"The Major Digital Library Initiatives in India"

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Abstract

This research provides a comprehensive systematic analysis of India's major digital library initiatives developed and implemented during the two-decade period from January 2000 to January 2021. The study examines the historical evolution, technological infrastructure, content scope, governance frameworks, and societal impact of five flagship initiatives: the National Digital Library of India (NDLI), the Digital Library of India (DLI), e-Granthalaya, Shodhganga, and the National Virtual Library of India (NVLI) through the National Mission on Libraries. Employing a mixed-method research design combining policy document analysis, quantitative content assessment, and historical case study methodology, the research evaluates each initiative against criteria including accessibility, content diversity, technological robustness, and alignment with national education objectives. Findings reveal that India's digital library landscape evolved through three distinct phases during this period: the pioneering phase (2000-2014) focused on preservation scanning and technical infrastructure development, exemplified by the Digital Library of India's partnership with the Million Book Project and e-Granthalaya's initial versions for government library automation ; the consolidation phase (2015-2018) driven by the National Mission on Education through ICT (NMEICT), marked by the launch of the NDLI pilot project in April 2015 and its official national launch on June 19, 2018 ; and the expansion phase (2019-2021) characterized by growing content aggregation, multilingual support enhancement, and the integration of grey literature and research outputs . The National Digital Library of India, developed at IIT Kharagpur under Ministry of Education sponsorship, emerged as the flagship initiative, aggregating over 3.85 crore content items from more than 160 sources by 2021, with support for multiple languages and federated searching capabilities. e-Granthalaya evolved from its initial 2003 version for public libraries to version 4.0 in 2015, becoming a cloud-ready application hosted on the NIC National Cloud. Shodhganga, established as the national reservoir of Indian theses, mandated electronic submission of doctoral dissertations following UGC regulations of 2009, creating open access to scholarly research. The Digital Library of India, initiated in the early 2000s, pioneered the vision of archiving one million books predominantly in Indian languages, scanning over 550,603 titles before becoming inactive in 2017. The study identifies key success factors including institutional collaboration (IITs, INFLIBNET, NIC), technology standardization, and policy support through NMEICT and the National Mission on Libraries. However, persistent challenges include limited vernacular content beyond English, interface language constraints, and the need for sustainable

funding models. The research concludes that by January 2021, India had established a foundational digital library ecosystem that significantly expanded access to educational resources, but realizing the full vision of inclusive, multilingual digital knowledge access required continued investment in content creation, technology enhancement, and capacity building.

Keywords:
National Digital Library of India (NDLI), Digital Library of India (DLI), e-Granthalaya, Shodhganga, National Mission on Libraries (NML), digital preservation, open educational resources, NMEICT, grey literature, institutional digital repository, library automation, doctoral theses, multilingual access, federated search, Indian languages, Million Book Project, INFLIBNET, National Informatics Centre (NIC).

Introduction

1. The Digital Imperative for Indian Libraries: Historical Context (2000-2021)

The turn of the twenty-first century marked a transformative period for libraries worldwide, as digital technologies promised to revolutionize how knowledge is preserved, accessed, and disseminated. India, with its ancient manuscript traditions, vast linguistic diversity, and growing information technology sector, stood at a unique crossroads. The country possessed one of the world's richest reservoirs of cultural and intellectual heritage—manuscripts in Sanskrit, Persian, Arabic, and dozens of vernacular languages; rare books from the colonial and pre-colonial eras; and a burgeoning output of modern scholarly research. Yet this wealth remained largely locked in geographically dispersed, under-resourced, and often inaccessible physical repositories. The majority of India's population, particularly in rural areas and small towns, was systematically excluded from accessing this knowledge due to geographic, economic, linguistic, and infrastructural barriers.

The digital revolution offered an unprecedented opportunity to resolve this paradox. Digital library initiatives promised to democratize access, preserve fragile materials for future generations, and unlock the educational and economic potential of India's knowledge assets. However, the transition from physical to digital knowledge systems was not merely a technical exercise. It required strategic vision, substantial investment, institutional coordination, technological standardization, and sustained commitment to equity and inclusion.

2. Defining Digital Libraries in the Indian Context (2000-2021)

During the period from 2000 to 2021, the conception of digital libraries in India evolved significantly. Early initiatives focused primarily on preservation—digitizing rare and fragile materials to ensure their survival. The Digital Library of India, initiated in the early 2000s, exemplified this preservation mandate,

aiming "to archive all the significant literary, artistic and scientific works of mankind and to preserve digitally and make them available freely for everyone over Internet".

By the mid-2010s, the definition had expanded to encompass service-oriented platforms. The National Digital Library of India, launched in 2015 as a pilot project, defined its mission as creating "a virtual repository of learning resources which is not just a repository with search/browse facilities but provides a host of services for the learner community". This service-oriented definition captured the evolution from passive digital archives to active learning platforms.

The Indian approach to digital libraries during this period encompassed several distinct but interconnected objectives:

Preservation: Digitization of rare, fragile, or deteriorating physical materials—manuscripts, historical documents, out-of-print books—to ensure their survival for future generations. The Digital Library of India's partnership with the Million Book Project exemplified this preservation mandate, scanning over 550,603 titles.

Access: Making knowledge resources available to geographically dispersed users, breaking the physical barriers of traditional libraries. NDLI's federated searching capability, which allowed users to query multiple distributed repositories simultaneously, directly addressed this objective.

Educational Support: Providing learning resources that supplement and enhance formal education, from primary school through doctoral research. NDLI was designed to hold content of any language and provide interface support for the most widely used Indian languages.

Research Enablement: Facilitating scholarly research through comprehensive, searchable collections of theses, journals, and primary sources. Shodhganga served as "a reservoir of Indian Theses," providing "a platform for research students to deposit their Ph.D. theses and make it available to the entire scholarly community in open access".

Library Automation: Transforming traditional library operations through integrated management systems. e-Granthalaya provided a complete ICT solution for government libraries, including automation of in-house activities, digital library integration, and online member services.

3. The Policy Framework: NMEICT and the National Mission on Libraries

Two major policy initiatives provided the overarching framework for digital library development in India during this period:

The National Mission on Education through Information and Communication Technology (NMEICT): Launched by the Ministry of Human Resource Development (now Ministry of Education), NMEICT served as the primary funding and oversight mechanism for digital education initiatives. The National Digital Library of India was initiated under NMEICT as a pilot project in April 2015, with a

project cost of Rs. 39.8 Crores, covering the period from April 2015 to March 2018. NMEICT's emphasis on using ICT to enhance educational access and quality directly aligned with digital library objectives.

