

Blockchain Solutions for Academic Libraries: A Framework for Trustworthy License Authentication and Secure Digital Resource Lending

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ABSTRACT

An increased number of dependencies on digital resources has fundamentally changed how academic libraries acquire, provide access to, and maintain information. The contemporary library depends not on physical materials in its possession but rather on subscription and license services issued to it by commercial vendors. Such licensing systems usually restrict downloading, printing, and interlibrary lending, thereby entrapping libraries in proprietary systems managed by Digital Rights Management (DRM). This dependency increases the lack of transparency and limits access to knowledge fairly. Blockchain is a decentralized and immutable registry that provides a new mechanism for addressing these challenges. Blockchain technology can rebuild trust and autonomy in digital lending environments by helping ensure the security of license authentication, automating lending processes via smart contracts, and tracking verifiable usage history. The paper explores the possibility of blockchain-based systems in academic libraries, specifically higher education consortia in India, such as INFLIBNET and DELNET, or on international projects such as MIT Digital Credentials Initiative and European Blockchain Services Infrastructure (EBSI). Our idea is a blockchain-based model that will increase the transparency, interoperability, and accountability of digital resource management. The research paper ends with a policy recommendation that is aligned with the National Education Policy (NEP) 2020 and it provides the creation of librarian competencies that will be needed in the sustainable implementation of the policy.

KEYWORDS: Blockchain; Academic Libraries; Digital Lending; Smart Contracts; Digital Rights Management (DRM); Licensing; National Education Policy (NEP) 2020; Information Governance.

1. INTRODUCTION

Libraries have widely been viewed as the custodians of the knowledge of culture making them the equitable access to information. The role has radically changed with the digital era as the print communication has in most cases been replaced by the digital modes. Traditional print collections were commonly owned and owned by the library in full and control but the digital collection like e-books, electronic journals and multimedia materials are usually given out on a time-based license. Since they are licenses and the libraries are left in charge of the publisher, the libraries do not have the authority of direct control of access and use, thereby limiting the independence that they used to have. Due to the spread of digital information and demands on the use of increased security, transparency, and efficiency in information management systems, blockchain technology has become a central instrument in redefining the contemporary library (Hussain, 2021). The value of blockchain is connected to the strength of its cryptographic base, which provides unparalleled chances to handle problems embedded in library ecosystems in terms of data integrity, authenticity, and intellectual property protection. It especially would help to strengthen digital preservation by ensuring that cultural and academic data cannot be tampered with and accessed by unauthorized individuals (Laboso et al., 2024). It is referred to as an innovation characterized as disruptive, blockchain can presents a new paradigm on distributed data storage, peer-to-peer transmission, smart contracts, and asymmetric encryption algorithms that can be potentially revitalize the traditional model of operations and management in academic libraries (Ma & Xia, 2022). The complex use of blockchain in libraries are analyzed, which include, but are not limited to building trust in digital assets, validating licensing deals, and ensuring digital lending practices. It also introduces a powerful platform that will increase the resources distribution, streamline the borrowing frameworks, and store sensitive customer information safely (Xu & Shang, 2023). The efficacy of blockchain in reducing data tampering in institutional databases can also be associated with the fact that blockchain offers a high level of stability, and libraries can more easily track the intellectual property rights and ownership (Oyelude, 2022). The review was carried out in a systematic manner to integrate current literature on the use of blockchain in libraries and define opportunities for and challenges of its implementation. It questions how this new technology, often associated with cryptocurrencies, can be used to help solve some of the most pressing problems in resource sharing, copyright safeguarding, and joint knowledge building within the library environment. This paper discusses how blockchain could bring about revolution regarding digital lending in academic libraries. Based on the examples of the higher-education settings in India, along with the international initiatives of similar digital-trust, the proposal outlines a blockchain-based lending model that would be in accordance with the principles of more inclusive and collaborative education as outlined in the National Education Policy (NEP) 2020 of India.

2.1 Blockchain Technology Fundamentals

Blockchain, as an innovation of the concept and, really, a continuation of the Bitcoin model, is a rather complex and stable technological process that has been created and is already implemented in a number of uses. This decentralized registry system uses the methodology to connect the transaction blocks to each other to create an indelible and clear chain of records that lacks any central controlling authority which subsequently ensures the integrity and security of the data. Every block has a hashing of its predecessor block, a time stamp and a data of the transaction, therefore creating an unbroken chain that may not be easily tampered with and traces the data becomes easy. This property of tamper-resistance is the side effect of its decentralized, append-only design that makes it a useful instrument in keeping reliable records in a variety of industries.

