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Digital Libraries in India: A Review

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Recent years have seen several digital library development initiatives in India. To gain insight, assess and understand the growth, development and current status of digital library initiatives in India as reflected through scholarly journals, 63 published studies on digital libraries in India have been reviewed. The study reveals that most articles focus on developing digital libraries and digital collections except for a few studies on copyright issues and management of digital libraries. No studies have touched upon issues such as digital rights management, security and digital library policies.

Introduction

It is well recognized that libraries all over the world are undergoing transformation, especially owing to the development in information and communication technologies. Traditional libraries are changing to digital libraries and new libraries that are being set up are increasingly of the digital kind. As a result, there is widespread interest and consequently, a lot of research and development activities are being carried out in this area world over. In India a number of institutions are also in the process of setting up digital libraries and many scholars and practitioners are conducting research on digital libraries.

In recent years, quite a few conferences on digital libraries and their various facets have been organized in India. In addition to many national conferences, international conferences such as the International Conference of Asian Digital Libraries (ICADL) 2001, International Conferences on Digital Libraries (ICDL) 2004 and 2006 gave necessary impetus to digital library awareness and developments in India. Both ICADL 2001 and ICDL 2004 were reported as widely attended (Kar & Seadle 2004; Urs & Raghavan 2002).

Although conference proceedings are a vital primary source of information, marginal papers get included in proceedings many times as papers may not go through the peer-reviewing process. On the other hand, scholarly journals with their peer-reviewing mechanism have better quality papers and further, and more importantly, owing to their coverage in abstracting and indexing databases, the visibility and readership of papers published in scholarly journals are much greater than conference proceedings.

India publishes about 20 scholarly journals in the field of library and information science. Articles on digital libraries in India have been published in Indian and foreign journals. A review of Indian and foreign periodicals literature published on digital libraries in India would be useful to assess and understand the state of digital library research and development in India.

Methodology

The literature review was limited to published articles covered by Library and Information Science Abstracts (LISA), Library, Information Science and Technology Abstracts (LISTA), and Emerald Insight databases. These databases were searched for the entire duration up to June 2007. Multiple search strategies were used on the keywords, 'digital libraries', 'digital library' and 'India'. Results of these searches were reviewed to identify relevant articles. The references of the relevant articles

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were further studied to collect articles that were not covered by these databases. This resulted in the 63 articles that were used for this study.

Results

The study reveals that most articles focus on digitization efforts and collection building, thereby on developing digital libraries and digital collections. There are few articles on copyright issues and management of digital libraries. Various issues such as digital rights management, security and policies have not been touched. A summary of findings of the study is presented below.

An overview

It is generally accepted in many studies that digital library initiatives in India began in the 1990s and this review also found that most of Indian literature on digital libraries is post-1995. One of the earliest articles giving an overview of digital libraries in India is by Rajashekar (1997b); this lucid article discusses the many advantages of digital libraries and the issues involved in their creation.

Srivastava and Saxena (2004) have also written an overview of digital libraries. Sharma and Arora (2005) highlighted the need for digital libraries along with the requirements, digitization process and future of digital libraries. One of the challenges of digital libraries discussed by Sadagopan (2000) includes availability of information at the fingertips but questions, where is knowledge. Digital libraries in the Indian context are discussed and the author highlights the opportunities available to library scientists for creating and accessing content in Indian languages.

Even as the digital library era was being ushered into Indian libraries and information centres, the *DESIDOC Bulletin of Information Technology* came out with a special issue on digital libraries in 1997. The issue carried six papers on digital library concepts and technologies and interestingly all six papers were contributed by authors from outside India (Rajashekar 1997a).

Electronic libraries have been the precursor to digital libraries though the terminologies have been used interchangeably and the term 'digital library' has evolved to be the widely accepted terminology encompassing the concepts and services of electronic libraries as well. Electronic library services of the Indian Institute of Technology, Kharagpur include video library services, database services, SDI services, online journal access service and retrospective database search services. Future programs which include plans for large-scale digitisation have been discussed by Mohapatra (2007).

