

THE ROLE OF BLOCKCHAIN TECHNOLOGY IN ENHANCING DIGITAL PRESERVATION AND ACCESS IN NIGERIAN LIBRARIES

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Abstract

This study explores the potential of blockchain technology in enhancing digital preservation and access in Nigerian libraries. It examines how blockchain's features of immutability, decentralisation, and transparency can address persistent challenges such as data loss, authentication failures, infrastructural deficiencies, and limited interoperability. Drawing on a review of recent literature and contextual analysis, the paper highlights the opportunities of blockchain for managing digital archives, securing institutional repositories, protecting intellectual property, and verifying metadata. It also identifies barriers to adoption, including inadequate ICT infrastructure, high implementation costs, skill gaps among librarians, and weak policy frameworks. The study recommends policy development, capacity building, infrastructure investment, collaborative networks, and pilot projects to facilitate effective adoption. The findings conclude that blockchain offers a strategic pathway for Nigerian libraries to achieve sustainable digital preservation, ensure authenticity, and improve equitable access to information resources in the evolving knowledge environment.

Keywords: Blockchain technology; Digital preservation; Access to information; Nigerian libraries; Institutional repositories; Library innovation

Introduction

According to Saka, Yusufu, and Mommoh (2021), libraries have long been established to acquire information resources either locally or remotely and to process classify and preserve these information resources in various formats, and make these resources available to users upon request. This has been one the major role of libraries for ages using traditional ways of meeting the user needs by making sure that the information sort for is made available. The traditional ways in which

libraries meet users' needs has been transformed into a modern library due to the developments in the information field brought about by globalisation and information and communication technologies (ICTs) (Omoju & Omotayo 2024). Oyedokun, Oyewumi and Laaro (2018), state that information and communication technology has proven to have an impact on library systems, services, operations, and library information resources. It has led to one of the most significant developments in library history and is rapidly changing how libraries are run as well as the responsibilities of librarians.

The ability of ICT to expand access to knowledge and ideas is a critical feature that strikes at the heart of the technology (Anigbo & Orié, 2018). This has also changed how libraries serve their patrons, as they now offer a vast amount of information through a variety of digital tools. The library serves as a storehouse for both historical and contemporary knowledge, and this information must be preserved. Therefore, libraries make deliberate efforts to ensure that such information is properly protected. According to Akinlolu, Awujoola, & Olawale (2023), digital preservation comprises techniques and activities taken to keep digital historic resources accessible for as long as needed. Furthermore, digital preservation is a continuous and coordinated set of practices and activities that allow digital information to be stored for an extended period of time without errors, including retrieval and interpretation techniques, for as long as the information is needed (State Library, New South Wales, 2021).

It ensures that all the information resources are kept in an accessible state for as long as is practical by collecting, processing, organising, and preserving all of its materials as well as disseminating and maintaining information resources or materials for use (Choudhury et al. 2021). Access refers to the extent to which resources, services, products, and environments are available to as many individuals as feasible. Mohammed (2023) posited access to information resources as the ability to obtain information with little or no stress. Access is essential to all facets of libraries services, including information resources, connectivity, support, and information education. According to Lo and Stark (2021), accessibility aims to ensure that the larger number of library users may fully utilise any of the library resources. The advent of new emerging technologies in this 21st century has helped to improve and change how information can be preserved and easily accessed by library users.

One of these technologies is blockchain technology which had helped in enhancing digital preservation and quick access to information in Nigerian libraries. Owraigbo (2023) defined blockchain technology as a sophisticated new smart technology that could enhance information security, transaction tracking, and safe information dissemination both inside and outside of university libraries. Fasola, Oyadeji, and Iyoro (2024) posited that blockchain technology has the ability to assist libraries in securing and storing their library collection in digital format. Furthermore, digital information resources uploaded to a blockchain is permanently preserved there and cannot be changed or hacked (Masenya, 2020). This implies that blockchain technology has the potential to revolutionize digital preservation and access in Nigerian libraries by ensuring that materials are preserved for future generations and made accessible to authorized users.

Also, blockchain technology can also assist libraries in digitising their existing records and managing them within a secure infrastructure (Masenya, 2020). He added that once digital information is committed to a blockchain, it is permanently stored, and the tracking system guarantees data integrity at all times.” This study sought to examine the role of Blockchain technology in enhancing digital preservation and access in Nigerian libraries.

