

Digital Divide and AI Adoption in Indian Public Libraries: A Comparative Study of Urban and Rural Libraries

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Abstract

This comprehensive research examines the critical disparity in Artificial Intelligence (AI) adoption between urban and rural public libraries in India, situating this analysis within the broader discourse on digital inequality and equitable technology access. Drawing on empirical data from a mixed-methods study involving surveys of 75 libraries across India, case studies of pioneering institutions, and a systematic review of over 60 scholarly sources, this research documents a stark urban-rural divide: 85% AI adoption in urban libraries compared to only 20% in rural libraries ($M=52\%$, $SD=12.5$, $p<0.05$). The study identifies the digital divide affecting 55% of rural India as a primary barrier, compounded by funding constraints, inadequate infrastructure, and a shortage of skilled professionals. Through comparative analysis of institutional case studies—including the National Digital Library of India (NDLI), IIT Bombay Library, and a rural library in Uttar Pradesh—the research demonstrates that while urban libraries benefit from AI-driven efficiencies (35-45% improvements in query resolution and cataloguing), rural libraries struggle with basic connectivity and digital infrastructure. The study also examines government initiatives, including the National Mission on Libraries' capacity building programmes that have trained over 2,600 professionals in AI and ICT tools, yet notes that these efforts have not sufficiently bridged the urban-rural gap. The findings reveal that digital literacy gaps, financial constraints, and institutional resistance further exacerbate the disparity. The research concludes that AI adoption in Indian public libraries cannot achieve its democratizing potential without targeted interventions to address structural inequalities, including increased rural funding, infrastructure development, and community-focused digital literacy programmes. Recommendations include public-private partnerships, open-source AI solutions, and policy reforms to ensure that the benefits of AI-enhanced library services reach all citizens, regardless of geographic location.

Keywords:

Digital Divide, AI Adoption, Public Libraries, Urban-Rural Disparity, Digital Inequality, Indian Libraries, Equitable Access, Digital Literacy, Library Automation, NDLI, National Mission on Libraries, ICT Infrastructure, Rural Libraries, Technology Adoption, Inclusive Development

1. Introduction

The digital divide in India represents one of the most significant barriers to equitable access to information and technology. While India has emerged as a global leader in information technology and digital innovation, the benefits of this transformation have been distributed unevenly across its vast and diverse geography. Public libraries, as institutions dedicated to democratizing knowledge and providing universal access to information, occupy a unique position at the intersection of this divide. They are both affected by and potentially capable of mitigating digital inequalities.

The integration of Artificial Intelligence (AI) into library services offers unprecedented opportunities to enhance information access, personalize user experiences, and streamline library operations. AI-powered cataloguing, intelligent search systems, virtual assistants, and recommendation engines have the potential to transform libraries from passive repositories of books into dynamic, user-centric knowledge centers. However, the adoption of these technologies has been significantly uneven, with urban libraries leading the way while rural libraries lag substantially behind.

This research examines the comparative landscape of AI adoption in urban versus rural public libraries in India. Empirical evidence reveals a stark disparity: while 85% of urban libraries have adopted some form of AI technology, only 20% of rural libraries have done so. This gap is not merely a matter of technological infrastructure but reflects deeper structural inequalities in funding, professional capacity, digital literacy, and institutional support.

The digital divide in India is not a new phenomenon, but the rapid advancement of AI technologies has the potential to either bridge or widen this gap depending on how adoption is managed. Urban libraries, with their superior infrastructure, better funding, and access to skilled professionals, are well-positioned to leverage AI for enhanced services. Rural libraries, by contrast, often struggle with basic connectivity, inadequate computing resources, and a shortage of trained staff, making AI adoption a distant aspiration rather than an immediate priority.

This study situates the urban-rural AI adoption gap within the broader context of digital inequality in India and examines the implications for equitable access to information. It also evaluates the effectiveness of government initiatives, including the National Mission on Libraries (NML) and its capacity building programmes, in addressing this disparity. By analyzing the barriers to AI adoption in rural libraries and identifying factors that enable successful implementation in urban contexts, this

research aims to propose actionable strategies for bridging the divide and ensuring that AI-enhanced library services benefit all citizens.

2. Definitions

2.1 Digital Divide

The digital divide refers to the gap between those who have access to digital technologies and the internet and those who do not. In the Indian context, this divide is multidimensional, encompassing urban-rural disparities, gender gaps, socioeconomic inequalities, and differences in digital literacy. The digital divide affects 55% of rural India, according to survey data, and represents a fundamental barrier to AI adoption in rural public libraries .

2.2 AI Adoption in Libraries

AI adoption in libraries refers to the integration of artificial intelligence technologies into library operations and services. This includes automated cataloguing and classification, intelligent search and recommendation systems, virtual assistants and chatbots, predictive analytics for collection development, and personalized user services .

2.3 Urban Libraries

Urban libraries are public libraries located in cities and metropolitan areas, characterized by higher population density, better infrastructure, greater funding availability, and access to a larger pool of skilled professionals. In this study, urban libraries demonstrate an 85% AI adoption rate .

2.4 Rural Libraries

Rural libraries are public libraries located in villages and rural areas, characterized by lower population density, limited infrastructure, constrained funding, and shortage of trained personnel. In this study, rural libraries demonstrate a 20% AI adoption rate .

2.5 Digital Literacy

Digital literacy refers to the ability to use digital devices, communication applications, and networks to access and manage information. It encompasses skills ranging from basic computer operation to critical evaluation of digital content. The lack of digital literacy among both library staff and users is a significant barrier to AI adoption in rural libraries .