The National Mission on Libraries (NML): An initiative of the Ministry of Culture, the National Mission on Libraries provided the framework for the National Virtual Library of India (NVLI). The mission aimed to modernize library services, digitize collections, and create a virtual library platform that would make India's cultural heritage accessible online. By 2021, the National Library in Kolkata was actively working to upload select parts of its collection, including 5,000 titles under the Indian Culture section.

4. Historical Evolution of Digital Libraries in India (2000-2021)

The trajectory of digital library development in India from 2000 to 2021 can be understood through three distinct phases:

Phase I: Pioneering Initiatives (Early 2000s – 2014)

The Digital Library of India (DLI) project, initiated by the Office of the Principal Scientific Advisor to the Government of India and subsequently taken over by the Department of Electronics and Information Technology (DeitY), represented the foundational phase. Initially hosted by the Indian Institute of Science, CDAC Noida, and IIIT-Hyderabad, DLI worked in partnership with the Million Book Project. The vision was ambitious: to create a free-to-read, searchable collection of one million books, predominantly in Indian languages, creating a test bed for researchers to improve scanning techniques, optical character recognition (OCR), intelligent indexing, and Indian Language Technology Research. By 2016, DLI had scanned 550,603 titles. However, the DLI website became inactive from 2017 due to maintenance reasons, though contents remained available through archive.org .

Also, during this period, e-Granthalaya was initiated as an in-house project at the Karnataka State Centre of NIC, Bangalore. The first version (1.0) was designed for public libraries in the state, using Visual Basic 6/ASP/HTML technology and MS SQL Server 7 as the database management system. Version 2.0 was released in 2005 as a Government Libraries Edition, and Version 3.0 followed in 2007 as a Network Edition using VB.NET/ASP.NET 2.0.

Phase II: Consolidation and Scale (2015 – 2018)

The launch of the National Digital Library of India pilot project in April 2015 marked a significant escalation in ambition and resources. Sponsored by the Ministry of Human Resource Development under NMEICT and developed at IIT Kharagpur, NDLI was conceived as "a framework of virtual repository of learning resources with a single-window search facility". The alpha version of the NDLI Phase I Portal was made operational in February 2016. The project targets included aggregating 5 lakh content items, integrating 100 Institutional Digital Repositories, and registering users from 200 Participating Institutions.

The portal was officially inaugurated on June 19, 2018, by the Union Human Resource Development Minister, Shri Prakash Javadekar, on the occasion of National Reading Day. At launch, NDLI provided access to 1.7 Crore content items from more than 160 sources, in over 200 languages, and had registered 30 lakh users. The platform was also available as a mobile app, which had been downloaded over 6.70 lakh times, supporting English, Hindi, and Bengali languages initially.

During this period, e-Granthalaya version 4.0 was released in 2015, representing a major technological upgrade. Version 4.0 was developed as a "Cloud Ready Application" using ASP.NET 4.0/AJAX/JQUERY/JSON/SilverLight technology, with PostgreSQL as an open-source DBMS. This version was made available on the NIC National Cloud (Meghraj) for government libraries.

Phase III: Expansion and Integration (2019 – January 2021)

The period from 2019 to January 2021 witnessed significant expansion of India's digital library ecosystem. NDLI continued to aggregate content, and by 2020, academic research began examining its collections systematically. A study published in 2020 analyzed the grey literature in NDLI, including synopses, theses, reports, and patents, revealing that out of 1,819,319 resources, reports constituted the largest category (57.87 per cent), followed by theses (33.28 per cent). The study also found that 57.04 per cent of grey resources had full open access, with the Education Resources Information Center (ERIC) being the largest source (45.54 per cent).

The National Virtual Library of India (NVLI), under the National Mission on Libraries, continued its development. By June 2021, the National Library in Kolkata announced plans to upload 5,000 titles under the Indian Culture section, with the National Mission on Libraries India providing financial support. The library also announced the introduction of eight new sections for developing repositories in Sindhi, Konkani, Manipuri, Nepali, Bodo, Dogri, Maithili, and Santhali, expanding its linguistic coverage.

The COVID-19 pandemic, which began in early 2020, significantly accelerated the adoption of digital library resources. As schools, colleges, and universities across India went into complete lockdown on March 25, 2020, NDLI adapted by shifting from a 'data-driven' approach to an approach centered on 'agility and service', requiring significant efforts in classifying content into user-focused categories.

By January 2021, Shodhganga had become well-established as the national repository for electronic theses and dissertations, mandated by UGC regulations. The repository was set up and maintained by the INFLIBNET Centre, providing open access to Indian doctoral theses to the academic community worldwide.

5. The Problem: Fragmentation and Coordination Challenges

Despite impressive individual achievements, India's digital library landscape as of January 2021 faced significant challenges. The proliferation of initiatives—each with its own portal, authentication system, metadata standards, and user interface—created a fragmented user experience. A student seeking

resources across NDLI, Shodhganga, and the National Virtual Library of India would need to navigate multiple systems, maintain separate credentials, and master different search interfaces.

Content coverage remained uneven across languages. While NDLI provided interface support for multiple Indian languages, the actual availability of learning resources in languages other than English was limited. Research data showed that 89.92 per cent of grey literature resources in NDLI were available in English, with only about 1 per cent contributed by indigenous languages.

Infrastructure constraints persisted. Digital libraries required reliable internet connectivity, devices, and digital literacy—all of which remained unevenly distributed across India's urban-rural divide. The DLI website became inactive in 2017, highlighting the challenges of maintaining long-term digital preservation infrastructure.

6. Research Questions

This study addresses the following research questions within the period January 2000 to January 2021:

1. What were the major digital library initiatives in India during this period, and what were their respective mandates, content scopes, and technological architectures?
2. How did these initiatives evolve over time, and what historical forces shaped their development?
3. What were the key success factors and persistent challenges across India's digital library ecosystem during this period?
4. How did these initiatives align with national education and technology policies, including NMEICT and the National Mission on Libraries?
5. What coordination mechanisms existed among different initiatives, and what were the interoperability challenges?
6. What was the state of multilingual content availability, and what gaps remained in covering India's linguistic diversity?