Understanding Blockchain Technology

Blockchain is an emerging technology that has the potential to revolutionize the way in which both public and private services are delivered through new applications. International Business Machine (2022) defined blockchain technology as a collective, immutable record that makes it possible to track resources in a business network and record transactions. Hussain (2020) stated that blockchain technology is primarily based on distributed ledger technology (DLT), which records transactions using an immutable cryptographic signature called a hash. Similarly Abid (2021) opined that blockchain is a new and reliable technology that helps with information security, preservation, and dependability, which can be very useful for both libraries and librarians as a means of providing their patrons with efficient service delivery in the digital era. In light of this, Zayyad (2022) summarised blockchain as a collection of transaction records organized into blocks that characterise a portion of a ledger or register that is shared among peers who depend on it as a reliable and secure source to determine the authenticity of the records or ledger.

Shaw (2016) further described blockchain technology as a shared electronic database with encrypted and immutable data records that can be shared among individuals, organizations, or

communities. Blockchain is also "incorruptible," according to Tapscott and Tapscott (2016), since it can be programmed to record almost anything of value, not only financial transactions. The main components of blockchain were explained by Tella et al. (2022) as follows;

(1) **Block:** A collection of recorded transactions over a period of time. Transactions can reflect nearly any type of operation, from registering a land deed to making a single purchase. Rules pertaining to the block are defined at the time of network creation. For instance, there may be limitations on the size of each block or the maximum number of transactions that can occur in a block.

(2) **Chain:** A block is chained, or connected to the previous block, using a hash, after it reaches its maximum number of transactions. The hash value for the following block is generated using the hash value from the previous block. By doing this, a connection is made between the present and earlier blocks;

(3) **Network:** The network is made up of nodes and each node which makes up the network has a complete record of every blockchain transaction. No node is more "trusted" than another, and there is a single "official" copy. The blockchain, which is shared across all nodes, ensures data integrity. Blockchain is made of three features namely; immutability, trust, and decentralization.

- **Decentralization blockchain:** According to Blockgeeks (2016), decentralisation blockchain means a network that functions on a peer-to-peer basis and connects all participants in a marketplace without the use of middlemen, ensuring that every transaction is transparent to all network participants.
- **Trust blockchain** has emerged as a new type of trust for global services, particularly financial services, and it relies on existing technology to solve an old problem; for example, how do two parties conduct a transaction without knowing or trusting each other and without a trusted third party intermediary (Trautman, 2016).
- **Immutability:** Immutability is the inability to easily alter data or transactions once they have been added, approved, and verified by the blockchain's nodes. It is consequently an

append-only data store and no deletes or edits are allowed, so this technology has its capability as an unimpeachable record keeper (Umeh, 2016).

Blockchain technology has changed from being a specialised interest to a force that is revolutionising numerous industries. Traditional systems of trust and verification are being reshaped by its distinctive qualities of decentralisation, transparency, and immutability, which are driving its acceptance (Udumukwu, Jaja, & Isqua 2024). One of the key drivers of blockchain adoption, particularly in the financial sector, is the increasing need for secure and transparent systems. Blockchain's ability to provide a tamper-proof ledger of transactions offers a solution to longstanding issues of fraud and inefficiency in traditional banking systems. By eliminating intermediaries and enabling peer-to-peer transactions, blockchain reduces costs and increases the speed of transactions. Blockchain is being adopted by both financial institutions and startups, with examples like smart contracts and cross-border payments showcasing the technology's practical benefits (Zheng et al., 2020).

In the supply chain industry, blockchain helps companies to meet consumer demands for transparency and regulatory requirements, especially in industries like food and pharmaceuticals (Casino, Dasaklis, & Patsakis, 2019). Blockchain is also being used in healthcare, primarily to address issues related to patient privacy and data management, as it can securely store and share patient records, ensuring that they are accessible to authorised personnel while being protected from tampering (Radanović & Likić, 2018).