An article that reaffirms the evolutionary position of the electronic library as the predecessor of digital libraries by Deb and Kar (2005) describes the setting up of the electronic library at The Energy and Resources Institute (TERI). The TERI electronic library opened for its researchers in 1999 and includes a number of services. The concepts of a physical electronic library and a virtual electronic library are discussed including the various resources and benefits of the TERI electronic library.

The phenomenon of information hidden in the traditional library set-up being a barrier to communication, and the potential of digitization as means to overcome this phenomenon is discussed by Giri (2006).

Country initiatives

In recent years there have been a number of digital library initiatives in India and there are several papers that have attempted to study these initiatives. Bhattacharya (2004) traced the development of digital libraries with respect to India and concluded that India's attempt towards digital library development has been sporadic and partial. In the paper, digital library initiatives have been divided into eleven categories that includes art and culture, academic institutions, national-level institutions, R&D organizations, government, NGOs, financial institutions, media, private, society and university levels. The problems and the policy of the Government of India towards digital library development in India as well as the digital divide in general are also discussed.

Similarly, Jain and Babbar (2006) have categorized the different Indian digital library initiatives viz., at the government level, at academic institutions and within society-level organizations. Fifteen digital library initiatives that fall under the three categories have been highlighted. The authors also affirm that only sporadic and partial attempt have been made towards digital library initiatives in India.

India is rich in various kinds of traditional knowledge that is documented in various forms and is available in museums, archives and some libraries. With digital library technology and tools, it is possible not only to archive these for posterity but also to replicate and disseminate such information with ease. Rao (2005) discusses two such digital library projects, viz., Digital Library of Indian Heritage and Indian Art Preservation Research Project.

One of the major digital library initiatives in recent times has been the Million Books to the Web Project initiated by Prof. Raj Reddy of Carnegie Mellon University. It is a worldwide mission and India is a major contributor to this project with the Indian effort being named Digital Library of India (Balakrishnan 2005). Balakrishnan discusses the technological challenges with regard to the Indian languages and future directions including the possibility of creating a 21st century equivalent of the public library and that PBS and All India Radio might create Web contents.

Krishnamurthy (2004) also gives an overview of digital libraries describing the Digital Library Initiative – Phase I and Digital Library Initiative – Phase II projects. He also touches upon research issues involved in digital libraries such as interoperability, collection development and management, preservation, cataloguing and indexing and reference services.

Case Studies

The Central Food Technological Research Institute's (CFTRI) efforts to create a digital library of theses and dissertations are discussed by Padmavathi, Lal and Mahakuteshwar (2005). A case study outlining the practical issues and key stages involved in creating a digital library of mathematics using DSpace has been reported by Krishnamurthy (2005a). Further, the importance of open source software has been explained.

A brief on the digital library initiatives at the Indian Institute of Astrophysics, Bangalore is discussed by Vagiswari and Birdie (2003). It includes the digitization of archival material and participation in the Million Books to the Web Project.

Kalra (2001) mentions a few digital library initiatives that began in the 1990s but discusses mostly Web-based searchable databases, bulletin board, listservs® and OPACS. Highlighting the importance of ceramics for society, the need for developing a digital library on ceramics has been dealt at length by Patra (2006). Brief mention is also made on the actual implementation of the digital library in ceramics.

Efforts at The Energy and Resources Institute (TERI) to create an integrated digital library have been discussed by Deb (2006). The concept of the hybrid digital library and the steps involved in its creation are also discussed. The hybrid digital library is a digital library that holds the metadata for accessing resources available in cyberspace and in the organization's library. Deb also discusses the physical digital library for born-digital documents in TERI and explains the TERI integrated digital library that provides a single window to provide access to born-digital resources as well as digitized documents.

Vidyanidhi, the Indian Digital Library of Electronic Theses initiative, is highlighted by Urs and Raghavan (2001) who mention that Vidyanidhi is a direct consequence of government policy initiatives and is intended to demonstrate the utility of digital library technologies in maintaining and enhancing access to and visibility of Indian academic research.

