Blockchain Applications for Academic Digital Archives: Investigating Perception and Awareness in the Era of 5IR

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Abstract
This study aims to examine the perception and awareness regarding the relevance of adopting blockchain technology for managing digital archives in the context of fifth industrial revolution (5IR). Ten system librarians who were chosen from five distinct academic libraries in Nigeria's Southwest geopolitical zone serve as the study's sample. An open-ended survey was used to gather data for the study, which took a strictly qualitative approach. Based on the findings, system librarians are aware of blockchain technology adoption and its benefits for digital archive management in academic libraries. The adoption of blockchain technology is perceived positively since it can help digital archives collect, preserve, and disseminate authoritative information in a distributed setting. It can also help digital archives create a single, verifiable record that is accessible to all and deserves respect. As such, the adoption of blockchain technology faces several hurdles, including challenging installation, scalability, maintenance costs, integration, data protection, governance, user adoption, energy consumption, long-term viability, and legal and ethical issues.
Keywords: Academic libraries. Digital archives. Advanced technologies. Blockchain technology.

Aplicações de *blockchain* para arquivos digitais acadêmicos: investigando a percepção e a conscientização na era da 5ª Revolução Industrial
Resumo
Este estudo tem como objetivo examinar a percepção e a conscientização sobre a relevância da adoção da tecnologia blockchain para o gerenciamento de arquivos digitais no contexto da quinta revolução industrial (5IR). Dez bibliotecários de sistemas, selecionados em cinco bibliotecas acadêmicas distintas na zona geopolítica sudoeste da Nigéria, serviram como amostra do estudo. Uma pesquisa aberta foi utilizada para coletar dados para o estudo, que adotou uma abordagem estritamente qualitativa. Com base nas conclusões, os bibliotecários de sistema estão cientes da adoção da tecnologia blockchain e de seus benefícios para o gerenciamento de arquivos digitais em bibliotecas acadêmicas. A adoção da tecnologia blockchain é vista de forma positiva, uma vez que pode ajudar os arquivos digitais a coletar, preservar e divulgar informações confiáveis em um ambiente distribuído. Ela também pode ajudar os arquivos digitais a criar um registro único e verificável, acessível a todos e que merece respeito. Como tal, a adoção da tecnologia blockchain enfrenta uma série de obstáculos, incluindo instalação desafiadora, escalabilidade, custos de manutenção, integração, proteção de dados, governança, adoção pelo usuário, consumo de energia, viabilidade a longo prazo e questões legais e éticas.
Palavras-chave: Bibliotecas universitárias. Arquivos digitais. Tecnologias avançadas. Tecnologia blockchain.

Aplicaciones de blockchain para archivos digitales académicos: investigación sobre la percepción y la concienciación en la era de la 5IR

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Resumen

El objetivo de este estudio es examinar la percepción y la concienciación sobre la relevancia de adoptar la tecnología blockchain para la gestión de archivos digitales en el contexto de la quinta revolución industrial (5IR). Diez bibliotecarios de sistemas, seleccionados de entre cinco bibliotecas académicas distintas de la zona geopolítica del suroeste de Nigeria, constituyen la muestra del estudio. Se utilizó una encuesta abierta para recopilar datos para el estudio, que adoptó un enfoque estrictamente cualitativo. Según los resultados, los bibliotecarios del sistema son conscientes de la adopción de la tecnología blockchain y de sus beneficios para la gestión de archivos digitales en bibliotecas académicas. La adopción de la tecnología blockchain se percibe de forma positiva, ya que puede ayudar a los archivos digitales a recopilar, conservar y difundir información fidedigna en un entorno distribuido. También puede ayudar a los archivos digitales a crear un registro único y verificable, accesible para todos y digno de respeto. Sin embargo, la adopción de la tecnología blockchain se enfrenta a una serie de obstáculos, entre los que se incluyen la dificultad de instalación, la escalabilidad, los costes de mantenimiento, la integración, la protección de datos, la gobernanza, la adopción por parte de los usuarios, el consumo de energía, la viabilidad a largo plazo y cuestiones legales y éticas.

Palabras clave: Bibliotecas académicas. Archivos digitales. Tecnologías avanzadas. Tecnología blockchain.