2.6 National Mission on Libraries (NML)

The National Mission on Libraries was established in 2014 by the Government of India to strengthen the public library system. Its four components include: setting up model libraries, conducting surveys of public libraries, organizing capacity building programmes for library professionals, and developing the National Virtual Library of India . The NML has trained more than 2,600 library professionals through 57 capacity building programmes, including sessions on AI and ICT tools .

2.7 National Digital Library of India (NDLI)

The National Digital Library of India is a cloud-based platform that provides access to millions of educational resources across disciplines and languages. It demonstrates the potential of AI and cloud technologies to democratize access to knowledge, serving as a model for equitable digital library development .

2.8 ICT Infrastructure

Information and Communication Technology (ICT) infrastructure refers to the hardware, software, networks, and systems that enable digital services. In the library context, this includes computers, internet connectivity, servers, library management software, and digital storage systems. Inadequate ICT infrastructure is a primary barrier to AI adoption in rural libraries .

3. Need for the Study

3.1 The Significance of Equitable Access

Public libraries are institutions with a mandate to serve all citizens equally. The disparity in AI adoption between urban and rural libraries threatens this mandate, potentially creating a two-tier system where urban users enjoy advanced, AI-enhanced services while rural users are left with basic or declining services. Understanding and addressing this disparity is essential for fulfilling the democratic promise of public libraries.

3.2 The Digital Divide as a Barrier to Development

The digital divide in India is not merely a technological issue but a fundamental barrier to social and economic development. Rural areas, which already face disadvantages in education, healthcare, and economic opportunity, are further marginalized when they lack access to the information resources that urban libraries increasingly provide. AI adoption in libraries could either bridge or widen this gap depending on how it is managed.

3.3 Evidence of Disparity

The empirical evidence of the urban-rural AI adoption gap is striking: 85% versus 20% . This disparity demands systematic investigation to understand its causes, consequences, and potential remedies. Without such research, policy interventions may be misdirected or insufficient.

3.4 Government Initiatives and Their Effectiveness

The Government of India has invested significantly in library modernization through the National Mission on Libraries. Evaluating the effectiveness of these initiatives in addressing the urban-rural divide is essential for ensuring that public resources are used effectively and that policy goals are achieved.

3.5 Lessons from Pioneering Institutions

Case studies of successful AI implementation in Indian libraries, including the National Digital Library of India, IIT Bombay Library, and MICA's facial-authentication system, provide valuable lessons for extending AI adoption to rural contexts. Understanding what works and what doesn't in different contexts can inform strategies for equitable technology adoption.

4. Aims of the Study

The primary aim of this research is to examine the digital divide in AI adoption between urban and rural public libraries in India, analyzing the causes, consequences, and potential remedies for this disparity through a comparative case study approach.

5. Objectives

1. To measure and document the disparity in AI adoption between urban and rural public libraries in India.
2. To identify the primary barriers to AI adoption in rural libraries, including infrastructure, funding, professional capacity, and digital literacy.
3. To analyze the factors that enable successful AI implementation in urban libraries and assess their transferability to rural contexts.
4. To evaluate the effectiveness of government initiatives, particularly the National Mission on Libraries, in addressing the urban-rural digital divide.
5. To examine the role of digital literacy among library staff and users in facilitating or hindering AI adoption.
6. To assess the implications of AI adoption disparities for equitable access to information and knowledge.
7. To identify successful models of AI implementation in resource-constrained settings.
8. To propose strategic recommendations for bridging the urban-rural AI adoption gap in Indian public libraries.

6. Hypothesis

H0: There is no significant difference in AI adoption rates between urban and rural public libraries in India.

H1: There is a significant difference in AI adoption rates between urban and rural public libraries, with urban libraries demonstrating substantially higher adoption.

H2: The primary barriers to AI adoption in rural libraries are inadequate ICT infrastructure, funding constraints, shortage of skilled professionals, and low digital literacy.

H3: Government initiatives, including the National Mission on Libraries, have not sufficiently bridged the urban-rural AI adoption gap despite their capacity building efforts.

7. Literature Search

7.1 Empirical Evidence on Urban-Rural AI Adoption Disparity

Mishra's (2024) study, "Global Perspectives on AI-Driven Library and Information Services: Insights from India," provides the most comprehensive empirical evidence on the urban-rural AI adoption gap. Employing a mixed-methods approach—a systematic review of over 60 sources, surveys of 75 libraries, interviews, and case studies—the study found an 85% AI adoption rate in urban libraries versus 20% in rural ones ($M=52\%$, $SD=12.5$, $p<0.05$). The digital divide was identified as affecting 55% of rural India, based on survey data. Case studies showed 35-45% improvements in efficiency metrics, with query resolution time reduced by 45% (95% CI [40%, 50%]).

7.2 Digital Inequality and Library Services

Sukula, Shettar, Balutagi, Yap, and Chand (2024) published a study in the International Journal of Research in Library Science titled "Digital Inequality and Pathways to Inclusive Development: The context of library services and AI in India." This paper explores how digital divides persist in India and proposes actionable pathways for libraries to leverage AI for inclusive development, addressing gaps in access, literacy, and equitable services. The study identifies libraries as pivotal agents in reducing digital inequality through AI-driven tools and provides real-world strategies for Indian contexts, from rural outreach to urban innovation.

7.3 Smart Libraries and Digital Transformation

Sachdeva's (2024) research on "Smart Libraries and Digital Transformation" examined pathways for digital transformation in Indian libraries from 2018 to 2024, analyzing data from the National Knowledge Network, INFLIBNET, and the National Digital Library of India, along with a cross-sectional survey of 186 academic and public libraries across 22 states and 2 Union Territories. The study found "a clear diffusion pattern with the premier universities (IITs and IIMs) having a good proportion of their files digitised and small state universities and public libraries are less well served." It documents "structural inequities in achieving an equitable digital transformation (urban-to-rural digital divide)" and offers policy suggestions to make the smart library ecosystem truly inclusive.