A conceptual model of Networked Digital Libraries (NDL) for IIMs (Indian Institutes of Management) have been drawn up by Jose and Raina (2005) following successful NDL (National Digital Library) programmes initiated in the U.S., like the Networking Digital Library of Theses and Dissertations (NDLTD) and Networked Computer Science Technical Reference Library (NCSTRL).

Creation of a digital library using satellite technology and the GSDL (Greenstone Digital Library) software is described by Malathy (2005). Organising digital information in the corporate sector using the GSDL is discussed by Munnolli (2004).

E-government initiatives

Government-to-citizen programmes largely fall under the e-governance initiatives undertaken by various countries and in the recent years there has been stress on e-governance in India. Sharma and Yurcik (2001) have discussed the Gyandoot Digital Library Intranet, highlighting the challenges and prospects of the rural digital library. Government digital library initiatives for reparation of public

grievances, such as information kiosks for dissemination of information regarding water tanker schedules, marriage matchmaking, just-in-time employment, are discussed. Gyandoot, an intranet-based digital library in the Dhar district of Madhya Pradesh state connecting rural public cybercafés in India, is discussed as a model for future rural digital libraries.

Public libraries

The public library system has been an area of major concern in India with development of public libraries being rather slow. Ghosh (2005) sketches a vision for the public library system based on the concept of ICT for development.

E-consortia

With a number of e-resources consortia, especially e-journals consortia, available all over the world and with many e-resources consortia being formed in India, authors discussing this phenomenon need to distinguish consortia for shared licensed resources from the concept of digital libraries. Fox *et al.* (1995), in one the earliest papers on digital libraries, state that the phrase 'digital libraries' evokes a different impression to different readers. The Indian literature on digital libraries, mostly post-1995, supports this notion of authors treating digital libraries differently.

Pandian, Jambhekar and Karisiddappa (2002) have suggested a framework for the design and development of an intranet-based IIM digital system based on a consortial approach. This model proposes digitization of the IIM resources in a cooperative manner with subscriptions to electronic journals and databases through a consortial mode.

Yet another consortium approach to digital libraries, in this case primarily of licensed e-resources, is the INDEST consortium (Arora 2001, 2003). INDEST (Indian National Digital Library of Engineering Science and Technology) includes licensed e-resources acquired and shared on the principles of the other widespread U.S. e-resources consortia like GALILEO (Georgia Library Learning Online), OhioLINK, VIVA (The Virtual Library of Virginia) and SUNYConnect. INDEST also envisages including in its collection CD-ROMs, DVDs, portal sites, content creation by scanning/digitization.

Institutional repositories

As a digital library is a collection of digital objects, sometimes it is also called a repository containing different content types ranging from research papers, reports and newspapers. Institutional repositories are not exactly digital libraries but digital collections that capture, collect, manage, disseminate and preserve scholarly work created by the members of an institution. The open source software movement has created digital library and institutional repository software. Software programs like the Greenstone Digital Library software and DSpace have hastened the digital library creation process. Libraries are today playing a lead role in the creation of institutional repositories supporting the cause of open access.

Anuradha (2007) discussed the design and development of an institutional repository for the Indian Institute of Science (IISc), Bangalore. While there are about 40 software packages for creating OAI-complaint (Open Archives Initiative) databases, Greenstone Digital Library (GSDL) software has been chosen for developing the IISc institutional repository. Yet another study discussed in detail the design and development of an institutional repository at the Indian Institute of Technology, Kharagpur using DSpace (Sutradhar 2006). Doctor (2007) addresses the development of a digital repository of summer internship project reports using the GSDL software at the ICFAI Business School, Ahmedabad.

While there are many other papers on institutional repositories, only a few have been mentioned here to highlight that institutional repositories can be created by adopting the tenets of digital library creation such as use of digital library software, standardised metadata and digital collections management.