3. REVIEW OF LITERATURE

(Laboso et al., 2024) This paper summarizes the existing empirical evidence on possible applications of blockchain technology, which can be defined as a decentralized and immutable registry, in overcoming the existing obstacles encountered by digital libraries, especially those related to data integrity, provenance, and safe access to resources. (Oyelude, 2022) It talks about how blockchain technology helps to improve the credibility of online documents, gives transparent and traceable sources of intellectual property and creates effective structures to support licensing and lending deals involving digital content. (Gautam, 2025) It also looks at how blockchain is able to protect the information of patrons and users, their privacy, and the efficiency of research paper information, with special attention on the use of secure authentication methods through the use of public and private keys. (Hussain, 2025) The combination of blockchain and artificial intelligence in academic libraries is an emerging field of development, as the first mentions of AI in use in cataloging, classification, and indexing libraries can be found as early as the late 1980s with the growing size of library materials. (Hussain, 2021) Despite its known usage over time, blockchain and its application to managing digital rights and ensuring the integrity of scientific publications have developed more recently and created verifiable records and ensured the integrity of these publications. (Lengoatha & Seymour, 2020) Even though the adoption of blockchain in libraries is still nascent, academic libraries are starting to recognize its potential to revolutionize the work of collaborating with others and providing information services. (Oladokun et al., 2025) This view is also supported by the fact that there is an overall receptiveness to new technologies among librarians; AI, in this matter, has a similar set of principles in the data management and security domains, and thus, they are becoming the first to introduce new solutions aimed at improving the library services. (Wheatley & Hervieux, 2020) The openness mentioned above highlights the need to continue training library employees and patrons about AI, a trend that is bound to spread to include blockchain applications. (Safdar et al., 2022) The ultimate knowledge of these new technological frameworks will be necessary in order to harness the inherent potential of the blockchain to guarantee trust, license authentication, and digital lending to the changing library systems. (Nova et al., 2025) The fact that AI and blockchain complement each other also supports this position. The AI-based services are enhancing the experiences of clients and making library processes smoother. (Bairagi & Lihitkar, n.d.) AI can be used to maximize resource distribution and predict user preferences, whereas blockchain can be used to guarantee the provenance and authority of these resources. Convergence of these technologies will enable libraries to offer high-tech solutions, including automated circulation and improved reference services whereby AI controls mainly efficiency in operations, and blockchain ensures that records cannot be changed and controlled access management.

3.1 Research Gap:

Although blockchain technology has so far been explored in the areas of digital preservation and identity verification, its incorporation into the digital lending workflow within Indian academic library consortia has received limited attention. The present study proposes a policy consideration, infrastructure requirement, and professional practice-informed blockchain based lending model.

3.2 Problem Statement:

The current status of licensing ambiguity, limited transparency of usage statistics, monopolistic vendor control, and the general lack of support for equitable resource sharing defines the digital resource ecosystem within libraries. A

decentralized, verifiable, and sustainable model of digital lending that protects both copyright compliance and user access rights is fundamentally needed.

3.3 Research Questions

1. How can blockchain increase digital resource licensing transparency and trust?
2. What blockchain-based framework can support secure and auditable digital lending in academic libraries?

OBJECTIVES

1. To assess the feasibility of the adoption of blockchain for digital library lending and license authentication.
2. To analyze stakeholder perceptions concerning blockchain-driven digital resource governance.
3. To identify implementation challenges and propose policy recommendations.

4. METHODOLOGY

This research design is a mixed-method exploratory design entailing a systematic review of the literature regarding blockchain applications in information systems from 2015 to 2025, an assessment of the technology frameworks of blockchain platforms like Hyperledger, Ethereum, and Filecoin, and conceptual model development using workflow and architecture mapping.

4.1 Tools Employed in this study: M.S. PowerPoint is used for graphical visualization.

5. STATUS OF DIGITAL LENDING IN ACADEMIC LIBRARIES

5.1 Indian Academic and Research Libraries

Indian academic libraries function largely as consortia-driven ecosystems, which provide maximum access through shared licensing. Major initiatives like e-Shodh Sindhu (INFLIBNET), DELNET, and NDL India (IIT Kharagpur) have enlarged scholarly access through collaboration across universities. Despite such success stories, however, there still remain serious limitations to these frameworks.

