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Towards unified retrieval system for GLAM institutions in India: Designing a prototype for biblio-cultural information space

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Generally, the galleries, libraries, archives, and museums (GLAM) of developing countries use two different information representation and retrieval systems to manage bibliographic datasets and cultural-heritage objects. These software-centric systems create different retrieval silos, and end users need to hop from one retrieval interface to another with diverse search techniques for an all-encompassing search. A centrally indexed biblio-cultural information system in place of multiple retrieval silos, as a single-window search mechanism for bibliographic and cultural resources, may help users of GLAM find the required information with ease. This study is an attempt to design a technical framework towards this goal of a unified system of retrieval by applying different domain-specific open-source applications related to a library software ecosystem, and open standards. The methodology, based on open-source software and open standards, may well be adopted by libraries with complex information management needs.

Keywords: Library discovery; Single-window search interface; Cultural heritage resources; Digital archive; ArchivesSpace; Koha, OAI/PMH; VuFind

Introduction

The concept of unification of GLAM (Galleries, Archives, Libraries, and Museums) institutions has emerged in recent times, and institutions have adopted more sustainable, culturally sensitive, human rights-based preservation and conservation strategies to achieve this goal. Cultural heritage objects are the legacy of various types of physical, immaterial, or natural resources of a society that have been inherited from predecessors. The Helsinki Conference (1996)[1] defined cultural heritage as, "In a wide sense, the concept of cultural heritage covers all the manifestations and messages of intellectual activity in our environment. These messages are passed down from generation to generation through education, intellectual exploration, and insights". These may be tangible objects (in physical aspects like buildings, monuments, landscapes, manuscripts, books, works of art, artefacts and ecofacts etc.) or intangible (in non-physical aspects like folk songs, folk dances, rituals, extinct languages, traditional knowledge etc.), and natural heritage (in natural aspects like flora, fauna, biodiversity etc.).

As of July 2021, there are 1154 World Heritage Sites, including 897 cultural, 218 natural, and 39 mixed properties across 167 countries[2]. India has more than 3500 national monuments along with 25 cultural heritage sites, and the Archaeological Survey of India (ASI) under the Ministry of Culture (GoI) has declared its primary objective "the protection of the cultural heritage of the nation." Cultural heritage is not a legacy in any part already complete, rather a continuously evolving process like an organism, and may wane or change as modern social and cultural conditions unfold in the future that only to be resurrected by the subsequent generations[3].

In 1972, the World Cultural and Natural Heritage Convention (WCNHC) declared that the deterioration of cultural heritage resources constitutes a 'harmful impoverishment' of the nation and emphasises not only a national responsibility for heritage preservation but also an extended community responsibility. According to the World Heritage Convention (WHC)[4] cultural heritage is "to reveal and sustain the great diversity of the interactions between humans and their environment, to protect living traditional cultures and preserve the traces of those which have disappeared."

Unfortunately, tourists damage resources, and some 'cultural genocide' occurs, such as when militants dynamited one of the great sacred and religious sites, the 1500-year-old 'Buddhas of Bamiyan' statues, in March 2001. The Grand Library

of Baghdad and its collections were destroyed in 1258 by the Mongols, and later in 2003, some hooligans burned over 70,000 books and manuscripts from the University of Baghdad's library[5]. Cultural heritage sites are being destroyed by 'illegal encroachers'—they are exploiting them economically and resulting in displacement for new condominium complexes, shopping malls, etc[6]. The Varanasi Development Authority[7] mentioned that "Classical civilizations, especially the Indian, have attributed supreme importance to the preservation of tradition. Its central idea was that social institutions, scientific knowledge and technological applications need to use a 'heritage' as a 'resource'."

Digital preservation (digital reproduction of existing objects or available digital assets) can support technological solutions that are able to make the objects appear with unprecedented precision. Librarians and archivists have greater responsibilities regarding information dissemination by preventing contact, etc in this COVID-19 pandemic world, and libraries, archives, and museums require multitasking professionals[8,9]. "Libraries have changed from a silent space to a community hub that hosts all kinds of activities"[10]. Libraries and archives should incorporate opportunities and challenging technologies to create a new digital information ecosystem for learning new methods and sharing relevant and valuable information amongst their patrons in the pandemic situation[11].

Archival records management may be benefited by implementing blockchain or distributed ledger technology, and archivists should be familiar with this technology[12]. A large volume of India's cultural wealth that was created in the last two centuries is stored in different forms by various governmental or non-governmental institutions and private collections. These are the invaluable national heritage resources that need to be preserved for all time and made accessible to users. Such collections have suffered from inadequate funding, looting and dispersal, and have been destroyed due to wars, illegal trading, social upheaval, etc.

The National Virtual Library of India (NVLI) (https://www.it.iitb.ac.in/nvli-ls/About_T10kT.html) has been set up by the Ministry of Culture (GoI) to host information about Indian cultural heritage on an easily accessible digital platform. With the help of the Centre for Development of Advanced Computing (C-DAC) and the Art Institute of Chicago, the Ministry of Culture (GoI) has also developed a national portal and digital repository, 'Museum of India' (http://museumsofindia.gov.in), for both the effective utilisation of technology in museum or archive management and making available to the public these scarce collections over the Internet through a virtual museum builder, namely 'Jatan'.

Another comprehensive repository, the 'Gandhi Heritage Portal' (https://www.gandhiheritageportal.org), preserves and disseminates thoughts (original writings, fundamental works, commentarial, and memoir literature) of Mahatma Gandhi, designed and maintained by the Sabarmati Ashram Preservation and Memorial Trust in 2003. Sharma[13] further reported that some key initiatives like the National Mission for Manuscripts (https://www.namami.gov.in/) and the National Archives of India (http://nationalarchives.nic.in/) have been taken by the Govt. of India for the purpose of preserving and disseminating collections of rare manuscripts, confidential Netaji papers, etc, through a web portal.

The Indian Culture (https://indianculture.gov.in/) online portal has been developed by IIT-Bombay as a part of the NVLI project. This single unified portal holds diversified resources about archives and photo archives, intangible cultural heritage, food and culture, museum collections, ancient manuscripts in India, images and paintings, etc., where qualified DCMES has been used as a metadata encoding standard. There are multiple examples in this pipeline, but unfortunately, these organisations follow neither a granular domain-specific metadata standard nor an OAI-PMH compatible open source digital asset management software (DAMS)—the prerequisites for integration with other bibliographic software systems. A few major Indian and global initiatives, along with UNESCO and IFLA guidelines in this direction, are given at Appendix I.

Statement of the research problem

An integrated GLAM retrieval system is required in India. In the absence of systematic and modern preservation technologies, lack of awareness and proper upkeep, as well as the fragility of the medium they are stored in, many heritage materials are in imminent danger of being lost forever. Despite India's rich cultural heritage, little effort has been made to integrate resources from GLAM components, the country's memory institutions, to provide a unified retrieval interface. Such an integrated interface, where

users may find their required resources about cultural heritage along with bibliographic resources, can increase the efficiency of retrieval for the GLAM institutions in India.