Issues and policies

Considering that India has been a late entrant into the arena of digital library creation and also considering that the pace at which digital libraries are being created is less than desirable, it is evident that there are problems in digital library development in India. While many papers have cursorily discussed the problems, Jeevan and Dhawan (2002) focus on the issues in detail. The authors discuss the problems and issues related to

integration of information technologies, digital library tools and software, models for resource development, IT training needs, content development and copyright management.

Kaur and Singh (2005) discuss the transformation of traditional libraries into digital libraries in the Indian context. They note that in developed countries, 60% to 70% of information is available in digital format whereas in developing countries like India, this availability is 2.5%. The authors highlight the need for a National Information Policy and for the training of library professionals to accelerate the transformation of traditional libraries to digital libraries in India.

Content for digital libraries

As information sources are increasingly available in digital form, it is natural that any digital library would have different kinds of digital formats and sources. The various constituents that contribute to the making of a digital library at the central library, IIT Delhi, include, in addition to the network infrastructure, a variety of digital collections (Arora 2004). These include e-journals, in-house born digital collections such as theses, scanned books, CD-ROM databases, the library OPAC, and courseware.

In the early years of digital library development in India, there have been problems related to high infrastructural costs, lack of experience and expertise in creating digital libraries. However, over the years, ICT infrastructural costs are decreasing and expertise and experience have been gained in handling digital library software especially in using open source software such as DSpace and GSDL. In this scenario, the contents of digital libraries have assumed significance, especially the source of this content. There are not many studies in this area and one study that deals with identifying sources of content for developing countries with special reference to India is by Jeevan (2004). The paper answers questions such as why digitize, what to digitize, how to digitize and also elaborates on the various kinds of contents that can be sources for digital libraries.

Another paper on content for digital libraries is by Sreekumar and Sunitha (2005) who share the experience of creating a state-of-the art digital library information system by seamlessly integrating and aggregating print as well as the diverse distributed digital content of the Indian Institute of Management, Kozhikode knowledge domain. The paper recommends this seamless dissemination of scholarly information by means of content aggregation and content integration through library automation, a library portal, a digital library and an open access archive. Greenstone software was used for developing this digital library.

Shukla (2005) discusses content creation as a new trend in IT and stresses the need to develop digital libraries and not digital collections. The author emphasizes that care should be taken to surround collections with appropriate metadata supplying context and interpretation to develop synergy. The article also suggests areas for greater exploration and addresses issues of concern in content creation.

Digitization

The digital library stores digital objects representing different types of information. Older collections are digitized through a conversion process where documents in paper format are converted to electronic format, i.e. analogue to digital conversion. Converting texts in different languages requires careful consideration of character sets. Unicode provides a standard scheme for world's languages. Chandrakar (2004) discusses Unicode and the related technologies available for localizing Indian language materials.

Gaur's paper (2003) entitled "Rethinking the Indian Digital Divide: The present state of digitization in Indian management libraries" focuses more on library automation and its facets rather than on digitization or digital libraries. The paper highlights the status of libraryautomation in the Indian management institutes' libraries and there is only a passing mention of digital library initiatives by these libraries; in fact, the study found these initiatives dismal. Murthy (2005), however, shares the practical experience of digitization at the National Tuberculosis Institute, Bangalore.

Digital library services

Libraries provide services. Letha (2006) has discussed the library portal as a tool for Web-enabled information services. Highlighting the portal of the Technical Information Resource Centre (TIRC) of

National Physical and Oceanographic Laboratory (NPOL), various services are discussed; one of the services included is the digital library that can be accessed from the portal. Gupta *et al.* (2004) points out that the library website is by nature a vehicle for delivering digital library services.

Another case study describes the building of digital resources at the Indian National Science Academy (INSA), New Delhi (Munshi 2003). The article points out that the growing acceptance of digital media has resulted in libraries buying and providing access to Internet resources, acquiring CD-ROM-based data sets and providing services for standalone or networked CD-ROMs environments and digitizing documents. It further goes on to explain these three facilities at the INSA library.

