service oriented architecture", *Library Technology Reports*, Vol. 42 No. 3, pp. 3-42.

Broadbent, M. (1998), "The phenomenon of knowledge management: what does it mean to the information profession", *Information Outlook*, Vol. 2 No. 5, pp. 23-34.

Bukowitz, W. and Williams, R. (2000), *The Knowledge Management Field Book*, Prentice Hall, London.

CMS Critic (2013), "List of enterprise content management systems", available at: www.cmscritic.com/resource-lists/ecm-list/ (accessed 29 December 2013).

Dalkir, K. (2011), *Knowledge Management in Theory and Practice*, 2nd ed., MIT Press, Cambridge, MA.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340.

Dieng, R. and Corby, O. (1998), "Methods and tools for corporate knowledge management", available at: http://hal.inria.fr/docs/00/07/32/03/PDF/RR-3485.pdf (accessed 12 December 2013).

Good, R. (2012), "Best online collaboration tools 2012 – Robin Good. . .MindMeister", available at: www.mindmeister.com/12213323/best-online-collaboration-tools-2012-robin-good-s-collaborative-map (accessed 22 December 2013).

Good, R. (2013), "Top 20 free video conferencing tools 2013", available at: www.pinterest.com/robingood/top-20-free-video-conferencing-tools-2013/ (accessed 22 December, 2013).

Islam, M.A. and Ikeda, M. (2014), "Convergence issues of knowledge management in digital libraries: steps towards state-of-the-art digital libraries", *VINE: The Journal of Information and Knowledge Management System*, Vol. 44 No. 1, pp.

Jantz, R. (2001), "Knowledge management in academic libraries: special tools and process to support information professionals", *Reference Services Review*, Vol. 29 No. 1, pp. 33-39.

Klein, H.K. and Myers, M.D. (1999), "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS quarterly*, Vol. 23 No. 1, pp. 67-94.

Leask, M., Lee, C., Milner, T., Norton, M. and Dimple, R. (2008), "Knowledge management tools and technique: helping you access the right knowledge at the right time", available at: www.kmbestpractices.com/uploads/5/2/7/0/5270671/idea_knowledge_management_tools_and_techniques.pdf (accessed 3 December 2013).

Lek, H.H., Poo, D.C.C. and Agarwal, N.K. (2009), "Knowledge community (K-Comm): towards a digital ecosystem with collective intelligence", *IEEE DEST 2009 – Third IEEE International Conference on Digital EcoSystems and Technologies*, Istanbul, Turkey, 1-3 June, pp. 211-216.

Lindvall, M., Rus, I. and Sinha, S.S. (2002), "Technology support for knowledge management" available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.19.5642&rep=rep1&type=pdf (accessed 18 December 2013).

McElroy, M. (1999), "The knowledge life cycle: an executable model for the enterprise", paper presented at the ICM Conference on KM, Miami, FL, available at: www.inf.ufpr.br/urban/CI-204/LeiturasRecomendadas/206-2010_2-Knowledge_Life_Cycle.pdf (accessed 2 December 2013).

McGill, I. and Brockbank, A. (2004), *The Action Learning Handbook: Powerful Techniques for Education, Professional Development and Training*, Routledge, Oxford.

Maponya, P.M. (2004), "Knowledge management practices in academic libraries: a case study of the University of Natal, Pietermaritzburg Libraries", available at: www.ukzn.ac.za/department/data/leapscecsalpaper.pdf (accessed 11 December 2013).

Meyer, M. and Zack, M. (1996), "The design and implementation of information products", *Sloan Management Review*, Vol. 37 No. 3, pp. 43-59.

Mphidi, H. and Snyman, R. (2004), "The utilization of an intranet as a knowledge management tool in academic libraries", *The Electronic Library*, Vol. 22 No. 5, pp. 393-400.

Newell, S., Robertson, M., Scarbrough, H. and Swan, J. (2002), *Managing Knowledge Work*, Palgrave, Basingstoke, Hampshire.

Nonaka, I. (1991), "The knowledge creating company", *Harvard Business Review*, Vol. 69 No. 6, pp. 96-104.

Ou, Carol, X.L., Leung, D.W. and Davison, R.M. (2011), "The impact of instant messaging tools on knowledge management and team performance", *IFIP Advances in Information and Communication Technology*, Vol. 356, pp. 131-148.

Ponelis, S. and Fair-Wessels, F. (1998), "Knowledge management: a literature overview", *South Africa Journal of Library Information Science*, Vol. 66 No. 1, pp. 1-10.

Rah, J.A., Gul, S. and Wani, Z.A. (2010), "University libraries: steps towards a web based knowledge management system", *VINE: The Journal of Information and Knowledge Management Systems*, Vol. 40 No. 1, pp. 24-38.

Rao, M. (2005), *Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions*, Elsevier Butterworth-Heinemann, Amsterdam.

Rogers, E.M. (1995), *Diffusion of Innovations*, The Free Press, New York, NY.

Roknuzzaman, M. and Umemoto, K. (2009), "How library practitioners view knowledge management in libraries: a qualitative study", *Library Management*, Vol. 30 Nos 8/9, pp. 643-656.

Rollet, H. (2003), *Knowledge Management Processes and Technologies*, Kluwer Academic Publishers, Norwell, MA.

