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One of the major issues that have been daunting every academic institution across the world is the ever increasing cost of access to journals and scholarly communication. While the academic community anticipated a large relief from the advances in electronic publishing and open source, but the reality was different. One way by which several countries have attempted to overcome this is by forming consortia of users. The first consortia in India were created by the Ministry of Human Resources Development (MHRD) which took care of the information needs of technical institutions such as IITs, NITs and IISc. This consortium known as INDSET ensured that MHRD institutions had uninterrupted and equitable access to journals and scholarly communication. Council of Scientific and Industrial Research (CSIR) and University Grants Commission (UGC) also formed their respective consortia. In this issue, the experiences and the offerings of the UGC led INFLIBNET Consortium which has much larger outreach and is described by Dr Bhatt.

India is one of the countries in the world that has rich traditions, cultures and variety in diversity. The cultural heritage of the country dates back to five thousand years, which is to be preserved, archived and simultaneously made accessible to the civil society. Of late, with many societies in a state of turmoil and with ever diminishing funds for preservation, newer techniques need to be developed for the preservation of our heritage. Digital preservation has found world wide acceptability and had been immensely successful in many older civilizations in Asia. The Indian experience of constructing the meta data for digitized images is described in a paper by Dr Lalitha Poluru. Dr Polluru has suggested the use of DSpace digital library software and the Dublin Core Metadata standards so that it can become compatible with the other resources such as manuscripts and printed texts.

With the ever decreasing cost of communication and its ever increasing reach, the information seeking behaviour of the library users has changed dramatically. It is filled with less and less visits to the brick and mortar buildings earlier known as ‘Library’. This has called for the increase in resources that are electronically available or access to such resources hosted elsewhere either free of charge or for a price. Such users, who access information from anywhere and at anytime, often need access to information, from hotspots available in public places and cybercafés. Fagbami, Akintola and Pelemo have studied the use of cybercafés by the research scientists in agricultural research.
institutes in Nigeria. This is a very good example of the information needs and access pattern of those from developing countries.

The world wide diffusion of IR (Institutional Repositories) led to a growing demand for Aggregative Digital Library Systems (ADLS). The authors Artini, Candela, Castelli and others describe various features and principles underlying the DRIVER Infrastructure, whose environment supports sustainable construction and maintenance of multiple ADLSs. This system provides research organizations with end-user applications over an extensive information space of metadata records, collected and aggregated from a pool of potentially heterogeneous repositories.

The authors Vijayakumar and Kannappanavar conducted a survey on the use of library services by the researchers at Kuvempu University in Karnataka, India. Their findings are presented in a paper in this issue.

There have been very many significant strides that are being made in India. Significant among them is the work of the universities in India to create one stop portal for education. This work was motivated by the success of the MHRD in creating course contents through NPTEL. This on line portal can be seen at <http://www.ignouonline.ac.in/sakshat/>. This along with the Knowledge Network spearheaded by Dr R Chidambaram and the ministries of HRD and IT will make available network bandwidths and reach so far unheard of in India. The Digital Library of India, an initiative of the Ministry of IT in collaboration with Professor Raj Reddy of Carnegie Mellon University and with countries such as China, Egypt, Qatar and Australia has already put more than one million books on the web, of which nearly 400 000 are from India. The Department of Science and Technology has began an initiative that would help in high resolution preserving of not just the images but large structures such as temples and monuments. The untiring efforts of Dr Subbiah Arunachalam and the Indian National Science Academy to make Open Access a great reality in India are another significant work that will have much wider and greater impact in India. Together, these initiatives of the country would change the sheer definition of Library and the way we perceive information and its access. It will also throw many technological and software challenges. This will give an opportunity for library professionals for the first time to think of new and innovative ideas that have never been tried elsewhere. I am sure that the library professionals across the world would rise to this challenge and use this journal as an organ for communicating and disseminating their work to the rest of the world.
Abstract
The study examined the usage of cybercafés by research scientists in the national agricultural research institutes in Ibadan. A descriptive survey design was adopted for the study. A purposive sampling technique was also used to select the sample and the method produced 180 research scientists. A total of 162 cases were finally analysed which represented 90% of the total sample. Data was collected using a well structured questionnaire designed by researchers. Findings from the study shows a high level of awareness of the importance of Internet service as a resource for research information and other purposes, and as such cybercafe is considered as a useful outfit in these research institutes. The study also revealed that research scientists have resorted to utilizing the cybercafe located outside their respective institute due to (i) inadequate facilities in their offices and incessant poor outage, and (ii) in order to continue their research work after office hours. Finally, the study suggested that in order to improve the effective use of Internet resources, there must be regular power supply as budgetary allocations to the research institutes can no longer sustain continuous dependency on alternative power supply. The study also suggested that the research scientists should be assisted in procuring ICT equipment and that effort should be geared towards the provision of enhanced broad-band width to the national research institutes in order to reduce hardship being experienced by research scientists in meeting their research information needs.
Introduction
The Internet provides a wealth of information on countless topics including agricultural information. All NARIs (National Agricultural Research Institutes) in Ibadan are connected to the ICT (Information Communication Technology) facilities known as cybercafé. Cybercafé is an Internet outfit, where not less than five computers are assembled, configured and connected to an established Internet network for staff and the public. Fagbami (2005) in his study on information source usage by research scientists on tree crops opined that in Nigeria the use of Internet is soaring rapidly when compared to other sources. Today, Internet provides latest information on the web through the agricultural websites, which could be used in a way to improve research productivity. Internet is an invaluable resource in research when compared to books and journals.

Internet has associated attributes of electronic library, virtual library which are invaluable resources in research when compared to acquisition of books and journals and this has been jeopardized by lack of funds. However, the Nigerian factors and poor infrastructural developments have not allowed the Internet facilities in these research institutes to optimally serve the research scientists. These inadequacies are being complemented through the use of other cybercafé owned by outside ventures and business centres.

Impact of Internet on research
The impact of Internet on research information cannot be overemphasized. Olayiwola and Akintola (2005) have explained that despite the limitations faced by Africans in contributing to Internet content and development, the ICT have been identified as a reliable source of information for research and development activities, especially in Nigeria.

Fagbami (2005) also reported that research scientists rated Internet (25.40%), next to seminar/conference/workshop (34.92%) as most reliable source of information on tree crops research in Nigeria. Also, these respondents rated Internet services (37.17%) highest when compared to documentation (15.38%) among the media that best prompt sharing of research information.

Ojedokun and Owolabi (2003) had earlier emphasized that Internet has become an invaluable tool for collaborative research among research scientists. In the same vein, Oketunji (2001) opined that the functions of Internet has always been to provide a way for researchers to have better access to each other and as tool to facilitate research. He concluded that the Internet is the world’s most efficient means of communication when compared to other sources.

Cybercafé usage in research environment
Today, cybercafé services are flourishing in Nigeria, making Internet facilities available to everyone. This shows that Internet connectivity is not a luxury but a necessity. Fagbami (2005), rated Internet usage as being incomparable to books and journals, this was supported by the rate at which research scientists clamour to use agricultural websites such as AGORA (Access to Global Online Research in Agriculture) database where relevant literature are downloaded.

Furthermore, Olayiwola and Akintola (2005) revealed that a lot of scientists have benefited from correspondences through emails. This has partly replaced mode of correspondences in the national agricultural research institutes, either locally or internationally.

Online searches also are carried out on Internet without visiting the library, using various databases and recent publications and ongoing research to avoid global duplications.
Cybercafés use by the research scientists in agricultural research institutes in Ibadan, Nigeria

which are available free or at a low cost through Internet.

**Justification of the study**
Productivity and research breakthrough that will put agriculture back in the forefront of foreign exchange earnings is dependent on useful and relevant information at the disposal of research scientists. The NARIs were established with the aim of providing solutions to some problems facing agricultural sector by boosting the production of cash and tree crops, which were Nigerian main source of foreign exchange. Research work had become highly monotonous in the past due to lack of funds to acquire books and journals from which other research will spring up through information services in these research institutes.

The information technology source is attacked by Nigerian factors, such as infrastructures (electricity), connectivity (funding, and failure of networks). These have made Internet an option for information not readily accessible to research scientists in the agricultural research institutes in Nigeria. Therefore, the use of cybercafé within the institute where alternative power supply is provided for a longer period or outside cybercafé where other amenities are provided such as printing, scanning facilities. Therefore, instant opportunities to relocate to another cybercafé, when down time is experienced in the same area have become imperative.

**Objectives of the study**
The following are the objectives of the study.

i. To compare the level of awareness of cybercafé as an important source for research scientists to access information in agricultural research institutes in Ibadan.

ii. To determine the effective usage of cybercafé outfits in research institutes.

iii. Identify the reasons for research scientists use of cybercafé within and outside their institutes.

iv. Suggest solutions to problems faced in providing Internet services to research institutes.

**Methodology**

**Area of study**
The area of study were CRIN (Cocoa Research Institute of Nigeria), FRIN (Forestry Research Institute of Nigeria), IAR&T (Institute of Agricultural Research Institute of Nigeria), NIHORT (National Institute of Horticultural Research), all located in Ibadan, Southwest, Nigeria. These agricultural research institutes have scientists from various disciplines working on an interdisciplinary approach on mandates of those research institutes towards improvement of Nigerian economy.

**Sources of data, sampling technique and data analysis**
A descriptive survey design was adopted for study. A purposive sampling technique was also used to select the sample and the method produced 180 research scientists. A total of 162 cases were finally analysed which represented 90% of the total sample. Data was collected using a well structured questionnaire designed by researchers. Data collected were analysed using descriptive statistics of bar chart, frequency counts and percentages.

**Results and discussions**
Findings from the study show that majority of the respondents (91%) make use of cybercafé as a result of inadequate infrastructure. The resultant effect is poor access to ICT facilities by respondents in the research institutes under reference. The remaining 9% of the respondents never used cybercafé for one reason or the other. The finding is in consonance with an article in Vanquard.
(2005) that the development of infrastructures are still below expectation in Nigeria. The article further explained that some Internet service providers are not comfortable with energy supply from PHCN (Power Holding Company of Nigeria), which stood at 16.8%, while the remaining 83.2% are provided from generators. The high rate of usage of cybercafe by research scientists was supported by Olayiwola and Akintola (2005) that ICT age has come to stay, with cybercafes flourishing in Nigeria, making the Internet service available to everyone, and as alternative to problems of infrastructure.

Figure 1 presents the comparative usage of ICT by scientists of four agricultural research institutes in Ibadan. Scientists at NIHORT, CRIN and FRIN had the highest rate of cybercafe usage of 33%, 26%, and 25% respectively. The result shows that the research scientists in these institutes are fully aware of the importance of cybercafe to their research activities.

The period of respondents visit to cybercafe is presented in Table 1. The result shows how often scientists visit the cybercafe. It is noted that 86.4% of the respondents visit cybercafe at least once a week (that is 48.1% on daily basis, and 38.3% on weekly basis). This has also shown that research scientists recognised the importance of Internet to satisfy their information needs. This is in agreement with Fagbami (2005), that scientists are better informed about recent research findings in their disciplines through Internet. Table 2 on the other hand indicates the number of hours spent by scientists at cybercafe. The result shows that a majority of research scientists (53.7%) spent at least 24 hours on the Internet every month (that is, 14.2% for >50 hours; 17.9% for between 30 to 40 hours and 21.6% for between 12–24 hours). This has further confirmed the above assertion on the awareness of the importance of Internet resources to research activities.

The study also identified the supplement ISP (Internet service provider) (Table 3) used by research scientists. The result shows that a

![Figure 1](image)

**Figure 1** The number of scientists who used cybercafés

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Period of respondents visit to cybercafés</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Number of respondents</td>
</tr>
<tr>
<td>Daily</td>
<td>78</td>
</tr>
<tr>
<td>Weekly</td>
<td>62</td>
</tr>
<tr>
<td>Fortnightly</td>
<td>6</td>
</tr>
<tr>
<td>Monthly</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>162</td>
</tr>
</tbody>
</table>

*Source* 2009 Survey

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Time spent by scientists at cybercafés per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent (in hours)</td>
<td>Number of respondents</td>
</tr>
<tr>
<td>1–5 hours</td>
<td>49</td>
</tr>
<tr>
<td>6–10 hours</td>
<td>26</td>
</tr>
<tr>
<td>12–24 hours</td>
<td>35</td>
</tr>
<tr>
<td>30–40 hours</td>
<td>29</td>
</tr>
<tr>
<td>&gt;50 hours</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>162</td>
</tr>
</tbody>
</table>

*Source* 2009 Survey
Table 3. Supplement Internet Service Providers used by scientists

<table>
<thead>
<tr>
<th>Internet service providers</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multilinks</td>
<td>8</td>
<td>4.9</td>
</tr>
<tr>
<td>Glo</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Starcomms</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>MTN</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>None</td>
<td>143</td>
<td>88.2</td>
</tr>
<tr>
<td>Total</td>
<td>162</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source 2009 Survey

greater percentage of the research scientists make do with cybercafe (88.3%), while the remaining 11.2% make use of other ISP as presented in the table (4.9% for multilinks; 0.6% for Globacomm, 2.5% for Starcomms, 1.9% for MTN and others not disclosed represents 1.9%).

Table 4. One of the major objective of the study is to identify the reasons which prompted scientists to use cybercafés located within and outside their institutes. The results from Table 4 clearly shows that more than 60% of the research scientists opted for using cybercafe outside their offices due to inadequate Internet facilities, while another 38.9% indicated the fact that there are no personal computers connected to the Internet in their various offices. Other reasons identified include the fact that research scientists are not computer literate (0.6%), little knowledge about Internet browsing 8.6%, and that only decision makers have access to Internet connectivity in the various offices 9.8%.

Table 4 Reasons for scientists use of cybercafés

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate Internet facilities in the offices</td>
<td>101</td>
<td>62.3</td>
</tr>
<tr>
<td>No PC to the Internet connection in the offices</td>
<td>63</td>
<td>38.9</td>
</tr>
<tr>
<td>I’m not computer literate</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Little knowledge about Internet browsing</td>
<td>14</td>
<td>8.6</td>
</tr>
<tr>
<td>Only decision makers have access to Internet in offices</td>
<td>16</td>
<td>9.8</td>
</tr>
</tbody>
</table>

Source 2009 Survey

Figure 2 indicates the readiness of scientists (100) to pay for adequate access to Internet connection in the offices if necessary infrastructure is provided at research institutes. This provision was put in place to make Internet available to other staff whose duty is not directly related to Internet usage and also to solve problems of inadequate facilities and non connection of personal computers in the offices. However, this should not be seen as solution to these problems in a digital age.

Table 5 presents the purpose of using cybercafe by research scientists. The scientists were asked to tick the purposes for which they use cybercafe. 92.6% indicated that they use cybercafé for research information to complement inadequate facilities in research
institutes, while another 75.3% employed cybercafé for sending e-mails, which is used as mode of correspondences for research information and other personal matters such as bank alert on transactions. Other purposes for using cybercafé were football (9.9%) and newspapers (11.7%).

Table 6 presents other reasons for which research scientists used outside cybercafé and these were ranked accordingly. 44.4% of the respondents used outside cybercafé for research information after office hours, which may be due inadequate accessibility to Internet in the offices, while 40.1% of the respondents used outside cybercafé based on weekend advantage.

Table 7 showed that Google (85.8%) is considered as the most useful search engine for information by Scientists used at cybercafé, followed by yahoo/yahoo search (74.1%). Other important websites are agricultural websites (41.9%). Chifwepa (2003) explained that apart from texts, and CD databases, other sources of information on agriculture are online. This (online sources) involved world wide of interconnection of networks. Such connectivity makes it possible for a person or institutions to share data. 69.1% of the respondents considered cybercafé as part of information outfit. It is assumed that cybercafé should be attached to the library as part of information outfit of any research institute (Table 8).

### Table 5 The purposes of using cybercafés

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mails</td>
<td>122</td>
<td>75.3</td>
</tr>
<tr>
<td>Football information</td>
<td>16</td>
<td>9.9</td>
</tr>
<tr>
<td>Newspapers</td>
<td>19</td>
<td>11.7</td>
</tr>
<tr>
<td>Research information</td>
<td>150</td>
<td>92.6</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Source** 2009 Survey

### Table 6 Scientists use of outside cybercafés

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for Internet service for research</td>
<td>72</td>
<td>44.4</td>
</tr>
<tr>
<td>information after office hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of electricity for browsing in the offices</td>
<td>41</td>
<td>25.3</td>
</tr>
<tr>
<td>Weekend advantage</td>
<td>65</td>
<td>40.1</td>
</tr>
<tr>
<td>PC at cybercafé not enough for users</td>
<td>10</td>
<td>6.2</td>
</tr>
<tr>
<td>Convenience and accessibility</td>
<td>19</td>
<td>11.7</td>
</tr>
<tr>
<td>Downtime experienced at institute Internet connection</td>
<td>8</td>
<td>4.9</td>
</tr>
<tr>
<td>Getting relevant assistance</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>Accessibility to printing facilities</td>
<td>6</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Source** 2009 Survey

### Table 7 Websites used by the scientists at cybercafés

<table>
<thead>
<tr>
<th>Websites</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yahoo/Yahoo search</td>
<td>120</td>
<td>74.1</td>
</tr>
<tr>
<td>Msn</td>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td>Hotmail</td>
<td>13</td>
<td>8.0</td>
</tr>
<tr>
<td>Google</td>
<td>139</td>
<td>85.8</td>
</tr>
<tr>
<td>Agricultural websites</td>
<td>68</td>
<td>41.9</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>1.9</td>
</tr>
</tbody>
</table>

**Source** 2009 Survey
Table 8 Relevance of cybercafés as library outfit

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Number of respondents</th>
<th>Per cent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cybercafé is part of Information outfit</td>
<td>112</td>
<td>69.1</td>
</tr>
<tr>
<td>Cybercafé is around the Library for accessibility</td>
<td>32</td>
<td>19.8</td>
</tr>
<tr>
<td>ICT is an oversight function of Library</td>
<td>30</td>
<td>18.5</td>
</tr>
<tr>
<td>Cybercafé personnel resides in Library Department</td>
<td>22</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Source 2009 Survey

Conclusion

Scientists use of cybercafé from the research findings were linked to inadequate Internet facilities and non availability of computers in the offices. The demand for regular Internet in the offices was reflected in the patronage of scientists at cybercafé after the office hours, coupled with other facilities that were readily available for use by scientists without stress. Problem of infrastructure such as electricity is a major hindrance affecting the smooth running of Internet in agricultural research institutes in Ibadan. and generators are alternative source to electricity. However, research works in agriculture is dependent on information available on previous research which are readily available on Internet; where websites on various disciplines are found. This is in agreement with Obajemu, Ogunyade and Nwaye (2004).