Krishnamurthy (2005b) discusses digital library services in the Indian Statistical Institute (ISI), Bangalore. According to the author, to create true digital libraries, not just digital collections, will require librarians to work closely together to create open, distributed, publicly accessible resources, as well as to establish a collaborative structure to coordinate and guide implementation. Interestingly, the digital library at ISI seems to be digital collections of consortia- based e-resources, OPAC and CD-ROM databases.

Access and information retrieval

The objective of an information retrieval system is to retrieve all the relevant documents in response to the user query. With limited vocabulary control, it may not be easy for a searcher to use terms in a query to match the terms in relevant documents. A thesaurus may be used for concept-based information retrieval. For a digital library, a thesaurus can be built automatically through semantic indexing in a particular subject. One approach to enhance the efficiency of the information retrieval system using experiments in intelligent information processing techniques is presented by Kumar *et al.* (2006). Latent semantic indexing, a technique in natural language processing, can facilitate subsequent retrieval.

Das, Dutta and Sen (2007) assess the present situation in the development of indigenous digital libraries focusing on the retrieval features of eight digital libraries in India. This study shows that information retrieval features of digital libraries vary significantly from each other due to the use of different content organization techniques and differing types of digital content.

Arumugam, Thangaraj and Shanti (2005) discuss about the concept of data mining and certain algorithms than can mine frequent user access patterns of the library database. Though the title of the article states that it is about discovering frequent access patterns in a digital library using association mining, the study itself is not on digital libraries but pertaining to the circulation or transaction database of an automated library.

Technology

The very premise, development, spread and use of digital libraries will become a reality only if the libraries and information centres in India have a fully developed and state-of-the art ICT infrastructure. Open source software packages are available to develop a digital library. Most of the research in India is done with these openly distributed packages. An Indian scenario on the use of ICT infrastructure in libraries and information centres depicts that special libraries are better equipped and are involved in consortia and digitization programmes in the country (Gulati 2004).

In India, the science and technology libraries are better situated than other libraries, particularly, with respect to application of information and communications technology, because these systems in India fare comparatively better with regard to budget. A survey of 25 institutions of the Indian Council of Social Science Research (ICSSR) reveals that digitization and networking is taking place in social science libraries in India but in a rather slow manner (Jain 2003).

Copyright

Copyright law protects the legal rights of individuals, groups and society. It supports and helps in enforcement of copyright. The very nature of digital information makes it vulnerable to copyright abuse and with digital libraries growing in numbers and expanding in collections, the copyright implications in the digital environment becomes exceedingly important, particularly in developing and under-developed countries where software piracy is significantly higher as compared to the developed world. The implications of copyright

in the electronic environment are discussed by Rao (2003).

James (2005) looks at digital libraries and copyright including various issues with respect to the different aspects of digitization and the copyright laws of India. This article points out that technical issues predominate and that legal issues are not given adequate attention in the digitization process.

Management of digital libraries

Once the digital library has been created, its management is important. The issues and strategies involved in management of digital libraries include hardware management, software management, collection management, preservation/archiving, financial management and the access system are focused on by Gupta and Singh (2006). Development of digital libraries involves substantial planning. Lakshmi and Suma (1998) emphasise planning digital library development, especially planning for the IT infrastructure and financial planning.

Das and Dutta (2004) discuss the need for audit and control of digital library systems. The authors identify the elements of audit and control that enhancing the capabilities and effectiveness of digital libraries. Finally, Ravi, Chandra and Sharma (2000) look at emerging trends and the future of digital libraries in terms of their usefulness and cost effectiveness.

The Role of information professionals

As the number of digital libraries grows, the role of the traditional librarian needs to be re-examined in the light of this new environment. Sreenivasulu (2000) authored one of the earliest papers looking at this aspect with particular reference to the emergence of the 'digital librarian'. The paper describes an array of roles for the digital librarian and discusses the competencies, skills and professional education and training needed by the digital librarians.