1. Introduction

In an era of rapid technological advancement, blockchain technology is being adopted across diverse sectors, including business, education, the economy and social systems (Warkentin; Orgeron, 2020; Kayode; Oguntayo, 2025). The emergence of the Fifth Industrial Revolution (5IR) has brought transformative technologies into the educational landscape, with academic libraries recognized as central hubs of information being key beneficiaries. Blockchain offers promising solutions for securing library records, improving metadata systems and facilitating the sharing of resources in digital environments. This study examines how blockchain is utilized in managing academic library records and digital archives in the context of the 5IR.

Given these developments, it is essential to assess how academic libraries are evolving in response to technological change. Traditionally regarded as custodians of knowledge, libraries must now embrace digital innovations while preserving their core values (Tella; Ukwoma; Kayode, 2020; Adigun; Ajani; Enakrire, 2024; Kayode; Oguntayo; Harriet, 2024). Technologies such as machine learning, robotics, the Internet of Things (IoT), and blockchain are reshaping library operations and service delivery, offering solutions to longstanding challenges and enhancing institutional performance (Shah *et al.*, 2024; Aderonmu, 2021). Blockchain, as a distributed ledger system, has been recognized by the World Economic Forum (2024) as one of the top ten emerging technologies.

Academic libraries play a critical role in the acquisition, preservation, and dissemination of information. Blockchain can strengthen these functions by verifying document ownership and facilitating secure, decentralized transactions. Libraries provide access to a wide range of materials including digital, print, audio, and special collections that support lifelong learning and scholarly growth. While institutions in developed countries are beginning to adopt blockchain,

those in developing regions face challenges such as limited awareness and slow implementation (Tella; Amuda; Ajani, 2022).

In this study, "perception" refers to how librarians interpret and evaluate the use of blockchain in library services. It encompasses their understanding of its functionality, recognition of its benefits, awareness of potential challenges, and openness to innovation. Some librarians view blockchain as a tool for enhancing service delivery, while others express concern about its impact on traditional library practices (Oguntayo *et al.*, 2024; Tella; Amuda; Ajani, 2022). "Awareness," on the other hand, denotes the extent to which librarians are informed about blockchain and its relevance to library operations. Jakati (2022) emphasized that understanding blockchain involves grasping both its applications and implications. Librarians who are technologically literate are better positioned to leverage emerging tools and develop innovative service models (Singh; Qazi, 2020).

Ultimately, blockchain has the potential to support the development of decentralized metadata systems, reducing reliance on centralized control. However, many librarians still lack a comprehensive understanding of their capabilities and significance. This study is therefore necessary to explore how librarians in Nigeria perceive and understand blockchain adoption in academic libraries, and to identify the benefits and challenges they associate with its use in managing digital archives and information services.

2. Objectives of the Study

Specific objectives that the study aimed to achieve were as follows:

• Examine the librarian's perceptions regarding the relevance of adopting blockchain technology for managing digital archives in academic libraries.

• Ascertain the level of librarian's awareness regarding the relevance of adopting blockchain technology for managing digital archives in academic libraries.

• Identify the anticipated challenges regarding the relevance of adopting blockchain technology for managing digital archives in academic libraries.

3. Literature Review

According to Jha (2023), academic libraries are increasingly functioning as data providers by selecting, storing, and sharing digital assets. However, emerging technologies like blockchain present significant challenges to library and educational management. Blockchain helps reduce risks and protect users while enabling access to both digital and print content. As a result, modern academic libraries are adopting innovative tools to deliver information more efficiently. The impact of blockchain on library services is therefore considered substantial.

Jakati (2022) noted that blockchain is primarily used for secure digital transactions by storing records in a time-stamped and distributed format, making data difficult to duplicate or falsify. His article explains the mechanics of blockchain and its current and future applications in libraries. Similarly, Abid (2021) discussed blockchain and artificial intelligence in library contexts, emphasizing the limited number of existing studies. His work supports researchers and librarians in understanding key issues before implementing AI in library operations.

Suman and Patel (2021) traced blockchain's origins to Bitcoin, describing it as a relatively new and not yet fully understood technology. Their study explored its potential use in libraries and data centers to enhance data management. They also cautioned that while blockchain is powerful, it carries risks and must be applied thoughtfully by librarians.

Omame and Alex-Nmecha (2021) positioned blockchain within the framework of the Fourth Industrial Revolution, highlighting its use in libraries and data centers through cryptographic data sharing across networks. Although initially developed for digital currency, blockchain now influences fields such as data science and library services. Their study identified various applications in libraries, including record keeping, storage, categorization, and research data management, while also acknowledging that its benefits and limitations depend on institutional needs.