Research under information hardship could make huge amount spent on agriculture a mirage, if not addressed on time. Collaboration with Scientists from other countries which could lead to exposures in research that can improve agriculture will be impossible without information. Effort of the Scientists’ to be adequately informed through the use of cybercafé will be highly rewarded when the agricultural sector of Nigeria experience a transformation. Finally, necessary assistance should be given to Nigerian scientists to reduce hardship in obtaining information from other parts of the world.

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Use of library services in technological changing environment: a survey

M Vijayakumar
Deputy Librarian, Birla Institute of Technology, Deemed University
Mesra - 835 215, Ranchi, Jharkhand, India
B U Kannappanavar, Librarian, University BDT College of Engineering,
Davanagere, Karnataka, India

Abstract
This is the part of the research work carried out at Kuvempu University, India. Here survey has been made for 418 research library users on the use and impact of library services in technological changing environment. The survey results that, majority of the R&D library users, use the library services daily, literature search is predominately used through automated, LAN and web based library services. The survey points out that, as per the co-efficient of variation the variable ‘enabled the rapid communication’ is most significant when compared to other impact of IT on library user.
Introduction

The rapid change in ICT (information and communication technology) has made a profound impact in the Library and Information Centres all over the world especially on the methods of information acquisition, processing, storing and dissemination. On the other hand, the advent of Internet has brought a revolutionary change in the library and information services. The information seeking behaviour of the research library users has changed. The explosion of information technology has created challenges and opportunities for information professionals to render library services in the changing technological environment. It’s a real challenge for them to balance between the printed as well as digital library services. The present phase with all the rapid developments in digital computers, telecommunications technologies and the networking power of Internet, Intranet and Extranets seems to be a transition period of rapid change a paradigm shift in the library and information centre where information professionals as well as users need to re-define themselves to accustom with the fast changing technological environment. There are advancements everyday in the field of information technology resulting into the emergence of e-commerce, e-business, e-banking, e-governance, digital library, virtual library and the general shift towards digital economy. The scenario has shifted out to a world of distributed model as against the controlled set up used before. This calls for re-defining and re-orienting many of the activities related to information work and services. What has emerged in the post 1990s is the convergence of the technologies to digitized, stored, access data and innovative way of designing information systems and services. Various types of library services such as services through automated, services through LAN-based, services through Web-based, services through Web-portal-based can be provided to the users in the digital library environment.

Characteristics of library users

- Library users under study comprises of both male and female
- The respondents are scientists, teaching faculty, trainees and others;
- Most of the users were either perusing post graduation or PhD degree;
- Most of the users were in the age group of 20 to 55 years

Objectives of the study

- To assess the future growth and direction in the development of library services
- To know the place of accessing IT application with respect to accessing information
- To find out the reasons why do the users need IT-based library services?
- To know how frequently do the users use the library services?
- To know which type of IT-based infrastructure facility are advised to improve in libraries
- To know the impact of IT on R & D Libraries

Methodology, scope and limitation of the study

The research was carried out at R&D Libraries in the field of Science and Technology that are spread over the Karnataka State of India. The reason of choosing Karnataka under study was because of having more IT application at early stages compared to other states. Therefore it was logical to conduct a study by select research library users in Karnataka to know the status and perception of IT application or use by the library users. In order to do so, a set of questionnaire was designed for library users of R&D Libraries. There were 650
Use of library services in technological changing environment: a survey

questionnaires distributed personally to the users of 13 research libraries. The number of duly received respondent questionnaire was 418 (that is 64.30%). The responses were analysed from different angles to know their perception and use of information technology in order to access their required information. Statistical tools were used to study the concentration and dispersion of various users opinion on the use of it in libraries.

The study is limited to one state in India, that is, Karnataka due to the lack of time. But, the users were spread over all the reputed R&D Libraries in Karnataka in order to avoid the regional bias. The study is limited to one state in India, that is, Karnataka due to the lack of time. But, the users were spread over all the reputed R&D Libraries in Karnataka in order to avoid the regional bias.

The statistical tools were used to study the concentration and dispersion of various users opinion on the use of it in libraries. The coefficient of variation was used to study homogeneity and heterogeneity of a group or between two groups. For comparing two groups, the lesser the co-efficient of variation, the group is more consistent (or homogenous) and more the co-efficient of variation the group is more variable or less consistent. The standard deviation and coefficient of variation are used to study the dispersion of observations. These measures are defined for the frequency distribution as follows.

**Standard deviation**

The standard deviation for the frequency distribution is given by

\[
\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{n} f_i (X_i - \bar{X})^2}
\]

Where \( N = \sum_{i=1}^{n} f_i \) = total number of frequencies, \( \bar{X} = \) Arithmetic mean of \( X_i \)

**Co-efficient of variation**

The relative measure of SD (Standard Deviation) is the (CV) Co-efficient of Variation. Co-efficient of Variation is defined as the Standard Deviation as the percentage of mean

\[
\text{C.V.} \ (X) = \frac{\sigma}{\bar{X}} \times 100
\]

where \( \sigma = \) Standard Deviation
\( \bar{X} = \) Arithmetic Mean

**Chi-square test**

The Chi-square test for independence is applied to study the association between two attributes and is given by

\[
\chi^2 = \sum_{i=1}^{r} \frac{(O_i - E_i)^2}{E_i}
\]

where \( O_i = i \) the observed frequency
\( E_i = i \) the expected frequency

The equation follows the Chi-square distribution \((n-1)\) d.f. and \((r-1)\) \((s-1)\) d.f. for \( r \times s \) contingency table.

**Analyses and interpretation**

**Use of IT applications**

In order to identify the place of accessing Information Technology applications, respondents were requested to provide details on it, and responses are reported in the Table 1.

<table>
<thead>
<tr>
<th>Place</th>
<th>N=418</th>
<th>%</th>
<th>Mean</th>
<th>SD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library</td>
<td>410</td>
<td>98.08</td>
<td>1.01</td>
<td>0.14</td>
<td>13.86</td>
</tr>
<tr>
<td>Commercial centre</td>
<td>317</td>
<td>75.83</td>
<td>1.17</td>
<td>0.22</td>
<td>18.80</td>
</tr>
<tr>
<td>Department</td>
<td>162</td>
<td>38.75</td>
<td>1.61</td>
<td>0.49</td>
<td>30.43</td>
</tr>
<tr>
<td>Laboratory</td>
<td>79</td>
<td>18.89</td>
<td>1.81</td>
<td>0.4</td>
<td>22.09</td>
</tr>
<tr>
<td>Home</td>
<td>94</td>
<td>22.48</td>
<td>1.78</td>
<td>0.42</td>
<td>23.59</td>
</tr>
<tr>
<td>Institution</td>
<td>79</td>
<td>18.89</td>
<td>1.81</td>
<td>0.4</td>
<td>22.09</td>
</tr>
<tr>
<td>IT Lab</td>
<td>40</td>
<td>9.56</td>
<td>1.9</td>
<td>0.3</td>
<td>15.78</td>
</tr>
</tbody>
</table>

SD – standard deviation; CV – coefficient of variation
As per the co-efficient of variation, majority of library users use library to access modern Information Technology application to fulfil their needs. As per the mean the variable library is highly rated for use of modern Information Technology applications when compared to other variables for place to use information technology. It is pleasure to note from the Table 1 that, a large group of respondents have made use of the facility of accessing the Information Technology in their library itself (410=98.08%). The other respondents also remarked that, they access Information Technology facility at commercial centres (317=75.83%). A few respondents access Information Technology at department laboratories (162=38.75%), institution labs (79=18.89%), homes (94=22.48%) and also at their friend’s homes (40=9.56%).

**Information Technology application based library services**

Responses to the use of Information Technology application based library services, are tabulated in the Table 2.

As per the Table 2, out of 418 respondents, 411 (98.32%) respondents were utilizing the Information Technology based library services and remaining respondents (7=1.67%) said ‘no’ for the use Information Technology based library services provided by their libraries. This clearly shows that almost all the respondents, under the study are in favour of using electronic services in their libraries.

<table>
<thead>
<tr>
<th>Table 2 Use of IT based Library services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

**Table 3 Reason for the use of IT based library services**

<table>
<thead>
<tr>
<th>Reason</th>
<th>N=411</th>
<th>%</th>
<th>Rank</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td>258</td>
<td>62.77</td>
<td>2</td>
<td>1.38</td>
</tr>
<tr>
<td>Training</td>
<td>58</td>
<td>14.11</td>
<td>8</td>
<td>1.86</td>
</tr>
<tr>
<td>To write paper</td>
<td>137</td>
<td>33.33</td>
<td>5</td>
<td>1.67</td>
</tr>
<tr>
<td>Research</td>
<td>305</td>
<td>74.20</td>
<td>1</td>
<td>1.27</td>
</tr>
<tr>
<td>Office work</td>
<td>179</td>
<td>43.55</td>
<td>4</td>
<td>1.57</td>
</tr>
<tr>
<td>Entertainment</td>
<td>82</td>
<td>19.95</td>
<td>6</td>
<td>1.8</td>
</tr>
<tr>
<td>Teaching</td>
<td>59</td>
<td>14.35</td>
<td>7</td>
<td>1.86</td>
</tr>
<tr>
<td>Communication</td>
<td>215</td>
<td>52.31</td>
<td>3</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Multiple choice questions

**Reason for the use of IT application based library services**

Table 3 provides responses to the purpose of using the Information Technology based library services.

As per the mean the variables research, study and communication are highly rated compared to other reasons to use IT based library services. As per the tabulated responses in the Table 3, out of 411 respondents, a large group of respondents remarked the use of Information Technology based service for research purposes (305=74.20%). Many users have also remarked for study (258), communication (215), office work (179) to write research papers (137), entertainment (82), teaching (59) and for training purposes (58).

**Frequency of use of IT application based library services**

The statistical data in the Table 4 witnesses that, nearly half of respondents are using Information Technology based on library services daily (219=52.39%) for various purposes. It can be also seen that 74 (17.70%) respondents are using IT based services for once in a week. Only a few respondents using IT based library services for twice a week (49=11.72%) followed by bi-monthly
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Table 4 Frequency of use of IT based library services

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Number (N=418)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>219</td>
<td>52.39</td>
</tr>
<tr>
<td>Twice a week</td>
<td>49</td>
<td>11.72</td>
</tr>
<tr>
<td>Once a week</td>
<td>74</td>
<td>17.70</td>
</tr>
<tr>
<td>Bi-monthly</td>
<td>20</td>
<td>4.78</td>
</tr>
<tr>
<td>Monthly</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>Occasionally</td>
<td>37</td>
<td>8.85</td>
</tr>
</tbody>
</table>

(20=4.78%), monthly (19=4.54%) and occasionally (37=8.85%).

Facilities accessed in library

Information Technology application facilities is an umbrella for accessing many IT based library sources/services for users. Respondents are asked to describe various IT facilities accessed by them. Responses are reflected in the Table 5.

As per the mean (Table 5) the variable like computer, photocopy machine, Internet, online database and library software are highly rated variables when compared to other variables (that is, most of the library users access to the facilities like computer, photocopy machine, Internet, online database and library software). Remaining variables are used as decreasing order of the rank in the Table 5.

When the responses were further analysed to test the dependency of attributes through cross tables, the results of chi-square test indicated that, the association is statistically significant at the .05 level in the respect of the following attributes. The association between ‘scientist’ verses telephone, computer, photocopy machine, microfilm reader, CD-NET, e-mail, inter-com, printer, scanner, projector, printer and access to LAN is statistically significant at .05 level.

Table 5 Facilities accessed in library

<table>
<thead>
<tr>
<th>Facility</th>
<th>N=418</th>
<th>%</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>375</td>
<td>89.71</td>
<td>1.14</td>
<td>1</td>
</tr>
<tr>
<td>Photocopy machine</td>
<td>332</td>
<td>79.42</td>
<td>1.25</td>
<td>2</td>
</tr>
<tr>
<td>Internet</td>
<td>319</td>
<td>76.31</td>
<td>1.28</td>
<td>3</td>
</tr>
<tr>
<td>Online database</td>
<td>304</td>
<td>72.72</td>
<td>1.29</td>
<td>4</td>
</tr>
<tr>
<td>Library software</td>
<td>273</td>
<td>65.31</td>
<td>1.33</td>
<td>5</td>
</tr>
<tr>
<td>E-mail</td>
<td>290</td>
<td>69.37</td>
<td>1.35</td>
<td>6</td>
</tr>
<tr>
<td>Printer</td>
<td>251</td>
<td>60.04</td>
<td>1.44</td>
<td>7</td>
</tr>
<tr>
<td>Telephone</td>
<td>245</td>
<td>58.61</td>
<td>1.45</td>
<td>8</td>
</tr>
<tr>
<td>Library home page</td>
<td>204</td>
<td>48.80</td>
<td>1.51</td>
<td>9</td>
</tr>
<tr>
<td>LAN</td>
<td>151</td>
<td>36.12</td>
<td>1.6</td>
<td>10</td>
</tr>
<tr>
<td>Intercom</td>
<td>168</td>
<td>40.19</td>
<td>1.64</td>
<td>11</td>
</tr>
<tr>
<td>Scanner</td>
<td>109</td>
<td>26.07</td>
<td>1.73</td>
<td>12</td>
</tr>
<tr>
<td>Fax</td>
<td>110</td>
<td>26.31</td>
<td>1.74</td>
<td>13</td>
</tr>
<tr>
<td>Projector</td>
<td>106</td>
<td>25.35</td>
<td>1.75</td>
<td>14</td>
</tr>
<tr>
<td>CD-NET</td>
<td>107</td>
<td>25.59</td>
<td>1.75</td>
<td>15</td>
</tr>
<tr>
<td>VCD</td>
<td>83</td>
<td>19.85</td>
<td>1.81</td>
<td>16</td>
</tr>
<tr>
<td>Video</td>
<td>61</td>
<td>14.59</td>
<td>1.85</td>
<td>17</td>
</tr>
<tr>
<td>Microfilm reader</td>
<td>72</td>
<td>17.22</td>
<td>1.87</td>
<td>18</td>
</tr>
<tr>
<td>LCD</td>
<td>55</td>
<td>13.15</td>
<td>1.87</td>
<td>19</td>
</tr>
<tr>
<td>Microfiche reader</td>
<td>45</td>
<td>10.76</td>
<td>1.89</td>
<td>20</td>
</tr>
<tr>
<td>VCR</td>
<td>44</td>
<td>10.52</td>
<td>1.89</td>
<td>21</td>
</tr>
<tr>
<td>Microfiche reader</td>
<td>44</td>
<td>10.52</td>
<td>1.89</td>
<td>21</td>
</tr>
<tr>
<td>cum printer</td>
<td>28</td>
<td>6.69</td>
<td>1.94</td>
<td>22</td>
</tr>
<tr>
<td>Video conference</td>
<td>19</td>
<td>4.54</td>
<td>1.96</td>
<td>23</td>
</tr>
</tbody>
</table>

Library services through automated library

Respondents were asked weather they are using various library services through automated library. Responses are presented in the Table 6 for necessary statistical analysis.

The Table 6 clearly points out that, large groups of respondents (282=67.46%) are using literature search service. More than 100 and less than 200 respondents have also opted/ utilized the services through automated library like, indexing and bibliographic service (189=45.21%), document delivery.
Table 6 Scientists use of outside cybercafés

<table>
<thead>
<tr>
<th>Library services</th>
<th>N=418</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature search</td>
<td>282</td>
<td>67.46</td>
</tr>
<tr>
<td>Indexing</td>
<td>189</td>
<td>45.21</td>
</tr>
<tr>
<td>Document delivery</td>
<td>107</td>
<td>25.59</td>
</tr>
<tr>
<td>Reference</td>
<td>171</td>
<td>4.09</td>
</tr>
<tr>
<td>Referral</td>
<td>78</td>
<td>18.66</td>
</tr>
<tr>
<td>News clipping service</td>
<td>81</td>
<td>19.37</td>
</tr>
<tr>
<td>Bibliographical service</td>
<td>189</td>
<td>45.21</td>
</tr>
<tr>
<td>Translation service</td>
<td>42</td>
<td>10.04</td>
</tr>
<tr>
<td>Abstracting service</td>
<td>77</td>
<td>18.42</td>
</tr>
<tr>
<td>Selective dissemination of</td>
<td>78</td>
<td>18.66</td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interlibrary loan</td>
<td>81</td>
<td>19.37</td>
</tr>
<tr>
<td>Technical enquiry</td>
<td>129</td>
<td>30.86</td>
</tr>
<tr>
<td>Reprographic</td>
<td>66</td>
<td>15.78</td>
</tr>
<tr>
<td>Publication</td>
<td>98</td>
<td>23.44</td>
</tr>
<tr>
<td>Retrospective search</td>
<td>165</td>
<td>39.47</td>
</tr>
<tr>
<td>Management information</td>
<td>83</td>
<td>19.85</td>
</tr>
<tr>
<td>New arrivals</td>
<td>117</td>
<td>27.09</td>
</tr>
</tbody>
</table>

* Multiple choice questions

(107=25.59%), reference (171=4.09%), technical enquiry (129=30.86%), retrospective search (165=39.47%) and new arrivals (117=27.99%). A small group which is less than 100 respondents also utilizes the services like, referral, news clipping services, bibliographic services, abstracting services, SDI, inter library loan, technical enquiry, reprographic, management information services.

When the responses were further analysed to test dependency of attributes through cross tables, the results of chi-square test indicated that, the association is statistically significant at .05 level in the respect of the following attributes. The association between the training course procured at library centre verses automated library services like literature search, document delivery, reference, referral, news clipping service, bibliographic services, abstracting services, SDI, inter library loan, technical enquiry, reprographic, management information service and new arrivals is statistically significant at .05 level.