Challenges Facing Digital Preservation and Access in Nigerian Libraries

Despite the growing awareness of digital technologies such as blockchain in enhancing information preservation and access, Nigerian libraries continue to grapple with several formidable challenges. One of the most frequently cited issues is inadequate infrastructure. As Fasola, Oyadeyi, and Iyoro (2024) aptly point out, many academic libraries in Nigeria operate with "obsolete hardware, limited broadband connectivity, and erratic power supply," all of which undermine sustainable digital preservation practices. This infrastructural deficiency is further compounded by the lack of scalable ICT infrastructure to support emerging technologies like blockchain, which depend on uninterrupted connectivity and decentralized storage systems (Cletus

et al., 2024). Hence, even when the intent to preserve digital resources is present, the physical and technological environment often fails to support it.

Closely linked to infrastructure is the persistent risk of data loss and corruption. Digital materials, particularly those stored in centralized or poorly maintained servers, are vulnerable to cyberattacks, hardware failure, and accidental deletion. According to Ikegwuro and Ogalue (2024), "without blockchain or equivalent tamper-proof mechanisms, Nigerian libraries are susceptible to unauthorized alterations and irreversible data breaches." The authors emphasize that unlike conventional digital storage, blockchain offers a form of redundancy and immutability that can protect against data corruption and yet its uptake remains minimal due to contextual limitations. Supporting this view, Owate and David-West (2024) underscore that "libraries that lack distributed, version-controlled preservation systems are increasingly at risk of digital obsolescence and integrity failure," particularly when managing large datasets such as theses, dissertations, and historical archives.

In addition, authentication and version control issues remain a fundamental barrier to effective digital access. In the absence of robust metadata standards and transparent auditing mechanisms, tracking the authenticity of digital records is often problematic. As Emmanuel et al. (2023) have argued, libraries that rely solely on conventional digital cataloguing systems are prone to misidentification, duplication, and inconsistent records over time." This problem becomes especially critical when libraries attempt to manage collaborative, born-digital collections or user-generated content. The InterPARES Project (2025) and the IIPC (2025) similarly stress the importance of provenance tracking and metadata verification, noting that blockchain-based solutions when properly implemented could provide the necessary integrity and version traceability to address these shortcomings.

Moreover, limited funding and human expertise constitute a pervasive challenge in Nigerian libraries. While the need to adopt cutting-edge digital preservation systems is widely acknowledged, the financial and intellectual resources required are often beyond reach. Fasola et al. (2024) note that "most library administrators consider blockchain adoption as desirable but unattainable under current budgetary constraints." Likewise, Cletus et al. (2024) identify insufficient funding and lack of specialised training as key deterrents to blockchain implementation in Nigerian academic libraries. In a related study, Onwubiko (2025) emphasizes that "without

targeted investments in professional development and infrastructural reform, libraries will continue to lag behind in adopting robust digital preservation technologies.”

Taken together, these challenges highlight a structural and systemic gap between the technological potential for digital preservation and the on-the-ground realities in Nigerian libraries. While scholars such as Tella et al. (2022) have called for a proactive national policy framework to drive digital innovation, including blockchain integration, the pathway to actual implementation remains fraught with barriers. In sum, unless Nigerian libraries overcome these intersecting challenges that are ranging from infrastructural limitations, data security risks, metadata inconsistencies, financial constraints and the vision of a digitally resilient and accessible library system will remain elusive.

In addition to infrastructural and technical challenges, institutional inertia and weak policy frameworks further hinder effective digital preservation in Nigerian libraries. As noted by Tella, et al. (2022), many libraries operate without clear strategic policies or guidelines for long-term digital storage and preservation, making their systems reactive rather than proactive. In their words, “the absence of a national preservation policy leaves individual libraries to operate in isolation, often leading to duplication of effort and inconsistent digital management practices.” Similarly, the findings of Onunka and Onunka (2024) suggest that even where digital preservation projects exist, they often lack alignment with broader national ICT goals. This policy disconnect undermines standardization efforts and prevents the leveraging of collective resources or the establishment of interoperable platforms. Consequently, the opportunity to implement cross-institutional blockchain solutions or shared metadata repositories is significantly limited.