Digital divide

Digital library creation is currently being done in fits and starts in India. However, looking at the growing interest shown by libraries and information centres in India, one can conclude that digital library development is on a growth path, albeit a slow one. Amidst this growth and development, we need to keep in mind the emerging digital divide in India highlighted by Singh (2002). This paper discusses, among other things, a few digital library initiatives but cautions that checking the permeating "digital determinism" and "digital divide" requires adopting various means.

Parvathamma (2003) discusses the social and economic issues that need to be considered to bridge the digital divide between rural and urban populations in order to ensure sustainable development of India. These are the problems of shrinking budget; high initial and recurring expenditures; social and economic problems, such as illiteracy, population growth, and poor health conditions; inadequacy of resources for development programs; and weak infrastructure. These factors make access to digital information difficult for the majority of the population in the country.

Discussion

Previous review studies on digital libraries have not included Indian literature on digital libraries (Fox & Urs 2002; Bearman 2007). Digital library developments in India began rather slowly in mid-1990s and have gathered momentum at the turn of the century. Libraries of S&T organisations have developed a number of digital library initiatives. This may have to do with the fact that S&T libraries have greater economic and human resources by far to undertake digitization programmes. Even in the library automation era, it was the S&T libraries that took the lead in computerization activities.

India has a large public library system, but we find that the public libraries lag far behind in digitization activities. There is an urgent need to initiate digitization activities in public libraries in India and also to speed up the creation of digital libraries in other areas.

In the present era, there is great amount of interest in creating digital libraries. Previous studies have highlighted the fact that the terminology 'digital libraries' takes on different meanings for different groups, such as students, government, institutions, publishers, librarians, etc. The present study reveals that even among the LIS fraternity, the terminology 'digital libraries' refers to different things, such as digitization, access to consortia resources, creation of institutional re-

positories, automated library services and library websites. However, to generalize the term 'digital libraries' for any ICT-based activity or resource in the library is inappropriate.

The creators of digital libraries have to be knowledgeable about the all the encompassing aspects involved in digital library creation and management. At present, this is lacking in most instances. Training programmes in the creation and management of digital libraries are essential to educate and impart skill sets to library and information professionals so that purposeful digital libraries are created in the right context, essence and manner. This study found no report or study on any training programmes although digital library conferences in India hold pre-conference tutorials and there are a few institutes that have been imparting training on digital libraries and institutional repositories software.

As digitization initiatives have picked up momentum in the country, there is a need to make consistent national policies and procedures for creation and management of digital libraries. However, there have been no reports on this all-important area of digital library policy in India. To facilitate policy makers, studies need to be conducted to chart out standardization requirements, examine interoperability and copyright issues, and outline classification of documents, among other issues.

India is the second most culturally, linguistically and genetically diverse geographical entity after the African continent. According to the Census of India, there are a total of 122 languages, out of which 22 languages are included in the Eighth Schedule to the Constitution of India. Evidently, India has rich information resources in languages other than English and presently, it is seen that the digital library activities are more concentrated on information resources in the English language. It is essential to expand digital library activities to include Indian language documents and consequently, technologies need to be developed to integrate such resources seamlessly with existing digital libraries or new digital libraries in multiple languages.

Conclusion

Digital library development in India has been skewed. Most developments have been in S&T libraries. Even among these libraries, focus has been on developing digital libraries without focus on issues such as education and training, copyright, management and promotion (marketing). There is a need to amend copyright legislation to suit the electronic environment. Few institutions have taken initiatives to hold workshops on digital libraries and digital technologies. Other important areas on which Indian studies have been few or totally missing are digital rights management, digital library security, content management, business and pricing model and policy studies. At present, a pricing model does not exist in India. With several digital library initiatives reported, it will be useful to have a survey of the digital libraries in India to understand the present status of the digital library initiatives. This assumes importance because the few studies on Indian digital library initiatives are primarily based on information available on websites or from other published sources. A survey would help not only in understanding the present situation but will help in drawing up an action plan for focused digital library development in India. Further, use and user studies of digital libraries in India are lacking. This area is also of paramount importance for assessing the existing digital libraries and creating highly user-centric digital libraries in India.

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