Chapter 7

Conclusion

“Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning”.

Winston Churchill (Speech at the Lord Mayor’s Luncheon, Mansion House, London, 10 November, 1942)
Structure

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7.0 Introduction

Research is thus characterised by the fact you can not know in advance exactly where you are heading when you begin the long walks into the new territory to be explored. Hence, at the beginning of this study six years ago, this mastodon-sized dissertation with around four hundred pages of text. The overall objectives of this study have been to yield a conceptual model for University-specific IDR and to develop open source software based framework for actualization of the model. The previous three chapters of this study namely chapter 4, 5, and 6 shows the achievements in general as well as specific objectives as framed in chapter 1. Chapter 4 presents the development of model and actualization of its technical components through Unicode-compatible FLOSS (Free/Libre Open source Software) based software framework. Chapter 5 deals with the development and practical implementation of the model through application of open source software and open standards. This framework shows the customization of user interface and concerns with the integration of harvesting software along with ontology driven vocabulary control device as well as user interaction communication tools. Chapter 6 shows the features and facilities of the software framework and its application in organization of IDR resources and managing Indic script based resources in a Unicode-compliant multilingual environment. The chapter also demonstrates Bengali script based user interface to search and browse IDR resources along side real-time integration of Bengali script based DDC based vocabulary control. This study thus may contribute to Library and Information Science including Web-enabled digital repository services by providing elements of a novel conceptual framework along with an off-the-shelf digital solution. In the final note, we may conclude that this research work kept its promises to develop an IDR model suitable for the University of Burdwan keeping in mind the requirements of the scholars and academia. The model conforms to the global recommendations for the IDR domain and thereby overcomes present constraints in developing IDR system in a developing country like ours. However, we may conclude this study under the following heads:

7.1 Novelties of the Study

7.2 Limitations of the Study

7.3 Scope of Further Research
7.1 Novelties of the Study

This doctoral dissertation may contribute to Library and Information Science in general and university specific Web-enabled distributed IDR system in particular through achieving following attributes that are useful in dissemination of university specific Web-enabled IDR services:

A.1 Unicode-compliant Bengali script based user interface along with provision of storing, processing, organising, retrieval and export/import (standards based) of multi-script records.

Local language or script based user interface is not the only requirement for a multilingual information retrieval system but such a system needs to support storing, processing, retrieval and exchange (export/import) of multi-script records. BURA software framework supports all these features including standards (METS/MODS etc.) based export/import of Unicode-compliant Bengali script based resources. Any IDR system thereby can utilize this software framework to support Bengali script based information retrieval and other associated services and the mechanism may be applied to manage other Indic scripts based resources.

A.2 A single window interface to access an array of Library 2.0 tools

BURA software framework has provision to integrate with other emerging technologies and integrates a number of social networking tools that provides services based on a set of web 2.0 tools like RSS, Blog, e-mail subscription and notification etc. The system has provision of incorporating such social networking tools in order to provide better services to its members. All these facilities in the software framework are provided through Unicode-compliant Bengali script based interface.

A.3 Secured user-driven access and submission of items or records

This system, as it is based on distributed architecture, allows remote access and submission by users (registered) or community members (BURA) from any place. This software framework has provision to support remote access and submission of records over the web against proper authorization and authentication (on the basis of LDAP – Light Directory Access Protocol standard).
A.4 Integrated single window Bengali script based interface that supports simple and advanced search in multilingual environment along with listing of recent additions and deletion of records

The system has provision to develop mechanisms for processing, retrieval and display of Indic script based information objects making software framework Unicode-compliant entity and has provision to design and apply multilingual user interfaces at different levels and different points of utilization.