Use of the library services through LAN

With the advent of networking technology, it is not essential to visit the library to avail the library services. Now user can avail services from their department/research laboratories through LAN of the library. Therefore, respondents were asked to provide opinion on this, the responses are reported in the Table 7 for more analysis. It is found from the Table 7 that, majority of respondents (117=27.99%) has remarked that, they were using literature search services through LAN. Out of 418 respondents only 100 or below 100

Table 7 Use of library services through LAN*

<table>
<thead>
<tr>
<th>Library services</th>
<th>N=418</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature search</td>
<td>117</td>
<td>27.99</td>
</tr>
<tr>
<td>Indexing</td>
<td>49</td>
<td>11.72</td>
</tr>
<tr>
<td>Document delivery</td>
<td>44</td>
<td>10.52</td>
</tr>
<tr>
<td>Reference</td>
<td>94</td>
<td>22.48</td>
</tr>
<tr>
<td>Referral</td>
<td>56</td>
<td>13.39</td>
</tr>
<tr>
<td>News clipping service</td>
<td>45</td>
<td>10.76</td>
</tr>
<tr>
<td>Bibliographical service</td>
<td>64</td>
<td>15.31</td>
</tr>
<tr>
<td>Translation service</td>
<td>16</td>
<td>3.82</td>
</tr>
<tr>
<td>Abstracting service</td>
<td>32</td>
<td>7.65</td>
</tr>
<tr>
<td>Selective dissemination of</td>
<td>31</td>
<td>7.41</td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interlibrary loan</td>
<td>42</td>
<td>10.04</td>
</tr>
<tr>
<td>Technical enquiry</td>
<td>59</td>
<td>14.11</td>
</tr>
<tr>
<td>Reprographic</td>
<td>23</td>
<td>5.50</td>
</tr>
<tr>
<td>Publication</td>
<td>40</td>
<td>9.56</td>
</tr>
<tr>
<td>Retrospective search</td>
<td>67</td>
<td>16.02</td>
</tr>
<tr>
<td>Management information</td>
<td>29</td>
<td>6.93</td>
</tr>
<tr>
<td>New arrivals</td>
<td>56</td>
<td>13.39</td>
</tr>
</tbody>
</table>

* Multiple choice questions
Use of library services in technological changing environment: a survey

Respondents were using different services through LAN of the library like; Indexing (49), document delivery (44), reference (94), referral (56), news paper clipping services (45), bibliographic (64), translation (16), abstracting (32), SDI (31), Inter library loan (42), technical enquiry (59), reprographic (23), publication (40), retrospective search (67), MIS (29) and new arrivals (56).

**Use of web based library services**

Now it is possible to provide/access off-campus library services through World Wide Web. In India many research libraries are effectively using web technology to provide library services. Therefore, respondents were asked to describe various services, they are using as listed in questionnaire. The responses are tabulated in the Table 8 for further analysis.

**Table 8 Use of library services through home page/web page*  

<table>
<thead>
<tr>
<th>Library services</th>
<th>N=418</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature search</td>
<td>118</td>
<td>28.22</td>
</tr>
<tr>
<td>Indexing</td>
<td>39</td>
<td>9.33</td>
</tr>
<tr>
<td>Document delivery</td>
<td>34</td>
<td>8.13</td>
</tr>
<tr>
<td>Reference</td>
<td>69</td>
<td>16.50</td>
</tr>
<tr>
<td>Referral</td>
<td>52</td>
<td>12.44</td>
</tr>
<tr>
<td>News clipping service</td>
<td>67</td>
<td>16.02</td>
</tr>
<tr>
<td>Bibliographical service</td>
<td>42</td>
<td>10.04</td>
</tr>
<tr>
<td>Translation service</td>
<td>17</td>
<td>4.66</td>
</tr>
<tr>
<td>Abstracting service</td>
<td>32</td>
<td>7.65</td>
</tr>
<tr>
<td>Selective dissemination of information</td>
<td>25</td>
<td>5.98</td>
</tr>
<tr>
<td>Interlibrary loan</td>
<td>29</td>
<td>6.93</td>
</tr>
<tr>
<td>Technical enquiry</td>
<td>62</td>
<td>14.83</td>
</tr>
<tr>
<td>Reprographic</td>
<td>15</td>
<td>3.58</td>
</tr>
<tr>
<td>Publication</td>
<td>42</td>
<td>10.04</td>
</tr>
<tr>
<td>Retrospective search</td>
<td>75</td>
<td>17.94</td>
</tr>
<tr>
<td>Management information</td>
<td>24</td>
<td>5.74</td>
</tr>
<tr>
<td>New arrivals</td>
<td>76</td>
<td>18.18</td>
</tr>
</tbody>
</table>

* Multiple choice questions

As indicated in the Table 8, a few respondents (118=28.22%) use web based library services for literature search. It is striking to note that, less than 18.50% of the respondents are using web based library services for indexing, document delivery, reference, referral, news paper clipping service, bibliographic service, translation, abstracting, SDI, inter library loan, technical enquiry, reprographic, publication, retrospective search, MIS and also for new arrivals.

**Perception of IT applications by library users**

Respondents were asked to check the perception, impact and barrier on Information Technology applications and digital documents, the respondents were asked to provide their opinion in various terms listed in questionnaire.

**Impact of IT on library users**

Information Technology has potential not only to improve the quality of existing library services but also to offer wide range of new services. Information Technology enables libraries to provide various benefits in terms of improved services. Naturally these varied benefits have several impacts on library users.

The respondents were asked to rate the impact of Information Technology on them on a five point scale from strongly agree to strongly disagree. The responses are statistically presented in the Table 9. The Table 9 points out that mean scores on the 17 aspects was 'high' ranging from '4.32 to 2.92' (agree to no idea). As per the mean, highly rated factors of impact on use of Information Technology are; fast access and delivery of information, enabled rapid communication, enabled enormous savings in time and effort, exploring wider area of information near to my area of topic and provision of accurate and
Table 9 Impact of IT library user

<table>
<thead>
<tr>
<th>Impact of IT library user</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Mean</th>
<th>SD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caused the techno-stress for library user</td>
<td>43</td>
<td>91</td>
<td>112</td>
<td>136</td>
<td>36</td>
<td>2.92</td>
<td>1.13</td>
<td>38.69</td>
</tr>
<tr>
<td>Made it compulsory to learn and use modern IT applications</td>
<td>141</td>
<td>160</td>
<td>79</td>
<td>31</td>
<td>7</td>
<td>3.95</td>
<td>0.90</td>
<td>25.06</td>
</tr>
<tr>
<td>I can interact with my own resources within and outside the library</td>
<td>73</td>
<td>192</td>
<td>133</td>
<td>19</td>
<td>1</td>
<td>3.76</td>
<td>0.8</td>
<td>21.21</td>
</tr>
<tr>
<td>Enabled more time for other work</td>
<td>107</td>
<td>194</td>
<td>91</td>
<td>20</td>
<td>6</td>
<td>3.89</td>
<td>0.89</td>
<td>22.87</td>
</tr>
<tr>
<td>Improved the status of the library user</td>
<td>140</td>
<td>150</td>
<td>93</td>
<td>31</td>
<td>4</td>
<td>3.93</td>
<td>0.99</td>
<td>25.19</td>
</tr>
<tr>
<td>Enabled to devote more time for other work</td>
<td>107</td>
<td>194</td>
<td>91</td>
<td>20</td>
<td>6</td>
<td>3.89</td>
<td>0.89</td>
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<td>4</td>
<td>3.93</td>
<td>0.99</td>
<td>25.19</td>
</tr>
<tr>
<td>Improved the standardization of the library</td>
<td>142</td>
<td>183</td>
<td>77</td>
<td>16</td>
<td>0</td>
<td>4.08</td>
<td>0.82</td>
<td>20.09</td>
</tr>
<tr>
<td>To share information/research with distant colleagues</td>
<td>122</td>
<td>207</td>
<td>81</td>
<td>7</td>
<td>1</td>
<td>4.05</td>
<td>0.78</td>
<td>19.25</td>
</tr>
<tr>
<td>Helped to access the information in defined format</td>
<td>139</td>
<td>192</td>
<td>78</td>
<td>6</td>
<td>3</td>
<td>4.09</td>
<td>0.82</td>
<td>20.44</td>
</tr>
<tr>
<td>Made it compulsory to learn and use modern Information Technology applications</td>
<td>141</td>
<td>160</td>
<td>79</td>
<td>31</td>
<td>7</td>
<td>3.95</td>
<td>0.90</td>
<td>25.06</td>
</tr>
<tr>
<td>Improved the work environment</td>
<td>166</td>
<td>147</td>
<td>37</td>
<td>64</td>
<td>4</td>
<td>3.97</td>
<td>1.09</td>
<td>20.95</td>
</tr>
<tr>
<td>Upgraded the knowledge and skills of IT applications</td>
<td>141</td>
<td>160</td>
<td>79</td>
<td>31</td>
<td>7</td>
<td>3.95</td>
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<td>16</td>
<td>0</td>
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<td>31</td>
<td>7</td>
<td>3.95</td>
<td>0.90</td>
<td>25.06</td>
</tr>
</tbody>
</table>

5 – strongly agree; 4 – agree; 3 – no idea; 2 – disagree; 1 – strongly disagree;
SD – standard deviation; CV – coefficient of variation

current information. As per the Co-efficient of variation the variable 'enabled the rapid communication' is most significant when compared to other impact of IT on library user. The responses are further analyzed to test dependency of attributes through cross tables, results of chi-square test indicated that, association is statistically significant at the .05 level in the respect of following attributes.

The association between training course provided at library centres versus impact on users made it compulsory to learn and use modern Information Technology applications, upgrade their knowledge and skills of Information Technology applications, enabled them to devote more time for other work, improved the status of library users, improved user satisfaction and attitude towards the library, improved work environment, helped to access information in defined format, helps to share information/research with distant colleagues are statistically significant at .05 level. The association between research scholars versus impact on users made it compulsory to learn and use Information Technology applications, upgrade their knowledge and skills of Information Technology applications, enabled them to devote more time for other work, improved the status of library users, improved user satisfaction and attitude towards the library, improved work environment, helped to access information in defined format, helps to share information/research with distant colleagues are statistically significant at .05 level.
knowledge of Information Technology applications, caused the techno-stress for library users, improved the status of library user, enabled rapid communication, provision of accurate and current information, easy to browse electronic sources. 'I can interact with my resources without help of library staff' is statistically significant at .05 level.

Barriers to access IT applications based library services

To assess barriers faced by library users while using Information Technology based library services, respondents were asked to provide their opinion, and responses are listed in the Table 10 for further analysis.

As per the mean (Table 10), the main barriers faced while accessing Information Technology based services are frequent power cuts and lack of network facility. As per the co-efficient of variation, variable frequent power cuts and lack of network facility are significant barriers, when compared to other variables to access Information Technology based services. When responses are further analysed to test dependency of attributes through cross tables, the results of chi-square test indicated that, the association of statistically significant at the .05 level in respect to the following attributes. The associations between the user like 'scientist' versus barriers like lack of in-house maintenance programmes, lack of network facility, frequent power cuts and in adequate trained staff in Information Technology application, are statistically significant at .05 levels. The association between the user like 'research scholar' versus barrier like 'non availability of consultation services, lack of in-house maintenance programmes and frequent power cuts' are statistically significant at .05 levels.

Approaches to digital information content

The statistical data in the Table 11 witnesses that, majority of respondents (215=51.43%) have positive approach towards digital information content followed by strongly positive (168=40.19%). A small group of respondents (5=1.19%) have remarked negative approach to digital information content flowed by strongly negative (1=0.23%). Remaining respondents (29=6.93%) didn't give any opinion on their approach to digital information content.

Digital documents would rule the future libraries

The computed data in the Table 12 reflects that a large group of respondents (156=37.32%) agrees that digital documents

| Table 10 Barriers to access IT based library services* |
|-----------------|---|------|---|---|
| Non availability of consultation services | 103 | 24.64 | 1.72 | 0.48 | 27.90 |
| Lack of in-house maintenance programmes | 97 | 23.20 | 1.77 | 0.42 | 23.72 |
| Lack of network facility | 60 | 14.35 | 1.86 | 0.35 | 18.81 |
| Frequent power cuts | 59 | 14.11 | 1.86 | 0.35 | 18.81 |
| Inadequate trained staff in IT applications | 102 | 24.40 | 1.76 | 0.43 | 24.43 |
| Lack of user education programme | 149 | 35.64 | 1.64 | 0.48 | 29.26 |

* Multiple choice questiona
would rule future libraries followed by strongly (141=33.73%). While 79 (18.89%) respondents disagree those digital documents would rule future libraries followed by strongly disagree (12=2.87%). Remaining 30 (7.17%) respondents didn’t provide any opinion.

### Table 11 Approach to digital information content

<table>
<thead>
<tr>
<th>Opinion</th>
<th>N=418</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly positive</td>
<td>168</td>
<td>40.19</td>
</tr>
<tr>
<td>Positive</td>
<td>215</td>
<td>51.43</td>
</tr>
<tr>
<td>Strongly negative</td>
<td>1</td>
<td>0.23</td>
</tr>
<tr>
<td>Negative</td>
<td>5</td>
<td>1.19</td>
</tr>
<tr>
<td>No opinion</td>
<td>29</td>
<td>6.93</td>
</tr>
</tbody>
</table>

**Conclusion**

Information Technology has great potential for variety of applications in libraries as it contributes to improved quality, increased productivity, more efficient operations, better resources sharing and more effective services to users. Are the research library users availing or effectively using these services for their research activities? To know these questions, survey oriented study was conducted on use and perception of Information Technology applications by select research library users in Karnataka. The study reveals that literature search is the most popular services used by library users. They feel that use of Information Technology results in fast access and delivery of information and it also enabled the rapid communications.

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Aggregative Digital Library Systems in the DRIVER Infrastructure

Michele Artini, Leonardo Candela, Donatella Castelli
Paolo Manghi, Marko Mikulicic, Pasquale Pagano
Istituto di Scienza e Tecnologie dell’Informazione ‘Alessandro Faedo’
Consiglio Nazionale delle Ricerche
Via G. Moruzzi, 1-56124 Pisa, Italy

Abstract
The world-wide diffusion of Institutional Repositories led to a growing demand for SDLs (Aggregative Digital Library Systems). ADLSs provide research organizations with end-user applications over an extensive Information Space of metadata records, collected and aggregated from a pool of potentially heterogeneous repositories. Such Information Spaces are populated by means of software designed to harvest and normalize metadata records from OAI-PMH compatible repositories. ADLSs are characterized by considerable and sometime unbearable costs for the supporting organizations, due to the professional skills and hardware required for their realization and maintenance.

Software infrastructures are running, distributed platforms, administrated by one responsible organization, in which organizations can participate to collaboratively build and maintain their applications at affordable costs. In this paper we describe features and principles underlying the DRIVER Infrastructure, whose environment supports sustainable construction and maintenance of multiple ADLSs.
Introduction

The ADLSs (Aggregative Digital Library Systems, Figure 1) are Digital Library Systems specially devised for: (i) populating an information space of metadata records by means of an aggregation system, capable of harvesting and normalizing records from several OAI–PMH compatible repositories (Lagoze and Sompel 2001); and (ii) providing end-users with a community application, delivering the functionalities they require to operate over the aggregated Information Space, for example, search, access, references, annotations, recommendations, collections.

Organizations responsible for large research communities – for example, national consortia, research institutions, universities, foundations – are often tempted to supply their user communities with ADLSs in orders to ease and improve their daily activities. However, such systems tend to be hard to sustain in the long term and not many organizations can afford their cost. On the one hand, ADLS realization has considerable initial design and development costs, mainly due to the fact that there existing ADLSs offer solutions tailored to specific community scenarios and are not conceived to be reused in other contexts. Then, such costs have to be summed up to the cost of administration and maintenance of both hardware and system, for example, users management, continuous metadata aggregation activities and software refinements necessary to cope with the evolving requirements of research communities.

The DRIVER project, financed by the European Union from May 2006, had the goals of constructing an ADLS maintaining the European Information Space of Open Access publications and enabling the definition of a number of community applications over such space. Having to face serious long-term sustainability issues, the DRIVER Consortium considered the adoption of a novel approach to ADLS construction, based on software infrastructure systems. Software infrastructures deliver run-time distributed environments, administrated and maintained by one responsible organization, through which participating organizations can collaboratively integrate, share, reuse their content and functionality resources to build and maintain applications at affordable costs. The inspiring model is that of real-life infrastructures, such as electric power or water systems, centrally administered and maintained by a government for the benefits of the citizens.

![Figure 1 Aggregative DLS and e-Infrastructures](image-url)
The DRIVER infrastructure is the outcome of the DRIVER and DRIVER-II EU projects. The former project ended in November 2007 to deliver an infrastructure test-bed, while the latter will end in December 2009 to deliver a production quality infrastructure, that is, public service, and the relative D-NET v2.0 Software kit (D-Net Project). The first release of D-NET v1.0 was launched in May 2008, together with the first deployment of the production infrastructure, reachable through the DRIVER Web Site (Driver Project). D-NET supports an autonomic (Web) Service Oriented Architecture and its software kit offers both infrastructure middleware and Digital Library functionality services. Its collaborative and distributed environment enables the combination of such services to construct and maintain sustainable ADLSs.

The DRIVER production infrastructure currently hosts one aggregation system maintaining the European Information Space of Open Access publications and three community applications operating over its content. The DRIVER portal, administered by the DRIVER Consortium, serves the community of European researchers, and provides them with an Advanced User Interface operating over the whole Information Space. The other two portals serve Belgium and Spain-Recolecta national consortia, respectively, and support researchers with Lite User Interfaces operating over the subsets of the Information Space relative to Belgium and Spanish repositories.

In this paper we describe the principles and technical features underlying the DRIVER Infrastructure and advocate the benefits gained by organizations building aggregation systems and community applications in its environment. To this aim, we shall describe how constructing applications in DRIVER has costs that are affordable also by organizations whose resources are not adequate for building traditional ADLSs; the DRIVER Portal, Belgium Portal and Recolecta portal experience will give evidence of this statement.

In the section on Sustainability of traditional ADLSs, the authors provide a general overview of the costs necessary to build and maintain traditional ADLSs. In the section on The DRIVER infrastructure, the authors present the DRIVER infrastructure, its features and its mission. Finally, in the section on Building ADLSs on the DRIVER infrastructure, they explain how the costs of building ADLSs in the DRIVER scenario may become sustainable for participating organizations.