Various apex bodies of cultural heritage in India, like the Indian Museum, the National Museum, Indira Gandhi National Centre for Arts[14], Victoria Memorial Hall, Salar Jung Museum, Asiatic Society, etc, have not taken any initiative for such integration of cultural heritage resources and bibliographic resources. Most often, in libraries of any type or size, where both groups of resources are available, the retrieval systems include different silos for different types of resources. The area of GLAM unification has been neglected so far, possibly due to lack of software support, complexity of domain specific metadata standards for cultural objects, and the absence of mechanisms to integrate resources into a single-window search system.

Libraries in India are using different open-source software for different activities, e.g., Koha as an integrated library management system (ILMS), DSpace as an institutional digital repository (IDR), and Greenstone as an e-book archive to provide a user-driven information service. These software programs also use different content designation standards for organising resources, such as the family of MARC 21 for organising bibliographic resources, Dublin Core (DC) as a generic metadata schema for managing digital resources, and other domain-specific metadata schemas for an array of resources (VRACore for images, FGDC for geographical objects, and so on)[15].

On the other hand, museums and archives are using various open-source digital archiving software, e.g., Omeka, ArchivesSpace, CollectionSpace etc, which use domain specific open standards for encoding cultural resources, e.g., VRA Core, EAD, etc. Furthermore, these diverse software employ various retrieval techniques through different various open-source back-end text retrieval engines (e.g., Koha is based on Zebra and has recently adopted a fast and scalable search engine called 'Elasticsearch' as well; Greenstone supports both MGPP and Lucene; Lucene is also used by Omeka via Zend Engine 3 (phpng); Apache-Solr support for DSpace and ArchivesSpace)[15,16]. Hence, these software systems are creating different retrieval silos for end users.

The cornerstone of this research is to design and develop a harmonized, sophisticated, unified, and 'one stop search' system for both types of resources, such as bibliographic as well as cultural heritage objects that form an integral part of some libraries. Generally, those are available under the different retrieval platforms (as mentioned above) by using different open-source software and open standards.

Objectives of the study

- To develop a framework that supports a seamless and integrated search facility for various types of digitised materials, such as, bibliographic resources, cultural heritage objects, and museum objects generally encoded through different types of metadata standards;
- To integrate cultural heritage objects into the same central index alongside bibliographic resources to provide real-time information retrieval in the discovery layer; and
- To develop mechanisms for indexing metadata as well as full text resources, including image objects belonging to bibliographic resources and cultural heritage objects.

Research questions

RQ1 Which metadata schema provides more granular description for cultural objects? What open standards should be followed to import or to harvest bibliographic metadata (applied in libraries), and metadata of cultural heritage objects into a single central indexing system? How to develop a central index that can accommodate both bibliographic resources and cultural heritage objects in a library?

RQ2 How to identify an open-source discovery layer that can handle different metadata standards, support harvesting, and allow configuring of search systems as per the objectives as framed? Is it possible to fetch and integrate the real-time item-level status for bibliographic resources, and cultural heritage objects within a discovery layer?

RQ3 How to design a single search interface for combined information retrieval to allow simple search, advanced search, faceted navigation, and browsing by different keys? Is it possible to categorise the retrieved results in a 'Bentobox' style retrieval to identify the origin layer (bibliographic or cultural) of the retrieved resource?

Review of literature

Cultural heritage resources

Civilization is divided into various ethnic, religious, caste, linguistic, and regional groups.

Despite its vast and diverse composition, cultural diversity has inspired many social scientists to write about this complex field. Archaeology has helped to rediscover the lost identities of a nation[17,18]. Many researchers in the domain think that a cultural heritage consists of beliefs, religions, attitudes, resources, meanings, values, and knowledge acquired through people or families[19,20], whereas some researchers have objections to the logical integration of the constituent terms 'cultural' and 'heritage'[21].

The International Council on Monuments and Sites (ICOMOS)[22] has defined heritage as a phenomenon that people choose to constitute continuously. Many researchers have supported this view, but at the same time, they have mentioned that the scope of cultural heritage resources depends on the community. For example, hardship to water harvesting, and maintaining the integrity of water sources should be considered as tangible cultural heritage in the Thar desert in Rajasthan, while several rituals (panghat, pakhal etc.) of the natives are intangible cultural heritage[23,24].

A few researchers are of the opinion that new concepts in defining the scope of cultural heritage objects like 'ecomuseum' (local distinctiveness with unique cultural character and values)[25], music as heritage[26], digital replicas in 3D[27], indigenous culture[28], and role of community-based cultural theatre (for example, Budhan Theater, an adivasi theater troupe)[29]. However, a lot of domain researchers have mentioned that cultural heritage is a valuable inheritance that requires uncompromising conservation to foster cultural resilience of the past and reconciliation with future generations[30-33].

A few researchers remind us of the current disparities in the distribution of intangible cultural heritage in the online environment[34,35], whereas another group of researchers proposed digital solutions for expanding coverage and improving dissemination via digital knowledge frameworks such as ontology for Indian folk dance, namely 'Rabha' for preserving indigenous cultural knowledge base[36].

Defining the metadata infrastructure

Cross-walking among metadata standards has been extensively discussed in the literature. For example, MARC records to EAD via XSLT[37], Voyager catalogue[38], and EAD records to MARC dataset[39]. EAD has grown in popularity in the archival domain due to its low local variation[40], ability to support CDWA, DC, and other data structures in addition to the DACS[41], and low cost-effective finding aid[42,43]. Despite some distinct characteristics, the CIDOC Conceptual Reference Model (CIDOC-CRM) is insufficient to accurately incorporate analogue, hybrid, and born-digital archival materials[44,45], and requires a contextual descriptive metadata framework to accommodate the essential components of cultural objects[46]. Even the Premodern Manuscripts Application Profile (PMAP) schema for mediaeval manuscripts requires certain refinements for more granular discoverability[47].

The GLAM sector may use EAD in conjunction with ISAD(G) (for archival objects) and the MARC-21 family (for bibliographic objects) to overcome a serious issue of semantic interoperability[48,49]. Large digital ecosystems (like Europeana) greatly benefit from some authority data systems like the Social Networks and Archival Context (SNAC) project, the Encoded Archival Context—Corporate Bodies, Persons, and Families (EAC-CPF) standard, and others[50,51]. Many memory institutions manage isolated data silos due to a lack of standardised tools and domain-specific metadata standards, whereas GLAM collections should adhere to the FAIR (Findable, Accessible, Interoperable, and Reusable) principle of de-siloed and cross-platform interoperability via cutting-edge technologies such as ontology-driven content management systems[52,53].