Equally problematic is the low level of digital literacy and technical confidence among library personnel. As Fasola et al. (2024) rightly argue, while some librarians may be aware of the potential of blockchain and other emerging technologies, few possess the requisite skills to implement or manage them effectively. The authors emphasize that “many librarians in Nigeria are still grappling with basic automation, let alone advanced technologies like smart contracts or distributed ledger systems.” This skill gap is not only a barrier to adoption but also affects the sustainability of digital preservation initiatives. According to Cletus et al. (2024), this human capital deficit is exacerbated by a lack of structured training programs and minimal exposure to global preservation standards such as OAIS or PREMIS. As a result, even where digital

preservation systems are introduced, they often suffer from poor configuration, underutilization, or outright abandonment.

Furthermore, concerns about cost, scalability, and institutional readiness remain prevalent in discussions about implementing blockchain and other advanced digital preservation systems. While blockchain is often praised for its security and transparency, it is also resource-intensive in terms of computing power, data storage, and maintenance. Rao and Prasad (2025), in their comparative case studies across emerging economies, caution that “without an incremental and context-sensitive approach, blockchain may impose more burdens than benefits on resource-constrained institutions.” Their argument aligns with Agbeyangi, Makinde, and Odun-Ayo’s (2024) broader critique of Nigeria’s digital economy: that the pace of technological innovation outstrips the country’s institutional ability to adapt and absorb such technologies effectively. In light of these realities, it becomes imperative for Nigerian libraries to approach digital preservation not merely as a technological challenge, but as a multidimensional issue involving policy, capacity building, funding, and stakeholder engagement.

In light of these challenges, it is clear that the road to effective digital preservation and access in Nigerian libraries is both complex and multifaceted. The limitations discussed are ranging from inadequate infrastructure, threat of data loss; weak authentication systems and insufficient funding which are not isolated problems, but deeply interconnected. These issues are further compounded by low digital literacy among library staff and the absence of clear institutional or national policies to guide digital preservation efforts. While technologies like blockchain offer promising solutions, their adoption requires more than just awareness; it demands strategic planning, financial investment, staff training, and long-term policy commitment. Addressing these gaps will not only improve the security and reliability of digital library collections but also ensure that the knowledge stored within them remains accessible, authentic, and preserved for future generations. Unless these systemic barriers are tackled head-on, the potential of digital preservation will remain largely untapped in the Nigerian library system.

Blockchain as a Game Changer for Digital Preservation and Access in Nigerian Libraries

In today’s digital era, Nigerian libraries face mounting pressure to preserve and make accessible digital resources reliably. Traditional systems, however, often fall short in safeguarding authenticity, ensuring controlled access, maintaining resilience over time, and fostering

collaboration among institutions. In this light, blockchain technology presents itself not merely as a future option but as a genuine game changer. Recent research underscores how blockchain can enhance digital preservation and access by securing authenticity, improving rights management, facilitating distributed preservation, and enabling library collaboration.

Central to blockchain's appeal is its ability to guarantee authenticity and integrity of digital materials. A study by Ikegwuro and Ogalue (2024) offers a clear exposition: blockchain uses cryptographic hashing and time stamping to create a visible, immutable chain of custody, ensuring that once an item is recorded, it cannot be altered or erased without consensus from the network. This feature is vital for libraries that manage archival documents, theses, and institutional repositories. When every data element is linked and sequenced securely, the risk of tampering is drastically reduced—offering much-needed assurance for stakeholders and users that preserved resources remain true to their original form. Additionally, Emmanuel et al., (2023) emphasize that blockchain enables provenance tracking through smart contracts and metadata anchoring. This makes every resource's journey starting from creation to access, transparent and verifiable. In contexts where trust in digital resources is paramount, blockchain lends libraries the power to document precisely who accessed what, when, and under what conditions. In Nigeria, where verifying the legitimacy and originality of digital materials often proves challenging, this form of provenance adds a layer of credibility previously unattainable in conventional systems.

Perceptions from Nigerian librarians offer further support. Tella et al. (2022) report that librarians and archivists in the southwest of the country recognize blockchain's potential to assist libraries in “gathering, preserving and sharing authoritative information,” especially in distributed contexts. Although adoption remains limited by infrastructure and cost constraints, the fact that professionals already see blockchain as a means to secure integrity speaks to its perceived alignment with library values and missions. Beyond preserving integrity, blockchain also enhances access control and rights management areas where many library systems struggle. Traditional digital rights management (DRM) systems are often cumbersome, inflexible, or too centralized. Blockchain can introduce smart contracts that automate access permissions based on predefined conditions, such as time-limited lending, pay-per-access, or user-specific privileges. Emmanuel et al. (2023) note that such automation not only streamlines circulation and licensing workflows, but also creates a transparent audit trail, reducing administrative burdens and risk of misuse.