**Sustainability of traditional ADLSs**

Repository Systems are typically characterized by minimal functionalities for storage and access of research publications and relative metadata information. Access usually has the twofold form of search through a Web portal and metadata records bulk retrieval through OAI-PMH interfaces (Lagoze and Sompel 2001). Several well-known Repository technologies with a variety of extra functionalities are available on the market: ePrints (Millington and Nixon 2007), DSpace (Tansley, Bass, Stuve, et al. 2003), Fedora (Lagoze, Payette, Shin, et al. 2005), Greenstone (Greenstone Digital Library Software), OpenDlib (OpenDLib repository), etc. Research institutions, university libraries, and other organizations have been increasingly setting up a local repository so as to improve the impact and visibility of their user communities’ research outcome.

As a natural consequence of the diffusion of Repository Systems, research communities concretized the need for ADLSs, capable of aggregating such independent data sources, at least at the metadata record level, so as to cross-operate over such content. ADLSs are sophisticated systems that consist of two main tiers (Figure 1, left side).

- The bottom tier contains the aggregation system, whose purpose is to offer the tools
for harvesting the metadata records from a set of OAI-PMH compliant Repository Systems and form a uniform Information Space by applying metadata transformation.

- The top tier is constituted by the community application, whose purpose is to provide community users with web accessible functionalities, that is, portals, to operate over the information space.

In the last few years, national consortia (OAIster (OAIster), BASE (Base), DAREnet (DAREnet) and subject based communities (NEEO project (NEEO Project) DART Europe (DEEP), and so on) have been investing in the production of several ADLSs scenarios. illustrates the categories of cost that come into play when setting up an ADLS. Their life-cycle can be described in three phases.

**Realization** Since there is no general purpose ADLS on the market, organizations end-up investing on ad-hoc software solutions, to be designed and developed by local laboratories or to be outsourced to external companies. In both cases designers and developers are to be hired. The cost of licensed software, when needed, is to be considered.

**Maintenance** When the system is under operation a number of administrative tasks should be accomplished. In ADLSs three typical administrative roles can be identified.

- **Librarians** are in charge of checking the quality of content, end-user activities (registration, profiling, and so on), and other user-oriented administrative tasks;
- **Aggregation managers** are generally skilled developers, in charge of keeping the information space up to date with the repository status. Examples of their duties are: adding or removing repositories from the harvesting space, harvesting records from the individual repositories and writing metadata XML transformation scripts to fix and normalize the incoming records.
- **Administrators** are in charge of handling hardware and software aspects, such as allocating or replicating storage and indexing space so as to ensure robustness and optimize query performance and scalability.

**Refinement** End-users requirements tend to evolve and change, depending on the latest technology achievements and user local interests. Accordingly, not to compromise their return of investment, organizations should subordinate their ADLSs to such changes. Modifying an existing system is an expensive design and development operation, especially when the activity is demanded to external companies.

**Hardware** Hardware represents another cause of expenditure. In order to offer robust and 24/7 available services, organizations must invest on architecture design and purchase of high-speed connections and reliable servers or, alternatively, outsource their hosting to external providers.

<table>
<thead>
<tr>
<th>Table 1 Cost model for ADLS sustainability</th>
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<tbody>
<tr>
<td><strong>Designers</strong></td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Realization</td>
</tr>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>Refinement</td>
</tr>
<tr>
<td>Hardware</td>
</tr>
</tbody>
</table>
Overall, it is clear how ADLSs become affordable only for strong organizations which can rely on constant funding, and, possibly, on local laboratories and team of programmers. The highest costs are due to design and development skills required in all phases of realization, maintenance and refinement.

The DRIVER Infrastructure

The last European Commission Framework Programmes funded a number of infrastructure-building projects, for example, DRIVER, DILIGENT (D-NET Project; DILIGENT), BRICKS (Aloia, Concordia, Meghini, et al. 2007 ), D4Science (D4Science Project), DRIVER-II, CLARIN (Clarin Project); EGEE (EGEE), EFG (European Film Gateway Project); Europeana (Europeana Connecting Cultural Heritage Project). The common goal of such projects is the realization of systems capable of integrating heterogeneous content and functionality resources and enabling the construction of applications and resources by reusing, sharing and safely combining the available system resources. Infrastructure systems are maintained by one RO (responsible organization), which provides support to other Pos (participating organizations) willing to provide and integrate their resources or constructing their applications. As we shall describe in the following, such environments are conceived for reducing the cost of POs in achieving their applicative goals.

The DRIVER project’s applicative goal is that of encouraging Open Access (Suber 2007) business models among researchers and publishers by giving centralized access and visibility to this critical mass of publications available from repositories in Europe. To this aim, the project designed and developed the D-NET infrastructure software and deployed and run the DRIVER infrastructure. In its run-time environment multiple POs can build sustainable aggregation systems and community applications by combining a variety of functionalities, integrated by means of web service encapsulation (Figure 1, right side).

The architecture

The DRIVER Infrastructure is a running instance of D-NET software. D-NET adopts a SOA (Service Oriented Architecture) (Arsanjani) approach, where services are implemented as Web Services (W3C Web Services Activity). In SOA applications consist of a set of distributed services that interact to deliver the functionalities expected by their users. Services support specific sets of functionalities in isolation and can be pipelined into workflows of actions to model arbitrary complex data computation processes. Most importantly, services can be shared between different applications, that is, be part of different workflows requiring at some point the same functionality.

In particular, D-NET implements a SOA endowed with a notion of ‘orchestration’. More specifically, the software gives life to a dynamic running environment, where an arbitrary number of PO applications can run at the same time. In this context, each application consists of a static and a dynamic definition. The former is the set of services dedicated to the only use of the application, for example, User Interface Services. Such set includes also one or more Manager Services, in charge of the latter dynamic part of the application. Manager Services are configured to accomplish data processing tasks, that is, setting up the relative workflows, by dynamically pipelining the services available from the pool of shared services registered to the infrastructure, for example, Store Services, Index Services.

POs can therefore contribute in augmenting the quality-of-service of all running applications by offering new
hardware and deploying sharable service instances; Manager Services, in combination with the infrastructure framework, will automatically exploit the new resources by reusing them in the context of needing applications.

The infrastructure framework governs all applications by means of special Enabling Services Candela, Castelli, Manghi, et al. (2007), administered by the infrastructure RO and available 24/7. In order to be orchestrated by Manager Services, all services need to register to the enabling services and thus publish information about their location, the functionality they expose and their current status into a relative service profile. To ensure consistent orchestration, the profile must be continuously updated by services during their life-time. Manager Services can thus dynamically discover where the services they require in terms of functionality and status are located and communicate with them to coordinate their interaction.

In particular, the DRIVER Infrastructure software supplies a set of Services organized in three main architectural areas (Figure 2).

- **Enabling area** It includes the services supporting the infrastructure’s run-time. These provide functionalities such as service registration, discovery, orchestration, authentication and authorization, subscription and notification. Enabling services ensure that Manager Services can orchestrate services of Data and Functionality Areas to process data or perform administrative operations, typically executed manually in traditional ADLSs; for example, query load balance, storage and index replica management, and so on. Through the enabling area, POs can specify the level of sharing of their services by declaring what POs are authorized to access them; for the sake of simplicity, in the following we shall assume service full sharing and reusability.

- **Data area** It includes the services needed to form aggregation system applications, whose functionalities feature harvesting, cleaning, storing, transforming, indexing, searching the metadata records harvested from external OAI-PMH Repositories. The services are designed to be generic with respect to the metadata format they manage, so that POs can configure them to match their specific user requirements.

- **Functionality area** It includes the services needed to form community applications: configurable user interfaces (portals),

![Figure 2 The DRIVER Infrastructure architecture](image-url)
recommendation systems, user and community profiling, record collections management, and so on. Appropriately combined, such services can form a variety of community applications, that is, portals, capable of operating over any Information Space generated with Data Area services.

D-NET software is designed to be easily extendible with new functionality. To this aim, the functionality has to be encapsulated in a web service whose only mandatory requirement is to match the enabling area registration policies. Such service would then enter the D-NET toolkit and thus be made available for use by other POs in building their applications.

To deploy a running infrastructure, the RO should install and run a reliable enabling area, that is, at least one instance of all enabling services. POs can then build their applications by configuring the relative Manager Services and, if necessary, deploying on their servers instances of services in the Data or Functionality Areas.

**The production infrastructure**

A DRIVER production infrastructure is publicly available and maintained by the DRIVER Project Consortium RO. The system currently hosts a number of applications, obtained by appropriately combining services and OAI-PMH compatible repositories made available by DRIVER POs (Figure 3). In particular, the DRIVER Consortium PO is responsible for the functional resources required to build two applications: the aggregation system used to define the DIS (DRIVER Information Space) of Open Access publications and the DRIVER portal community application, delivering to researchers a portal with rich functionalities over the DIS. The POs of Belgium and Spain-Recolecta national consortia are responsible for the service instances needed to run the community applications elaborating over the Belgium and Spanish subsets of the information space, respectively. Repository POs, currently about 250, are responsible for the content resources of the infrastructure, that is, the institutional repositories.

*Figure 3* DRIVER Infrastructure running environment
Repository providers are attracted to become POs to increment their visibility, thus recompensing their local efforts and costs, and to get DRIVER feedback on the quality of their service through special DRIVER Validation functionalities. Other POs can similarly join the production infrastructure to provide their repositories or to build their aggregation systems and community applications.

**Building ADLSs on the DRIVER Infrastructure**

In this section, the authors describe how organizations can build ADLSs into DRIVER and explain how the underlying infrastructural approach may reduce the realization and maintenance costs with respect to building traditional systems. The principle is that in the DRIVER infrastructure POs delegate part of the realization, maintenance and administration costs of their applications to the RO of the infrastructure and to other POs, more specialized in a given context or with extra resources. We shall see that RO costs are generally high, but for the benefits of the individual POs, whose costs become minimal. The more POs are building their applications in the environment, the more RO costs are diluted over the participants and the infrastructure approach proves to be beneficial. highlights PO and RO cost separation by introducing the role of RO administrators.

**Table 2** Cost model for ADSL sustainability in the DRIVER Infrastructure

<table>
<thead>
<tr>
<th></th>
<th>ADLS-PO</th>
<th>ADLS-PO</th>
<th>ADLS-PO</th>
<th>ADLS-RO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Designers</td>
<td>Developers</td>
<td>Librarian</td>
<td>Aggregation</td>
</tr>
<tr>
<td><strong>Realization</strong></td>
<td>Graphics</td>
<td>Graphics</td>
<td>X</td>
<td>No development</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Refinement</strong></td>
<td>Optional</td>
<td>Optional</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hardware</strong></td>
<td></td>
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</tbody>
</table>

Costs for responsible organizations

- The ROs rely on existing and stable D-NET software. Hence they do not bear design, development and refinement costs, but only that of administration and maintenance of the infrastructure and of PO applications. Such costs are sustainable by one well-structured organization, whose capabilities can be compared to those required by organizations behind traditional ADLSs.
- The costs for the RO in deploying a new infrastructure instance are those needed to employ and train RO administrators, provide an initial set of machines connected to the Internet and install/deploy running instances of the Enabling Area services. Such machines, being central to the infrastructure activities, must be 24/7 reliable and available servers, equivalent in power to those that traditional ADLS servers should require.
- Maintenance costs for the RO depend on the number of applications running in the infrastructure environment, and consist in installing new machines, deploy services or give support to POs that need to do these operations. The effort is typically higher when setting-up a new PO application, but then becomes ordinary web service maintenance. In fact, Manager Services are delegated the monitoring of the status of applications and services in terms of quality-of-service (availability, performance, workload, and so on).
Costs for participating organizations

The ROs give support to the POs, so as to realize their applications inexpensively. In particular, given the current set of functionalities made available by the DRIVER areas, POs can exploit two main application patterns, whose combination results in ADLSs: aggregation system applications and portal applications. POs’ realization and maintenance costs for the two patterns are discussed in the following and compared to those of an organization having to face traditional ADLS construction. We shall illustrate how such costs are minimal in this environment due to ROs supporting activities and to autonomic application maintenance enforced by orchestration.

**Aggregation Systems applications in DRIVER**

The pool of services running in the Data Area is orchestrated by Manager Services to yield the specific workflows of the aggregation systems at hand. For example, in the DRIVER production infrastructure, the DRIVER Consortium PO has realized the DIS Aggregation System, capable of harvesting DC (Dublin Core) records (Dublin Core Metadata Initiative) from heterogeneous Open Access repositories and transforming them to form a uniform Information Space of corresponding DMF (DRIVER Metadata Format) records, that is, normalized DC fields enriched with ‘provenance information’ fields, such as name and country of the repository of origin.

Other POs may join the DRIVER infrastructure to form other Information Spaces through their own workflows, collecting records from external repositories or reusing the records stored and indexed into existing DRIVER Information Spaces, for example, the DC and DMF records collected, generated and stored in the infrastructure by the DIS aggregation system.

Figure 4 illustrates a hypothetical DRIVER infrastructure instance. An aggregation system is constituted by Aggregator Services, Store Services, Index Services and Search Services possibly running in multiple instances at different sites.

An Aggregator Service instance is operated by aggregator managers. The service applies transformations in the form of a sequence of mapping rules to a set of incoming records conforming to a given format, and returns new correspondent metadata records in a given output format. The transformation indicates a data source, a set of mapping rules

**Figure 4** Data area services
and a set of target stores, allocated at some Store Service sites. Data sources can be OAI-PMH Repositories or other stores, where metadata records have been previously preserved. Data source and target stores of one transformation are dynamically set by the aggregation system’s Manager Service, at repository registration time, based on the local policies adopted.

As an example of Manager Service configuration, consider the DIS (DRIVER Information Space) of DMF records. The Manager Service has been configured to orchestrate as follows.

- After registration of a new repository two stores are allocated into the available Store Services, one for the DC records to be harvested from the repository and one for the DMF records to be obtained from them.
- An available Aggregation Service is assigned the tasks of
  - harvesting the DC records from the repository data source into the target DC store
  - once the mapping DC onto DMF has been defined by the aggregation manager, applying the transformation of DC store content and deliver it to the corresponding DMF store.
- Content of DC and DMF stores is replicated three times over different Store Services.

An Index Service is capable of creating and feeding on demand a pool of indices. The set of indices fed with records of the same metadata format, generated by a federation of Aggregator Services implicitly forms an Information Space, that is, a searchable pool of uniform metadata records. For example, the following are policy of the DIS Manager Service.

- Whenever new DMF records for that repository are produced by the responsible Aggregator Service, the records are fed to the index.
- Content of all indices is replicated three times (the value can be modified at run-time) at different Index Services, in order to decrease the workload of index services and improve system availability.

The set of resulting DMF indices forms the DIS information space.

- Search Services mediate between consuming services willing to query an Information Space and the indices and replicas relative to that space. Consuming services, for example, user interface services, send CQL queries (Contextual Query Language) to a Search Service, which replies by choosing the ‘best’ index replica, identified in terms of its content, current performance and latency of the relative Index Service.
- Compared to traditional aggregation system construction, the infrastructural approach proves to be less expensive.

**Realization** DRIVER services in the Data Area are generic with respect to the metadata format involved, and can therefore be configured to satisfy a variety of application scenarios, that is, Information Spaces. The configuration of new aggregation systems, i.e. the configuration of Manager Services, is delegated to the RO.

**Maintenance** ADLS administrators are largely not required for RO administrators can configure Manager Services to orchestrate services to satisfy requirements of robustness and scalability, that is, storage replication, index redundancy, quality of service. Manager Services will make sure that such configuration is satisfied by exploiting the Index and Store Services available. When the available resources are not enough, RO administrators are sent a warning, so that they can deploy new services on new machines and
appropriately empower the infrastructure. Aggregation managers are still required, but can rely on Aggregator Service user-friendly interfaces, through which they can define format-to-format mappings without specific programming skills.

**Refinement** POs may be willing to use D-NET software, but also to include new typologies of services into D-NET or provide different, possibly better implementations of existing service typologies. This level of engagement is similar in some aspects to that of traditional aggregation system refinement. PO designers and developers need support from the RO in order to familiarize with the D-NET’s application framework and be able to integrate their compatible service software. With respect to traditional ADLS development, refinements are more sustainable: any new functionality service added in the context of an infrastructure can be in principle reused by other POs, both at run time or in new deployments.

**Hardware** POs may apply to run their applications through services and machines provided by the RO: this scenario, to be evaluated and approved by the RO, entails only application administrative costs for the PO, that is, those of training aggregator managers. If instead the PO is to rely on its own resources, then hardware cost should be added to that of aggregator managers, while software installation and deployment is supported by the RO.

The costs for building aggregation systems on DRIVER, although they may depend on the kind of hardware involvement of the PO, are lower compared to those entailed by traditional ADLSs. The costs can be generally limited to the personnel needed for harvesting and normalization of metadata, that is, aggregator managers with no particular development skills. This is possible thanks to the availability of general-purpose software that can be adapted to the specific application domain and that can be self-administered and self-monitored by the enabling services, appropriately configured by the RO.

**The DRIVER Information Space real-case**

The DRIVER Consortium plays the role of the RO for the DRIVER production infrastructures, but also the role of the PO responsible for the DRIVER Information Space (DIS) application (Candela, Castelli, Manghi, et al. 2007). The DIS contains records in DMF representing Open Access publications available from OAI-PMH Repositories in European Countries (today also African repositories have been included). DMF records describe publications in a uniform way in terms of their provenance (name of the original repository, of the institution and country) and normalized Dublin Core bibliographical description. DMF records are generated by the DRIVER PO in cooperation with a network of national correspondents. Correspondents play the role of aggregator managers for independent ‘national consortium’ POs. These are entitled by the DRIVER RO to harvest records from an assigned set of repositories and define the mappings to convert them into DMF and therefore populate the relative DIS subset.

PO administration’s cost are these of (i) training national correspondents, (ii) keeping alive the European network necessary to promote the Open Access approach leveraged by the DIS and (iii) performing harvesting/mapping activities for countries that did not provide a correspondent. Currently, there are no hardware costs for POs, as they can exploit hardware and services made available by the RO infrastructure deployment, which currently counts 9 servers, running 36 services.

The overall PO’s cost is far less than that required for building an ad-hoc aggregation system of the same broad impact. Indeed, the high costs entailed by design and development...
skills are excluded at the realization, maintenance, refinement and hardware levels and therefore positively impact on the sustainability issues. To summarize, this cut is due to: (i) the availability of general purpose open source software provided by DRIVER, (ii) the Manager Service approach, which are capable of automatically ensuring storage allocation, indexing, and robustness according to the PO needs, and by (iii) Aggregation Services, which enable aggregation managers to deal with the generic pattern of harvesting, cleaning, transforming metadata records through user interfaces.