Digital repository – changing technologies

Even though EAD is a widely used open standard for the hierarchical and nested description of archival records, and that a few tools (such as CollectionSpace) have the technical feasibility with two exceptional features – collection level control and item level control, some video archival management software have some difficulties with technical and licensing issues, metadata encoding for audio-visual objects, and so on[54-57]. Many researchers envisaged a web-based, scalable, and interoperable tool, namely ArchivesSpace that has some common challenges but more soluble functional opportunities to expose EAD finding aid as well as MARCXML of resource records for dynamically managing heterogeneous archival records[58-63].

Some other researchers unearthed various major features of different open source as well as proprietary digital asset management tools and critically examined the robustness of Omeka contextually[64,65], also discussed the challenges and preservation guidelines of FAIR data for 3D digital

objects through CollectiveAccess software at country level[66]. A few recent research works have reported that the use of the digital asset management tool ArchivesSpace[67], as well as an open-source integrated library management tool Koha and an open-source language analysis tool Voyant[68], would benefit the preservation of extinct languages.

Software tools for the framework

This entire research may be subdivided into three distinct stages – (a) harvesting bibliographic resources; (b) harvesting cultural heritage resources; and (c) importing harvested resources (bibliographic and cultural) into a unified, single resource discovery layer. Several kinds of backend software are prerequisites for completion of this study – to manage cataloguing records, handle full text objects of bibliographic resources, and control cultural heritage resources with their domain-specific encoding standards. Moreover, a well-suited resource discovery software is needed to control the retrieval of both types of resources seamlessly through an integrated and intuitive search interface.

Bibliographic resources and discovery layer software

This field has already been investigated by several researchers in their early experiments. Mukhopadhyay and others have identified software and analysed its functionalities in a special issue of this journal [Special issue: Library Discovery Systems – Vol 63, No 4 (2016)]. The lead programmer of the VuFind project said that flexibility and extensibility have made the library discovery system namely VuFind popular worldwide by demonstrating its full architecture[69].

In addition to the query forwarding mechanism to external data sources, Vufind can index, harvest, and retrieve MARC-21 datasets from Koha[70]. An open source software namely DSpace is considered to design a prototype IDR for its enhanced features like multilinguality through Unicode compliance, controlled vocabulary (Dewey Decimal Classification) support, and additional features like support almost all file formats, provision of qualified DCMES, support for standards like OAI-PMH or OAI-ORE for better interoperability, usage statistics generation, ability to incorporate domain specific metadata (LIDO) for cultural heritage objects[71-73].

A few researchers carefully scrutinised VuFind with other available similar software based on four crucial parameters – indexing and organisation of information, advanced search facilities, relevance ranking, and extended services (query forwarding mechanism). They justified that it may be the most comprehensive open-source solution along with some outstanding features like – 'Bentobox' search interface, geospatial search through bounding-box data, FRBRized information retrieval, controlled vocabulary based browsing interface, recommender system, exclusively available in Bengali script based retrieval interface to overcome the 'language barrier'[74-76]. The software also provides a single-window, real-time search system for up-to-date information of cataloguing records from different participating libraries by using Koha through a multi-backend driver namely Integrated Library System–Discovery Interface (ILS–DI)[77].

This research study has selected the VuFind library discovery system as the candidate software for developing the integrated and intuitive one-stop search interface for bibliographic and cultural heritage resources.

Digital Asset Management (DAM) layer – software selection in archival context

Five globally accepted open source tools (available under open licenses) have been taken into account for carrying out a comparative study to select a suitable one for the DAM layer. The framework of comparison includes many relevant parameters like metadata standards, retrieval features, backend software requirements, administrative facilities, export/import features, harvesting protocol support, file format support, etc. In the case of cultural heritage resources, the availability of image display management utilities in retrieval interfaces (like the International Image Interoperability Framework – IIIF, and Mirador – a fully featured IIIF viewer) is an essential component, and thereby, it has been included in the comparative study as a feature of the DAM layers under consideration.

Omeka (v2.8) was developed by the Roy Rosenzweig Center for History and New Media, the Corporation for Digital Scholarship, and George Mason University[65]. CollectionSpace (v.6.1) is another powerful open-source DAM tool supported by the Andrew W. Mellon Foundation[56,64]. ArchivesSpace (v.3.0.1) was developed in 2009 by merging two popular tools—Archon and Archivists Toolkit. The project is a collaboration of the University of Illinois Urbana-Champaign Libraries, New York University Libraries, and the University of

California San Diego Libraries, and is funded by the Andrew W. Mellon Foundation, where LYRASIS is the product manager[61].

CollectiveAccess was developed by Whirl-i-Gig with other European institutions and consists of two separate modules—one is the cataloguing or data management module 'Providence' (v.1.7.14), and the other is the public user interface 'Pawtucket2' (v.1.7.13). Islandora (v.7.x-1.13) is built upon the digital library software Fedora, with a front-end interface of the content management system Drupal, and a back-end text retrieval engine Solr[78,79]. It was developed by the Robertson Library of the University of Prince Edward (Island) and supports PREservation Metadata: Implementation Strategies (PREMIS) as domain-specific metadata[80]. The comparison (Table 1) is prepared based on some potential attributes supported by the tools, which are prerequisites for the technical functionalities and architectural design of this study.

This analysis shows that ArchivesSpace (used by more than 400 institutions all over the world) secured the maximum marks as it provides more fine-tuned features than other similar tools, with Omeka being a close second. The unique features of ArchivesSpace are – networked archival information system with a relational database and linked data management system (to create contextual relationships amongst items and agents), preconfigured with globally accepted domain-specific metadata standard in an archival context, namely Describing Archives: A Content Standard (DACS)[81], which can share resource descriptions by using EAD (finding aid) and MARC 21 (content standard). DACS (version 2021.0.0.2) is closely related to RDA and International Standard Archival Description—General (ISAD [G]) (https://saa-ts-dacs.github.io/).

RDA adopted some important archival rules of DACS, particularly for the creation of family names and 'devised titles' in alignment with ISAD(G). Encoded Archival Context for Corporate Bodies, Persons, and Families (EAC-CPF) is associated with EAD too, which is an XML schema that adheres to the International Standard Archival Authority Record for Corporate Bodies, Persons, and Families (ISAAR[CPF]) for facilitating content-rich authority records of agents to interoperate efficiently in the global environment[82].

ArchivesSpace can manage the hierarchical and associative relationships amongst the agents, and the latest version (3.0.1) may accommodate the agent relationship graphs of SNAC. Moreover, the architecture and programing environment of ArchivesSpace is immensely user-friendly as it does not host any digital media[83], as objects are stored on either local or global servers, fully OAI-PMH compliant for cross-system harvesting, partially IIIF compatible by plug-in API (though Mirador viewer is still underdeveloped)[84], and it has a very active user community.

All these parameters have been scrutinised carefully to measure the applicability and usability, and ArchivesSpace has finally been selected as the DAM layer for the integrated retrieval system. Finally, it may be concluded that Koha (as ILS layer), DSpace (as IDR layer), and ArchivesSpace (as DAM layer) have been selected as component parts of the entire software solution framework, and VuFind has been considered as a discovery layer based on download statistics, user base, continuous revisions, reports of researchers, and a super active user forum.