7.4 Digital Adoption Trends in Indian Libraries

A study published in SIJARA (2023) provides detailed descriptive statistics on digital adoption across library types. The findings reveal that 78% of libraries provide e-resources and 65% offer digital lending services, with academic libraries demonstrating the highest level of digital integration.

Public libraries, however, lag significantly: only 45% have implemented digital indexing and only 38% provide online catalogue access. Comparative analysis shows that private and corporate libraries outperform government-funded libraries, with 85% of corporate and private libraries reporting full-scale digital library establishment compared to only 55% of government-funded libraries. Financial constraints and administrative inertia were identified as key factors in this disparity .

7.5 National Mission on Libraries and Capacity Building

The National Mission on Libraries has been the primary government initiative for library modernization. As of 2024, 57 capacity building programmes have been completed, training more than 2,600 library professionals. The programmes focus on KOHA (free and open-source library automation software), improving services for Divyangjan, deploying artificial intelligence and ICT tools, and scientific preservation of library resources . However, the effectiveness of these programmes in reaching rural libraries and facilitating AI adoption remains limited.

7.6 Cloud, Blockchain, and AI Integration

Mathangi's (2024) research on "Integrating Cloud, Blockchain, and AI in Libraries" explores the transformative potential of these technologies for democratizing knowledge towards Viksit Bharat 2047. The study identifies challenges including the digital divide and equity concerns, noting that "cloud and AI-based services often assume high-speed internet access and digital literacy. In rural or underserved regions, this assumption breaks down. This digital divide can inadvertently exclude users, contradicting the democratization objective." The research proposes a phased roadmap for implementation, including funding via RUSA, CSR partnerships, and government grants .

7.7 SAARC Regional Context

A study on "Transforming Library Services through AI in SAARC Countries" found that "the rate of adoption differed significantly among nations due to enduring obstacles, including insufficient digital infrastructure, constrained financial resources, low AI literacy among library personnel, and inadequate regulatory frameworks regarding data ethics and privacy." India and Sri Lanka emerged as regional frontrunners in AI-driven library innovation and research productivity, while other nations lagged. The study emphasizes "the pressing necessity for investment in digital infrastructure, the creation of AI-specific training programs for library professionals, and the establishment of inclusive, region-specific regulations" .

7.8 AI Adoption in Indian Libraries: Survey Evidence

A 2024 study on "AI Powered Libraries: Charting the Future of Information Services" surveyed 200 library professionals in India. The findings revealed that "while awareness of AI applications—such as automated cataloguing, virtual assistants, recommendation systems, and natural language search tools—is growing, actual implementation remains limited due to challenges like inadequate training,

budget constraints, and ethical concerns." Academic libraries showed a comparatively higher rate of AI integration than public or special libraries. The study recommends "targeted training programs, the development of ethical AI frameworks, cross-sector collaborations, and user-driven development strategies" .

8. Research Methodology

8.1 Research Design

This study employs a descriptive, analytical, and comparative research design, combining quantitative survey data with qualitative case study analysis to examine the urban-rural AI adoption gap in Indian public libraries.

8.2 Primary Data Sources

Quantitative Sources:

1. **Survey Data:** Surveys of 75 libraries across India, measuring AI adoption rates, infrastructure availability, and service delivery metrics. Data reveals 85% AI adoption in urban libraries versus 20% in rural ones ($M=52\%$, $SD=12.5$, $p<0.05$) .
2. **Efficiency Metrics:** Data from case studies on query resolution time (45% reduction, 95% CI [40%, 50%]), cataloguing efficiency (35-45% improvements), and user satisfaction .
3. **Digital Adoption Statistics:** Data from a study of Indian libraries showing 78% e-resource provision, 65% digital lending, 45% digital indexing in public libraries, and 38% online catalogue access .
4. **Survey of Library Professionals:** Data from 200 library professionals on AI awareness, implementation, and barriers .

Qualitative Sources:

1. **Case Studies:** In-depth examination of key institutions including the National Digital Library of India, IIT Bombay Library, MICA, and a rural library in Uttar Pradesh .
2. **Government Reports:** Documents from the National Mission on Libraries, Ministry of Culture, and Ministry of Education .
3. **Expert Interviews:** Interviews with library directors, technology implementers, and policy makers.
4. **Institutional Documentation:** Reports on digital transformation from libraries including XLRI and the British Council Library.

8.3 Analytical Frameworks

Theoretical Frameworks:

1. **Digital Divide Theory:** Analyzing the gap between urban and rural AI adoption in libraries, including access, usage, and outcomes dimensions.
2. **Technology Acceptance Model (TAM):** Examining factors influencing AI adoption, including perceived usefulness, ease of use, and organizational support.
3. **Institutional Theory:** Analyzing how coercive, normative, and mimetic pressures shape library technology adoption patterns.

Analytical Methods:

1. **Descriptive Statistics:** Calculation of AI adoption percentages, efficiency improvement metrics, and infrastructure availability .
2. **Comparative Analysis:** Systematic comparison of urban vs. rural libraries across multiple dimensions including infrastructure, funding, staffing, and digital literacy.
3. **Regression Analysis:** Examination of predictors of digital adoption, with IT infrastructure and institutional funding showing $R^2=0.68$ ($p<0.01$) .
4. **Correlation Analysis:** Analysis of relationship between digital literacy, user engagement, and service effectiveness ($r=0.56$, $p<0.01$) .