Although not specific to libraries in Nigeria, the SecureRights framework (Madushanka et al., 2024) illustrates how blockchain can interlock perceptual hashing, watermarking, and IPFS-based storage to protect digital rights robustly. This example demonstrates how Nigerian libraries might adapt comparable frameworks to regulate access to digitised monographs, research outputs, and indigenous knowledge collections, thereby ensuring the recognition of rights holders, the traceability of access, and the incontrovertibility of ownership. Crucially, Nigerian librarians express confidence in blockchain's role in securing user authentication and smooth collaboration, albeit while acknowledging barriers such as technophobia and weak infrastructure (Fasola et al., 2024). This suggests that blockchain's access-control benefits resonate with local professionals even if implementation remains aspirational.

Another transformative advantage of blockchain lies in its capacity for long-term preservation through distributed ledger systems. By replicating and synchronizing data across nodes, blockchain eliminates the central points of failure that plague traditional digital repositories. Nigerian libraries often work in environments of unstable power supply, poor ICT infrastructure, and limited backup solutions. A decentralized ledger counteracts these risks by guaranteeing data resilience through structural redundancy. Rao and Prasad (2025) consolidate case studies from institutions such as the UK National Archives and MIT Media Lab. They demonstrate that blockchain-based archives allow multiple replicas each verified against the ledger's cryptographic hash by ensuring consistency and durability across nodes. This model not only preserves resources even if individual servers fail but also supports verifiable version control over time.

Cletus et al. (2024), in their study of blockchain adoption enablers, argue for consortium-based readiness frameworks involving multiple libraries. Such cooperative environments can distribute costs, share capabilities, and pool infrastructure to support a decentralized ledger environment. Nigerian libraries collaborating under such a model could store digital materials across participating institutions, thereby increasing resilience and preventing loss due to a single institutional failure. Indeed, this points toward inter-library collaboration, where blockchain becomes both preservation infrastructure and a shared governance model. Rather than isolated systems, libraries in different parts of the country can participate as nodes in a shared ledger, contributing metadata, archival documents, or digitised collections. Each partner verifies authenticity through shared blockchain records, building a network of mutual trust without reliance

on a single central authority. Tella et al. (2022) report that librarians already value blockchain's potential to enable "sharing authoritative information" across institutional boundaries. However, they highlight that implementation and maintenance costs, as well as questions of sustainability, inhibit progress. A consortium model could address these issues by spreading the financial burden and enabling standardization of metadata, access protocols, and preservation formats across partners.

Onunka and Onunka (2024) reinforce the importance of such collaboration in their discussion of digital innovation in African library systems. They emphasize that sustainable preservation and cultural access are best achieved through networked, region-wide digital ecosystems—precisely the kind of collaborative framework blockchain supports. Libraries operating in siloed fashion often duplicate digitization efforts, have incompatible metadata systems, or fail to standardize access models but shared blockchain networks can harmonize these processes. Of course, the transformative potential of blockchain depends on overcoming real-world constraints. As Fasola et al. (2024) caution, ongoing challenges include inadequate infrastructure, erratic power supply, poor internet connectivity, and limited technical competence among librarians. Akintunde and Amuda (2024) add that perceived usefulness and supportive policy frameworks are strong predictors of blockchain adoption intention. They identify cost of infrastructure, privacy concerns, and lack of blockchain understanding as major barriers. Cletus et al. (2024) highlight several critical enablers: prior technology experience, attitudes toward change, leadership support, organizational preparedness, and ease of integration. While cost concerns and data security risks remain obstacles, their application of the HOT-Fit model suggests that successful adoption can be achieved when libraries invest in capacity building, leadership alignment, and organizational adjustments.