ArchivesSpace – organization and harvesting of cultural resources

The framework of ArchivesSpace (released under the Educational Community License, v.2.0.) is based on the Linux – Apache – MySQL – Ruby architecture. The Linux distribution used in this case is Ubuntu 20.04 LTS as the operating system; Apache v.2.4.39 as the web server; MySQL v.5.7.33 as the backend RDBMS; Ruby v.2.7 as an open-source programing environment; and Apache-Solr v.8.9 as an open-source robust search and indexing application that supports an array of search operators, auto suggestion feature, faceted navigation, and so on. The back-end application of ArchivesSpace is written in JRuby using the Sinatra framework, which links to MySQL through a Java connector (or Apache Derby by default), and communicates with the decoupled front-end application over a Representational State Transfer (REST) API. Both the staff interface and the user interface are written in JRuby using Ruby on Rails, and the Twitter Bootstrap framework has been used for consistently providing user interface elements[85].

Figure 1 shows a hierarchical as well as nested arrangement (#tree::resource_7) of resources in ArchivesSpace. 'Natural History' is the top level collection, 'Cluster I – Primitive', 'Cluster II – Ancient', 'Cluster III – Medieval', and 'Cluster IV – Neoteric' are four series under this top level collection. Also, each of the first two series has five files. These are called items,

Table 1 — Comparison of digital asset management tools

Evaluation Criteria	Omeka	Collection Space	Archives Space	Collective Access	Islandora
1. Interface					
1.1. Administrative	1.0	1.0	1.0	1.0	1.0
1.2. Staff	1.0	1.0	1.0	1.0	1.0
1.3. User	1.0	1.0	1.0	1.0	1.0
2. Metadata support					
2.1. Generic	1.0	1.0	1.0	1.0	1.0
2.2. Domain specific	0.5	0.5	1.0	1.0	0.5
3. Finding Aid					
3.1. EAD	0	0	1.0	1.0	0
4. Authority record support					
4.1. Generic context	1.0	1.0	1.0	1.0	1.0
4.2. Archival context	0	0	1.0	0	0.5
5. Protocol / standard support					
5.1. OAI-PMH	1.0	0.5	1.0	0.5	1.0
6. Format support					
6.1. Text file	1.0	1.0	1.0	1.0	1.0
6.2. AV file	1.0	1.0	1.0	1.0	1.0
6.3. Image file	1.0	1.0	1.0	1.0	1.0
7. Retrieval features					
7.1. Browse	1.0	1.0	1.0	1.0	1.0
7.2. Basic search	1.0	1.0	1.0	1.0	1.0
7.3. Advanced search	1.0	1.0	1.0	1.0	1.0
7.4. Visualized searching	0.5	0	0	0	0
8. Environment required					
8.1. Backend software (as open-source)	1.0	0.5	1.0	1.0	0.5
8.2. Storage optimization	0.5	0.5	1.0	0.5	0.5
9. Scalability and Interoperability Support	1.0	0.5	1.0	0.5	0.5
10. Enhanced features					
10.1. Geographic map display	1.0	0.5	1.0	1.0	1.0
10.2. Visualizing graphs/relationships display	1.0	0	0	0.5	0
10.3. Plugins / add-ons enabled	1.0	0	1.0	1.0	0
10.4. Linking mechanism to agents	0.5	0.5	1.0	1.0	1.0
10.5. RDF XML support	1.0	1.0	1.0	1.0	1.0
10.6. Linking with LOD	1.0	0.5	1.0	0.5	1.0
10.8. Exporting citations	1.0	0	1.0	0	0
10.9. PDF generation of collection record	0	0	1.0	1.0	1.0
11. Display of replica in retrieval interface					
11.1 IIIF toolkit support	1.0	0	0.5	1.0	1.0
11.2 Mirador viewer	1.0	0	0	1.0	0.5
Total	24	16	25.5	23.5	21

1.0 = fully support; 0.5 = partially support; 0 = not available

which are the actual digital archival objects. On the right-hand side, boxes, cartons, and cases indicate the locus of physical objects here.

Figure 2 depicts one archival object record (archival_objects/29) under the repository, namely 'Gallery at KUDLIS', and 'Indian Sculpture' as a sub-collection. Users can follow the related information such as extent and agents (with specific role operators) of this specific item, as well as navigate the entire collection, using the right-hand navigation panel.

ArchivesSpace is fully compatible with the Library of Congress Name Authority File (LCNAF), the Library of Congress Subject Heading (LCSH), and partially compliant with the SNAC relationship graph