8.4 Sample Selection

Institutional Sample:

1. 75 libraries surveyed across India (urban and rural)
2. 186 academic and public libraries across 22 states and 2 Union Territories
3. Case study institutions: National Digital Library of India, IIT Bombay Library, MICA, rural Uttar Pradesh library

Professional Sample:

1. 200 library professionals surveyed on AI awareness and implementation
2. 2,600+ library professionals trained through NML capacity building programmes

8.5 Data Analysis Methods

1. **Statistical Analysis:** Calculation of means, standard deviations, confidence intervals, and significance tests for efficiency and adoption metrics .
2. **Visualization:** Use of pie charts, bar graphs, and tables to illustrate adoption trends, regional disparities, and barriers .
3. **Thematic Analysis:** Qualitative data from case studies and interviews analyzed for recurring themes related to barriers, enablers, and strategies.

8.6 Limitations

1. The study relies on secondary data from existing research, which may have inherent limitations.

2. The focus on selected institutions may not represent all Indian public libraries.
3. Data on rural libraries is limited compared to urban and academic institutions.
4. The rapid pace of AI development means findings may become outdated quickly.
5. Self-reported data on AI adoption may be subject to response bias.

9. Strong Points of AI Adoption in Urban Libraries

9.1 Significant Efficiency Improvements

Urban libraries that have adopted AI technologies demonstrate substantial efficiency gains. Case studies show 35-45% improvements in efficiency metrics, with query resolution time reduced by 45% (95% CI [40%, 50%]) . These improvements translate to faster service delivery, reduced waiting times, and enhanced user satisfaction.

Key Efficiency Gains in Urban Libraries:

1. **Cataloguing Efficiency:** AI-powered cataloguing systems reduce manual effort and improve accuracy, handling metadata tasks, boosting federated search, and reducing duplicates .
2. **Search Optimization:** Semantic search capabilities enhance information discovery and retrieval .
3. **Query Resolution:** Automated chatbots and AI assistants handle routine inquiries, freeing staff for complex tasks .
4. **Personalized Recommendations:** AI algorithms analyze user behaviour to provide tailored book and resource suggestions .

9.2 Advanced Infrastructure and Connectivity

Urban libraries benefit from superior infrastructure that enables AI adoption:

1. Reliable high-speed internet connectivity
2. Adequate computing resources and hardware
3. Cloud-based platforms and digital storage systems
4. Integration with existing library management systems such as KOHA, DSpace, and SOUL

9.3 Professional Capacity

Urban libraries have access to a larger pool of skilled professionals:

1. Librarians with training in digital workflows and AI platforms
2. IT support staff for system maintenance and troubleshooting
3. Opportunities for continuous professional development
4. Collaboration with academic institutions and technology providers

9.4 Funding Availability

Urban libraries generally have better access to funding:

1. Higher budgets for technology acquisition and maintenance
2. Access to government schemes such as PM-USHA and e-Shodh Sindhu
3. Potential for corporate CSR funding and PPP models
4. Support from parent institutions (universities, research organizations)

9.5 Pioneering AI Innovations

Urban libraries have been at the forefront of AI innovation in India:

1. **National Digital Library of India (NDLI):** Cloud-based platform with millions of resources, multilingual access, and AI-powered search .
2. **MICA Facial Authentication:** India's first library to introduce facial-authentication self-service kiosks .
3. **Jio Institute Automated News Delivery:** AI-powered news alert system using ChatGPT .
4. **IIT Bombay Library:** Advanced AI integration for cataloguing, search, and user services .

9.6 Enhanced User Experience

AI adoption in urban libraries has significantly enhanced user experience:

1. 24/7 access through digital platforms and virtual assistants
2. Personalized services tailored to individual preferences
3. Multilingual support for diverse user populations
4. Mobile-first access for on-the-go users

9.7 Integration with National Initiatives

Urban libraries are well-positioned to benefit from national digital initiatives:

1. NDLI provides aggregated discovery layers and AI training environments
2. INFLIBNET's Shodhganga and ShodhShuddhi offer digital resources and plagiarism detection
3. e-ShodhSindhu provides access to scholarly databases

10. Weak Points of AI Adoption in Rural Libraries

10.1 Stark Urban-Rural Disparity

The most significant weakness in AI adoption is the stark disparity between urban and rural libraries. While 85% of urban libraries have adopted AI technologies, only 20% of rural libraries have done so . This 65-percentage-point gap reflects deep structural inequalities and threatens the democratic mission of public libraries.

10.2 Digital Divide and Connectivity

The digital divide is the primary barrier to AI adoption in rural libraries:

1. The digital divide affects 55% of rural India
2. Inadequate internet connectivity in rural areas

3. Limited computing resources and hardware
4. Unreliable power supply in some regions
5. Cloud and AI-based services assume high-speed internet access, which breaks down in rural settings

10.3 Inadequate ICT Infrastructure

Rural libraries face significant infrastructure deficiencies:

1. Outdated or insufficient computer hardware
2. Limited digital storage and server capacity
3. Lack of integration with modern library management systems
4. Inability to support AI-driven applications

10.4 Funding Constraints

Rural libraries operate under severe financial constraints:

1. Inadequate budgets for technology acquisition and maintenance
2. Dependence on state government funding, which is often limited
3. Central assistance released only on recommendation of State Library Planning Committee in 75:25 Centre-State ratio
4. Competing priorities for limited resources
5. Limited private sector investment in rural libraries

10.5 Professional Staffing Crisis

Rural libraries face a critical shortage of qualified professionals:

1. In a study of three district central libraries in Andhra Pradesh, only three qualified librarians were found among 35 total staff members
2. Limited training in AI and digital technologies
3. High turnover and retention challenges
4. Inability to attract skilled professionals to rural locations

10.6 Digital Literacy Gaps

Low digital literacy among both staff and users constrains AI adoption:

1. Library staff lack skills to utilize AI-powered tools effectively
2. Users are unaware of or unable to use digital services
3. Language barriers in AI interfaces
4. Training opportunities are limited in rural areas

10.7 Institutional Resistance

Rural libraries often face institutional resistance to change:

1. Traditional management techniques and mindsets

2. Apprehension about new technology
3. Bureaucratic delays in implementation
4. Lack of clear policies and guidelines

10.8 Limited AI Awareness

Awareness of AI applications remains limited in rural libraries:

1. While awareness of AI applications is growing among library professionals, actual implementation remains limited
2. Rural librarians may lack exposure to AI possibilities
3. Limited dissemination of successful AI implementation models

10.9 Ethical and Privacy Concerns

AI adoption raises ethical concerns that are amplified in rural contexts:

1. Data privacy concerns in small communities
2. Risk of algorithmic bias in AI systems
3. Lack of governance frameworks for ethical AI use

10.10 Compounding Disadvantages

Rural libraries face compounding disadvantages that create a cycle of underdevelopment:

1. Limited resources lead to limited services
2. Limited services lead to limited user engagement
3. Limited user engagement leads to reduced political priority
4. Reduced political priority leads to continued resource limitations

11. Current Trends

11.1 Accelerating AI Adoption with Persistent Disparities

AI adoption in Indian libraries is accelerating, driven by technological advancements, government initiatives, and growing awareness of benefits. The evolution from early Integrated Library Systems like LIBSYS to contemporary AI applications marks a significant trajectory . However, the urban-rural disparity remains persistent, with urban libraries adopting AI at more than four times the rate of rural libraries .

11.2 Government-Led Capacity Building

The National Mission on Libraries is actively building capacity for AI integration:

1. 57 capacity building programmes completed, training over 2,600 professionals
2. Focus on KOHA (open-source library automation software), AI tools, and ICT integration
3. Inclusion of services for Divyangjan (persons with disabilities) in training programmes
4. 58th programme launched at Kumaun University in August 2024

However, these programmes have not sufficiently reached rural libraries or bridged the urban-rural gap.

11.3 Smart Library and Digital Transformation

Libraries are increasingly adopting smart library models:

1. RFID-enabled circulation services
2. Self-service kiosks for autonomous transactions
3. Unified discovery platforms for integrated resource access
4. 24/7 digital access and remote learning support

The diffusion pattern shows premier universities (IITs and IIMs) having a high proportion of digitized files, while small state universities and public libraries are less well served .

11.4 Cloud-Based Solutions for Scalability

Cloud computing is emerging as a key enabler of AI adoption:

1. National Digital Library of India demonstrates cloud scalability for mass knowledge delivery
2. Cloud eliminates infrastructure dependency and enables multilingual digital content delivery
3. Mobile-first access for underserved users
4. Automated backups and disaster recovery

11.5 AI-Powered Innovations

Pioneering AI applications are emerging across India:

1. **NDLI**: Cloud-based platform with millions of resources and AI-powered search
2. **INFLIBNET**: ShodhShuddhi plagiarism detection using AI
3. **DELNET**: AI-enhanced federated search
4. **Indian Culture Portal**: AI-powered chatbot Bharti integrated with Bhashini platform for 22 Indian languages

11.6 Focus on Digital Literacy and Training

There is growing recognition of the need for digital literacy programmes:

1. User engagement and digital literacy show positive correlation with service effectiveness ($r=0.56$, $p<0.01$)
2. Libraries with systematic digital training programmes show higher user adoption rates
3. NML capacity building programmes include digital literacy components

11.7 Policy Frameworks and National Initiatives

Policy frameworks are evolving to support library digital transformation:

1. National Education Policy 2020 emphasizes digital library development
2. Digital India and Library 2047 initiatives for citizen empowerment

3. Viksit Bharat 2047 vision includes universal knowledge accessibility
4. National Mission on Libraries provides funding for model libraries and capacity building

11.8 Open-Source Solutions

Open-source software is gaining traction as a cost-effective alternative:

1. KOHA library automation software now used by institutions including the National Library in Kolkata
2. Open-source AI tools offer feasible avenues for libraries with limited budgets
3. Community-driven development reduces costs and increases sustainability

11.9 International Comparisons and Learning

India is increasingly engaging with international best practices:

1. Comparisons with China and USA in AI adoption
2. SAARC regional collaboration and knowledge sharing
3. India and Sri Lanka as regional frontrunners in AI-driven library innovation

12. History of Digital Divide and AI Adoption in Indian Libraries

12.1 Pre-2010: Early Automation

The history of library automation in India began with the introduction of Integrated Library Systems (ILS):

1. **LIBSYS:** One of the first ILS systems adopted by Indian libraries
2. **KOHA:** Open-source ILS gaining popularity from the late 2000s
3. Early automation focused on cataloguing, circulation, and acquisitions
4. Urban and academic libraries led early adoption, while rural libraries remained largely manual

12.2 2010-2014: Digital Transition

The period 2010-2014 saw growing digital adoption:

1. Expansion of digital repositories and institutional archives
2. Introduction of digital libraries in academic institutions
3. Growing internet connectivity in urban libraries
4. National Mission on Libraries established in 2014
5. Digital divide beginning to be recognized as a policy concern

12.3 2014-2019: National Mission and Capacity Building

The establishment of NML marked a turning point:

1. Model libraries development in states and districts
2. Surveys of public libraries conducted

3. Capacity building programmes initiated
4. National Virtual Library of India (now Indian Culture Portal) developed
5. Training focused on automation and basic digital tools

12.4 2020-2022: Pandemic Acceleration

The COVID-19 pandemic accelerated digital transformation:

1. Shift to digital and remote library services
2. Increased adoption of e-resources and digital platforms
3. British Council Library's full digital transition
4. Growing recognition of the digital divide as a critical barrier
5. Early AI applications in academic and private libraries

12.5 2023-2024: AI Integration and Persistent Disparities

The most recent period has witnessed rapid AI innovation alongside persistent disparities:

1. **NDLI expansion:** Cloud-based platform serving millions
2. **AI-powered innovations:** VEDA AI Librarian, MICA facial authentication, Jio Institute news delivery
3. **NML capacity building:** 57 programmes, 2,600+ professionals trained
4. **Persistent urban-rural gap:** 85% vs. 20% AI adoption
5. **Policy focus:** Viksit Bharat 2047, NEP 2020, Digital India
6. **Research attention:** Growing scholarly focus on digital inequality and AI adoption

13. Discussion

13.1 The Digital Divide as a Fundamental Barrier

The most significant finding of this research is the stark disparity in AI adoption between urban and rural libraries in India. The 85% adoption rate in urban libraries versus 20% in rural ones represents a 65-percentage-point gap that reflects deep structural inequalities. This divide is not merely a matter of technological infrastructure but encompasses funding, professional capacity, digital literacy, and institutional support.

The digital divide affecting 55% of rural India is the primary barrier to AI adoption. Cloud and AI-based services assume high-speed internet access and digital literacy, assumptions that break down in rural and underserved regions. This creates a paradox: the technologies that could most benefit rural libraries by democratizing access to information are precisely those that rural libraries are least able to adopt.

13.2 Compounding Disadvantages in Rural Libraries

Rural libraries face compounding disadvantages that create a cycle of underdevelopment:

1. **Infrastructure:** Inadequate connectivity and computing resources
2. **Funding:** Severe financial constraints, with Central assistance dependent on State matching contributions
3. **Staffing:** Critical shortage of qualified professionals—only three qualified librarians among 35 staff in studied Andhra Pradesh libraries
4. **Digital Literacy:** Low levels among both staff and users
5. **Institutional Resistance:** Traditional mindsets and bureaucratic delays

These disadvantages reinforce each other, making AI adoption progressively more difficult.

13.3 The Role of Government Initiatives

Government initiatives, particularly the National Mission on Libraries, have made important contributions:

1. 57 capacity building programmes completed, training 2,600+ professionals
2. Focus on KOHA, AI tools, ICT integration, and services for Divyangjan
3. Model library development in states and districts
4. National Virtual Library of India/Indian Culture Portal development

However, these initiatives have not sufficiently bridged the urban-rural gap. The capacity building programmes, while valuable, have not reached enough rural librarians. The model library component, while providing funding, has not addressed the systemic underfunding of rural libraries. As the study of digital adoption trends shows, only 55% of government-funded libraries report full digital transformation compared to 85% of corporate and private libraries .

13.4 Predictors of Digital Adoption

Regression analysis reveals that IT infrastructure and institutional funding are powerful predictors of digital adoption ($R^2=0.68$, $p<0.01$) . This finding has significant implications for policy: without investment in infrastructure and funding, rural libraries cannot overcome the barriers to AI adoption. The correlation between digital literacy, user engagement, and service effectiveness ($r=0.56$, $p<0.01$) further underscores the importance of training programmes .

13.5 Successful Models and Their Transferability

Successful AI implementation models in Indian libraries provide valuable lessons:

1. **NDLI:** Demonstrates cloud scalability for mass knowledge delivery
2. **MICA Facial Authentication:** Shows potential of AI for user convenience
3. **KOHA:** Proves viability of open-source solutions

However, the transferability of these models to rural contexts depends on addressing infrastructure, funding, and capacity constraints. Open-source solutions like KOHA offer a cost-effective pathway, but they still require basic infrastructure and trained staff.

13.6 Digital Literacy as a Critical Factor

Digital literacy emerges as a critical factor in AI adoption. The lack of digital literacy among library staff and users in rural areas is a significant barrier. Libraries with systematic digital training programmes show higher user adoption rates, and user engagement correlates positively with service effectiveness. This suggests that investment in digital literacy programmes is as important as investment in technology itself.

13.7 Ethical and Governance Considerations

AI adoption raises ethical concerns that are particularly significant in rural contexts:

1. **Data Privacy:** Concerns about collection and use of patron data
2. **Algorithmic Bias:** Risk of AI systems perpetuating existing biases
3. **Governance Gaps:** Lack of regulatory frameworks for ethical AI use

These concerns require robust governance frameworks to ensure that AI adoption in libraries is ethical, transparent, and accountable.

13.8 International and Regional Comparisons

India's experience with AI adoption in libraries offers insights for comparative studies. India and Sri Lanka have emerged as regional frontrunners in AI-driven library innovation within SAARC. The persistence of urban-rural disparities in India, despite its relatively advanced digital infrastructure compared to other SAARC nations, suggests that economic development alone does not automatically resolve digital inequalities.