Table 1 Consortium/Initiatives and their roles

Consortium / Initiative	Coordinating Body	Primary Role
e-Shodh Sindhu	INFLIBNET (UGC)	Provides shared access to journals and databases for universities
DELNET	Developing Library Network	Facilitates inter-library loan and document delivery
NDL India	IIT Kharagpur (MoE)	Aggregates metadata for scholarly resources at the national scale

Digital materials generally cannot be lent outside of the licensing institution, even within the same consortium.

- Often the case, publishers demand separate institutional licenses for the same resource, which causes duplication and inflated costs across IITs, NITs, and universities.

For example, IIT Bombay and IIT Kanpur may purchase the same electronic book collections, each individually, say, without any one of them getting the license or being able to share it digitally with the other; this is quite

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astonishing, even though they are public-funded institutions. This is against the long traditional spirit of cooperation among libraries on such grounds of efficiency.

5.2 Global Models and Experiments

5.2.1 MIT Digital Credentials Initiative (DCI)

Several international projects indicate how blockchain might solve some of these challenges. The MIT Digital Credentials Initiative showcased blockchain's ability to securely issue and verify digital assets without central control, and that model scales easily to digital lending rights.

5.2.2 European Blockchain Services Infrastructure (EBSI)

Similarly, the European Blockchain Services Infrastructure allows for cross-border verification among European universities and provides a scalable model for interlibrary collaboration.

5.2.3 Controlled Digital Lending (CDL) Model

The innovative concept of the Controlled Digital Lending, developed by the Internet Archive, was aimed at translating the traditional lending principles into the realm of digital space through a one-copy-one-user principle. But they met legal challenges of publishers who were mainly challenged by the difficulties of proving controlled circulation. Verifiable blockchain records provide a possible solution to this conundrum, which will guarantee the digital lending practices become both regulatory and responsible.

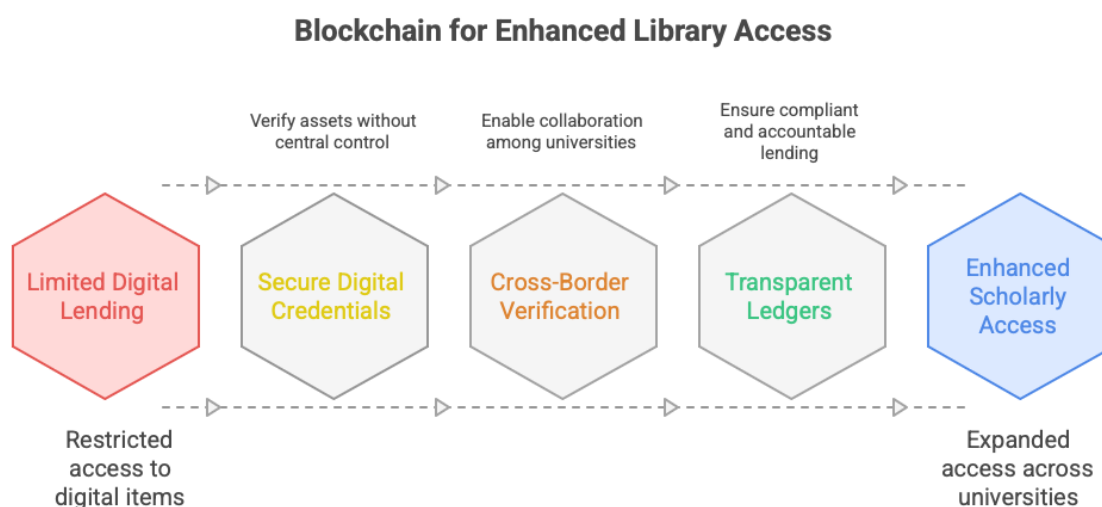


Figure 1 Blockchain for Enhanced Library Access

6. CASE-BASED ANALYTICAL DISCUSSION

6.1 Indian Institute of Technology (IITs) System in India

One of the most advanced academic ecosystems in the country is Indian Institutes of Technology, which has highly digitized and interconnected library systems, which facilitate the shared educational goals. However, the precariousness of the currently existing licensing systems creates serious barriers to the real cooperation in the digital sphere. The individual IITs subscribe to separate and expensive e-book and database packages, which often leads to purchasing the same content, possibly but not invariably to a redundant degree. This redundancy bloats costs, overstretches institutional funds and hinders fair access in the consortium.