7. Significance of the Study

This research is significant for multiple stakeholders. For **policymakers**, it provides a comprehensive inventory and assessment of digital library assets developed over two decades, identifying gaps and opportunities for strategic coordination. For **library professionals**, it offers a roadmap for leveraging digital resources and understanding the evolving technological landscape. For **educators and students**, it serves as a guide to available resources and access mechanisms. For **international researchers**, it documents India's distinctive approach to digital library development, offering lessons for other multilingual, resource-constrained contexts.

8. Scope and Delimitations

The study focuses on five major national-level digital library initiatives active during the period January 2000 to January 2021: National Digital Library of India (NDLI), Digital Library of India (DLI), e-

Granthalaya, Shodhganga, and the National Virtual Library of India/National Mission on Libraries. State-level digital library initiatives and international collaborations (except where they directly partnered with Indian initiatives, such as the Million Book Project) are excluded. The analysis covers developments from January 2000 to January 2021, with the endpoint selected to capture the pre-COVID-19 expansion and the initial pandemic response period.

Definitions

Term	Definition
Digital Library	A virtual repository of learning resources providing search/browse facilities and a host of services for the learner community, designed to hold content of any language and provide support for all academic levels, disciplines, access devices, and differently-abled learners.
National Digital Library of India (NDLI)	A project sponsored by the Ministry of Education (formerly MHRD), developed by IIT Kharagpur under NMEICT, serving as a single-window platform providing learning resources that make e-learning and education accessible to all. Launched as a pilot in April 2015 and officially inaugurated on June 19, 2018.
Digital Library of India (DLI)	A pioneering initiative started in the early 2000s by the Office of the Principal Scientific Advisor, subsequently under DeitY, working in partnership with the Million Book Project, aiming to archive one million books predominantly in Indian languages. Initially hosted by IISc, CDAC Noida, and IIIT-Hyderabad.
e-Granthalaya	A Digital Platform developed by the National Informatics Centre, Ministry of Electronics and Information Technology, for Government Libraries for automation of in-house activities, member services, and networking for resource sharing. Version 1.0 released in 2003, Version 4.0 released in 2015 as a cloud-ready application.
Shodhganga	A reservoir of Indian Theses maintained by the INFLIBNET Centre, providing a platform for research students to deposit their Ph.D. theses and make them available to the scholarly community in open access, mandated by UGC regulations of 2009.
ShodhGangotri	A repository where research scholars/research supervisors deposit an electronic version of approved synopses submitted for Ph.D. registration. These synopses are later mapped to full-text theses in Shodhganga.
National Mission on Education through	The funding and oversight mechanism for digital education initiatives including NDLI, launched by the Ministry of Human Resource Development.

Term	Definition
ICT (NMEICT)	
National Mission on Libraries (NML)	A Government of India scheme under the Ministry of Culture with components including the National Virtual Library of India, Model Libraries, Quantitative & Qualitative Survey, and Capacity Building Programme.
National Virtual Library of India (NVLI)	A component of the National Mission on Libraries, intended as a massive online library with resources covering arts, music, dance, culture, theatre, science, technology, education, archaeology, literature, museums, and manuscripts.
Million Book Project	An international digital library partnership in which DLI participated, aiming to digitize one million books.
Federated Search	A search technique that allows users to query multiple distributed repositories simultaneously and receive aggregated results, employed by NDLI to facilitate focused searching.
Grey Literature (GL)	Primary sources of locally generated information including synopses, theses, reports, and patents, considered valuable for research.
INFLIBNET	Information and Library Network Centre, an autonomous inter-university centre of the University Grants Commission responsible for Shodhganga.
National Informatics Centre (NIC)	The government agency responsible for developing e-Granthalaya and hosting it on the NIC National Cloud (Meghraj).

Need for the Study

1. **Historical documentation imperative**: The two-decade period from 2000 to 2021 witnessed the foundational development of India's digital library ecosystem. Systematic documentation of this period is essential for understanding current capabilities and future directions.
2. **Scale of investment**: India invested substantial public resources in digital library development during this period, including the Rs. 39.8 Crore NDLI Phase I project (April 2015-March 2018), the National Mission on Libraries supporting multiple state central and district libraries, and the DLI's Million Book Project partnership. Evaluation of returns on this investment is overdue.
3. **Policy evolution understanding**: The period saw significant policy developments including NMEICT, the National Mission on Libraries, and UGC regulations mandating electronic thesis

submission. Understanding how these policies shaped digital library development provides lessons for future policy design.

4. **Fragmentation assessment**: The proliferation of multiple platforms—NDLI, NVLI, DLI, e-Granthalaya, Shodhganga—raised concerns about user confusion and duplicative efforts. Research is needed to identify coordination mechanisms.
5. **Linguistic diversity challenge**: India recognizes 22 scheduled languages, yet research data from 2020 showed that 89.92% of grey literature resources in NDLI were in English, with only about 1% in indigenous languages. Understanding this gap is critical for equitable access.
6. **COVID-19 impact documentation**: The pandemic, which began in early 2020, significantly accelerated digital library adoption. Documenting this period provides insights for future crisis response.
7. **Infrastructure and access gaps**: Despite digital library availability, usage remained constrained by connectivity, devices, and digital literacy. Research must identify barriers and solutions.
8. **Preservation mandate urgency**: The DLI website became inactive in 2017, highlighting the fragility of digital preservation infrastructure. Understanding why initiatives fail is as important as documenting successes.
9. **International benchmarking**: India's digital library initiatives offer lessons for other multilingual developing nations, but systematic documentation in accessible formats is lacking.
10. **Educational equity imperative**: Digital libraries represent a potentially transformative tool for democratizing education, but their effectiveness depends on strategic coordination and accessibility. Research must guide policy and investment decisions.

Aims

To systematically document, analyze, and evaluate the major digital library initiatives in India developed and implemented during the period January 2000 to January 2021, assess their alignment with national education and technology policies, identify success factors and persistent challenges, and provide a foundational understanding of India's digital library ecosystem at the end of this two-decade period.

Objectives

1. To identify and catalog the major digital library initiatives in India active between January 2000 and January 2021, documenting their respective mandates, sponsoring agencies, technological architectures, and content scopes.
2. To trace the historical evolution of digital library development in India through three distinct phases: pioneering (2000-2014), consolidation (2015-2018), and expansion (2019-2021).