14. Results

14.1 AI Adoption Rates by Location

Category	AI Adoption Rate	Significance
Urban Libraries	85%	Significantly higher ($p < 0.05$)
Rural Libraries	20%	Significantly lower
Overall Average	52%	SD=12.5

14.2 Digital Adoption by Library Type

Library Type	Full Digital Transformation	E-Resource Provision	Digital Lending	Online Catalogue

Library Type	Full Digital Transformation	E-Resource Provision	Digital Lending	Online Catalogue
Academic Libraries	Highest	78%	65%	High
Public Libraries	55%	Moderate	Moderate	38%
Corporate/Private	85%	High	High	High

14.3 Efficiency Improvements from AI Adoption

Metric	Improvement
Query Resolution Time	45% reduction (95% CI [40%, 50%])
Cataloguing Efficiency	35-45% improvement
Circulation Processing	Significantly faster with self-service kiosks

14.4 Predictors of Digital Adoption

Predictor	R ²	Significance
IT Infrastructure & Funding	0.68	p<0.01
Digital Literacy & User Engagement	r=0.56	p<0.01

14.5 Barriers to AI Adoption in Rural Libraries

Barrier	Impact
Digital Divide	Affects 55% of rural India
Funding Constraints	Severe, dependent on state matching

Barrier	Impact
Staffing Shortage	Only 8.6% qualified librarians in studied libraries
Digital Literacy Gaps	Both staff and users affected
Infrastructure Deficiencies	Limited connectivity and computing resources

14.6 NML Capacity Building Impact

Metric	Achievement
Capacity Building Programmes Completed	57
Library Professionals Trained	2,600+
Training Focus Areas	KOHA, AI tools, ICT, Divyangjan services, preservation

14.7 Digital Literacy and Service Effectiveness

Correlation	r Value	Significance
Digital Literacy & User Engagement	0.56	p<0.01
Training Programmes & User Adoption	Positive	Significant

15. Conclusion

15.1 Summary of Findings

This comprehensive research has examined the digital divide in AI adoption between urban and rural public libraries in India, documenting a stark disparity and analyzing its causes, consequences, and potential remedies.

Key Findings:

1. **Significant Urban-Rural Disparity:** AI adoption is 85% in urban libraries compared to only 20% in rural libraries ($M=52\%$, $SD=12.5$, $p<0.05$), representing a 65-percentage-point gap .

2. **Digital Divide as Primary Barrier:** The digital divide affects 55% of rural India and is the primary barrier to AI adoption in rural libraries .
3. **Compounding Disadvantages:** Rural libraries face compounding disadvantages including inadequate infrastructure, severe funding constraints, professional staffing shortages, and low digital literacy .
4. **Efficiency Improvements in Urban Libraries:** AI adoption in urban libraries has demonstrated 35-45% improvements in efficiency metrics, with query resolution time reduced by 45% .
5. **Government Initiatives Insufficient:** While the National Mission on Libraries has trained over 2,600 professionals, these efforts have not sufficiently bridged the urban-rural AI adoption gap .
6. **Digital Literacy as Critical Factor:** Digital literacy correlates positively with user engagement and service effectiveness ($r=0.56$, $p<0.01$), highlighting the need for training programmes .
7. **Predictors of Digital Adoption:** IT infrastructure and institutional funding are powerful predictors of digital adoption ($R^2=0.68$, $p<0.01$) .
8. **Successful Models Exist:** Pioneering innovations including NDLI, MICA facial authentication, and KOHA open-source solutions provide models for AI adoption, though transferability to rural contexts requires addressing infrastructure and capacity constraints .

15.2 Hypothesis Testing

H0 (Null Hypothesis): There is no significant difference in AI adoption rates between urban and rural public libraries in India.

Verdict: Rejected. The evidence demonstrates a statistically significant difference (85% vs. 20%, $p<0.05$) .

H1: There is a significant difference in AI adoption rates between urban and rural public libraries.

Verdict: Accepted. Urban libraries demonstrate substantially higher AI adoption.

H2: The primary barriers to AI adoption in rural libraries are inadequate ICT infrastructure, funding constraints, shortage of skilled professionals, and low digital literacy.

Verdict: Accepted. These barriers are consistently identified across multiple studies .

H3: Government initiatives have not sufficiently bridged the urban-rural AI adoption gap.

Verdict: Accepted. Despite NML capacity building programmes training 2,600+ professionals, the 65-percentage-point gap persists .

15.3 Implications

The findings have significant implications for library policy, practice, and research:

Policy Implications:

1. Need for targeted investment in rural library infrastructure and connectivity
2. Requirement for increased and sustained funding for rural libraries
3. Importance of digital literacy programmes for staff and users
4. Need for ethical AI governance frameworks

Practice Implications:

1. Rural libraries require tailored AI adoption strategies that account for resource constraints
2. Open-source solutions offer cost-effective pathways
3. Community-focused approaches are essential for meaningful adoption

Research Implications:

1. Need for longitudinal studies tracking AI adoption over time
2. Importance of empirical research on AI impact in rural contexts
3. Requirement for intersectional analysis of digital inequality

15.4 Contribution to the Field

This study contributes to the growing body of knowledge on digital inequality and AI adoption in Indian libraries by:

1. Providing comprehensive empirical evidence on the urban-rural AI adoption gap
2. Identifying the compounding barriers that rural libraries face
3. Evaluating the effectiveness of government initiatives
4. Proposing strategic recommendations for bridging the divide

16. Suggestions and Recommendations

16.1 For Government and Policymakers

Targeted Investment in Rural Infrastructure:

1. Increase funding for rural library technology infrastructure and connectivity
2. Develop specialized programmes for bridging the digital divide
3. Provide subsidies for internet connectivity in rural libraries
4. Ensure reliable power supply for digital infrastructure

Enhanced Funding Mechanisms:

1. Increase Central assistance for rural libraries beyond the current 75:25 Centre-State ratio
2. Simplify funding procedures to reduce bureaucratic delays
3. Create dedicated funding streams for AI adoption in rural libraries
4. Encourage corporate CSR funding and public-private partnerships

Expanded Capacity Building:

1. Scale up NML capacity building programmes to reach more rural librarians

2. Develop specialized AI training modules for rural contexts
3. Create online learning resources for remote training
4. Establish mentorship programmes connecting urban and rural librarians

Digital Literacy Initiatives:

1. Develop community-focused digital literacy programmes
2. Provide training for library staff in AI tools and applications
3. Create multilingual training materials
4. Integrate digital literacy into broader adult education programmes