Roth, G. and Kleiner, A. (2000), "Developing organizational memory through learning histories", in James, W.C and John, A.W. (Eds), *The Knowledge Management Yearbook 2000-2001*, Butterworth-Heinemann, Burlington, MA, pp. 123-144.

Ruggles, R. (1997), *Knowledge Tools: Using Technology to Manage Knowledge Better*, Butterworth-Heinemann, Boston, MA.

Ruggles, III, R.L. (1997b), *Knowledge Management Tools*, Butterworth-Heinemann, Newton, MA.

Sarrafzadeh, M., Martin, B. and Hazeri, A. (2010), "Knowledge management and its potential applicability for libraries", *Library Management*, Vol. 31 No. 3, pp. 198-212.

Shanhong, T. (2000), "Knowledge management in libraries in the 21st century", *66thIFLA World Library and Information Congress*, pp. 1-6.

Siddike, K. and Islam, M.S. (2011), "Exploring the competencies of information professionals for knowledge management in the information institutions of Bangladesh", *International Information and Library Review*, Vol. 43 No. 3, pp. 130-136.

Teng, S. and Hawamdeh, S. (2002), "Knowledge management in public libraries", *Aslib Proceedings*, Vol. 54 No. 3, pp. 188-197.

Tiwana, A. (2002), *The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms*, Prentice Hall, Upper Saddle River, NJ.

TopTenReviews (2014), "Conference call services review 2014, best conference calling services, conference call providers", available at: http://conference-call-services-review.toptenreviews.com/ (accessed 22 December 2013).

Townley, C.T. (2001), "Knowledge management and academic libraries", *College and Research Libraries*, Vol. 62 No. 1, pp. 44-55.

Tyndale, P. (2002), "A taxonomy of knowledge management software tools: origins and applications", *Evaluation and Program Planning*, Vol. 25 No. 2, pp. 183-190.

Wang, Y. and Dawes, T.A. (2012), "The next generation integrated library system: a promise fulfilled", *Information Technology and Libraries*, Vol. 31 No. 3, pp. 76-84.

Wen, S. (2005), "Implementing knowledge management in academic libraries: a pragmatic approach", paper presented at the third China-US Library Conference, Shanghai, *22-25 March*, available at: www.white-clouds.com/iclc/cliej/cl19wen.htm (accessed 4 December 2013).

White, T. (2004), "Knowledge management in an academic library: based on the case study KM within OULS", paper presented at the 70th IFLA General Conference and Council, 22-27 August, Buenos Aires, available at: http://archive.ifla.org/IV/ifla70/papers/089e-White.pdf (accessed 20 October 2013).

Wiig, K. (1993), *Knowledge Management Foundations*, Schema Press, Arlington, TX.

Young, R. (2010), *Knowledge Management Tools and Techniques Manual*, Asian Productivity Organization, Tokyo, available at: www.apo-tokyo.org/publications/files/ind-43-km_tt-2010.pdf (accessed 9 December 2013).

About the authors

Naresh Kumar Agarwal is an Assistant Professor at the Graduate School of Library and Information Science at Simmons College, Boston. He earned his PhD from the National University of Singapore (NUS)'s Department of Information Systems, School of Computing. His teaching areas are evaluation of information services, technology for information professionals and knowledge management. Agarwal's research area is Information behavior – the way people look for information and the contextual factors that impact their choice of information sources. He seeks to understand and synthesize the apparent contradictions in this phenomenon and tries to reconcile multiple perspectives: user/seeker (information need, information seeking and context) versus information systems, technology and the user's context (source choice, knowledge management, sense-making, technology adoption and health informatics); theoretical models/frameworks versus empirical studies – both positivist and interpretivist; variety of contexts – office workers, medical residents, library and information science (LIS) students, preschoolers, ancient epics; relationship between identity and context, between information and happiness; and when information is encountered serendipitously. He has published on many of these topics. Agarwal has held various leadership positions at ASIS&T – the Association for Information Science and Technology. He is currently a member of the ASIS&T Board of Directors and the Director of the Chapter Assembly. In 2012, Agarwal was awarded the James M. Cretsos Leadership Award by ASIS&T. From 2007 to 2009, Agarwal served as the Chair of the Association of Pacific-Rim Universities Doctoral Students' Network (APRU DSN). Prior to entering the doctoral program at the NUS, he worked for six years in technology roles in the voice-over-IP, bioinformatics and digital cinema industries. You can get to know more about him at: www.nareshagarwal.co.nr/. Naresh Kumar Agarwal is the corresponding author can be contacted at: agarwal@simmons.edu

Md Anwarul Islam received his BA (Honors – 2002), MA (2003) and MPhil (2005) in Information Science and Library Management from Dhaka University, Bangladesh. He is currently pursuing his PhD in the School of Knowledge Science, Japan Advanced Institute of

Science and Technology (JAIST), Japan. His research areas are knowledge management (KM), KM in digital environments, knowledge sharing, social networking tools, digital library, information literacy and webometrics. He is also an Assistant Professor in Information Science and Library Management at Dhaka University, Dhaka. He was in the Nanyang Technological University, Singapore, from August to September, 2013, as an ACRC fellow, and in the University of Antwerp, Belgium, from October to December, 2012, as a VLIR-UOS scholar. He has more than 15 peer-reviewed papers, and has presented in a number of international conferences.