3. To analyze each initiative's content coverage across dimensions including subject areas, educational levels, languages, and media types.
4. To assess the technological infrastructure of each initiative, including search capabilities, user interfaces, metadata standards, and interoperability features.
5. To evaluate the linguistic coverage of digital library content, identifying gaps in covering India's 22 scheduled languages.
6. To analyze the role of grey literature (theses, reports, synopses, patents) within NDLI and other platforms.
7. To examine the impact of the COVID-19 pandemic on digital library adoption and adaptation during 2020-2021.
8. To identify coordination mechanisms and interoperability challenges across different initiatives.
9. To analyze usage patterns, adoption rates, and user demographics where data is available.
10. To provide evidence-based recommendations for policymakers, library professionals, and technology developers based on the lessons of 2000-2021.

Hypothesis

Primary Hypotheses

1. **H_1 (Evolutionary Phase Model)**: India's digital library development between 2000 and 2021 followed a three-phase evolutionary trajectory—pioneering (2000-2014), consolidation (2015-2018), and expansion (2019-2021)—with each phase characterized by distinct technological capabilities, institutional arrangements, and policy drivers.
2. **H_2 (Content-Language Gap)**: Despite policy emphasis on multilingual access, there existed a statistically significant gap between the number of languages with interface support and the actual availability of learning content in those languages, with English content disproportionately represented.
3. **H_3 (Grey Literature Significance)**: Grey literature, particularly reports and theses, constituted a substantial portion of digital library content, with reports representing 57.87% of selected grey literature resources in NDLI as of 2020.

Literature Search Strategy

Databases and Sources Consulted

1. **Government Sources**: Ministry of Education (formerly MHRD) Press Information Bureau releases, National Informatics Centre documentation, INFLIBNET Centre publications
2. **Institutional Repositories**: IIT Kharagpur (NDLI) official website, e-Granthalaya official portal
3. **Academic Databases**: Scopus, Google Scholar, Emerald Insight

4. **Digital Archives**: DBpedia (Digital Library of India), Wikipedia
5. **News Sources**: Firstpost, Mathrubhumi

Search Strings

1. ("National Digital Library of India" OR "NDLI") AND ("history" OR "development" OR "launch")
2. ("Digital Library of India" OR "DLI" OR "Million Book Project")
3. ("e-Granthalaya" OR "NIC library automation" OR "National Informatics Centre")
4. ("Shodhganga" OR "INFLIBNET" OR "doctoral theses" OR "electronic theses")
5. ("National Mission on Libraries" OR "National Virtual Library of India" OR "NVLI")
6. ("NMEICT" OR "National Mission on Education through ICT")
7. ("grey literature" AND "NDLI" AND "India")

Key Foundational Works Identified

1. Moid, A., Raza, M.M. & Jahan, K. (2021). A study of grey literature in National Digital Library of India: analyses and trends. *Collection and Curation*, 40(3), 122-127
2. PIB Release (June 19, 2018). Union HRD Minister dedicates National Digital Library of India to the Nation
3. PIB Release (November 29, 2016). MHRD initiates Digital Library
4. e-Granthalaya Official Documentation (Version History)

Research Methodology

Research Design

A mixed-method research design combining policy document analysis, quantitative content assessment, and historical case study methodology.

Phase 1: Initiative Identification and Cataloguing

Method: Systematic identification of major digital library initiatives through government documents, press releases, academic literature, and official websites.

Output: Comprehensive catalog of five major initiatives with standardized metadata (sponsor, launch date, technological platform, content scope, user base).

Phase 2: Content and Technology Assessment

For each initiative, the following dimensions were assessed:

Dimension	Assessment Criteria	Data Sources
Content Volume	Number of resources/records/titles	Official statistics, PIB releases
Language	Number of languages supported; actual	Research studies, platform

Dimension	Assessment Criteria	Data Sources
Coverage	content distribution	documentation
Subject Coverage	Disciplines represented	NDLI classification data
Technology Platform	Web, mobile app, cloud hosting	Technical documentation
Access Restriction	Open, limited, subscribed, authorized	NDLI access classification
Metadata Standards	Dublin Core, LRMI, Shodhganga	NDLI technical specifications

Phase 3: Grey Literature Analysis

Special focus on the analysis conducted by Moid, Raza, and Jahan (2021) examining NDLI's grey literature collection. This study analyzed:

1. Four types of grey literature: reports, theses, synopses, and patents
2. Access restriction status across 1.8+ million resources
3. Top ten sources for grey literature extraction
4. Subject classification using Dewey Decimal Classification
5. Language-wise distribution of the collection

Data Sources

Primary Sources:

1. Official project websites (ndl.iitkgp.ac.in, egranthalaya.nic.in)
2. Press Information Bureau releases
3. Ministry of Education and Ministry of Culture notifications

Secondary Sources:

1. Academic literature on digital libraries in India
2. Wikipedia and DBpedia entries
3. News reports and industry analyses

Analytical Framework

The analysis employs a Digital Library Assessment Matrix with the following dimensions:

1. **Strategic Alignment**: How well did the initiative align with NMEICT and National Mission on Libraries objectives?
2. **Technological Sophistication**: What was the technical architecture and feature set?

3. **Content Breadth and Depth**: How comprehensive was coverage across subjects and levels?
4. **Linguistic Coverage**: How well did the initiative serve India's multilingual population?
5. **Accessibility**: How easily could target users access and utilize the platform?
6. **Sustainability**: What was the funding model and long-term viability?
7. **Interoperability**: How well did the initiative integrate with other platforms?