A.5 Standardized data entry format for IDR resources integrated with data standardization tools including vocabulary control device

The system supports and is based on structured and internationally agreed upon standards for long-term storage, file format, export and import of files etc. The software framework provides a data entry framework on the basis of Dublin Core/Qualified Dublin Core metadata standard to identify items. It manages resource description for learning objects and ETD through domain-specific metadata schemas (IEEE-LOM for learning objects and ETD-MS for ETDs). Dublin core (DC), as a common minimum elements set is useful not only for indexing, but also for listing and browsing results. Unqualified Dublin Core has been the basic metadata format, useful for interoperability. Dublin Core registry can be extended. The system uses and supports integration of data standardization tools like controlled vocabulary device, code list etc. for standardization of data entry activities to facilitate subject access by organizing IDR resources.

A.6 Provision of community interaction tools

The system has provision to integrate Web 2.0 tools i.e. Blogs and RSS. User interface provides links to access these tools through easy-to-use Bengali language based interface. The Bengali language based user interface for Blog (Wordpress) is used as FLOSS based software to support blog facilities in BURA.

A.7 Integrated backup utility

The software framework uses DSpace in the IDR Cluster (Cluster-II) to manage IDR resources and bibliographic items. DSpace uses PostgreSQL as backend RDBMS to store Dublin Core formatted records. This software framework applies pgAdmin III as an integral tool for maintenance, backup and restoration.
A.8 Display of usage statistics

Usage and download statistics are becoming increasingly important as access and dissemination are key priorities for a repository. Usage statistics are a means of expressing and understanding the impact and usage of the resources contained within the system. Download statistics and other usage tools are more accessible to implement and use in the BURA software framework.

A.9 Customized Workflows

The software framework offers several types of workflow - workflows to manage user registration and administration; workflows to manage authorization and permissions; and various administrative workflows to allow easy maintenance and software updates. However, the most significant achievement is the workflow that focuses on the submissions process. It ensures separate submission interfaces for different object types to display relevant metadata schema. The system has provision to remove unwanted submissions.

A.10 Open Standards Based

The software framework is based on global standards in relation to metadata, interoperability, network, export/import etc. These standards ensure that data remains free, migration to competing platforms is possible and interoperability with other open standards based systems is guaranteed. Standards are stable and highly recognized, which makes IDRs interoperable and the creation of a world-wide digital library nearer.

A.11 Multilingual and regional language based submission interface

The system has provision to make the software framework Unicode-compliant through the application of an array of FLOSS based multilingual tools for storing, processing and retrieving of objects available in Indic scripts. The system support multilingual search (simple and advance), retrieval, and export/import of IDR resources. In addition to these end-user level facilities this software framework supports – i) Bengali script based registration interface; ii) Bengali script based submission interface; and iii) Bengali script based administrative interface.

A.12 Federated single window embedded search interface for multiple OAI-PMH compliant IDRs

This research work recommended provision for federated search mechanism and integration of federated search option to retrieve resources.
from multiple IDR systems. This research work has fulfilled that promise by
developing a metadata harvesting framework using PKP harvester that allows users browsing and searching multiple repositories through a single-
window search interface.

A.13 Integrated Blog

BURA software framework has provision to integrate with other emerging
communication support systems like Blog, Wiki, Discussion Forum etc. It provides a platform to its members where they can make comment, post
articles, exchange their views etc. It (Blog) has been incorporated both in
administrative interface as well as in user interface of the BURA software
framework. All these facilities in the BURA software framework are provided
through Unicode-compliant Bengali script based interface.

A.14 Auto alerting services

BURA is fully compliant with RSS feed as RSS 2.0 standard has been
incorporated in the BURA software framework. This provides a way for users
to keep up with the latest information posted on different blogging sites and
other Web services that are compatible to Feed. It alerts users about new
addition and displays latest submissions to the repository.