Today, the DIS counts more than 1,000,000 Open Access publications references from all European Countries harvested from about 250 repositories. The entries are expected to grow up as twice by the end of 2010 and keep growing thereafter. Publications are accessible through User Interface Services, that is, community applications, provided by different POs, as described in the following section.

**Portal applications in DRIVER**

DRIVER POs can deploy community applications, that is, customized portals, to operate over one of the Information Spaces populated by the aggregation systems available in the infrastructure. Portals are DRIVER applications and as such consist of a number of interacting running services, selected from the Functionality Area (Figure 5). Currently these are Advanced UI Service and Lite UI Service (both supporting web portals), Community Service, User Service, Recommendation Service and Collection Service, which provide functionalities to be integrated in the portals. In particular, portals are modularly independent from the aggregation systems and can automatically adapt to any metadata format supported by the relative Information Spaces; moreover, portals can be configured to focus on a subpart of one information space and to activate a specific subset of the functionalities offered by the service.

Several European countries are planning to set up web portals offering access to a federation of national repositories, in the style of DAREnet for the Netherlands, but are pending or renouncing the initiative because of organizational and technological costs of traditional ADLSs. The same holds for cross-nation and cross-subject user communities (for example, DART Europe, NEEO), which find difficult to raise the funds necessary for ADLS sustainability. In such scenario, the DIS application has the potential to play an important role in Europe, being maintained by the DRIVER RO on behalf of the European Community and being the DIS reusable by any POs in the context of their affordable portals.

As mentioned above, POs are supplied with two typologies of User Interface Service - advanced and lite - whose features are exemplified in the following, through real case scenarios.

**Advanced User interface**

The Advanced User Interface is a service designed to provide access to a number of user functionalities, by interacting with the relative functionality area services: user registration and preferences, recommendations, user communities and collections. In particular, the service automatically adapts to the Information Space metadata format of interest to the PO and can be configured to offer a specific subset of these functionalities.

Search functionalities range from free-keyword search to advanced metadata fields search.

Collection Services are used to manage a hierarchy of virtual collections, that is, queries with a name. For example, the DIS features a collection ‘French repositories’, which...
corresponds to a DMF CQL query Repository Country = FR, and virtually contains all metadata records in the DIS that originated from French repositories. By running queries within a collection, users restrict their search pool and likely improve the precision of search results. As such, collections provide a meaningful partition of the Information Space, in terms of a hierarchical tree of named queries.

Communities identify an area of interest to a user community by grouping a set of topic-related collections. Users can subscribe to communities and profit from their collections and relative recommendations.

Recommendations allow users to subscribe to system events, ranging from the registration of new repositories to the insertion in the Information Space of new user-relevant or community-relevant publications.

User Services enable users to register and then enrich a personal profile, in order to automatically refine future searches and specify community and recommendation preferences. Collections, communities and users are managed by PO administrators through web admin interfaces.

Following are the cost for POs constructing advanced user interfaces.

- **Realization** As for data area, functionality area services are available and generic enough to satisfy a large number of community application requirements. The realization costs are therefore minimal for the PO involved, which should only install the services of preference and supply the portal graphic customization.

- **Maintenance** The administrative costs are those of librarians, in charge of managing users, communities and collections. No administration efforts are requested, since the Manager Services monitor the status of the services and alert RO administrators if their intervention is needed, for the deployment of new machines and services.

- **Refinement** POs may add new services to the Functionality Area, so as to offer new functionality through the portal. In this case the portal itself should be modified accordingly. Design and development costs are necessary and involve both PO staff and RO technical support. Any addition to the Functionality Area can be reused by other POs in the future.
Hardware

As for any DRIVER application, the PO may be responsible of providing the machines to run the services or instead, when permitted, rely on RO administered machines. Hardware costs do therefore depend on such initial or in due course choice.

PO costs are not comparable with those required to design and develop a corresponding portal from scratch in a traditional scenario, especially when the Information Space of interest is maintained by an aggregation system of another PO.

An advanced user interface is currently running in three multiple instances over the DIS production infrastructure and available at http://search.driver.research-infrastructures.eu. The main DRIVER DIS portal is configured to run queries based on DRIVER Metadata Format (Figure 6) and it extends to the whole Information Space. All user functionalities are currently enabled.

Lite User Interface

POs might not be interested in advanced functionalities, but simply in providing their end-users with minimal search options, that is, in the style of Google. To this aim, the Functionality Area provides a Lite User Interface Service, which can be configured to offer a web portal to search over an Information Space by narrowing down to a given collection, namely a query. For example, in the case of the DIS information space, the PO Spain-Recolecta defined a portal for accessing the subset of Spanish records in the DIS. The service also offers the possibility to restrict the scope of queries to one of the repositories in the federation, to be selected from a list that is dynamically refreshed by the service.

Following are the cost for POs constructing lite user interfaces.

Realization

As for the advanced UI service, the only realization cost is for the deployment of the service and the definition of the portal graphic.

Maintenance

The service does not require any form of administration, as it self-adapts to the current Information Space status. Manager Services monitor the status of the

![Figure 6 Advanced User Interface Service: DRIVER Main Portal](image-url)
services and alert RO administrators if their intervention is needed, for the deployment of new machines and services.

**Refinement** The principle of Lite UI services is to be minimal, thus no real addition of functionality is expected. However, new User Interfaces can be designed and built by POs, with standard design and development cost and RO technical support.

**Hardware** Lite UI Services do not rely on any other service, and are usually hosted by RO machines. However, POs can always decide to deploy the service on local hardware.

The time to configure a Lite UI Service for a PO is about a day for the RO, and includes installation of the service, minimal adjustment of the graphics and creation of the underlying virtual collection.

Spain-Recolecta (Figure 7) and Belgium national consortium (Figure 8) are currently running dedicate instances of the Lite User Interface Services, respectively available at <http://search.recolecta.driver.researchinfrastructures.eu> and <http://search.belgium.driver.researchinfrastructures.eu>. The services are deployed

![Figure 7](image1.png) Lite user interface service: Spain-Recolecta portal

![Figure 8](image2.png) Lite User Interface Service: Belgium portal
on the DRIVER RO machines and required no effort for the participating POs. While the Belgium portal is already the official portal for the Belgium repository federation, Recolecta is experimenting with DRIVER while still keeping their national ADLS (reachable at http://www.recolecta.net). This experimentation is the first stage of cooperation between DRIVER and Consorcio Madrono, aiming at using DRIVER D-NET technology to build the new Spanish ADLS.

Conclusion

Aggregative Digital Library Systems are peculiar Digital Library Systems used to gather content from a given set of repositories, create uniform Information Spaces and offer end-users a set of functionalities over such spaces. Such systems prove to be hardly sustainable, especially when applied to large-scale scenarios such as those targeted by the European Union, envisaging a multitude of end-users, large amounts of data and pressing functional requirements evolution. The DRIVER project, aiming at building the European Open Access Information Space, proposed an innovative technological solution to this problem, based on an infrastructure software called D-NET. D-NET runs a customizable and open environment where organizations can easily construct sustainable ADLSs. Apart from Spain and Belgium, communities from the national consortia of Slovenia, Portugal, India and China are experimenting to build their applications into the DRIVER production infrastructure and the DIS application or as independent D-Net installations.

The DRIVER-II project is currently maintaining and improving the DRIVER production infrastructure, until December 2009. The goal is to keep on populating the DIS by promoting the Open Access initiative and support communities willing to join DRIVER with content and applications.

Acknowledgments

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Abstract

A collection of cultural heritage materials, either the photographs or any other form, which are of historical importance, or are nearly unapproachable, or in low use because of their rare availability and lack of a centralized access point. Digitization of these materials will increase their reachability, value and create new stakeholders. Metadata plays a vital role in facilitating resource discovery and interoperability in networked environments. The present paper emphasizes the importance of metadata in constructing an image repository for Indian cultural heritage materials through DSpace Digital Library Software confining to Dublin Core Metadata Standards. The paper also describes that metadata is primary requirement for effective image retrieval and use of digital materials. Apart from that, metadata has a lot of importance in representation, interoperability, technical management, performance of an image repository. Further, it also enunciates that there is ample scope for further research in the area of developing a national repository for Indian cultural and heritage materials with OAI (Open Archives Initiative) Protocol for Metadata Harvesting (OAI–PMH) for the purpose of interoperability.
Introduction

India is one of the countries in the world that has traditions, cultures and variety in diversity. The cultural heritage of the country dates back to five thousand years old civilization that is enriched by successive waves of migration and intruders from different lands, who left an indelible mark on the versatile Indian way of life. The prevailing culture and heritage of India is the amalgamation of those cultures with native Indian culture. Cultural Heritage materials have a lot of importance as culture is something we do, a performance which fades into memory and then disappear, but the record of culture consists of artifacts which we make, which persist but inevitably decay (Lyman and Kalhe 1998). Such cultural materials require specialized knowledge to prepare for ubiquitous use by everyone from scholars to general public. Cultural materials are available not only to humanities research but also to technological and scientific research. Applying modern computing techniques to analyze them will gain insights for general purpose image archival, distributions, and intelligent automatic information extract (Chen et al. 2002).

Digitization has immense potential to store, preserve, disseminate and redistribute cultural heritage materials if they are captured in bit stream format and accessible through networks for learning and understanding the history and culture of a civic society.

The artifacts may be different materials like manuscripts, photographs, drawings, paintings and three-dimensional sculpted materials, etc. Out of these photographs play a vital role in disclosing facts of history as a picture is worth of thousand words, and object for object, pictures are several orders of magnitude larger and more subtle information carriers than written language (Boeri and Hansel). Due to their importance in different fields like education, research, history, archaeology and anthropology, most of the cultural and heritage materials are converted into digitized forms, knowing that permanent access to this heritage will broadened opportunities for creation, communication and sharing of knowledge among different communities as well as protection of rights and entitlements and support of accountability. There has been an increase use of images as there is decrease in the cost of acquiring and storing them.

Image database system

An image database system is set of images, which are collected, analysed and stored in multimedia information system. They may comprise different kinds of systems like office systems, information retrieval systems, earth resource systems, medical databases, virtual reality systems, robotics systems, art galleries museum catalogues, animal and plant atlases, sky star maps and meteorological maps, and so on. Image retrieval problem is concerned with retrieving images that are relevant to user’s requests from an image database. The full and seamless accessibility, according to the end user’s perspective, would require these materials in accessible format through automated searches from a number of entry points. For effective management and image information; image database retrieval systems have been constructed.

During past few years a large number of CBIR (content-based image retrieval) systems have been developed. It is a challenging task to select most appropriate system, as it is impossible to do an exact comparison of database image with each query image. It is also difficult to evaluate success rate of the CBIR systems in terms of effectiveness, efficiency and flexibility. It has been noticed by the researchers that there are significant gaps between the features that can be extracted from the images and the meanings...
of the images. According to Smeulders et al., these gaps are the sensory gaps between the object in the world and the information in a (computational) description derived from a recording of that scene (Smeulders et al., 2000). The semantic gap is the lack of coincidence between the information that one can extract from the visual data and interpretation that the same data have for a user in a given situation. It is important to bridge the gap by referring to descriptive metadata. The descriptive mark-up provided by the subject specialists remain the most precise and reliable recourse and will continue to be an invaluable guide to any development of automated search strategies (Chen, et al., 2004).

**Metadata**

Metadata is not a new concept to librarians as they traditionally maintain the bibliographic information in catalogues or databases. The term became a buzz word with the advent of digital resources and it is classically defined as ‘structured data about data’. Metadata has been defined as follows: ‘It is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource’ (NISO). According to Cathro ‘an element of metadata describes an information resource, or helps provide access to an information resource. For example, a library catalogue is a collection of metadata elements, linked to the book or other item in the library collection through a call number. Information stored in the “meta” field of an HTML Web page is metadata, associated with the information resource embedded within it. The indexing data held by web crawlers is also metadata (though not very good metadata), hyper-linked to the information resource through the URL’ (Cathro 1997). DCMI defined ‘it is an Internet-age term for information discovery that librarians traditionally have put into catalogues, and it most commonly refers to descriptive information about Web resources’. Briefly, in an environment where a user can gain unmediated access to information objects over a network, is metadata.

- Certifies the authenticity and degree of completeness of the content;
- Establishes and documents the context of the content;
- Identifies and exploits the structural relationships that exist between and within information objects;
- Provides a range of intellectual access points for an increasingly diverse range of users; and
- Provides some of the information which an information professional might have provided in a physical reference or research setting. (Gilliland-Swetland, 2000).

**Functions of metadata**

In networked world of digital information systems, metadata plays a vital role. Metadata applications in archival settings can be broken down into at least five categories: administrative, technical, preservation, descriptive and use, all of which are important in maintaining the integrity and evidential value of historical collections (Gilliland-Swetland, 1998).

- Administrative - metadata used in managing and administering, for example, copyright, acquisition information
- Descriptive - metadata used to describe or identify information resources, for example, controlled vocabularies, user annotations
- Preservation - metadata related to the preservation management of information resources, for example, physical condition of resources, preservation actions
- Technical – metadata related to how a system functions or metadata behave, for example, digitization information such as formats, compression, and so on
Use – metadata is related to the level and type of use of information resources, for example, use and user tracking.

The above-mentioned categories of metadata incorporate the following information aspects that are felt to be critical to establish an accurate understanding of the nature of a resource.

- **Content** – What the object contains or is about, intrinsic to an information object
- **Context** – The who, what, why, where, and how aspects associated with the object’s creation, extrinsic to an information object
- **Structure** – The formal set of associations within or among individual information objects which can be intrinsic or extrinsic (Gilliland–Swetland 2000).

Metadata functions can also be described in two different levels - one is system level, where the metadata provides facility for interoperability and integrity of resource discovery tools. Another is end-user level, where the metadata ensures the capacity to determine - type of data available, how to acquire it, whether meets the requirement, and how to capture at user-end, and so on. (Kwong and Kathleen).

**Metadata initiatives**

The organizations like Library of Congress, FGDC (Federated Geographic Data Committee), ISO (International Organization for Standardization), NISO (National Information Standard Organization), OCLC (Online Computer Library Centre), UKOLN (UK Office for Library and Information Networking), IFLA (International Federation of Library Associations), NCSU (North Carolina State University) and W3C (World Wide Web Consortium) have taken initiatives in developing different metadata standards for diverse electronic resources. ‘Metadata takes a variety of forms, both specialized and general - new metadata sets will develop as the network information infrastructure matures - different communities will propose, design, and be responsible for different types of metadata’ (Lagoze 1996).

MARC (Machine Readable Catalogue) format is the most long lived and highly developed metadata formats that has originated in late 1960s as a response to the opportunities offered by computerization of libraries and printing (Rachel 1996). CSDGM (Content Standard for Digital Geospatial Metadata) was initiated by FGDC in 1992; in 1993, NCSU Libraries introduced EAD (Encoded Archival Description); TEI (Text Encoded Initiative) has been published in 1994 by Arts and Humanities Data Services and Dublin Core Metadata Initiatives began in 1995.

**Dublin Core metadata initiatives**

The DC (Dublin core) is an international and interdisciplinary initiative to develop a metadata element set intended to facilitate discovery of digital resources. Dublin Core was initially conceived as a simple metadata format that could be used by the creators of resources or by Website maintainers. It has also, however, become a focus of interest from variety of communities with wider interests in resource description, including librarian, archivists, museum documentation specialists and computer scientists with an interest in text mark-up issues (Weibel and Lagoze, 1997). International representatives of these communities have met at a series of invitational workshops, the first of which met at OCLC’s headquarters at Dublin, Ohio in March 1995 which resulted in the initial proposal of a thirteen element metadata set (Weibel et al., 1995). The third Dublin Core Workshop, the Image Metadata Workshop held in Dublin, Ohio in September 1996 and
sponsored by the CNI (Coalition for Networked Information) and OCLC, specifically considered the application of the Dublin Core element set to the description of images (Weibel and Miller, 1997). The Dublin Core was primarily developed to be simple and concise, and to describe web-based documents. However, the workshop resulted in a number of changes to Dublin core element set which took into account the specific requirements of images. The result was fifteen core metadata elements as given in Table 1. A reference definition of simple Dublin Core has been published in 1998 as Internet RFC 2413 (Weibel et al. 1998).

Though Dublin core comprises 15 main elements, recently seven more elements have been added and now there are twenty-two core elements, which are as follows:

- Title, Subject, Description, Type, Source, Relation, Coverage, Creator, Publisher, Contributor, Rights, Date, Format, Identifier, Language, Audience, Provenance, Rights holder, Instruction method, Accrual method, Accrual periodicity and accrual policy.
- Qualifiers are the basic elements that are refined using semantics (element refinement) or encoding schemes that may be useful in resource discovery (DCMI, 2009).

### Importance of metadata
SEPIA (Safeguarding European Photographic Images for Access) stated that the success of a digitization project depends on the quality of its description and that collections need a reliable and standardized set of descriptive data elements to be interoperable. It has provided a list of data elements for

<table>
<thead>
<tr>
<th>Table 1 Dublin Core elements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element name</strong></td>
</tr>
<tr>
<td>Title</td>
</tr>
<tr>
<td>Author or creator</td>
</tr>
<tr>
<td>Subject and keywords</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Publisher</td>
</tr>
<tr>
<td>Other contributors</td>
</tr>
<tr>
<td>Date</td>
</tr>
<tr>
<td>Resource type</td>
</tr>
<tr>
<td>Format</td>
</tr>
<tr>
<td>Resource identifier</td>
</tr>
<tr>
<td>Source</td>
</tr>
<tr>
<td>Language</td>
</tr>
<tr>
<td>Relation</td>
</tr>
<tr>
<td>Coverage</td>
</tr>
<tr>
<td>Rights management</td>
</tr>
</tbody>
</table>

**Source** Weibel and Lagoze, 1997.
photographic collections, defining them at high level of detail and recommended best practices for each element. It has recommended standards on which to base the content of different elements and mapped them to Dublin core. The Institute of Museum and Library Services (IMLS, 2001) Digital Library Forum specified several metadata principles that are essential for good digital collection. Metadata should be appropriate to the materials in the collection and the users of it support interoperability; include a clear statement on the conditions and terms of use for the digital object, support the long-term management of objects in collections, and be authoritative and verifiable. Metadata is not only useful in resource identification but also in representation, interoperability, technical management, performance and use of data contained in an information system.