Time Frame Delimitation

The study covers the period from January 2000 to January 2021, with the endpoint selected to capture:

1. The completion of NDLI Phase II (extended to March 31, 2021 due to COVID-19)
2. The pre-Phase III period (Phase III began April 1, 2021)
3. The initial COVID-19 pandemic response period

Strong Points of the Study

1. **Comprehensive temporal coverage**: The study spans two full decades (2000-2021), capturing the entire foundational period of India's digital library development.
2. **Multi-initiative analysis**: Examines five major initiatives from multiple sponsoring agencies (MHRD/Education, DeitY, NIC, INFLIBNET, Ministry of Culture), providing a holistic view.
3. **Grey literature focus**: Incorporates detailed analysis of NDLI's grey literature collection, including quantitative data on access restrictions, sources, subjects, and languages.
4. **Policy integration**: Explicitly connects digital library initiatives to policy frameworks including NMEICT and the National Mission on Libraries.
5. **Historical depth**: The three-phase evolutionary model provides analytical clarity to a complex, multi-decade development process.
6. **Evidence-based**: Analysis grounded in official statistics, government documents, and peer-reviewed research.
7. **Linguistic analysis**: Systematic attention to language coverage and the gap between policy intentions and actual content availability.
8. **COVID-19 impact documentation**: Captures the pandemic's accelerant effect on digital library adoption during 2020-2021.
9. **Failure analysis**: Includes examination of the DLI's inactive status post-2017, providing lessons on sustainability challenges.
10. **Technological evolution tracking**: Documents the evolution of e-Granthalaya from Version 1.0 (2003) to Version 4.0 (2015).

Weak Points / Limitations

1. **Data availability constraints**: Comprehensive usage statistics and user satisfaction data for most initiatives were not publicly available for the entire period, limiting evaluative conclusions.

2. **Language bias in sources**: Most official documentation and academic studies are in English, potentially missing perspectives from vernacular language users.
3. **DLI documentation gaps**: The Digital Library of India's documentation is limited, with much information derived from archival sources rather than active project documentation.
4. **State-level exclusion**: The study excludes state-level digital library initiatives, which may have served significant user populations.
5. **Limited user research**: Primary user research (surveys, interviews) was not conducted due to scope and resource constraints; the study relies on secondary data.
6. **COVID-19 impact isolation**: While the pandemic accelerated digital adoption, isolating this effect from underlying growth trends is challenging with available data.
7. **Content quality assessment**: The study assesses content quantity and coverage but not quality, pedagogical effectiveness, or accuracy.
8. **Sustainability uncertainty**: Future funding for initiatives, particularly those dependent on project-based rather than institutional funding, remained uncertain.
9. **Regional language complexity**: While the study addresses multilingual coverage, it does not assess dialectal variation or script complexities across Indian languages.
10. **NDLI's evolving content**: The 2020 grey literature study provides a snapshot; content volumes and composition continued to change through 2021.

Current Trends (as of January 2021)

1. NDLI's Response to COVID-19

As schools, colleges, and universities across India went into complete lockdown on March 25, 2020, NDLI adapted by shifting from a 'data-driven' approach to an approach cantered on 'agility and service'. This required significant efforts in classifying content into user-focused categories, resulting in the first major overhaul of the site since its inception.

2. Grey Literature Integration

By 2020, NDLI had aggregated substantial grey literature content, with reports (57.87%) and theses (33.28%) constituting the majority of selected grey literature resources. The Education Resources Information Center (ERIC) was the largest source (45.54%), followed by INFLIBNET-Shodhganga (13.26%).

3. Access Restriction Patterns

Analysis of NDLI's grey literature revealed that 57.04% of resources had full open access, while 34.62% had limited access, and smaller percentages were subscribed (2.51%), NDLI-access (4.92%), or authorized (0.91%).

4. Language Limitations

Despite policy emphasis on multilingual access, 89.92% of grey literature resources in NDLI were available in English, with Finnish (6.65%) and other languages (approximately 4%) constituting the remainder. Only about 1% of resources were contributed by indigenous Indian languages.

5. e-Granthalaya Cloud Migration

e-Granthalaya version 4.0, released in 2015, was established as a "Cloud Ready Application" hosted on the NIC National Cloud (Meghraj), providing web-based solutions for government libraries with centralized database management.

6. National Library Digitization Initiative

As of June 2021, the National Library in Kolkata was actively working to upload select parts of its collection, including 5,000 titles under the Indian Culture section, with plans to introduce eight new language sections.

7. Mobile Accessibility

By 2018, NDLI was available as a mobile app for both iPhone and Android users, with over 6.70 lakh downloads. The app initially supported English, Hindi, and Bengali languages.

8. Federated Search Implementation

NDLI employed filtered and federated searching to facilitate focused searching, allowing learners to find the right resource with least effort and in minimum time.

9. Shodhganga Mandate Implementation

Following UGC regulations of 2009, Shodhganga had become the established national repository for electronic theses and dissertations, with Shod Gangotri serving as the synopsis repository.

10. DLI Inactivity

By 2017, the Digital Library of India website had become inactive for maintenance reasons, though its contents remained available through archive.org. At its peak, DLI had scanned 550,603 titles.

History of Digital Library Development in India (2000-2021)

Phase I: Pioneering Initiatives (2000 – 2014)

Year	Initiative	Milestone
Early 2000s	Digital Library of India (DLI)	Initiated by Office of the Principal Scientific Advisor; partnership with Million Book Project; hosted by IISc, CDAC Noida, IIIT-Hyderabad
2003	e-Granthalaya Version 1.0	Initiated as in-house project at Karnataka State Centre of NIC; designed for Public Libraries; used Visual Basic 6/ASP/HTML, MS SQL Server 7

Year	Initiative	Milestone
2005	e-Granthalaya Version 2.0	Government Libraries Edition; Visual Basic 6/ASP/HTML; MS SQL Server 2000
2007	e-Granthalaya Version 3.0	Network Edition; VB.NET/ASP.NET 2.0; MS SQL Server 2005
2009	UGC Regulation	Mandated submission of electronic versions of theses and dissertations
By 2016	DLI scanning total	Scanned 550,603 titles

Phase II: Consolidation and Scale (2015 – 2018)

Year	Initiative	Milestone
April 2015	NDLI Phase I Pilot	Launched under NMEICT with project cost Rs. 39.8 Crores; coordinated by IIT Kharagpur; target: 5 lakh contents, 100 IDRs, 200 participating institutions
2015	e-Granthalaya Version 4.0	Enterprise Edition; ASP.NET 4.0/AJAX/JQUERY/JSON/SilverLight; PostgreSQL open-source DBMS; "Cloud Ready Application"
February 2016	NDLI Alpha Version	Portal made operational; available at https://ndl.iitkgp.ac.in
2017	DLI Inactive	Website became inactive for maintenance reasons; contents available via archive.org
June 19, 2018	NDLI Official Launch	Dedicated to the Nation by Union HRD Minister Prakash Javadekar on National Reading Day; 1.7 Crore content items, 160+ sources, 200+ languages, 30 lakh registered users; mobile app available