A.15 Subject categorization through DDC (22nd edition up to the 3rd summary)

Provision for incorporation of standard subject category system into any IDR
system is vital to satisfy subject approach. This research study has
incorporated DDC (22nd edition up to the 3rd summary) following the SKOS
standard and XML based format into BURA software framework to enhance
subject categories based organization of resources. English language subject
divisions and sub-divisions are based on DDC 22nd edition and are available
at the time of indexing as well as searching. Developing Indic script based
subject access system and seamless integration with IDR framework is
necessary to meet the subject requirements of the local scholars. This research
work has modified DDC (22nd edition up to the 3rd summary) in Bengali
script and divisions and sub-divisions of subject categories in Bengali are
available during submission and searching.

A.16 Porting of software framework as ISO image

All the modifications, additions and customizations made by this research
work is finally available as an off-the-shelf information product which can
readily be utilized by libraries of different universities and other knowledge
organizations to establish institute-specific IDR systems.
7.2 Limitations of the Study

Every research aims to solve a set of interrelated, interlinked and integrated research problems and invariably lands up with a new set of problems, which warrants attention of further research. This study is no exception and there is still a lot of ground to cover in the future. However, studies to date have tended to focus either on technology - how to build up an IDR or on the self-belief – in theory how useful people think their IDR is. Only a few studies are engaged in creating IR policies and procedures for contents management and concerned with technical as well as organizational and legal aspects that should be considered when setting up and running IDR system. The IDR has been developed all around the world during the last decade. But people argue about the success of IDR. Some think IDR has achieved more than they need and some believe it has not met the desired service level. This review looked at what studies have been done, what can be learned from the studies and what the gaps are, and more importantly attempted to develop a software framework keeping in view the required parameters.

This study has been dealt with a wide array of problems during development of the software framework. All these problems may broadly be classified into two groups – problems related with the organization and management of resources along with development of university specific IDR policy and problems originated from Bengali script based computing. Some of the problems are solved satisfactorily during investigation and some problems remained unsolved as these are beyond the control of this study. These unsolved problems may be reported here as limitations of the study. This study attempts to find out possible reasons(s) and tentative solution(s) for these limitations.

Limitation 1

Problem: Exact rendering and display of some Bengali letter is not possible in BURA software framework.

Possible reason: A few characters of Bengali script are not yet compatible with UTF-8 based rendering as far as existing glyph management systems are concerned.

Tentative solution: The next generation of glyph management systems, based on the latest Unicode standard may solve it as this problem is reported by many researchers in Unicode forum.
**Limitation 2**

**Problem:** Provision of accessing and incorporating learning objects, theses in BURA is quite straightforward and lacks structured approach.

**Possible reason:** The present rich set of metadata schema for learning objects like IEEE-LOM (with SCORM) is too complex to incorporate in DSpace in its present form.

**Tentative solution:** The next release of DSpace may include a better metadata management framework to accommodate wide variety of metadata schemas including IEEE-LOM and SCORM.

**Limitation 3**

**Problem:** Non-availability of standard category list and vocabulary control devices in Bengali language. These standards are available only in English language. This is a barrier to standardization of subject access terms.

**Possible reason:** Production of classification system in Bengali or other Indic scripts have limited scopes for commercial viability. Moreover keeping pace with the latest editions demands frequent updating and releases of such products in regional languages.

**Tentative solution:** Library associations and LIS schools in India may take up this very important task voluntarily; for example this research project applied one such Bengali translation of DDC published by Bengal Library Association but modified extensively to match it with DDC 22nd edition as the translation is based on DDC 20th edition.

**Limitation 4**

**Problem:** No display standard for IDR resources and therefore, the search interface of BURA software framework display resources/records in a simple non-standard format.

**Possible reason:** There is no ISBD like display format standard (like bibliographic data in library catalogue) available for displaying metadata of retrieved knowledge objects.
Tentative solution: BURA software framework displays metadata for retrieved records in simple tabular format due to lack of display standard as mentioned in earlier point.

**Limitation 5**

Problem: No rules pertaining to the encoding and recording of IDR resources exist and therefore, this study finds problems in organising and managing IDR resources.