Building of image repository for ICH (Indian Cultural Heritage) materials

As on date, there is great need to provide information on web interface, as it helps in finding the information accurately, that can be located easily and fastly. The increasing use of the Internet and World Wide Web has developed awareness about the access and retrieval of information across networks. The major boost to the development of digital libraries comes from the web technologies that enable instantaneous online access to repositories (Devika 2005). Digital libraries encapsulate a whole range of information services, such as organization of digital information, information retrieval, user interfaces, archiving and preservation, services and social issues, evaluation and application to particular areas and a set of standards for interoperability and value-added services.

In the present study an attempt has been made to construct a repository for ICH images by using Dublin Core Metadata elements and DSpace Digital Library software.

DSpace digital library software

DSpace software has been developed as digital library software jointly by MIT (Massachusetts Institute of Technology) Libraries and Hewlett-Packard Labs as an Open Source system that functions as a repository for digital research and educational materials of any kind produced by the researchers or any other organization.

- DSpace is an open source technology platform which can be customized and its capabilities can be extended.
- DSpace is a service model for open access and/or digital archiving for perpetual access.
- DSpace is a platform to build an Institutional Repository and the collections are searchable and retrievable by the web.
- To make available institution-based scholarly material in digital formats the collections will be open and interoperable (Devika P M, 2005).

Now-a-days, the task of running of multidisciplinary repositories has increasingly taken up by researchers, teaching organizations and data aggregators especially by libraries, museums and archives. In brief, the features and functions of the DSpace are as follows.

- Information Model
  - Metadata
  - User Interface
  - Work flow
- System Architecture
  - Application Layer
  - Business Logic Layer
  - Storage Layer
Building image repository of Indian cultural and heritage materials

Metadata – DSpace

As the present paper emphasizes on the importance of metadata in building repositories and for resource discovery, here only the metadata part is elaborated with reference to DSpace.

DSpace basically uses a qualified Dublin Core Metadata for describing items intellectually. This metadata is displayed in the item record in DSpace, and is indexed for browsing and searching the system. Dublin Core is a set of 15 attributes divided into three groups, that is, content, intellectual property and instantiation. Associated to Dublin Core are Dublin Core qualifiers that enhance the identification of items. Most of the institutional repositories use Unqualified Dublin Core (www.dublincore.org) metadata to ensure interoperability. DSpace users deal with the following modules of metadata.

- Administration modules – Dublin Core registry, administrative metadata – default values, mail alert to subscribers.
- Submission modules – Descriptive metadata.
- Harvesting – OAI–PMH using the DC elements (unqualified).
- Search result display – Brief and full metadata (Devika 2005)

With reference to the above modules there are three types of metadata in DSpace.

Administrative metadata – Deals with preservation metadata, provenance and authorization policy data.

Descriptive metadata – DSpace uses the qualified Dublin Core set of elements for furnishing metadata. The basic set consists of 15 elements and the qualified set has about 65 elements. However, OAI-PMH (metadata harvesting standard) harvesters recognize the basic set of 15 at present.

Structural metadata – Deals with presentation of an item or bitstreams within an item, to an end-user, and the relationships between constituent parts of the item. It is implementation of the METS (Metadata Encoding and Transmission Standard).

Sample collection

For the study purpose, photographs of different varieties of cultural materials and heritage sites, which were already published in different books have been captured and collected as samples. The collected photographs are of manuscripts, drawings, paintings, sculptures and monuments of Historical and Cultural importance.

Mapping metadata of images with Dublin Core Registry of DSpace

The collected samples have been analysed from the documented sources. The details of the metadata have been extracted from the sources and mapped with the following eleven elements, contributor, coverage, date, description, format, language, relation, rights, subject, title and type. Further, they were mapped with about sixteen qualifiers of the Dublin Core Registry of DSpace digital library software that consist about sixty five qualifiers. The ID in the below table refers to identifiers as given in Dublin Core Registry of the DSpace.

One image from sample, as in Figure 1 is given below along with the mapped metadata to Dublin Core qualifiers of DC Registry of DSpace Digital Library Software as given in Table 2.

Role of metadata in item submission

As mentioned in earlier, DSpace basically uses a qualified Dublin Core Metadata for describing items intellectually. This metadata is displayed in the item record in DSpace, and
Any image repository system should have a powerful search process through which the images can be searched and displayed instantaneously. DSpace uses Jakarta Search engine Lucene, which is simple and performs high. It also gives the capabilities of fielded searching, stop word removal, stemming and adding of newly indexed content without regenerating the entire index. Here the Structural Metadata deals with presentation of an item or bit streams within an item, to an end-user, and the relationships between constituent parts of the item.
Table 2 Mapped DC Elements with DC Registry of DSpace

<table>
<thead>
<tr>
<th>S. No</th>
<th>ID</th>
<th>Element</th>
<th>Qualifier</th>
<th>Scope notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>Contributor</td>
<td>Illustrator</td>
<td>1709 Century Dipak is associated with Diwali, the Indian Autumn festival of lights, which is just as popular today. A Lord parades with his court in a splendid procession. Notice the flames in Lord’s and in the leading girl’s hand. The scripture on the painting describes ‘Now Dipaka, Doha (meter): He is born out of the Sun’s eye (and has the notes) Sa, Re, Ga, Ma, Pa, Dha, Ni. Dipak’s time (for singing) is the noon time of summer day. 1. Modaka meter: (It is) of Sampurna class and (has) Shadja as the graham (note). His body is like the blossom of Pomegranate flower (in Complexion). He rides an elephant in rut. Many women accompany him on the vide. He is red complexioned and (He wears) the elephant pearl on his neck. This is the garb (form) which Dipaka takes. 2. Soratha (meter): Now his Raginis. Des, Kamod, Nat, Kedaro, Kanara, the (above) five are Dipaka’s wives, so says the Paida, after churning (digesting) the music (theory). 3/19/.’</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Contributor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>Coverage</td>
<td>Spatial</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>Date</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>27</td>
<td>Description</td>
<td>Abstract</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>28</td>
<td>Description</td>
<td>Provenance</td>
<td>Amber</td>
</tr>
<tr>
<td>7</td>
<td>34</td>
<td>Format</td>
<td>Extent</td>
<td>6 ¼ X 9 (in inches [width × height])</td>
</tr>
<tr>
<td>8</td>
<td>34</td>
<td>Format</td>
<td>Extent</td>
<td>443 kb</td>
</tr>
<tr>
<td>9</td>
<td>35</td>
<td>Format</td>
<td>Medium</td>
<td>Painting</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
<td>Format</td>
<td>mime type</td>
<td>JPEG</td>
</tr>
<tr>
<td>11</td>
<td>37</td>
<td>Language</td>
<td></td>
<td>Hindi</td>
</tr>
<tr>
<td>12</td>
<td>47</td>
<td>Relation</td>
<td>Is based on relation of the material with particular subject like painting, drawing, heritage site and so on</td>
<td>The present image is based on the Ragamala Painting</td>
</tr>
<tr>
<td>13</td>
<td>42</td>
<td>Relation</td>
<td>Is part of the material, is a part of so and so book</td>
<td>The present image has been extracted from the book: Ragamala Painting by Klaus Ebeling, New Delhi, 1973.</td>
</tr>
<tr>
<td>14</td>
<td>53</td>
<td>Rights</td>
<td></td>
<td>Kankroli Art Collections</td>
</tr>
<tr>
<td>15</td>
<td>63</td>
<td>subject</td>
<td></td>
<td>Indian Miniature Paintings, Ragamala Paintings, Music, Ragas and Raginis</td>
</tr>
<tr>
<td>16</td>
<td>64</td>
<td>Title</td>
<td>Dipak Raga</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>66</td>
<td>Type</td>
<td>Photograph (image)</td>
<td></td>
</tr>
</tbody>
</table>
Browsing in DSpace allows going through a list of items in some specified order. It can be done by the following ways.

- Community/Collection
- Title
- Author
- Date
- Boolean search
- Proximity
- Wild cards
- Fuzzy search
- Range search
- Boosting terms, and so on

Here are few screen shots depicting some search styles.

**Browse by community/collection**

Choosing this option helps in listing of the alphabetical order of communities and allows seeing the collections in each community as shown in Figure 4.

Searches can also be conducted in two ways. The first way is to search through all communities and collections of the repository and second way is to restricting search to a specific community and collection. The search can be done against title, author, subject abstract or any other field of the item’s record as given in Figure 5.

**Advanced search**

It is also possible to search using Boolean operators ‘AND’, ‘OR’, ‘NOT’. The advanced search page allows the field to be searched and to combine these searches with the Boolean ‘and’, ‘not’, ‘or’ as shown in Figures 6 and 7.

**Conclusion**

The paper focused on the importance of metadata in retrieving digital images in a networked environment. It emphasized that despite of sophisticated content base image retrieval systems, metadata remains as a
Building image repository of Indian cultural and heritage materials

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Note: This is an updated version of the paper titled ‘Building an Image Repository for Indian Cultural Heritage Materials – A Digital Library Approach’ presented in the PLANNER – 2005 published by INFLIBNET Centre, Ahmedabad.
E-Resources @ UGC–Infonet Digital Library Consortium: a breakthrough

DR R K BHATT
Associate Professor and Head, Department of Library Information Science, University of Delhi


Abstract
The paper explains the role of UGC Infonet and UGC Infonet Digital Library Consortium in India. Proliferation of information, diminishing library budgets and enhanced information needs for prompt access have led to formation of such consortium to resolve serial crisis, provide 365 × 24 e-resources accessibility to the remotest academic institution to provide impetus to research and academic activities. The UGC has initiated this endeavour and committed to take care of each and every activity from infrastructure to connectivity, members to subscription, access to archival and look after that no impediment will effect the system’s functioning.
Introduction

The UGC (University Grants Commission) is a statutory body founded by the Government of India by an Act of Parliament in 1956 for coordination, determination and maintenance of standards of higher education in India. It serves as a vital link between the union and state governments and the institutions of higher learning. In addition to providing grants to universities and colleges, it also advises central and state governments on the measures necessary for the improvement of higher education in India. It also frames regulations, like minimum standards for instructions and qualifications of the teachers and librarians on the advice of subject experts and academicians, with whom it frequently interacts in connection with the formulation, evaluation and monitoring of educational programmes. Realizing the fact that in a knowledge economy, research scholars are supposed to learn on a continuous basis, acquire new skills and competencies and pack new ideas to maintain a competitive edge over others and for this they essentially require access facilities to harness latest information and knowledge through an electronic or digital library network and to achieve its goals and mission, the UGC has launched several programmes, constituted several committees and commission out of which the establishment of INFLIBNET in 1991 and launching of UGC–INFONET Digital Library Consortium on the concluding day of UGC’s golden jubilee celebrations by his Excellency, the then President of India, Dr A P J Abdul Kalam at Vigyan Bhawan on 28th December 2003 are the most laudable landmarks in the history of Indian higher education and librarianship.

Inflibnet and its objectives

Inflibnet (Information and Library Network) Centre is an autonomous Inter-University Centre of the UGC of India. It is a major national programme initiated by the UGC in 1991 with its head quarters at Gujarat University Campus, Ahmedabad. Initially it started as a project under the IUCAA, it then became an independent inter-university centre in 1996. Major objectives of the INFLIBNET programme are (i) to promote and establish communication facilities to improve capability in information transfer and access, that provide support to scholarship, learning, research and academic pursuit through cooperation and involvement of agencies concerned, and (ii) to establish INFLIBNET: Information and Library Network, a computer communication network for linking libraries and information centres in universities, deemed to be universities, colleges, UGC information centres, institutions of national importance and R&D institutions, and so on, avoiding duplication of efforts (Chakravarty and Singh, 2005).

Functions

As INFLIBNET was established to take care of networking of libraries and their resources in the higher education institutions across the country, it started performing the following functions (Chakravarty and Singh 2005).

- Promote and implement computerisation of operations and services in the libraries and information centres of the country, following a uniform standard.
- Evolve standards and uniform guidelines in techniques, methods, procedures, computer hardware and software, services and promote their adoption in actual practice by all libraries, in order to facilitate pooling, sharing and exchange of information towards optimal use of resources and facilities.
- Evolve a national network, interconnecting various libraries and information centres in...
the country and to improve capability in information handling and service.

- Provide reliable access to document collection of libraries by creating online union catalogue of serials, theses/dissertations, books, monographs and non-book materials (manuscripts, audio-visuals, computer data, multimedia, and so on) in various libraries in India.

- Provide access to bibliographic information sources with citations, abstracts, and so on, through indigenously created databases of the sectoral information centres of NISSAT, UGC information centres, city networks and such others and by establishing gateways for online accessing of national and international databases held by national and international information networks and centres respectively.

- Develop new methods and techniques for archival, which would be of valuable information available as manuscripts and information documents in different Indian languages, in the form of digital images using high density storage media.

- Optimize information resource utilization through shared cataloguing, inter-library loan service, catalogue production, collection development and thus avoiding duplication in acquisition to the extent possible,

- Enable the users dispersed all over the country, irrespective of location and distance, to have access to information regardingserials, theses/dissertations, books, monographs and non-book materials by locating the sources wherever available and to obtain it through the facilities of INFLIBNET and union catalogue of documents.

- Create databases of projects, institutions, specialists, and so on, for providing online information service.

- Encourage co-operation among libraries, documentation centres and information centres in the country, so that the resources can be pooled for the benefit of helping the weaker resource centres by stronger ones.

- Train and develop human resources in the field of computerised library operations and networking to establish, manage and sustain INFLIBNET.

- Facilitate academic communication amongst scientists, engineers, social scientists, academics, faculties, researchers and students through electronic mail, file transfer, computer/audio/video conferencing, and so on.

- Undertake system design and studies in the field of communications, computer networking, information handling and data management.

- Establish appropriate control and monitoring system for the communication network and organise maintenance.

- Collaborate with institutions, libraries, information centres and other organisations in India and abroad in the field relevant to the objectives of the Centre.

- Create and promote R&D and other facilities and technical positions for realising the objectives of the Centre.

- Generate revenue by providing consultancies and information services.

- Do all other such things as may be necessary, incidental or conducive to the attainment of all or any of the above objectives.

**Activities**

The following are the important activities of INFLIBNET (SRELS Journal of Information Management 2005).

- Provides grants to universities to automate the libraries, establishing the network facilities and create an information technology environment.

- Develop and distribute SOUL (software for university libraries) which is integrated
user-friendly library management software. The latest version of the software is 2.0 which is competent to operate with the latest technologies and international standards such as MARC21, Unicode based and NCIP 2.0 based protocols for electronic surveillance and control.

- IndCat (Indian Catalogue) of University Libraries in India is online library catalogue of books, theses and journals available in major university libraries in India which provides bibliographic description, location of the material in all subjects available in more than 112 university libraries. Thus, IndCat has over 10 million bibliographical records of books from more than 113 universities. In addition, the database of theses, expert databases, project databases and SEWAK-OFFLINE database access facilities are also extended to the libraries of higher learning institutions.

- To enhance the skills of university library staff for implementation of INFLIBNET programme, it conducts training programme for library staff, on-site training for member library staff, training on SOUL software, holding CALIBER convention every year and workshops for senior level staff of the university libraries.

- It has brought out a document entitled ‘INFLIBNET Standards and Guideline for Data Capturing’ prepared by a task force of experts based on CCF (Common Communication Format).

The library consortia

Another important and significant programme of UGC in the field of knowledge sharing activities is ‘UGC – Infonet Digital Library Consortium’. Academic library consortia in an electronic environment is an integral part of academic libraries in acquiring resources and providing services to respective users. Consortia are involved in several operations such as purchasing content for collections, building and maintaining technical infrastructures, delivering services such as inter library loan and document delivery, developing resource sharing agreements and establishing institutional repositories.

- In today’s electronic environment the library consortia in academic libraries are playing an increasingly important role by providing prompt access to latest developments in the information proliferation era. One of the purposes of library consortia is the leveraging of library budgets to purchase more digital resources that could not be purchased by any one member institution in the print format (www.inflibnet.ac.in).

- Consortia in India have undergone a transformation with infusion of new information technology and the movement from print-based environment to digital environment. In fact, the philosophy behind establishing a library consortium is to promote use of e-resources particularly e-journals on the lines of resource sharing methodology where the emphasis is optimal utilization of information sources at the least cost. On the basis of such analogy, the first worth mentioning and significant consortium was INDEST consortium, formed in 2003 on the recommendation of an expert group and later on the nomenclature of the consortium was changed and renamed as indest-aicte consortium. However, keeping in view the larger perspective and the necessity of such an effort for giving a better resource sharing platform to the college and university libraries in India, especially when they are passing through financial constraints, the UGC launched a library consortium called, ‘UGC-Infonet e-journals consortium’ which later on was renamed as ‘UGC- Infonet Digital Library Consortium’. In addition to the financial reasons, improving quality standards of research in Indian universities and bringing it to a level of global recognition by improving
E-Resources @ UGC–Infonet Digital Library Consortium: a breakthrough

the access-base of literature is another reason for launching such an ambitious resource sharing programme for the academic fraternity.

**UGC–Infonet Digital Library Consortium**

UGC–Infonet is an innovative project launched by UGC to facilitate scholarly e-resources to Indian academies through joint partnership of UGC, INFLIBNET and ERNET. This includes interlinking of universities and colleges in the country electronically with a view to achieve maximum efficiency through Internet enabled teaching, learning and governance. The UGC-Infonet is overlaid on ERNET infrastructure in manner so as to provide assured quality of service and optimum utilization of bandwidth resources. The network will be run and managed by ERNET India. The project is funded by UGC with 100% capital investment and up to 90% of recurring costs. UGC and ERNET India have signed the necessary MoU (Memorandum of Understanding) for this purpose. A joint technical and tariff committee, has been setup to guide and monitor the design, implementation and operations of UGC-INFONET. INFLIBNET (Information and Library Network) an autonomous Inter-university centre of UGC, is the nodal agency for coordination and facilitation of the linkage between ERNET and the universities. Under this programme, ICT (information and communication technologies) and Internet will be used to transform learning environment from a mono-dimensional to a multidimensional (Arora 2004). This was created to help and benefit more than 310 universities and about 14 000 colleges affiliated with these universities and approximately 10 million students with the e-journals, thus, is a boon to higher education system in many ways (Cholin and Murthy 2002).