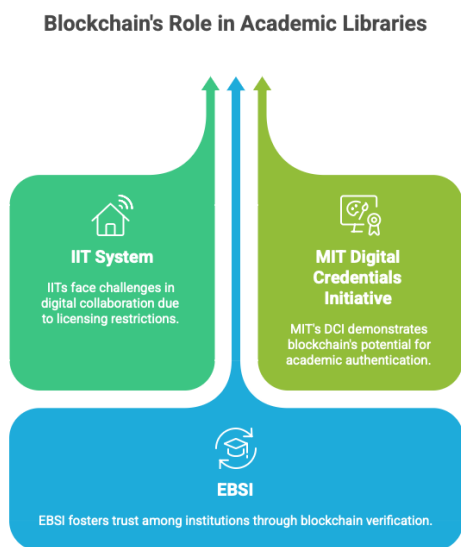


Figure 2 Blockchain's role in Academic Libraries

Blockchain technology, in this regard, would be a viable solution to such inefficiencies. Through providing an accountable ledger and verifiable history of transactions of digital loans, blockchain allows IIT libraries to redistribute resources under circumstances of controlled, time-limited access and be in compliance with licensing requirements. Lending restrictions (a single-user-at-a-time restriction) can be applied using smart contracts, thus regulating compliance with the regulations and promoting equal sharing of materials. As a result, the library systems will be able to sustain and strengthen the academic collaboration and reduce the inappropriate financial duplication.

6.2 MIT Digital Credentials Initiative

Among the most critical precursors of blockchain application in the academy, there is a Digital Credentials Initiative (DCI), situated at the Massachusetts Institute of Technology. DCI has so far clearly proven that digital records, including academic transcripts and certificates, can be verified using blockchain technology without necessarily using a central authority.

The generalisation of this paradigm to the library systems implies that the rights to borrow and licences to access can also be tokenised and authenticated. As a result, the library clients might receive provable digital lending privileges that can be transferred across the participating libraries and, thus, enable accessibility and protect authenticity and responsibility at the same time.

6.3 European Blockchain Services Infrastructure (EBSI)

EBSI acts as an international benchmark for trust across autonomous institutions, mediated by blockchain. EBSI builds a decentralized verification framework that allows universities and government agencies to validate digital transactions with confidence. If libraries were to implement a similar model, this could provide a pan-institutional network of trust for digital lending, whereby the resource entitlements are checked across borders without central reliance. It would enable collaboration between Indian and international academic libraries and place them within a worldwide digital knowledge environment.

7. PROPOSED BLOCKCHAIN-BASED DIGITAL LENDING MODEL

7.1 Components and Descriptions

Table 2 Components and their descriptions

Component	Description
Blockchain Ledger	Stores immutable lending and license records.
Decentralized Storage (e.g., IPFS/Filecoin)	Stores encrypted content metadata and hashes.
Smart Contracts	Automate loan periods, renewals, embargoes, and permissions.

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Component	Description
User Authentication Layer	Integrates institutional single sign-on (SSO) or Eduroam identity federation.

7.2 Simplified digital resource workflow on blockchain

Upon subscribing an e-resource, the library creates a license token on the blockchain. When the user requests access, a smart contract checks that they are eligible and what kind of loan conditions apply. Once granted, the system logs the transaction immutably. Upon expiration of the loan, access is automatically disabled by the smart contract.