Phase III: Expansion and Integration (2019 – January 2021)

Year	Initiative	Milestone
2019-2020	NDLI Content Growth	Continued aggregation of content; grey literature analysis conducted
October 2019	NDLI Grey Literature Study	Data collected for analysis of synopses, theses,

Year	Initiative	Milestone
		reports, patents
March 25, 2020	COVID-19 Lockdown	NDLI shifted from 'data-driven' to 'agility and service' approach; major site overhaul
NDLI Phase II Extension	Extended to March 31, 2021 due to COVID-19 pandemic	
June 2021	National Library Initiative	Plans announced to upload 5,000 titles under Indian Culture section; introduction of eight new language sections

Discussion

8.1 The National Digital Library of India: Flagship Initiative

The National Digital Library of India, sponsored by the Ministry of Education and developed at IIT Kharagpur, emerged as the most comprehensive digital library initiative in the country by January 2021. It positioning as "not just a repository with search/browse facilities but provides a host of services for the learner community" reflected an evolved understanding of digital libraries as active learning platforms rather than passive archives.

NDLI's architectural choice of federated searching—querying multiple distributed repositories and aggregating results—addressed the fragmentation problem at a technical level. Users did not need to know which repository held desired content; NDLI searched across sources. However, this approach depended on the willingness of content providers to expose their repositories to NDLI's search crawlers and on the maintenance of standardized metadata schemas.

The platform's support for "all academic levels including researchers and life-long learners, all disciplines, all popular forms of access devices and differently-abled learners" demonstrated commitment to universal design principles. The availability of an official mobile application recognized that mobile devices were the primary internet access points for many Indian users, particularly students.

NDLI's grey literature collection provided significant value for researchers. A systematic study published in 2021 found that reports constituted 57.87% of selected grey literature resources, followed by theses at 33.28%. The majority (57.04%) of these resources were openly accessible, though 34.62% had limited access.

8.2 The Digital Library of India: Pioneer with Sustainability Challenges

The Digital Library of India represented the pioneering vision of digital preservation in the Indian context. Its partnership with the Million Book Project and its focus on Indian language materials created a valuable test bed for OCR and language technology research. By 2016, DLI had scanned over 550,603 titles, a significant achievement given the technological constraints of the early 2000s.

However, DLI's eventual inactivity from 2017 onward highlighted critical sustainability challenges facing digital preservation initiatives. The causes of inactivity—whether funding, technical maintenance, or organizational issues—are not fully documented in available sources, but the outcome is clear: without sustained institutional commitment, even well-intentioned digitization projects can become inaccessible. This serves as a cautionary tale for subsequent initiatives like NDLI, which have built more robust institutional frameworks.

8.3 e-Granthalaya: Library Automation at Scale

e-Granthalaya's evolution from version 1.0 in 2003 to version 4.0 in 2015 demonstrates the long-term commitment of the National Informatics Centre to government library modernization. The platform's progression from desktop-based software to a "Cloud Ready Application" hosted on the NIC National Cloud (Meghraj) reflects broader trends in ICT infrastructure.

The platform's compliance with international library standards and its use of open-source DBMS (PostgreSQL) positioned it as a cost-effective solution for government libraries. The charging policy introduced for eG4 on NIC Cloud—Rs. 21,275 as a one-time payment for five years—suggests a sustainable funding model, though it may create barriers for resource-constrained libraries.

8.4 Shodhganga: Open Access to Research

Shodhganga's establishment under the UGC Regulation of 2009 represented a significant policy intervention to address the problem of poor visibility and duplication in doctoral research. By mandating electronic submission of theses and creating a centrally-maintained digital repository, Shodhganga aimed to "raise the standard and quality of research" and overcome the "poor visibility" and "unseen" factor in research output.

The distinction between Shodhganga (full-text theses) and ShodhGangotri (approved synopses) created a two-stage repository system that captured research from its early proposal stage through to completed dissertation. The mapping of synopses to full-text theses ensured comprehensive research documentation.

8.5 The Language Gap: Persistent Challenge

One of the most significant findings from the analysis is the persistent gap between policy aspirations for multilingual access and actual content availability. Despite NDLI's interface support for multiple Indian languages, research data from 2020 showed that 89.92% of grey literature resources were in English, with only about 1% contributed by indigenous languages.

This gap has multiple explanations. First, the sources from which NDLI aggregated content (ERIC, OSTI.GOV, CORE, etc.) are predominantly English-language repositories. Second, the digitization of Indian language materials requires specialized OCR capabilities that were still developing during this period. Third, copyright and permissions for Indian language publications may present unique challenges.

The National Library's 2021 initiative to introduce eight new language sections for repositories in Sindhi, Konkani, Manipuri, Nepali, Bodo, Dogri, Maithili, and Santhali represented an important step toward addressing this gap, but the scale of the challenge remained substantial.

8.6 COVID-19 as Accelerant

The COVID-19 pandemic, beginning in March 2020, served as a significant accelerant for digital library adoption in India. With educational institutions in complete lockdown, NDLI adapted by shifting from a 'data-driven' to an 'agility and service' approach. This required significant efforts in classifying content into user-focused categories, resulting in the first major overhaul of the site since its inception.

The pandemic highlighted both the potential and the limitations of digital libraries. While they provided essential continuity for remote learning, they also exposed the digital divide—students without reliable internet access or appropriate devices were unable to benefit from these resources. This tension between digital inclusion and digital exclusion would remain a central challenge for policymakers beyond January 2021.

8.7 Success Factors

Several factors contributed to the relative success of India's digital library initiatives during this period:

Institutional Collaboration: The partnership between IIT Kharagpur (NDLI), NIC (e-Granthalaya), INFLIBNET (Shodhganga), and multiple content providers created a distributed but connected ecosystem.

Open Standards: NDLI's use of Dublin Core, Learning Resource Metadata Initiative (LRMI), and Shodhganga metadata standards ensured interoperability.

Policy Support: NMEICT provided both funding and strategic direction for NDLI, while UGC regulations mandated Shodhganga participation.

Mobile Accessibility: The availability of mobile apps for NDLI recognized the reality of mobile-first internet access in India.

8.8 Persistent Challenges

Despite these successes, significant challenges remained as of January 2021:

Sustainability: DLI's inactivity from 2017 onward demonstrated the fragility of project-based digital preservation.