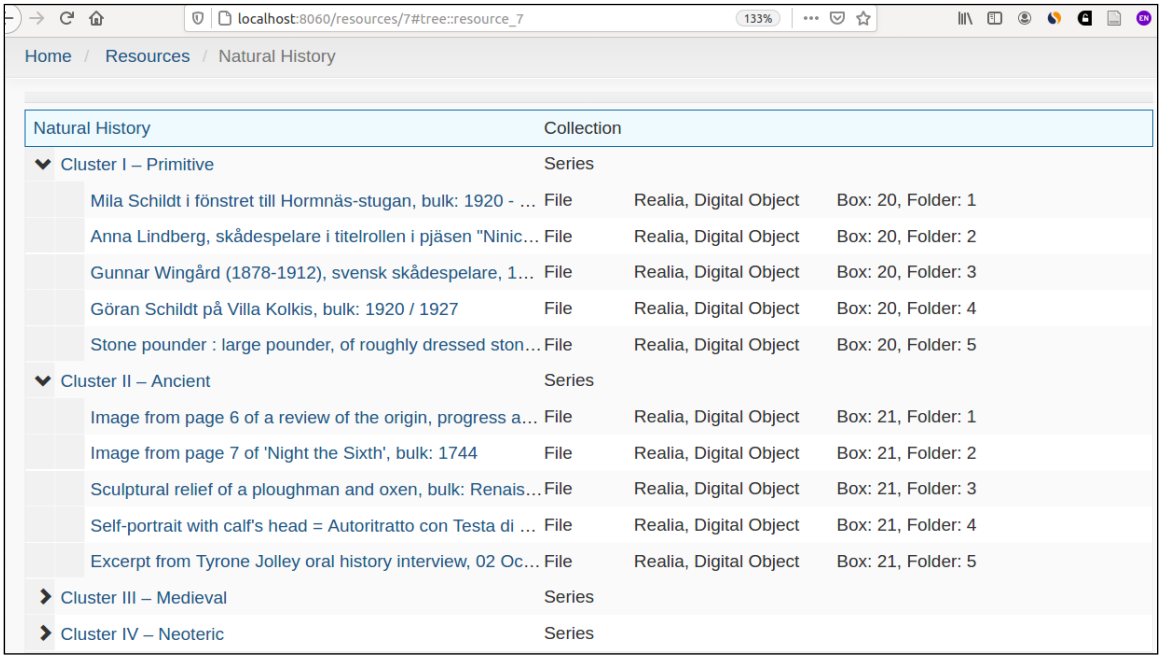

Fig. 1 — Hierarchical representation of a resource record

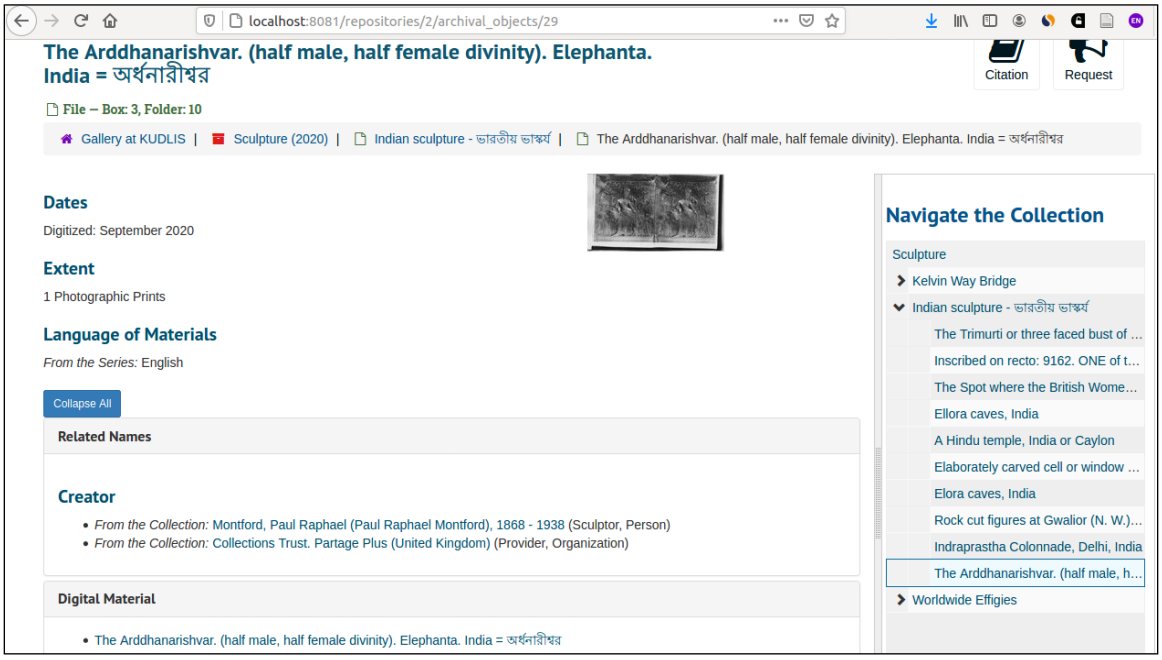

Fig. 2 —Retrieval of digital object (file) in public user interface

through URL forwarding. Fig. 3 represents an authority record of an agent (people/152) with the preferred name heading of this person, detailed information, linked records, 'see also' reference (in the right hand pane), and a SNAC identifier.

Fig. 4 and Fig. 5 illustrate the OAI-PMH data exposure interface of ArchivesSpace (through a dedicated port) in both oai_dc and oai_ead, respectively, as metadata prefixes of the same title <*Sailboat*> for cross-collection harvesting to achieve optimum interoperability. It can be understood from Figs. 4 and 5 that EAD can describe an item more granularly as well as precisely in comparison to DC schema. Table 2 represents a semantic mapping between DC elements and EAD elements as follows –

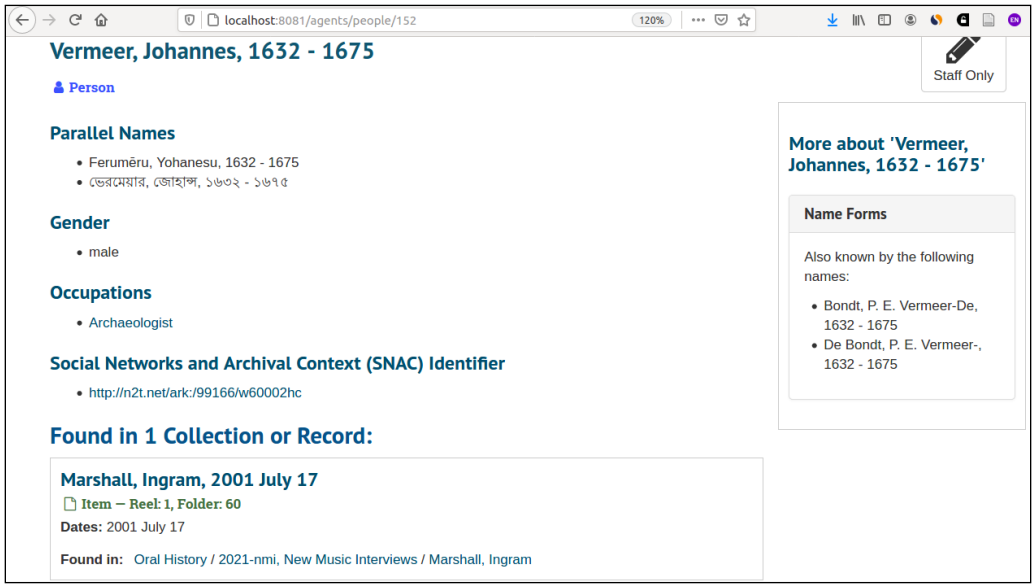

Fig. 3 — Authority record of an agent (as person)

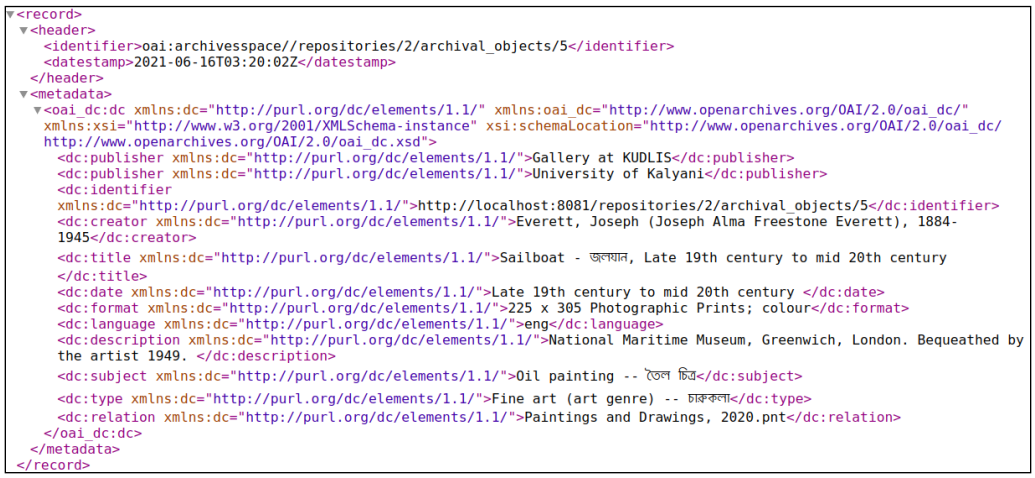

Fig. 4 — OAI-PMH interface (Metadata prefix set as oai_dc)