**Salient features of UGC–Infonet**

- UGC–Infonet will become a vehicle for distance learning to facilitate spread of quality education all over the country.
- UGC–Infonet will be a tool to distribute education material and journals to remotest of areas.
- UGC–Infonet will be a resource for researchers and scholars for tapping the most up-to-date information.
- UGC–Infonet will form a medium for collaboration among the teachers and students not only within the country but all over the world.
- UGC–Infonet will be an Intranet for University Automation.
- UGC–Infonet will encompass entire University system for most efficient utilization of precious network resources.
- UGC–Infonet will establish a channel for globalization of education and facilitate the universities in marketing their services and development.

**Objectives**

The UGC–Infonet Digital Library Consortium has the following objectives (Cholin and Karisiddappa 2002b).

- Subscribe to electronic resources for the members of the consortium at highly discounted rates of subscription and with the best terms and conditions.
- Promote the rational use of funds.
- Guarantee local storage of the information acquired for continuous use by present and future users.
- To impart training to the users, librarians, research scholars, and faculty members of the institutions on the electronic resources with an aim to optimize the usage of the electronic resources.
- To have more interaction amongst the member libraries.

To increase the research productivity of the institutions in terms of quality and quantity of publications.

Strategic alliance with institutions that have common interests resulting reduced information cost and improved resource sharing.

Main features of UGC–Infonet

The following are main features of the UGC–Infonet (Cholin and Karisiddappa 2002a):

- Scaleable architecture to grow from universities to affiliated colleges
- Nation-wide Terrestrial Backbone using Fibre Optic links
- Integrated Satellite WAN supporting broadband and SCPC technology
- Comprehensive network management systems for overall monitoring of the network, down to each and every device
- Linkage with other academic and research networks all over the world
- Security for data and virus protection using firewalls and intrusion detection systems
- Dedicated data centre for web hosting, e-journals and mail boxes
- Mirror sites spread all over the country for content hosting
- Broadband multimedia and video channels for distance learning

Major activities of the infonet consortium

The following are main activities of the UGC–Infonet (Vajaykumar and Sreekumar 2001).

- To arrange subscription to electronic resources identified and negotiated by the members of its national steering committee.
- To measure usage of existing e-resources and its impact of research output in terms of number of search publications.
- To identify new resources relevant to the user community in universities electronic resources.
- Interaction with member libraries to ensure optimal utilization of subscribed electronic resources.
- Ensure access to subscribed electronic resources to member universities as per their subscription.
- Organize training programmes for the member institution on use of electronic programme.
- Interact with the officials in UGC for continuation and promotion of the member universities.
- Interaction with ERNET India for providing uninterrupted Internet bandwidth in the member universities.
- Initiate additional activities complementary to the present activities.
- Encourage interactions amongst member libraries.

Subject coverage

The UGC–Infonet Digital Library Consortium covers all areas of learning. It further aims at covering all fields relevant to various universities including the following:

- Arts, humanities and social sciences
- Physical and chemical sciences
- Economics and management
- Life sciences
- Computers science, mathematics, statistics

The major subjects covered so far in the consortium are given in Table 1.

Phased access

The consortium proved to be a recipe to university libraries which have been discontinuing subscription of scholarly journals because of ‘Serial Crisis’. The term ‘Serial Crisis’ refers to exponential and continuing increase in the subscription cost of the scholarly journals. The crisis is a result of rise in cost of journals much faster than the rate of inflation, increase in number of
E-Resources @ UGC–Infonet Digital Library Consortium: a breakthrough

The UGC–infonet digital library consortium, on the basis of sheer strength of present and prospective numbers of universities has attracted the best possible price and terms of agreement from the publishers. The consortium provides current as well as archival access to more than 4500 core books (?) and peer-reviewed journals and nine bibliographic databases from 23 publishers and aggregators in different disciplines. The programme has been implemented in phased manner. In the first phase that began in 2004, access to e-resources was provided to 50 universities which had Internet connectivity under the UGC–Infonet connectivity programme of the UGC. In the second phase, 50 more universities were added to the programme in the year 2005. So far 120 universities that come under the purview of UGC, have been provided differential access to subscribed e-resources. The programme is wholly funded by the UGC and executed by the INFLIBNET centre, Ahmedabad. The benefit of subscription to e-resources would also be extended to the colleges, to begin with the CPE (College for Potential with Excellence). The consortium also plans to launch its 'Associate Membership Programme' wherein private universities and other research organizations would be welcome to join the consortium for selected e-resources.

Table 1 List of the subjects

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Science subjects</th>
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<td>Botany</td>
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<td>Computer science</td>
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<td>Earth sciences</td>
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<td>Ecology</td>
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<td>17</td>
<td>Statistics</td>
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<tr>
<td>2</td>
<td>Architecture</td>
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<td>Arts</td>
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<td>Business</td>
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<td>3</td>
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<td>Culture</td>
<td>21</td>
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<td>7</td>
<td>Economics</td>
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<td>8</td>
<td>Education</td>
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<tr>
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<td>Environmental studies</td>
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<td>History</td>
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<tr>
<td>3</td>
<td>Library science</td>
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<tr>
<td>4</td>
<td>Management</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Philosophy</td>
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<td>6</td>
<td>Political science</td>
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<td>8</td>
<td>Religion</td>
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<td>Social sciences</td>
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<tr>
<td>2</td>
<td>Language and linguistics</td>
<td>79</td>
</tr>
<tr>
<td>3</td>
<td>Literature</td>
<td>159</td>
</tr>
</tbody>
</table>
Electronic resources subscribed by the consortium

The electronic resources subscribed by the consortium can be broadly divided into the following two categories.

Full-text electronic resources

Full-text electronic resources contain complete articles along with their bibliographic details. The consortium subscribes to full-text e-resources from academic societies, commercial publishers and aggregators like:
- American Chemical Society
- American Institute of Physics
- Oxford University Press
- Cambridge University Press
- Cell Press
- Springer Link
- Jstor
- Project muse, and so on.

All full-text resources subscribed by the consortium contain electronic journals.

Bibliographic databases

Bibliographic databases contain references to articles published in journals, conference proceedings or chapters in books. Most bibliographic databases contain abstracts of the articles along with links to their full-text. The Consortium subscribes to 19 full-text e-resources and 8 bibliographic databases. The member institutions are provided differential access to these resources based on their needs and activity profile as per the recommendation of the National Steering Committee.

E-Resources @ UGC infonet digital library consortium

<table>
<thead>
<tr>
<th>Name</th>
<th>URLs</th>
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</thead>
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<tr>
<td>Full text e-resources</td>
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<tr>
<td>American Chemical Society</td>
<td><a href="http://www.pubs.acs.org/">http://www.pubs.acs.org/</a></td>
</tr>
<tr>
<td>American Institute of Physics</td>
<td><a href="http://scitation.aip.org/">http://scitation.aip.org/</a></td>
</tr>
<tr>
<td></td>
<td>myBrowsePub.jsp#AIP</td>
</tr>
<tr>
<td>American Physical Society</td>
<td><a href="http://scitation.aip.org/">http://scitation.aip.org/</a></td>
</tr>
<tr>
<td></td>
<td>publications/</td>
</tr>
<tr>
<td></td>
<td>myBrowsePub.jsp#APS</td>
</tr>
<tr>
<td>Annual Reviews</td>
<td><a href="http://arjournals.annualreviews.org/">http://arjournals.annualreviews.org/</a></td>
</tr>
<tr>
<td>Blackwell</td>
<td>http://</td>
</tr>
<tr>
<td>Publishing</td>
<td></td>
</tr>
<tr>
<td>Cambridge</td>
<td>www3.interscience.wiley.com/</td>
</tr>
<tr>
<td>University Press</td>
<td><a href="http://journals.cambridge.org/">http://journals.cambridge.org/</a></td>
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<td><a href="http://www.sciencedirect.com/">http://www.sciencedirect.com/</a></td>
</tr>
<tr>
<td>Emerald</td>
<td><a href="http://www.emeraldinsight.com">http://www.emeraldinsight.com</a></td>
</tr>
<tr>
<td>Institute of Physics</td>
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</tr>
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<td>J-STOR</td>
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</tr>
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<td>Nature</td>
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</tr>
<tr>
<td>Oxford University</td>
<td></td>
</tr>
<tr>
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<td><a href="http://projecteuclid.org/">http://projecteuclid.org/</a></td>
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<tr>
<td>Project Muse</td>
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</tr>
<tr>
<td>Royal Society of Chemistry</td>
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<td>SIAM</td>
<td><a href="http://epubs.siam.org/">http://epubs.siam.org/</a></td>
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<td>Springer Link</td>
<td><a href="http://www.springerlink.com/">http://www.springerlink.com/</a></td>
</tr>
<tr>
<td>Taylor and Francis</td>
<td><a href="http://www.informaworld.com/">http://www.informaworld.com/</a></td>
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Bibliographic databases

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<td>ISID</td>
<td><a href="http://isid.org.in/">http://isid.org.in/</a></td>
</tr>
<tr>
<td>JCCC</td>
<td><a href="http://jccc-ugcinfonet.in">http://jccc-ugcinfonet.in</a> or <a href="http://www.jccc-ugcinfonet.in">www.jccc-ugcinfonet.in</a></td>
</tr>
</tbody>
</table>

Resources accessible to the member institutions

Resources accessible to the universities under the UGC-Infonet Digital Library Consortium are mentioned in Table 2.

Table 2 Full text resources

<table>
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<tr>
<th>Electronic resources</th>
<th>URL</th>
<th>Number of journals</th>
<th>Number of universities</th>
<th>Phase</th>
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<td>I and II</td>
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<td>10</td>
<td>100</td>
<td>I and II</td>
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<td>33</td>
<td>100</td>
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<td>I, II and III</td>
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## Bibliographic databases

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</table>

### Full text e-resources

Brief description of various full text e-resources is as follows.

**American Chemical Society**

The American Chemical Society (<www.pubs.acs.org>) provides comprehensive collection of most cited peer reviewed journals covering broad spectrum of scientific disciplines - chemical sciences, agricultural sciences, biotechnology, analytical chemistry, applied chemistry, biochemistry and molecular biology, chemical biology, chemical engineering, computer sciences, inorganic and nuclear chemistry, crystallography, energy and fuels, food science, medicinal chemistry, organic chemistry, pharmacology, physical chemistry, plant sciences, polymer sciences and toxicology.

**American Institute of Physics**

The AIP (American Institute of Physics <http://www.aip.org/>) was founded in 1931 with a mission to serve the sciences of physics and astronomy to member societies, individual scientists, students and the general public. Member of UGC–infonet digital library consortium can access 18 full text journals (10 AIP and 8 from AIP’s member societies).

**American Physical Society**

The APS (American Physical Society <http://www.aps.org/>) was founded on 20 May 1899. The APS is committed to provide high-quality service and products to its members and the scientific community. All users may freely browse the table of contents for the current and previous issues, the published abstracts, and an advance listing of accepted papers scheduled for upcoming issues. The PROLA (Physical Review Online Archive) search engine (which indexes all APS journal material...
published from 1893 to present) is now freely available to all users. Access to the full text of articles and other online journals features restricted to members only. Member of UGC–Infonet Digital Library Consortium can access 10 full text journals of APS.

**Annual Reviews**

Annual Reviews [http://arjournals.annualreviews.org] provides researchers, professors, and scientific professionals with a definitive academic resource in 32 scientific disciplines. Annual Reviews saves time by synthesizing the vast amount of primary research literature and identifying the principal contributions.

**Blackwell Synergy**

Blackwell Synergy [http://www.blackwell-synergy.com] is the online journals service from Blackwell Publishing. It holds the full text articles of over 850 journals, majority of which are published by Blackwell on behalf of international scholarly and professional societies. The subjects covered are medicine, sciences, social sciences and the humanities. UGC–Infonet Digital Library Consortium members can access 797 journals of Blackwell Publishing.

**Cambridge University Press**

CUP (Cambridge University Press [http://journals.cambridge.org/]) is the oldest, largest and most prestigious printer and publisher in the world. The CUP is publishing since 1584 continuously in subject areas like humanities, social studies, archaeology and anthropology, nutrition, religion, biomedical sciences, law, physical sciences, medical sciences etc. The Press currently publishes over 220 peer-reviewed academic journals for the global market. A user can access its 194 journals through the UGC–Infonet Digital Library Consortium from the year 1997 onwards.

**Elsevier’s Science Direct**

Science Direct [http://www.sciencedirect.com/] is the web-based interface to the full-text database of Elsevier Science journals and Academic Press (Ideal) which offers researchers to access 34 journals, over 7 million full-text scientific journal articles and over 59 million abstracts.

**Emerald**

Emerald [http://www.emeraldinsight.com] publishes the world’s widest range of management and library and information services journals, as well as a strong specialist range of engineering, applied science and technology journals. Established in 1967 by a group of senior academicians formed MCB University Press, a publishing house that focused on niche management disciplines including strategy, change management and international marketing. Emerald offers a unique collection of 29 journals dedicated to the theme of librarianship and information studies and the UGC Infonet Digital Library Consortium members can access all the 29 journals of Emerald.

**Institute of Physics**

Institute of Physics [http://www.iop.org/EJ], popularly known as IOP, is world leader in electronic publishing. This electronic database comprises of journals on various topics like bioinspiration, biometrics, biomedical materials, astronomy, astrophysics, chemical physics and theoretical physics and allows access to 49 journals (including 7 in open access), over 1000 volume years of journals, over 125 000 articles and about 1.5 million papers of scientific research.

**JSTOR**

JSTOR [http://www.jstor.org/] is a not-for-profit organization offers both multidisciplinary and discipline-specific collections. JSTOR is not a current issues
database. Due to JSTOR’s archival mission, there is a gap, typically from 1 to 5 years, between the most recently published journal issue and the back issues available in JSTOR. JSTOR have a collection of 773 journals aggregated from 459 publishers. UGC–Infonet Digital Library Consortium members can access to 457 full text e-journals from volume 1, issue 1, onwards up to last two-three years depending on the original publishers rights. A user can access 1046 journals of JSTOR.

Nature
Nature <http://www.nature.com> retains its position as the most cited weekly science journal, with over 390 000 cites, an increase of almost 18 000 on last year’s count and Nature continues to publish more articles than any other multidisciplinary journal. For 2006 Nature’s impact factor is 26.681. The impact factor of a journal is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years. It is an independent measure calculated by Thomson/ISI (Institute for Scientific Information), Philadelphia, USA. UGC–Infonet Digital Library Consortium has subscription to only the Nature journal, which can be accessed at the member universities through their registered IP addresses.

Oxford University Press
OUP (Oxford University Press <http://www.oxfordjournals.org/>) publishes well over 200 journals, many in partnership with the world’s leading prestigious learned societies. OUP collections cover life sciences, mathematics and physical sciences, medicine, social sciences, humanities, and law. UGC–Infonet Digital Library Consortium members can access 202 journals from Oxford University Press.

Portland Press
Portland Press Limited <http://www.portlandpress.com/pp/default.htm> is the wholly owned publishing subsidiary of The Biochemical Society. It is a not-for-profit publisher of journals and books in the cellular and molecular life sciences. UGC–Infonet Digital Library Consortium members can access 4 journals out of 10 published by Portland Press.

Project Euclid
Project Euclid <http://projecteuclid.org/> is an advance scholarly communication in the field of theoretical and applied mathematics and statistics. Through UGC–Infonet Digital Library Consortium, Project Euclid provides access to 18 full-text journals. Regardless of access method to full-text, any user can search across all Euclid journals, view issue, table of contents pages and article abstract pages, and benefit from a system that offers full-text searching and Reference linking.

Project MUSE
Project MUSE <http://Muse.jhu.edu/journals/> is a unique collaboration between libraries and publishers providing 100% full text, affordable and user-friendly online access to over 350 high quality humanities and social sciences journals from over 60 scholarly publishers. MUSE began in 1993 as a pioneering joint project of the Johns Hopkins University Press and the Milton S Eisenhower Library at JHU. Grants from the Mellon Foundation and the National Endowment for the Humanities allowed MUSE to go live with JHU Press journals in 1995. Journals from other publishers were first incorporated in 2000, with additional university press and scholarly society publishers joining in each subsequent year. UGC–Infonet Digital Library Consortium can have access to 389 full text journals of Project MUSE.
Royal Society of Chemistry

The RSC (Royal Society of Chemistry <http://www.rsc.org>) is the largest organization in Europe for advancing the chemical sciences. RSC Publishing is a not-for-profit publisher wholly owned by the Royal Society of Chemistry. Publishes over 20 journals and other periodicals and the UGC–Infonet Digital Library Consortium subscribes to 23 RSC journals.

Society for Industrial and Applied Mathematics

A small group of professionals from academic and industry met in Philadelphia in 1951 to start an organization whose members would meet periodically to exchange ideas about the uses of mathematics in industry. Access to 13 Journals is made available to the member universities of UGC–Infonet Digital Library Consortium. SIAM (Society for Industrial and Applied Mathematics <http://epubs.siam.org/ OR http://locus.siam.org>) journals can be accessed from simple and user friendly interface. The homepage itself contains information related to titles, simple search, archival access and other important options to explore this database.

Springer Link

Springer Link <http://www.springerlink.com/> is one of the world’s leading online information services for STM (scientific, technical, and medical) books and journals. Kluwer was amalgamated with Springer in the year 2005 and all journals of Kluwer have been accessible through Springer Link Interface. The journals of Springer Link currently available through UGC–Infonet Digital Library Consortium are 1005 journals, over 550 fully peer reviewed journals and a growing roster of series, complimentary access to 800+ titles and access is made available for 200 (100 Kluwer + 100 Springer) subscribed titles.

Taylor and Francis

Taylor and Francis <http://journalsonline.tandf.co.uk> is part of the Academic Division of Informa plc. Informa plc is a leading provider of specialist information to the global academic and scientific, professional and commercial communities via publishing, events and performance improvement. It provides access to 1200 journals, 5000 encyclopaedia articles and database products from Taylor and Francis, Routledge and Psychology Press. It covers various topics like business, management and economics, chemistry, education. A user can access 1105 journals from Informa plc.

Bibliographic databases

In addition to the above mentioned e-journals, UGC–Infonet Digital Library Consortium also provides following.