Simplified Digital Resource Workflow on Blockchain

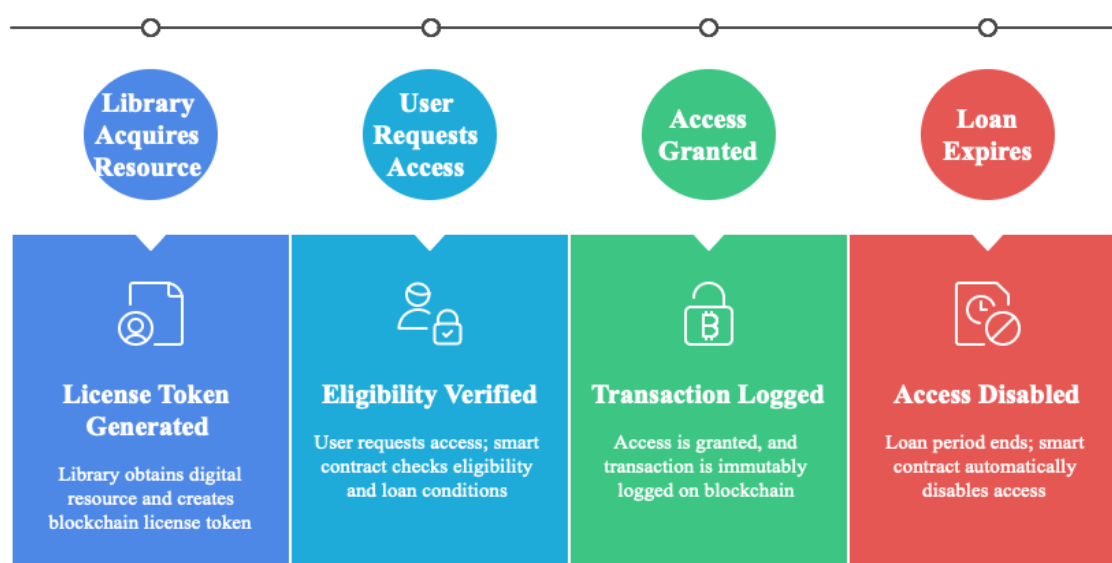


Figure 3 Simplified digital resource workflow on blockchain

The current model protects the access control and also offers clear verification procedures, which do not require the Vendor-managed Digital Rights Managements.

8. Correspondence between policy and governance

The vision of the National Education Policy 2020 (NEP 2020) is an information-abundant society that will prosper on the principles of equity and access to information, open educational resources, and open digital learning spaces. The blockchain technology can be used to support this vision by providing transparency, interoperability, and collaboration sharing amongst the institutions in education. NEP 2020 notes that the use of technology will improve research infrastructure and provide equal opportunities to quality education. These goals are directly supported by the distributed ledger mechanism of blockchain, which ensures the safety of transaction of digital resources with auditing accounts. The policy also encourages inter institutional cooperation to facilitate effective use of resources- a factor which blockchain ensures through verifiable sharing and decentralized governance. On the international level, the 2023 International Federation of Library associates (IFLA) proposes the need to have equal digital opportunities, open licensing, and long-term information maintenance. The imperatives can be met through blockchain-based lending systems that ensure the existence of tamper-proof rights metadata, verifiable use history, and decentralized

administration of lending regulations. NEP 2020 and IFLA principles, in turn, are aligned with the blockchain technology to create a powerful platform of reform and modernisation of library governance in India.

9. IMPLICATIONS OF THE PROFESSIONAL AND LIBRARIAN COMPETENCIES.

A shift towards blockchain-based digital lending systems and processes will also require a significant change in the librarian roles and skills. Conventional functions that involve acquisition, cataloguing, and user service need to be extended to have the knowledge of digital rights management, data ethics, and distributed technologies.

Librarians will continue to serve as:

- **Digital Rights Negotiators:** Advocating for equitable licensing terms and ensuring that smart contracts align with institutional priorities.
- **Metadata Stewards:** Maintaining standardized, interoperable descriptions that support resource traceability across multiple blockchain nodes.
- **Technology Facilitators:** Collaborating with IT specialists to implement and manage blockchain networks, including node operation and smart contract deployment.
- **Policy Interpreters:** Translating legal, ethical, and educational frameworks—such as NEP 2020 into actionable service models.