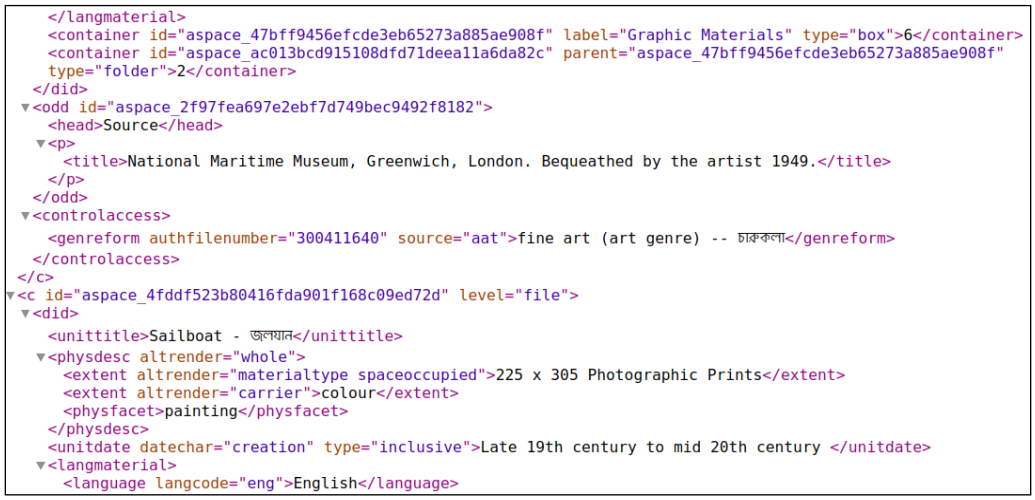

Fig. 5 — OAI-PMH interface (Metadata prefix set oai_ead)

Biblio-cultural information retrieval – discovery layer

This distinct mechanism works on three levels – (i) need to harvest the full text archival records in a predefined format in VuFind from the source ArchivesSpace collection; (ii) configuring to import the harvested records; and (iii) batch importing the harvested records to index resources for end user retrieval. The public user interface of the VuFind discovery tool supports simple as well as many sophisticated advanced search techniques, along with some effective filtering options.

Table 2—Semantic mapping between the elements of DC and EAD[86,87]

DC element	EAD element
Type	<controlaccess><genreform>
Title	<unittitle>
Date.Created	<unitdate>
Creator	<origination><persname>
	<origination><corpname>
	<origination><famname>
	<controlaccess><persname>
	<controlaccess><corpname>
Subject	<abstract>
	<scopecontent>
	<controlaccess><subject>
Location	<repository><physloc>
Location Period or Jurisdiction	

Generally, almost all resource discovery tools, including VuFind, have an inbuilt harvester that can be implemented without installing the full software package, and after preparing the component software system for providing metadata in the required formats (*marc_xml*, *oai_dc*, or *oai_ead*), the VuFind harvester may be instructed based on the OAI configuration file (*oai.ini* in VuFind) to fetch metadata for different kinds of resources (here archival, bibliographic, and textual materials) available in different layers (here ArchivesSpace, Koha, DSpace, and Greenstone) within a common place under VuFind. Fig. 6 displays the end-user interface of archival resources in the discovery interface of VuFind, where users may knock the details of any specific resources through finding aid.

Fig. 7 depicts the one-stop unified end user interface (Bentobox search interface) where the heterogeneous resources are coming from different silos ('Library Catalogue' from Koha ILS, 'Digital