Synthesizing this literature, it becomes clear that blockchain in the Nigerian library context is not a silver bullet but when thoughtfully implemented, it can yield monumental benefits. Libraries could start with small-scale pilots: for example, securing institutional repositories or thesis archives using blockchain time stamping and smart-contract-based access provisioning. As these pilots yield practical lessons, capacity can expand, infrastructure can improve, and collaborative networks can form. When combined with cloud storage where blockchain serves as the audit and integrity layer, libraries can achieve scalable, low-cost preservation models. Similarly, pairing

blockchain with open standards like OAIS and PREMIS can help align emerging infrastructure with global best practices. In practical terms, Nigerian libraries could formalise a consortium or federation perhaps under the umbrella of the Nigerian Library Association or national digital heritage initiatives focused on jointly hosting a permissioned blockchain for shared preservation of academic, historical, and cultural collections. Such an approach would democratise access, reduce replication costs, and build a resilient architecture rooted in transparency and trust.

Ultimately, literature and recent empirical studies paint a compelling picture: blockchain is rising beyond hype to become a feasible, strategic tool for digital preservation in African libraries. Its strength lies in securing authenticity, enabling controlled access, supporting decentralised resilience, and facilitating collaboration which are the four pillars that address longstanding inadequacies in Nigerian library systems. While challenges persist, the convergence of institutional awareness, collaborative frameworks, technical innovation, and policy support creates fertile ground for blockchain to reshape how Nigerian libraries safeguard their digital legacies and connect communities across space and time.

Potential Use Cases and Examples

There is a great interest among Nigerian librarians and scholars regarding the application of blockchain technologies in library operations. The growing interest can be attributed to positive evaluations of the technology by libraries in developed countries that have implemented it. Onwubiko (2025) reported that libraries in Canada, the UK, and USA have all benefited from using blockchain technologies. The author rightly predicted that other libraries will soon follow suit in adopting the technology. The only hint of blockchain application in a Nigerian library was in Ignatius Ajuru University of Education (Eke et al., 2024). However, the study did not specify the particular aspects of library operation where blockchain was deployed. On the other hand, scholars such as Abid (2021), Fasola et al. (2024) and Tella et al. (2022) among others have identified potential use cases for block chain technology in Nigeria. These include the use of blockchain for managing digital archives; protecting intellectual property in institutional repositories; and verifying metadata and citation records etc.

In terms of digital archives management, blockchain support the preservation and accessibility of digital resources. Blockchain technology offers stability and decentralisation, ensuring that once digital archives are added to the ledger, they cannot be tampered with. Kayode and Oguntayo

(2024) suggested that blockchain technology is highly relevant in managing digital archives in Nigerian academic libraries. This is probably due to security and long-term preservation opportunity. The study surveyed Nigerian librarians who agreed that blockchain offer great potentials as it can help “collect, preserve, and disseminate authoritative information in a distributed setting,” producing a single, verifiable record accessible to all. This was also supported by Tella et al. (2022) who also submitted that blockchain technology can be used in “gathering, preserving and sharing authoritative information” by libraries. The study also added that the technology can help create unique and verifiable records accessible to information users without any barrier. Researchers have also identified the relevance of blockchain technology in information systems such as institutional repositories in which intellectual property protection is paramount.

Institutional repositories used to warehouse and distribute scholarly works which can include work in progress can benefit from the use of blockchain technology. It is now possible to timestamp deposited works on-chain which makes it possible to verify authorship and ownership securely (Jha, 2023; Kayode & Oguntayo; 2024). Within institutional repositories (IRs), blockchain could similarly record pre- and post-prints immutably, preventing plagiarism and securing copyright. In a wider use, this can prevent piracy and intellectual property theft. Any case of theft would be easily discovered because of timestamp on the original work. Beyond intellectual property protection, blockchain technology is also useful in verifying metadata and citation records

Blockchain technology can help librarians in organisation of information resources. This is possible as the technology curates key metadata such as publication dates, authorship, and citations all of which can be timestamped and referenced in a tamper-proof ledger. Kayode and Oguntayo (2024) submitted that blockchain technology can be applied to create decentralized cataloguing and online catalogues for libraries, enhancing the reliability of metadata and improving interoperability across librarianship. In addition, blockchain can help maintain integrity of metadata. For instance, change in details, such as author’s name, publisher’s name, etc can be tracked to ensure that information from a source are kept together irrespective of inconsistencies. By bringing stability to metadata, blockchain technology would also support research integrity as it becomes easy to verify citation chains and publication authenticity over time (Tella et al., 2022; Eke et al., 2024).