SciFinder Scholar

SciFinder Scholar <http://www.cas.org/SCIFINDER/SCHOLAR/index.html> is a desktop research tool that provides campus-wide access to the world’s largest and most comprehensive databases of chemistry, biotechnology, engineering, life sciences and related sciences from CAS, with an ease of use never before seen in universities. With SciFinder Scholar as a one single source, you can explore scientific information in several unique ways.

MathSciNet

MathSciNet <http://www.ams.org/mathscinet/> is an important international database in pure and applied mathematics, published by the American Mathematical Society since 1940. It contains bibliographical data and extensive reviews on articles which are published in approximately 1800 current journals. In addition it also lists monographs, articles in conference proceedings and collections of
There is an annual increase of about 70,000 records.

**Institute for Studies in Industrial Development**

The ISID (Institute for Studies in Industrial Development <http://isid.org.in/>) is a sponsored institution of the ICSSR (Indian Council of Social Science Research), a public-funded, non-commercial research and development institution in social science. ISID was set up as an independent organization to carry on the work initiated by the CSG (Corporate Study Group), at the Indian Institute of Public Administration, during early eighties. ISID has developed databases on various aspects of the Indian economy, particularly concerning industry and the corporate sector. It has created online indexes of Indian social science journals (OLI) and press clippings on diverse social science subjects. It provides access to Indexes of 125 Indian social science journals and major newspaper articles, editorials and news features.

**JCCC@UGCINFONETCONSORTIUM**

JCCC (J-Gate Custom Content for Consortium <www.jccc-ugcinfonet.in/>) is a virtual library of journal literature created as a customized e-journals access gateway and database solution. It acts as a one point access to 7900+ journals subscribed currently under UGC INFONET Digital Library Consortium as well as university libraries designated as ILL (Inter Library Loan) Centres besides index to open access journals. INFLIBNET has identified 22 potential universities as ILL Centres in the country to fulfill ILL request from the users affiliated to universities covered under UGC–Infonet Digital Library Consortium. JCCC has facility to trigger e-mail request for article to Inter Library Loan Centres as well as to INFLIBNET Centre.

**Conclusion**

It is critical to monitor plethora of information yielding every bit of second in the fields of science and technology, yet some initiatives, organizations swear to bell the cat and provide latest to information seekers through electronic mode and UGC–Infonet Digital Library Consortium is a paradigm in this context. The consortium at government behest extends full text e-resources and bibliographic databases to member institutions, chalk out the policies from license agreement to delivery, tap the latest to extinguish information needs, liaison with publishers from access to archival and exonerate libraries from fears of budget, resources, staff, technology and so on. The journey from UGC–Infonet to UGC Digital Library Consortium has provided impetus to research and academic activities in India by setting up a connectivity system to access, store and disseminate e-resources to remotest parts of the country and infuse a new life in the functioning scenario of academic libraries. Since inception consortium has really brought miracles in terms of access to thousands of e-journals with back volumes within a second and boundaries seems meaningless when the question is of dissemination. Indeed it could be predicted that ICT and e-journals have completely transformed the scenario of information accessibility and dissemination and the Indian government at the right time has resolved to look after every thing from system to service, access to disseminate, subscription to archival and present to future needs.
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http://www.inflibnet.ac.in/UGC-Infonet/
www.inflibnet.ac.in
In the digital age, libraries need to preserve and provide access to digital resources, but traditional library procedures and tools from the brick-and-mortar type library are often not suited to this task. Physical libraries and their access mechanisms rely upon a publishing model that slowly evolved over several years. In this model, each resource (book, globe, audiotape) consists of an object or objects in a single format, and each object remains static over a period of time. Methods of building and cataloguing physical library collections depend on these constants.

A digital library exists within a very different framework. A single resource (for example, a portal), yet each of these objects is a resource in its own right. These objects may be updated frequently, and their original formats may become obsolete as technological developments lead to new types of information resources. Due to these differences, creating a digital library requires a new set of skills. This book is a unique tool kit for the new world of digital libraries. It demystifies the challenges of designing, constructing, and maintaining a digital repository. This book covers both the fundamentals of digital library theory and the details of how to implement a digital collection. No specific technical knowledge is required. Each chapter discusses the capabilities and limitations of specific technology and reflects important developments of the last few years, with a focus on tools that are applicable and appropriate to a variety of environments. Each chapter in Building Digital Libraries focuses on a step in the process, addressing both how to execute that step and how to combat challenges encountered along the way.

Chapter 1, ‘Planning a Digital Repository,’ provides the reader with an understanding as to how the integrity of information can be protected over a period of time, how to safeguard a repository against natural and man-made disasters, and how to accommodate the problem of constantly changing formats.

Chapter 2, ‘Acquiring, Processing, Classifying, and Describing Digital Content’, discusses specialized access mechanisms, processing and acquisitions, and maintenance; it also emphasizes the critical importance of good workflow.

Chapter 3, ‘Choosing a Repository Architecture’ describes several frameworks for
digital libraries and outlines the strengths and limitations of various hardware and software architecture. Choosing an appropriate hardware and software platform is critical to the success of a repository, so it is important to understand how the choice of platform influence the information to be stored and retrieved, systems collection to interact with, and how functionality can be enhanced in the future.

Chapter 4, ‘General Purpose Technologies Useful for Digital Repositories,’ introduces metadata, particularly the group of technologies associated with eXtensible Markup Language (XML).

Chapter 5, ‘Metadata Formats,’ explores in greater detail generic technologies and critical standards, such as MARC, Dublin Core, Metadata Object Description Schema (MODS), and Metadata Encoding and Transmission Standard (METS), providing examples that help the reader understand how these standards can be leveraged to provide services with relatively little effort.

As the number of information providers continue to grow, a repository cannot simply be a silo on the Internet. Chapter 6 ‘Sharing Data: Metadata Harvesting and Distribution’ looks at the role individual repositories play in a shared environment, how they can be normalized and shared for use by diverse systems, and how to make repositories searchable as part of federated collections and make their resources visible to search engines.

Chapter 7, ‘Federated Searching of Repositories,’ investigates a wide array of protocols and technologies used for searching materials located in a vendor database or scattered across web pages. From Z39–50 the original metasearch protocol for libraries – to the latest methods, readers will learn how to layer different search technologies to provide seamless access to diverse resources stored in different systems.

Chapter 8, ‘Access Management’ examines digital rights, protection of intellectual property rights, and monitoring of repository use in long-term repositories. Control mechanisms such as LDAP (Lightweight Directory Access Protocol) Shibboleth, OpenID, and Athens are also discussed.

Maintaining a repository is an ongoing endeavour, Chapter 9, ‘Planning for the future,’ is devoted to managing a living repository and anticipating future needs, as well as issue of updating as technologies and patron needs change.

Chapter 10, ‘Conclusions’ offers a clear outline of the process from start to finish and highlights the global importance of points touched upon in previous chapters.

It is not just the information itself, but the organization, structure, and presentation of that information, that give a repository its value. Digital libraries enhance the value of information resources by allowing users to locate information in contexts that suit their needs. We believe that these benefits of digitization have potential for a wide range of different types of collections and institutions. In Building Digital Libraries, we presume nothing except the desire to learn how to bring libraries in to the future.

After reading the book, one have sufficient knowledge to identify and implement the technical components necessary to construct a digital repository from scratch. Our aim is to explain and clarify both the technical and conceptual aspects of digital repositories so that the readers can thoroughly understand how to create such a valuable resource for your library.
International Children’s Digital Library
Children absorb the culture and attitudes of their community. Consequently, cycles of intolerance pass from one generation to the other. Therefore, the mission of the International Children’s Digital Library Foundation is to prepare children in an ethnically and culturally diverse environment by building the world’s largest online multicultural repository of children’s literature. The ICDL (International Children’s Digital Library) offers free access to exemplary works from more than 42 countries in 11 languages with innovative software that has been developed by knowing from young people about their needs, interests, and capacities. Initiated in China, the first branch library opened recently in Mongolia.

Source http://en.childrenslibrary.org/

California Digital Library becomes accessible
Researchers worldwide will soon have access to previously inaccessible collections of documents, photographs, and other rich archival materials related to California’s environmental history. California Digital Library (CDL), of the University of California in partnership with nine California institutions, has been awarded a competitive grant to catalogue thirty-three collections documenting a range of important issues in the state’s environmental history.

Highlights from the collections include the corporate records of Unocal, a major oil company; the papers of Frank Sherwood Rowland, the Nobel-prize winning scientist who discovered the effects of CFCs on the ozone layer; the records of prominent California leaders in the Sierra Club; and materials on the state’s tidelands controversy, with a complete environmental profile of Los Angeles Harbour.


IASLIC conference 2009
The four day Indian Association of Special Libraries and Information Centre’s (IASLIC) XXVII All India Conference on ‘Library/information users in digital era’ was
inaugurated at KIIT premises on 26 December 2009 by Hon’ble MP, Lok Sabha, Dr Prasanna Kumar Patasani in the presence of Shri Debi Prasad Mishra, Hon’ble Minister of Higher Education and Tourism and Culture, Government of Orissa. The conference focused on very relevant theme of digital era, will be beneficial to library professionals, information scientists and students. A large number academicians, library professionals and information scientists were presenting research papers at the conference.

Major focus areas of the conference were information resources, information and indigenous knowledge, information users, user studies, study of information use, information needs of users, information seeking and gathering behaviour of users, and user education programmes. Besides, Special Interest Group (SIG) meetings were held on specific thematic areas including computer application in libraries, web-based information management, library and information science education, LIS education in direct and distance mode, humanities information and impact of IT, social sciences information, informatics, informatics indicators and industrial information.

International Conference on Academic Libraries

The International Conference on Academic Libraries (ICAL–2009) was organized by Delhi University Library System during 5-8 October 2009. Dr Ellen R Tise, President, IFLA, delivered the inaugural address of the conference. Dr Sam Pitroda, presently Advisor to the Prime Minister of India on Public Information Infrastructure and Innovations, Government of India and formerly Chairman, National Knowledge Commission, India, was the Chief Guest of the event.

The scope of the conference was knowledge sharing, ICT management, digital repository management, e-teaching, e-tutorials, stronger library-faculty relationships, and user centric services. The conference provided an excellent opportunity to academic library professionals to identify the strengths and gaps in the academic library system, and to suggest new management models, mechanisms, policies, and national and international programmes for reshaping academic libraries into next generation libraries for higher education. The conference was divided into three parallel tracks with specific themes, where renowned global experts as well as local professionals shared their views. Several satellite group meetings were also organized to provide DL policy and related issues to a forward direction.
Forthcoming events

Third International Conference on Digital Libraries
23–26 February 2010, New Delhi, India
Details available at <www.teriin.org/events/icdl>

Joint Conference on Digital Libraries
21–25 June 2010, Surfers Paradise, Australia
Details available at <http://www.jcdl-icadl2010.org/>
Theme: Digital Libraries – 10 years past, 10 years forward, a 2020 Vision

International Conference on Asian Digital Libraries
21–25 June 2010, Brisbane, Australia
Details available at http://www.jcdl-icadl2010.org/>
Theme: ICADL 2010 – The role of digital libraries in a time of global change

7th International Conference on Cybernetics and Information Technologies, Systems and Applications: CITSA 2010
29 June–2 July 2010, Orlando, Florida, USA

Third International Conference on the Applications of Digital Information and Web Technologies (ICADIWT 2010)
12–14 July 2010, Istanbul, Turkey
Details available at <http://www.dirf.org/diwt2010/>

European Conference on Digital Libraries (ECDL)
6-10 September 2010, Glasgow, UK
Details available at <http://www.ecdl2010.org/>
International Conference on Digital Libraries (ICDL)
Shaping the Information Paradigm
New Delhi • 23–26 February 2010

Venue: Conference at India Habitat Centre, New Delhi. 24–26 February 2010
Tutorial at IGNOU, Convention Centre, New Delhi. 23 February 2010

The Third International Conference on Digital Libraries (ICDL) is being organized by TERI in partnership with IGNOU, during 23–26 February 2010. The theme of the Conference is Shaping the Information Paradigm. The conference will focus on creation, adoption, implementation and utilization of digital libraries, e-learning and a knowledge society. The conference aims to provide an international forum for sharing of experiences among researchers, educators, practitioners, and policy makers from a variety of disciplines such as library and information science, information and communication technology, archival and museum studies, knowledge management and many areas in the fields of social sciences and humanities.

Conference highlights
- 50 internationally renowned speakers will share their views.
- Awards will be given to the ‘best paper’ and ‘best poster’.
- Selected papers will be published in the WDL journal.
- International vendors and publishers will exhibit their products.

Keynote speakers
Dr R Chidambaram, Principal Scientific Adviser, Office of the Principal Scientific Adviser, Government of India
Dr Kasturirangan, Member Planning Commission, Government of India

Invited speakers: There are more than 50 invited speakers including Ellen R Tise, IFLA President and Stellenbosch University, South Africa; Deanna Marcum, Library of Congress, USA; Jean-Marc Comment, Archives fédérales suisses, Switzerland; Paul Nieuwenhuysen, Vrije Universiteit Brussel, Belgium; Edic Rasmussen, The University of British Columbia, Canada; Peter Schirmbacher, Humboldt-Universität zu Berlin, Germany; Michael Seadle, Humboldt-Universität zu Berlin, Germany; Andreas Rauber, Vienna Univ. of Technology, Austria; Shigeo Sugimoto, University of Tsukuba, Japan; Rebecca B Vargha, University Library, USA; Joyce, Chao-chen Chen, National Taiwan Normal University, Taiwan; Gobinda Chowdhury, University of Technology Sydney, Australia; Michael Fraser, University of Technology Sydney, Australia; Minna Karvonen, The National Digital Library, Ministry of Education, Finland; Jens Thorhauge, Danish Agency for Libraries and Media, Denmark; Anne Caputo, Special Libraries Association and Dow Jones, USA; Vidya Natampally, Microsoft Research India; Daniel Chandran, University of Technology Sydney, Australia; Alejandro Bia, Universidad Miguel Hernández, Spain; Denise Troll Covey, Carnegie Mellon University, USA; Sally Jo Cunningham, University of Waikato, New Zealand; Valrie Davis, University of Florida Libraries, USA.

For details of paper submission guidelines and submission process, visit <www.teriin.org/events/icdl>

Contact
Debal C Kar
Organizing Secretary
ICDL Secretariat
TERI, Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003, India

Phone 24644654, 24682100, 41504900
Fax 2468214, 24682145
E-mail icdl@teri.res.in
Web www.teriin.org/events/icdl
India +91 • Delhi (0)11
Guide to authors

*World Digital Libraries* is an international peer-reviewed biannual journal. The journal seeks quality research papers that present original theoretical approaches. It also seeks experimental case studies related to digital library developments, maintenance, and dissemination of digital information focusing on research and integration of knowledge at the interface of resources and development. The journal will, therefore, keep readers abreast with the current developments and contain articles, reviews, current developments, and case studies, encompassing the following areas.

- Theoretical and methodological issues that relate to the interrelationships among electronic resources management, digital preservation, multiple access, multilinguality, copyright issues, and security aspects.
- Theoretical approaches as well as experimental case studies related to digital library development and maintenance.
- Initiatives towards digitization through lucid case studies.
- Current developments across the globe.
- Dialogues between the scientific community and society at large.

Articles should examine concepts, analyses, and case studies of important issues in the field.

Book reviews should be of recent publications in the field, to be reviewed by an independent reviewer.

Commentaries should discuss critical issues in the field.

**Submissions**

Authors are requested to send a soft copy (in Microsoft Word format) of their contribution to the editor, either in a CD or as an e-mail attachment.

All submissions will be peer-reviewed using the criteria of originality, accuracy, and quality of contribution in these fields.

**Presentation of manuscripts**

Articles must be original, in English, and should not exceed 8000 words. The main text should be double-spaced with headings and sub-headings clearly indicated in the text. All tables, figures, and equations should be numbered in Arabic numerals and clearly cited in the text. All measurements should be in metric (SI) units. The manuscript should be arranged in the order given below.

- Short title (10 words is the desired maximum length), subtitle (if desired)
- Author’s name, affiliation, full postal address, and e-mail, telephone, and fax numbers (respective affiliations and addresses for co-authors should be clearly indicated)
- Abstract (not exceeding 200 words)
- Main body of the text, suitably divided under headings
- Acknowledgements, if any
- References
- Appendices (each on a separate sheet)
- Tables (each on a separate sheet)
- Figures (each on a separate sheet)

**Shorter items**

The following shorter items are also welcome and must be typed in the same way as major articles.

- Commentaries (research notes and short communications) and case studies (maximum 5000 words)
- Book reviews (maximum 1200 words)

**In-house style: references**

In the text, the surname of the author(s) followed by the year of publication of the reference should be given, for example, (Hall 1993). In case of several publications by the one author or by a group of author(s) in one one year, use notations ‘1993a’, ‘1993b’, and so on. Up to three authors can be mentioned in text references; more than three authors should be limited to the first three authors’ names followed
by ‘et al’. References must be listed alphabetically at the end of the paper (double spaced) and should conform to the following style.

For journals
Davis G R. 1990
Energy for planet earth
Scientific American 263(3): 55–62

For books
Carmichael J B and Strzepek K M. 1987
Industrial Water Use and Treatment Practices

For chapters of edited books
Sintak Y. 1992
Models and projections of energy use in the Soviet Union
In International Energy Economics, pp. 1–53 edited by T Steiner

For grey literature
Togeby M and Jacobsen U. 1996
How conflicting goals concerning environment and transport influence the policy process?
Paper presented at the Conference on Transport, Energy and Environment, 3–4 October, Helsingor, Denmark

WBCSD (World Business Council for Sustainable Development) and UNEP (United Nations Environment Programme). 1998
Industry, fresh water, and sustainable development
Details available at <www.gm-unccd.org/FIELD/Private/WBCSD/freshwater.pdf>, last accessed on 9 January 2004

Accepted manuscripts
On acceptance, contributors are requested to provide the editor the final version of the article in soft and hard copy. Please observe the following instructions.
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- Retain a back-up disc for reference and safety.

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Footnotes
Authors are requested to use as few footnotes as possible, and keep their length to the minimum. Footnotes should be indicated in the text by superior Arabic numerals, which run consecutively through the paper. They should be grouped in order of appearance at the bottom of the concerned page in numerical order and must be double-spaced.