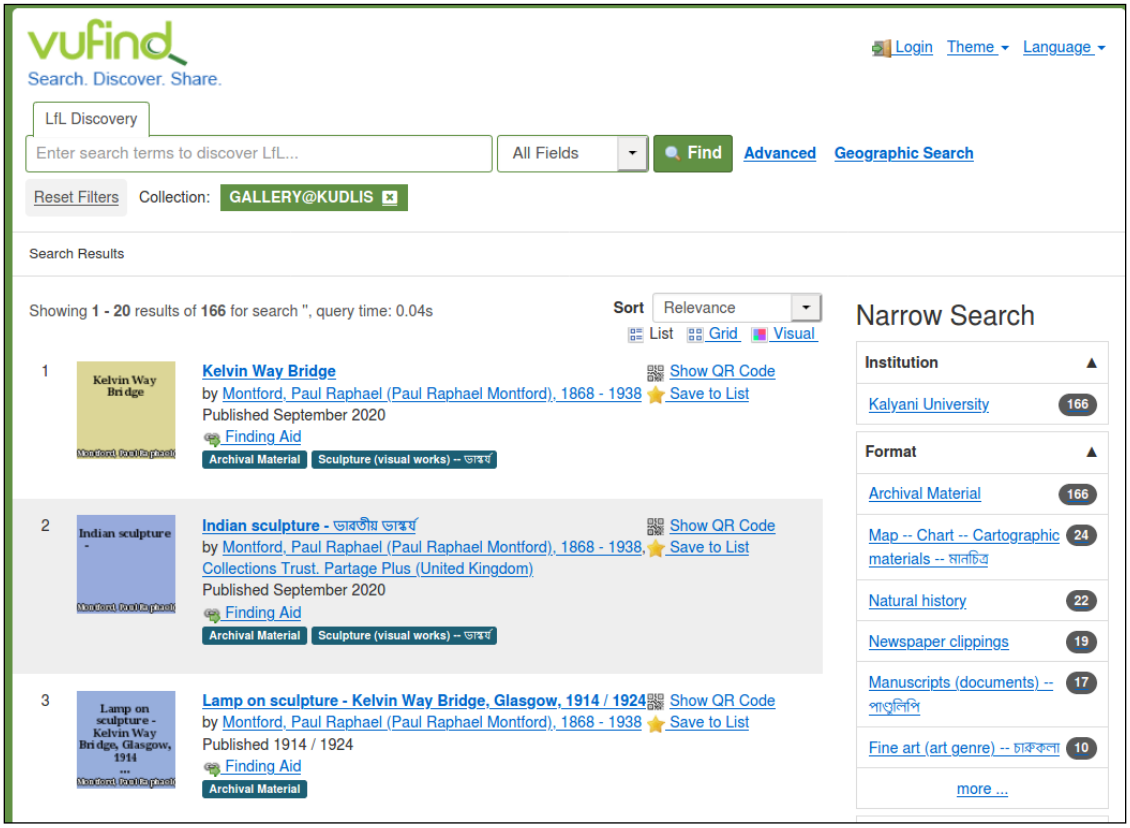

Fig. 6 — Retrieval of archival resources in discovery platform

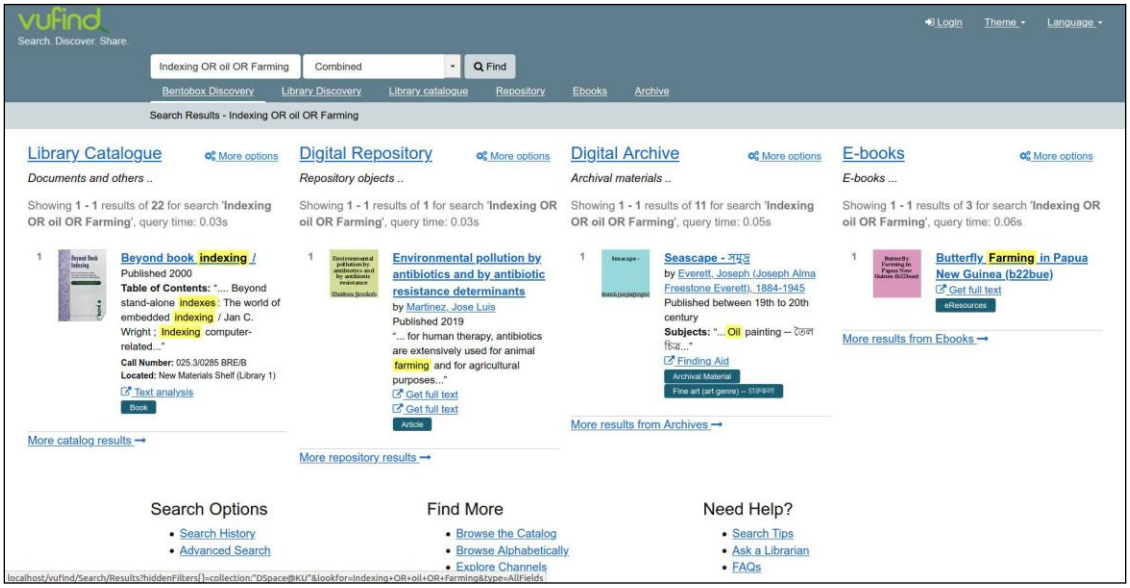

Fig. 7 — Unified search interface (Bentobox) for heterogeneous resources

Repository' from DSpace IDR, 'Digital Archive' from ArchivesSpace DAM, and 'E-books' from GSDL), and displayed in a common place. An illustration of the Bentobox search interface design is appended in the Appendix II.

Conclusion

This study is an attempt to solve a long overdue problem of retrieval silos in a search interface, where a library wishes to provide access to both bibliographic resources and cultural heritage resources through a single-window search box. The integration issues of two major categories of resources and services at the GLAM-end frequently results in serious retrieval problems for end users, such as steep learning curves for searching in two different interfaces (arising from different backend text retrieval engines in two categories of software), difficulties in field-level searching (arising from different metadata sets – MARC 21 for bibliographic resources vs. domain-specific metadata sets), and so on.

The workflows of managing galleries, libraries, archives, and museums vary so widely from each other that integration of workflow activities for GLAM institutes in a software framework is still a distant dream, even in this age of rapid technological advancements. This research work shows that though workflow integration is difficult to achieve at this stage, it is quite feasible to integrate retrieval silos originating from two different sets of software into a harmonized, FRBRized, one-stop search interface along with support for bibliographic relationships based navigation[88,89], bentobox search (compartments in a unified search interface to show which resource is coming from which category), and helpful browsing keys for searchers of GLAM retrieval systems.

As the entire mechanism is based on the open source library discovery system and open standards, the only precondition that remains is the availability of OAI/PMH-compatible component software that is in use for managing the workflow of GLAM institutes.

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Appendix I

1. A few major Indian initiatives of cultural heritage portal:

Name	Brief Description	URL
The Abhilekh Patal	An initiative of National Archives of India to access more than 2.7 million very rare Indian archival records at a single click of a button.	https://www.abhilekh-patal.in/jspui
Gandhi Ashram at Sabarmati	It contains a sizable physical collection of manuscripts of Gandhi's writings (111 letters and 371 manuscripts) along with around 50K rare books on India's freedom movement, 600 photo negatives, 800 audio-visual cassettes, and 210 films. A unified user interface is unavailable; rather, users need to visit different web pages.	https://gandhiashramsabarmati.org/en
Jewellery of the Nizam	The jewels of the Nizams are one of the most magnificent collections in the world. Just history of Nizams, and images of jewels are depicted with respective descriptions in the portal.	http://nizamjewels.nvli.in
Nehru Memorial Museum and Library	Provides digitized copy of some rare books, and just uses Koha ILS for providing OPAC (Online Public Access Catalogue) facilities. Online reprography, oral history, archive, and museum are unaccessible.	http://nehrumemoriallibrary.informaticsglobal.com
National Mission on Monuments and Antiquities	A GoI initiative. It consists of information about antiquities and built heritage sites. Browsing (state, dynasty, cultural affiliation wise) and advance searching (district, sub-district, village wise) are available in a different silo.	http://nmma.nic.in/nmma/indexAction.do
The Vedic Heritage portal	It is an initiative and one-stop solution of IGNCA that aims to communicate Vedic heritage knowledge in an abstract oral or full text form from the ancient publications, manuscripts etc. to the users.	https://vedicheritage.gov.in
Raja Deen Dayal gallery	An IGNCA initiative, consists of beautiful photographes taken by this eminent photographer of Colonial India. Collections are availabile mainly in physical mode.	https://ignca.gov.in/raja-deen-dayal-gallery
Begum Akhtar portal	Also an IGNCA initiative, pictures, and details of recordings (mainly in gramophone) of this legendary singer are available. Users can also listen to her 'mehfil recordings' directly in this portal.	https://ignca.gov.in/Begum_Akhtar/index.html
Intangible Cultural Heritage	The division of IGNCA research and documentation on the contextual aspects of the intangible cultural heritage of India includes things like Ramman Theater, which is a religious ritual theatre observed in the twin villages of Saloor and Dungra Village in the Chamba district of Himachal Pradesh; Buddhist Chanting of Ladakh: Recitation of Sacred Buddhist Texts in the Trans-Himalayan Ladakh Region, Jammu and Kashmir, India; Chhau Dance; Lama Dances of Sikkim; Durga Puja in West Bengal and many more. But various textual files, images, and videos are associated with the event separately.	https://ignca.gov.in/divisionss/janapada-sampada/loka-parampara/intangible-cultural-heritage
National Cultural Audiovisual Archives	Powered by an e-Library & Archival software named 'Digitalaya' (developed by C-DAC).	https://ncaa.gov.in/repository
Project Mausam	It is another notable global project holds by IGNCA with ASI to recommend as a trans-national inscription in the world heritage list of UNESCO at 38th world heritage session in Doha, Qatar in the year of 2014. Primarily, it has four objectives – a) to resuscitate the lost inter-connection with other countries on the Indian ocean; b) to promote relationships and link to other existing cultural and natural world heritage sites on the Indian ocean; c) to identify gaps amongst the cultural heritage sites, and redefine these cultural landscape by building relationships; and d) to accomplish the cross-national world heritage nomination on the Indian ocean for cultural heritage developments, sustainable tourisms etc.	https://ignca.gov.in/project-mausam