Possible reason: Similarly there is no ISBD like encoding/rendering standard (like encoding of bibliographic data in library catalogue) available for organization of metadata elements in domain-specific metadata schemas.

Tentative solution: BURA software framework follows encoding and rendering rules as prescribed in Qualified Dublin Core metadata schema for all domain-specific metadata schemas applied in the software framework for organizing special materials like learning objects, ETDs etc.

**Limitation 6**

Problem: No internationally agreed standards for long-term storage, export and import of files and metadata in approved formats to new platforms.

Possible reason: This problem is universal in nature for almost all institutional repositories all over the world. It is originated because of the high rate of obsolescence in storage formats and related technologies.

Tentative solution: BURA software framework follows TIFF as mother format and pdf as retrieval document format for most of the resources as these are open standards.

**Limitation 7**

Problem: No standard mechanism for access control and rights management of the objects deposited to IDR.

Possible reason: Open access philosophy advocates free access to all resources but sometimes local authority needs to exercise some control over some types of documents e.g. access to full-text resources.
after six months from the date of award. But till date there is no agreed upon solution for fixing of duration of embargo for different object types.

Tentative solution: Under such circumstances, to keep a balance between open access and needs for local control, BURA software framework sets a default six-month embargo for full-text theses access.

**Limitation 8**

**Problem:** No standardized file naming (name resolution) or persistent identification system (inside the framework) is properly followed for identification of objects.

**Possible reason:** Till date there is no international standard that prescribes naming convention for locally uploaded files; the name of the file is determined by local submitter and there is no control in file naming by the system administrator.

Tentative solution: Under such circumstances, the software framework designed and applied a local naming convention in the following form – two letters for department – two letters for collection type – three letters from surname of the first author/person responsible.

### 7.3 Scope of Further Research

Research is just like a relay race. It follows a continuous improvement cycle. All systems grow and change depending on the needs of their users. Some of these changes are incremental, such as small modifications to enhance the way the system interacts, while some developments can be more revolutionary, reacting to changes in the environment or organization. IDR is an emerging area of research with enormous possibilities to restructuring its services to the knowledge society. This is the responsibility of this study to earmark the possible areas of further research in the domain of IDR. This chapter considers the potential areas for developments, both large and small, in the domain of IDR. It is, of course, difficult to predict the remote future, so this chapter focuses on the near future. In fact, the scope of further research lies in the limitations of the present study, as mentioned in earlier paragraphs. Unfortunately most of these limitations warrant attention of the standardization bodies, institutions, and library associations working at national and international levels. One limitation of this study is associated with the provision of plain and simple access to learning objects in BURA software framework. Therefore, this area
i.e. integration of open learning standards like SCORM in IDR as an integral part requires urgent attention of further research. In this context provision of organizing resources and its integration with this software framework i.e. BURA may be taken as a research area to increase the scope and utility of BURA. Many researchers, professional organizations, which deal with IDR, are of the opinion that learning support system should be an integral part of such system. In other words, provision of a structured learning system and its integration with the BURA software framework may be taken as a research area to increase the scope and utility of BURA. Most of the IDR system is built on open source software e.g. DSpace, EPrints, Fedora etc. and are freely available in open source domain. These FLOSS based IDR system are fully based on and compatible with LAMP architecture in general and therefore can easily be integrated with the learning contents management software available in public domain.

Finally this study is meant to promote open access to knowledge through establishment of IDR in Indian universities. The directive authorities are also supporting University-specific IDRs. In this context this research work attempts to develop a standard IDR system by using traditional knowledge organization tools, open source software and open standards. It also achieved success in managing storing, processing and retrieving Bengali script based resources including integration of Bengali script based subject access system. The mechanism developed and applied by this research work may be extended to handle other Indian regional languages to satisfy the information needs of a wider section of the society. There are many exciting possibilities for repositories and the resources they hold. And this study is considered and can be used constructively for development efforts. In this context this research study may be viewed as an action in hope rather than hoping for action.