Policy Reform:

1. Align national and state policies on library modernization
2. Include AI adoption in national digital literacy missions
3. Develop clear guidelines for ethical AI use in libraries

16.2 For Library Administrators

Strategic Technology Planning:

1. Develop phased AI implementation roadmaps appropriate for resource-constrained settings
2. Prioritize low-cost, high-impact AI applications (e.g., automated cataloguing, basic chatbots)
3. Pilot AI applications before full-scale deployment
4. Leverage open-source solutions such as KOHA

Professional Development:

1. Invest in continuous training for staff
2. Partner with technology providers for training programmes
3. Create peer learning networks among rural librarians
4. Utilize NML capacity building programmes

User Engagement:

1. Conduct user needs assessments before implementing AI services
2. Provide digital literacy training for users
3. Develop multilingual AI interfaces
4. Ensure AI services are accessible to users with disabilities

Collaborative Approaches:

1. Partner with academic institutions and technology providers
2. Share resources and expertise through library consortia
3. Participate in NDLI and INFLIBNET initiatives
4. Establish twinning arrangements between urban and rural libraries

16.3 For Technology Providers

Affordable Solutions:

1. Develop cost-effective AI solutions for resource-constrained libraries
2. Provide open-source alternatives to proprietary systems
3. Offer scalable solutions suitable for different library sizes
4. Consider low-bandwidth designs for rural connectivity

Language and Localization:

1. Support multiple Indian languages in AI interfaces
2. Develop culturally appropriate AI applications
3. Consider local content and resource needs
4. Leverage Bhashini platform for multilingual AI

Training and Support:

1. Provide comprehensive training for library staff
2. Offer technical support and maintenance services
3. Develop user-friendly documentation and resources
4. Create remote support capabilities for rural libraries

16.4 For Educators and Researchers

Curriculum Development:

1. Integrate AI and digital library technology in LIS education
2. Develop specialized courses in library AI applications
3. Include practical training in AI tools and open-source software
4. Address digital inequality in LIS curricula

Research Priorities:

1. Conduct empirical research on AI impact in rural libraries
2. Study digital divide and equity issues systematically
3. Examine ethical and governance frameworks for AI in libraries
4. Document successful AI implementation models in resource-constrained settings

Knowledge Sharing:

1. Disseminate research findings to practitioners
2. Organize conferences and workshops on library AI
3. Create platforms for practitioner-researcher collaboration
4. Publish case studies of AI adoption in rural contexts

16.5 For International Organizations and Donors

Funding and Support:

1. Provide targeted funding for rural library infrastructure

2. Support capacity building for rural librarians
3. Fund research on digital inequality in library services
4. Support open-source AI development for libraries

Knowledge Exchange:

1. Facilitate South-South cooperation on library AI adoption
2. Document and share successful models from other developing countries
3. Support regional collaboration within SAARC and beyond

17. Future Scope of the Study

17.1 Emerging Research Areas

Longitudinal Studies:

1. Track AI adoption trends over time in both urban and rural libraries
2. Examine long-term impact on library services and user outcomes
3. Study career trajectories of library professionals with AI skills
4. Assess the sustainability of AI interventions in resource-constrained settings

Comparative Research:

1. International comparison of AI adoption in libraries
2. Comparison between academic, public, and special libraries
3. Cross-regional studies within India
4. SAARC regional comparisons

User Studies:

1. Empirical research on user experience with AI-powered services in rural settings
2. Study of digital literacy and AI access barriers
3. Examination of user trust and acceptance of AI
4. Assessment of AI impact on information-seeking behaviour

Technology Assessment:

1. Evaluation of emerging AI technologies (GenAI, LLMs, etc.) for library applications
2. Assessment of cost-effectiveness of AI investments in rural contexts
3. Study of technology sustainability in resource-constrained settings
4. Development of appropriate technology models for rural libraries

17.2 Policy and Practice Opportunities

AI Integration Framework:

1. Development of comprehensive framework for equitable AI adoption in libraries
2. Creation of implementation guides and best practices for rural contexts

3. Establishment of standards and benchmarks for AI in libraries
4. Development of ethical AI governance frameworks

Collaborative Initiatives:

1. Public-private partnerships for rural library technology
2. Library consortia for shared AI resources
3. Community-driven innovation models
4. Twinning arrangements between urban and rural libraries

Capacity Building Expansion:

1. Scaling up training programmes to reach all rural librarians
2. Developing specialized AI certification for library professionals
3. Creating online learning resources for remote training
4. Establishing mentorship networks

17.3 Emerging Technologies

Generative AI:

1. Impact of GenAI on reference services and content creation
2. Ethical implications of AI-generated content in libraries
3. Integration of large language models in library systems
4. Potential for AI to bridge language barriers in rural contexts

Open Source Solutions:

1. Development and adoption of open-source AI tools
2. Community-driven AI innovation
3. Sustainability of open-source library platforms
4. Cost-effectiveness of open-source vs. proprietary solutions

Cloud and Edge Computing:

1. Cloud-based solutions for scalability and accessibility
2. Edge computing for low-connectivity environments
3. Hybrid models combining cloud and local resources
4. Disaster recovery and data backup solutions

17.4 Future Trends

Hyper-Personalization:

1. AI-powered personalized learning journeys
2. Customized resource recommendations
3. Adaptive user interfaces
4. Proactive service delivery

Immersive Learning:

1. Integration of Metaverse technologies in libraries
2. Virtual reading rooms and collaborative learning spaces
3. 3D content and interactive experiences
4. VR/AR for immersive information access

Data-Driven Decision Making:

1. Predictive analytics for collection development
2. User behaviour analysis for service improvement
3. Evidence-based library management
4. Real-time monitoring and evaluation

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