(*Contd.*)

1. A few major Indian initiatives of cultural heritage portal: (*Contd*.)

Name	Brief Description	URL
C-DAC	Developed many open-source applications including BOSS (Bharat Operating System Solutions, based on GNU/Linux distribution), and other software domain-oriented open-source applications to enhance the use of FLOSS (Free/Libre Open Source Software) throughout the country for different purposes. But single interface of heterogeneous resources is still unavailable.	https://www.cdac.in/index.aspx?id=st_oss_free_open_source_software
Tribal Art & Culture	Various paintings, audio-visual clips, photographs, lifestyle of major tribal communities of India are available along with a downloadable file of Bhil geet.	https://ignca.gov.in/divisionss/janapada-sampada/tribal-art-culture

2. A few major global initiatives of cultural heritage portal:

Name	Brief Description	URL
Finna.Fi	An excellent model of unified search interfaces at the global scale. Millions of cultural (works of art, pictures, videos, maps, etc.) and scientific materials (documents, theses, etc.) in Finland are available within a single and harmonized resource discovery platform which is powered by open-source resource discovery tool VuFind.	https://www.finna.fi
Yale Centre of British Art	The largest museum outside of the United Kingdom devoted to British art. It include around 40k prints, 35k rare books and manuscripts, 20k drawings and watercolors, 2k paintings, 250 sculptures, and over 40k volumes supporting research in British art and allied fields. The portal is fully IIIF and Mirador complatible.	https://collections.britishart.yale.edu/
Digital Public Library of America	This portal provides a one-stop discovery experience of nearly 45 million texts, images, moving images, sounds, physical objects, artifacts, and interactive resources from most trusted sources across the United States by maximizing access to their shared history, culture, and knowledge.	https://dp.la/
Europeana	It provides digital access to millions of cultural heritage items (books, audio-visual files, artworks, science, sounds, newspapers, archaeology, sports, fashion, etc.) from more than 3.7k different institutions (galleries, libraries, archives, and museums) across Europe, and enriches data by geo-location, or links it to other material or datasets through associated people, places, or topics.	https://www.europeana.eu/en
Google Arts & Culture	It helps to remove space and time barriers by developing online repositories and enhancing accessibility to the world's culture (e.g. photographs, artworks, artefacts, books etc.)	https://artsandculture.google.com
UNESCO Digital Library	It is a rich source of resources in diverse formats reflecting UNESCO's activities and programmes since 1946. It consists of 1.7 Lakhs prints, negatives, and slides of photographs; 12,5k cans containing over 1k titles of films; 30k audio recordings including oral histories and interviews; nearly 5k video tapes, and many more.	https://unesdoc.unesco.org/archives
UNESCO Archive AtoM Catalogue	An open-source DAM 'AtoM' has been used for developing this interactive portal to provide hierarchical representation. Resource records may be exported as DC xml or EAD xml format.	https://atom.archives.unesco.org
Internet Archive	This digital library platform furnishes millions of web pages, texts, audio-visual materials, TV programmes, software, images, live concerts, and other collections through qualified DC schema.	https://archive.org

3. UNESCO and IFLA guidelines:

Organization	Guideline	URL
UNESCO	UNESCO undertook 'Memory of the World" programme in 1992 to attain three targets – a) to increase awareness about endangered cultural heritage resources, b) to preserve such resources using the most appropriate techniques, and c) to provide universal access to these significant but endangered cultural heritage collections worldwide. The general guidelines and a list of severely damaged libraries and archival collections were prepared by UNESCO with the joint collaboration of IFLA (International Federation of Library Associations) and ICA (International Council on Archives).	https://en.unesco.org/programme/mow
IFLA	The IFLA also recommends the 'Memory of the World' programme of UNESCO by its two core programmes in 1984 —"Preservation and Conservation' (PAC), and 'Universal Availability of Publications' (UAP) — ensuring all the published as well as unpublished library resources and archival materials in all formats should be preserved for a long time, and provide accessibility as far as possible.	https://archive.ifla.org/IV/ifla64/116-64e.htm

Appendix II: Bentobox configuration mechanism in VuFind

Collection: Library Catalogue (marc_local.propreties)

collection = “Catalogue of Library1 (KU)”

Collection: Digital Repository (dspace.properties)

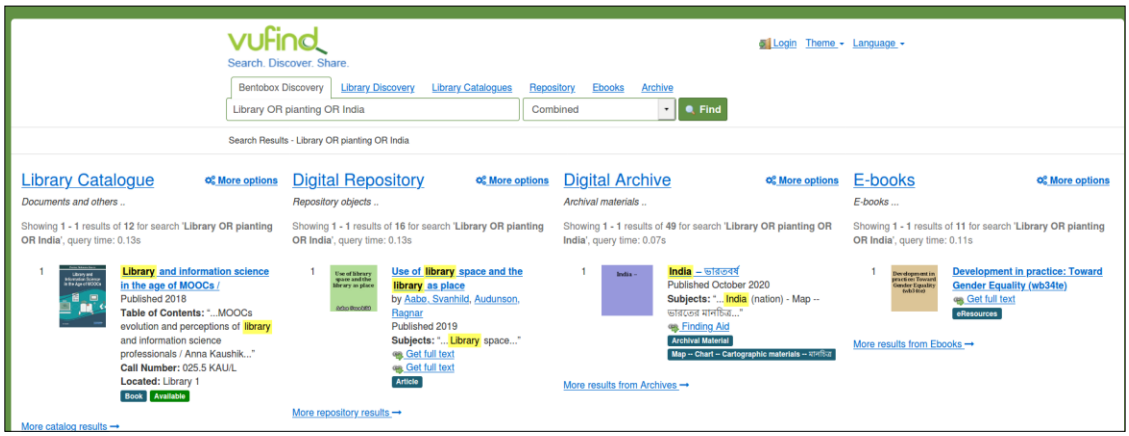
collection = “DSpace@KU

Collection: DigitalArchive (aspace.properties)

collection = “Archive@KU

Collection: E-books (gsdl.properties)

collection = “GSDL@KU”



[SearchTabs] in config.ini of VuFind

Combined = "Bentobox Discovery"
Solr = "Library Discovery"
Solr:koha1n2n6 ="Library Catalogues"
Solr:dspace = "Repository"
Solr:gsdl = "Ebooks"
Solr:aspace = "Archive"

[SearchTabsFilters] in config.ini of VuFind

Solr[]='(collection:"Catalogue of Library1 (KU)" OR collection:"DSpace@KU" OR collection:"GSDL@KU" OR collection:"Archive@KU")'
Solr:koha1n2n6[] = '(collection:"Catalogue of Library1 (KU)" OR collection:"Catalogue of Library2 (KU)" OR collection:"Catalogue of Library6 (KU)")'
Solr:dspace[] = 'collection:"DSpace@KU"'
Solr:gsdl[] = 'collection:"GSDL@KU"'
Solr:aspace[] = 'collection:"Archive@KU"'