Evolving Librarian Roles and Skills in Blockchain Era

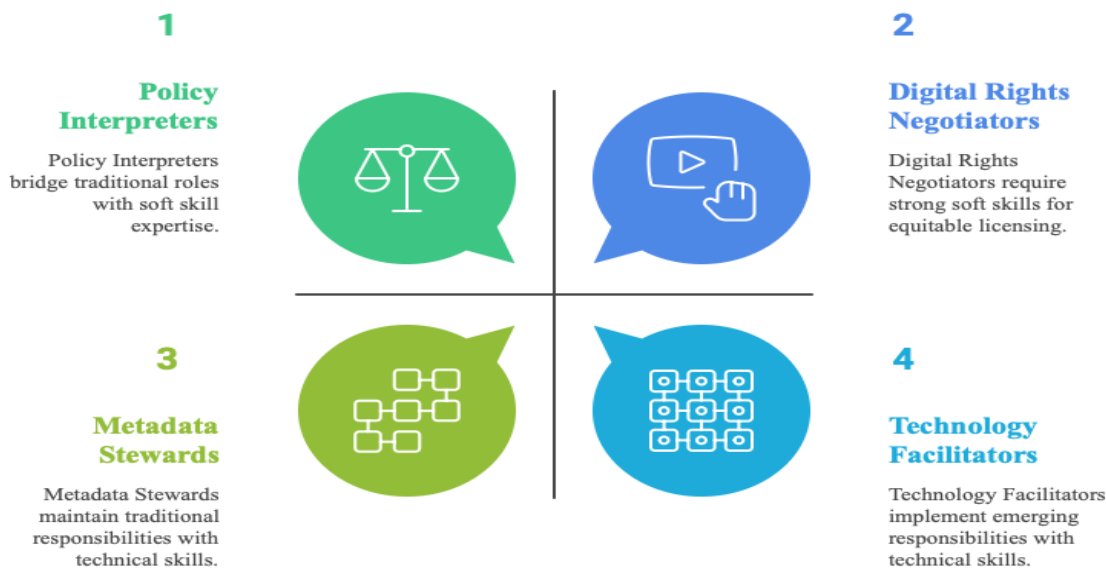


Figure 4 Evolving librarian roles and skills in blockchain era

To enable these expanded roles, professional development programs should emphasize:

- Comprehensive training in copyright, licensing, and contract analysis
- Technical literacy in blockchain architecture and distributed data management
- Ethical awareness regarding privacy and data sovereignty

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- Capacity-building initiatives at institutional and consortium levels

This evolution will transform librarians into proactive agents of digital governance, ensuring that technological innovation aligns with academic values and user rights.

FINDINGS

Academic Libraries In India Greatly Rely On Shared Licensing Through Consortia Like INFLIBNET, DELNET, And NDL India. However, Digital Materials Remain Non-Transferable Between Institutions.

Redundant Purchases Of Licenses, For Example, By Iits, Result In Higher Costs And Reduced Equity. This Therefore Calls For The Need For A Decentralized, Immutable Tracking With Smart Contracts.

MIT Digital Credentials Initiative: Demonstrates Secure Issuance And Verification Of Library-Based Digital Assets, Scalable To Lending Rights.

European Blockchain Services Infrastructure: Demonstrates Secure Cross-Institutional Verification In Europe That Could Serve As A Model For Federated Digital Lending.

Internet Archive's Controlled Digital Lending Model: Faced Legal Challenges But Illustrates The Critical Need For Verifiable, Auditable Circulation Potentially Resolved Via Blockchain.

DISCUSSION

- By using Blockchain libraries can operate free, from vendor restrictions. Develop digital lending systems that uphold the values of transparency, trust and collaboration.
- Smart contracts will implement lending rules. Streamline compliance, aligning with NEP 2020 objectives, for transparent and fair access.
- The roles of librarians need to evolve negotiating digital rights, metadata stewardship, technical facilitation, and policy interpretation are now paramount.

CONCLUSION

During the present day, libraries are being digitized and the process has brought with it a lot of advantages and at the same time, a lot of challenges. Although digital resources have led to the growth in knowledge accessibility, constraining licensing measures, proprietary DRM systems, and fractured infrastructure provisioning are all sabotaging the independence of libraries. The blockchain technology is a possible avenue that can be used to restore transparency, confidence, and regulation in online lending platforms.

The use of smart contracts can help librarians to simplify the process of loans, define rights of usage and generate verifiable records of every lending operation through distributed ledger technology. The experiences of the MIT Digital Content Infrastructure (DCI) and the European Blockchain Services Infrastructure (EBSI) show that decentralized validation systems could be used at scale.

The implementation of blockchain in academic libraries and their consortia, especially INFLIBNET and DELNET, has the possibility to decrease the redundant expenses, promote collaboration between libraries, and achieve the NEP 2020 goal of equal access to digital information. To switch to this paradigm, it is not only necessary to be technologically ready, but there must be a wholesale policy alignment, skill training, and prudent administration.

Finally, blockchain can be used to support the original mission of libraries which is the provision of open, secure, and sustainable access to knowledge in the twenty-first century. This technology, when implemented appropriately, can make libraries shift their passivity as receiver of content produced by vendors to active creators of open, participative information environments.

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