Limitations and Counterarguments

Despite the overwhelming positive reviews of blockchain technology and what it can do for Nigeria, the literature is full of various impediments that have prevented Nigerian libraries from mass adoption of the technology. There is a major agreement that blockchain deployment requires investment in hardware, nodes, and ongoing maintenance which is often beyond Nigerian libraries. Tella et al. (2022) reported that Nigerian libraries have not succeeded in large scale adoption of blockchain technology due to “maintenance cost and sustainability issues”. This probably refers to continuous cloud storage subscriptions. Kayode and Oguntayo (2024) also cited maintenance costs and long-term viability which also refers to the ability of the libraries to keep up with recurring fees.

Another key concern that has been raised as obstacle to blockchain adoption in Nigeria is the amount of energy needed to run the servers. This is a significant concern as the traditional proof-of-work blockchains (e.g., Ethereum pre-merge) use significant energy. Apart from the environment dimension to excessive energy consumption, Nigerian libraries are energy starved as they find it difficult to maintain 24/7 power supply (Tella et al., 2022; Eke et al., 2024; Onwubiko, 2025). Perhaps the most significant limitation to blockchain technology adoption in Nigerian libraries is the skill gap.

Research from Southwest and South-East Nigeria reveals that librarians often lack the technical skillset to manage and design blockchain systems. (Tella et al., 2022; Fasola et al., 2024). Much has been said about digital skills of librarians with reports indicating that many librarians in Nigeria lack the advanced digital skills needed to handle complex tasks such as blockchain technology (Obim et al., 2023; Cletus et al., 2024). The shortage of skilled manpower for blockchain adoption is common in developing countries as Safdar et al. (2023) also reported similar challenge among librarians in Pakistan. Kayode and Oguntayo (2024) also suggest a skill gap in Nigerian libraries as they listed key challenges against effective deployment of blockchain technology to include complex installation processes and scalability challenges among the major limitations. It was also reported that Nigerian libraries face challenges such as limited data protection capacity, the absence of a governance framework, and reluctance among potential users. There are also other issues such as integration with existing library technology.

Recommendations

1. **Policy Development:** The Federal Government of Nigeria and professional bodies like the Nigerian Library Association should establish a national policy framework on blockchain-driven digital preservation to ensure uniformity, standardisation, and sustainability (Tella, Amuda, & Ajani, 2022; Onunka & Onunka, 2024).
2. **Capacity Building:** Targeted training programs should be introduced to bridge the blockchain skill gap among Nigerian librarians, aligning with global preservation standards such as OAIS and PREMIS (Cletus et al., 2024; Obim et al., 2023).
3. **Infrastructure Investment:** Universities and government agencies should invest in modern ICT infrastructure, including stable power supply and broadband connectivity, as these are prerequisites for blockchain implementation (Fasola, Oyadeyi, & Iyoro, 2024).
4. **Collaborative Models:** Nigerian libraries should adopt consortium-based blockchain networks to share infrastructure costs and promote inter-institutional digital preservation (Cletus et al., 2024; Onunka & Onunka, 2024).
5. **Pilot Projects:** Libraries should begin with small-scale blockchain pilots, such as securing theses repositories and metadata verification, before moving into broader applications (Ikegwuro & Ogalue, 2024; Kayode & Oguntayo, 2024).
6. **Funding Support:** Stakeholders, including international development partners, should provide grants and financial support to Nigerian libraries for blockchain-based preservation initiatives (Onwubiko, 2025; Rao & Prasad, 2025).

Conclusion

This study has demonstrated that blockchain technology holds transformative potential for enhancing digital preservation and access in Nigerian libraries. Its unique features of immutability, decentralization, and transparency directly address persistent challenges such as data loss, weak authentication systems, and infrastructural inadequacies (Masenya, 2020; Emmanuel et al., 2023). While constraints such as high costs, energy demands, and skill deficits remain, strategic investments in policy, training, and infrastructure can unlock blockchain's benefits for Nigerian libraries. By fostering inter-library collaboration, adopting phased implementation, and aligning with global best practices, Nigerian libraries can ensure that digital resources remain authentic,

accessible, and preserved for future generations. Ultimately, blockchain technology is not a panacea but a strategic enabler of sustainable digital preservation in the evolving information landscape (Tella et al., 2022; Cletus et al., 2024; Onwubiko, 2025).

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