Linguistic Diversity: The overwhelming dominance of English content (89.92% of grey literature) contradicted policy commitments to multilingual access.

Access Restrictions: While 57.04% of grey literature was open access, over 42% had some form of restriction (limited, subscribed, authorized, NDLI-only).

Infrastructure Gaps: Reliable internet connectivity, devices, and digital literacy remained unevenly distributed across India.

Content Quality: The study did not assess the quality, pedagogical effectiveness, or accuracy of digital library content.

Results

9.1 Initiative Summary Table

Initiative	Launch Period	Sponsoring Agency	Technology Partner	Key Features	Status as of Jan 2021
Digital Library of India (DLI)	Early 2000s	DeitY	IISc, CDAC Noida, IIIT-Hyderabad	Million Book Project partnership; 550,603 titles scanned	Inactive (since 2017)
e-Granthalaya	2003	NIC, Ministry of Electronics & IT	NIC	Version 4.0 (2015) Cloud Ready; hosted on NIC National Cloud	Active
NDLI Phase I	April 2015	MHRD under NMEICT	IIT Kharagpur	Pilot project; Rs. 39.8 Cr; target: 5 lakh contents	Completed March 2018
NDLI Official	June 19, 2018	MHRD under	IIT Kharagpur	1.7 Cr content;	Active

Initiative	Launch Period	Sponsoring Agency	Technology Partner	Key Features	Status as of Jan 2021
Launch		NMEICT		160+ sources; 200+ languages; 30 lakh users	
Shodhganga	Post-2009 UGC Regulation	UGC	INFLIBNET Centre	National ETD repository; open access to doctoral theses	Active
NDLI Phase II	Oct 1, 2017 - March 31, 2021	Ministry of Education	IIT Kharagpur	Extended due to COVID-19	Completed

9.2 NDLI Grey Literature Analysis (as of October 2019)

Resource Type	Number	Percentage of Selected GL
Reports	1,053,000+	57.87%
Theses	605,000+	33.28%
Patents	145,000+	7.99%
Synopses	15,000+	0.85%
Total	**1,819,319**	**100%**

Source: Moid, Raza & Jahan (2021)

9.3 Access Restriction Status (NDLI Grey Literature)

Access Type	Percentage	Largest Resource Category
Open	57.04%	Reports (0.29 million)
Limited	34.62%	Reports
NDLI (signed-in access)	4.92%	Reports
Subscribed	2.51%	Reports
Authorized	0.91%	Theses

Source: Moid, Raza & Jahan (2021)

9.4 Top Ten Sources for Grey Literature (NDLI)

Source	Percentage	Rank
Education Resources Information Center (ERIC)	45.54%	1
INFLIBNET-Shodhganga	13.26%	2
OSTI.GOV (US Dept of Energy)	9.01%	3
CORE	7.87%	4
Research System	6.89%	5
World eBook Library	5.29%	6
Internet Archive	3.77%	7
State Library of Massachusetts	3.09%	8
CiteSeerx	2.91%	9
arXiv.org	2.37%	10

Source: Moid, Raza & Jahan (2021)

9.5 Language Distribution (NDLI Grey Literature)

Language	Percentage
English	89.92%
Finnish	6.65%
Other languages (combined)	~3.43%
Indigenous Indian languages	~1%

Source: Moid, Raza & Jahan (2021)

9.6 Subject Classification (NDLI Grey Literature)

Subject Category (DDC)	Percentage	Dominant Resource Type
Technology	34.39%	Theses
Natural Sciences and Mathematics	27.66%	Theses
Social Science	14.62%	Theses
Computer Science, Information	14.33%	Theses
Literature and Rhetoric	3.59%	Theses
Philosophy and Psychology	1.60%	Theses
History and Geography	1.50%	Theses
Language	1.40%	Theses
The Arts	0.81%	Theses
Religion	0.11%	Theses

Source: Moid, Raza & Jahan (2021)

9.7 e-Granthalaya Version History

Version	Year	Technology	DBMS	Edition
1.0	2003	Visual Basic 6/ASP/HTML	MS SQL Server 7	Public Library Edition
2.0	2005	Visual Basic 6/ASP/HTML	MS SQL Server 2000	Government Libraries Edition
3.0	2007	VB.NET/ASP.NET 2.0	MS SQL Server 2005	Network Edition
4.0	2015	ASP.NET 4.0/AJAX/JQUERY/JSON/SilverLight	PostgreSQL (Open Source)	Enterprise Edition (Cloud Ready)

Source: e-Granthalaya Official Website

Conclusion

10.1 Summary of Findings

This study provides a comprehensive analysis of India's major digital library initiatives developed during the two-decade period from January 2000 to January 2021. The key conclusions are:

1. **Three-phase evolution documented**: India's digital library development followed a clear trajectory from pioneering initiatives (2000-2014) focused on preservation and basic automation, through consolidation (2015-2018) marked by NMEICT-funded scale-up, to expansion (2019-2021) characterized by content growth and COVID-19 acceleration.
2. **NDLI emerged as flagship initiative**: By January 2021, the National Digital Library of India had aggregated over 1.7 crore content items from 160+ sources, registered 30 lakh users, and established federated searching capabilities across multiple languages.
3. **Grey literature constituted significant content**: Reports (57.87%) and theses (33.28%) dominated NDLI's grey literature collection, with the majority (57.04%) openly accessible.

4. **Persistent language gap**: Despite policy commitments to multilingual access, 89.92% of NDLI's grey literature was in English, with indigenous Indian languages representing only about 1% of content.
5. **Sustainability challenges evident**: The Digital Library of India's inactivity from 2017 onward demonstrated that project-based digitization without sustained institutional commitment can lead to inaccessible collections.
6. **e-Granthalaya achieved long-term evolution**: From version 1.0 (2003) to version 4.0 (2015), e-Granthalaya demonstrated successful long-term evolution of library automation infrastructure, transitioning to cloud-ready architecture.
7. **Shodhganga institutionalized open access**: UGC regulations mandating electronic thesis submission established Shodhganga as the national ETD repository, addressing problems of duplication and poor visibility in doctoral research.
8. **COVID-19 accelerated digital adoption**: The March 2020 lockdown forced NDLI to shift from data-driven to service-oriented approaches, resulting in major platform overhauls and user-focused redesign.
9. **Foreign sources dominated content aggregation**: The top three sources for NDLI's grey literature were ERIC (45.54%), Shodhganga (13.26%), and OSTI.GOV (9.01%), highlighting reliance on international content.
10. **Technology and policy alignment critical**: Successful initiatives demonstrated alignment between technological capabilities (federated search, cloud hosting, mobile apps) and policy frameworks (NMEICT, UGC regulations, National Mission on Libraries).

10.2 Theoretical Contributions

This research contributes to digital library and information science theory by:

A. **Extending evolutionary models**: The three-phase framework (pioneering, consolidation, expansion) provides an analytical lens for understanding digital library development in resource-constrained, linguistically diverse contexts.
B. **Documenting the language-technology gap**: The persistent gap between policy commitments to multilingual access and actual content availability (89.92% English) highlights the need for theoretical frameworks that distinguish between interface multilingualism and content multilingualism.
C. **Identifying sustainability factors**: The contrast between DLI's inactivity and NDLI's continued operation suggests that institutional embedding (within IIT Kharagpur) and ongoing funding (through NMEICT) are critical sustainability factors.

10.3 Practical Conclusions

For policymakers, implementers, and researchers, the lessons from 2000-2021 are clear:

A. **Invest in institutional embedding**: Project-based digitization without institutional home is vulnerable to discontinuity. NDLI's location within IIT Kharagpur and e-Granthalaya's within NIC provided sustainable homes.

B. **Address the language gap systematically**: With only ~1% of content in indigenous languages, targeted digitization of Indian language materials is essential for equitable access.

C. **Balance open access with sustainability**: While 57.04% open access is commendable, the 42.96% with access restrictions requires attention to ensure that barriers do not undermine the democratizing mission.

D. **Build crisis resilience**: COVID-19 demonstrated the importance of adaptable, service-oriented platforms. Digital libraries must be designed for agility, not just data aggregation.

E. **Leverage mobile platforms**: NDLI's mobile app (6.70 lakh+ downloads by June 2018) confirmed that mobile-first strategies are essential for reaching Indian users.

Suggestions and Recommendations

For Policymakers

1. **Establish sustainable funding mechanisms**: Move from project-based to institutional funding for digital library initiatives. DLI's inactivity from 2017 demonstrates the risks of project-dependent models.
2. **Mandate Indian language content creation**: With only ~1% of NDLI's grey literature in indigenous languages, policies requiring or incentivizing Indian language content are urgently needed.
3. **Strengthen open access mandates**: While 57.04% of NDLI's grey literature is open access, expanding open access requirements would enhance educational equity.
4. **Support interoperability standards**: Ensure that all digital library initiatives adopt compatible metadata standards (Dublin Core, LRMI) to enable federated searching.
5. **Invest in digital infrastructure**: Address the digital divide through investments in connectivity, devices, and digital literacy, particularly in rural areas.

For Technology Developers

1. **Prioritize Indian language OCR**: The dominance of English content (89.92%) partly reflects OCR limitations for Indian scripts. Investment in Indian language OCR is critical.
2. **Enhance mobile platforms**: With mobile apps demonstrating significant adoption (6.70 lakh+ downloads), continued investment in mobile accessibility is essential.

3. **Develop federated search capabilities**: NDLI's federated searching model should be extended and enhanced to include more Indian language sources.
4. **Implement cloud-ready architectures**: e-Granthalaya's transition to cloud hosting provides a model for scalable, maintainable library automation.
5. **Design for crisis agility**: COVID-19 demonstrated the need for platforms that can rapidly shift from data-driven to service-oriented approaches.

For Library Professionals

1. **Develop digital curation competencies**: The scale of digital library content requires professional skills in metadata creation, quality assessment, and digital preservation.
2. **Advocate for Indian language content**: Library professionals should actively advocate for and participate in Indian language digitization initiatives.
3. **Leverage open access resources**: With 57.04% of NDLI's grey literature openly accessible, librarians should promote these resources to researchers and students.
4. **Contribute to Shodhganga**: Research supervisors and librarians should ensure compliance with UGC mandates for electronic thesis submission.
5. **Participate in capacity building**: The National Mission on Libraries' training programmes for library professionals should be expanded and utilized.

For Researchers

1. **Conduct user studies**: Research on how diverse user populations (students, researchers, general public) actually use digital library resources is needed.
2. **Analyze content quality**: Assess the pedagogical effectiveness, accuracy, and currency of digital library content across disciplines.
3. **Study language barriers**: Investigate the specific barriers to Indian language content creation, digitization, and discovery.
4. **Evaluate sustainability models**: Compare the sustainability of different institutional and funding models for digital libraries.
5. **Document failure cases**: Systematic study of initiatives that became inactive (like DLI) provides valuable lessons for future projects.

Future Scope

1. Post-2021 Longitudinal Analysis

Extend the analysis beyond January 2021 to capture NDLI Phase III (April 2021-March 2020), the continued evolution of e-Granthalaya, and the impact of NEP 2020 implementation on digital library development.

2. User-Centered Research

Conduct primary research with diverse user populations to understand how digital library resources are actually used, barriers to access, and satisfaction levels.

3. Indian Language Content Expansion

Research focused specifically on strategies for increasing Indian language content in digital libraries, including OCR development, crowdsourced digitization, and copyright solutions.

4. Comparative South-South Analysis

Compare India's digital library development with other Global South countries (Brazil, South Africa, Indonesia) to identify transferable lessons and context-specific solutions.

5. Digital Preservation Sustainability

Longitudinal study of digital preservation initiatives to identify factors that distinguish sustainable from non-sustainable projects (comparing DLI and NDLI).

6. AI and Machine Learning Integration

Research on how AI and ML technologies can enhance digital library capabilities, including automated metadata generation, content recommendation, and language translation.

7. Accessibility for Differently-Abled Users

Evaluate the effectiveness of digital library accessibility features and develop guidelines for inclusive design.

8. Economic Impact Assessment

Quantify the economic returns of digital library investments, including educational outcomes, research productivity, and workforce development.

9. Metadata Quality and Interoperability

Assess the quality of metadata across different digital library initiatives and develop recommendations for enhanced interoperability.

10. Crisis Response Capabilities

Research how digital libraries can be designed for rapid adaptation during crises (pandemics, natural disasters, conflicts), building on COVID-19 lessons.

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