Shah *et al.* (2024) examined blockchain's potential impact on records management, predicting a transformative effect on information systems, though adoption in records management may lag. Hoy and Brigham (2017) also explored blockchain's future relevance for librarians and medical professionals. Lemieux (2017), a leading expert, demonstrated blockchain's utility in real estate, healthcare, and finance, offering a model for secure recordkeeping based on archival science. Her work underscores blockchain's potential to preserve authentic documents over time.

Despite these contributions, it is evident that limited research has addressed blockchain's role in managing digital archives within academic libraries, particularly in Africa. Most existing studies focus on records management and originate from developed countries. Empirical research remains scarce, with much of the literature being theoretical. Therefore, this study seeks to explore how librarians in Africa—especially Nigeria—perceive and understand blockchain technology for digital archive management, including the benefits and challenges they encounter in practice.

4. Methods

A qualitative research approach was adopted to explore librarians' understanding and experiences regarding the adoption of blockchain technology for managing digital archives. This

method was chosen for its strength in capturing rich, descriptive data and enabling researchers to draw meaningful conclusions from participants' narratives. Additionally, qualitative methods are cost-effective and practical, especially when self-administered (Creswell; Poth, 2018). The study employed an open-ended questionnaire to gather in-depth insights into librarians' awareness, perceptions, perceived benefits, and challenges associated with blockchain integration. Although various qualitative tools exist, open-ended questionnaires remain a common and effective instrument for eliciting detailed responses in exploratory research. Participants were system librarians from five academic libraries located in Southwest Nigeria. Each librarian holds a degree in Library and Information Science (LIS), ensuring subject-matter relevance. Two librarians were purposively selected from each institution, resulting in a total of ten participants. These individuals were responsible for data and information management within their libraries, making them well-suited to provide informed perspectives on the topic. The questionnaire included pre-formulated questions aligned with the four core objectives of the study. It also featured a brief definition of blockchain technology and clear instructions to aid comprehension. During the data collection phase, participants were invited to complete the survey promptly. All ten questionnaires were returned fully completed and subsequently analyzed. Information consent was obtained from all participants, who were assured of their right to withdraw at any point should they feel uncomfortable or encounter any issues. Their voluntary participation and openness contributed significantly to the depth and reliability of the findings.

5. Results

5.1 Librarian's Awareness Regarding the Relevance of Adopting Blockchain Technology

When asked whether they had started utilizing blockchain technology for digital archives in their libraries and whether they were aware of it, the majority of system librarians are aware of blockchain technology. According to the findings overall, it can be applied to the creation of immutable digital archives, guaranteeing that information once saved will never be changed or removed. This is crucial for preserving the integrity of academic records, historical documents, and cultural heritage materials. Also, it ensures that digital resources remain accessible and intact over time, even as technology evolves.

One respondent emphatically mentioned:

> "My level of understanding regarding blockchain technology is rather high as a result of my exposure to it from reading and hearing about it, as well as seeing firsthand how academic libraries that have already implemented it are doing well right now. Academic libraries will reap endless benefits from adopting blockchain technology, which is an amazing technology in digital era."

Concerning the above, another respondent has this to say:

> "Clearly, I am aware of blockchain technology; it is a fantastic tool that can be found in many academic libraries. That technology has not been incorporated into my library, though, is quite regrettable."

The study indicates that all participating system librarians are knowledgeable about blockchain technology and its application in libraries and information centers. Blockchain's strongest use cases lie in immutable record-keeping and transactional data management. Its alignment with core library values—such as accountability, transparency, and privacy—makes it a promising tool, even if not a perfect solution. Importantly, blockchain encourages academic libraries to rethink their processes around verifiable transactions and integrates well with supply chain principles across library operations.

5.2 Librarian's Perception Regarding the Relevance of Adopting Blockchain Technology

Librarians were asked to indicate how they perceive blockchain technology adoption in their respective libraries. The results reveal generally that the perception of librarians on blockchain technology for managing digital archives in academic libraries is positive.

One respondent remarked that:

> "Immutable, tamper-proof records are considered a major advantage of blockchain technology by many in the library sector. For the preservation of digital collections, research data, and academic documents in particular, this is pertinent. Said another way, academic libraries entrusted with knowledge preservation view blockchain technology as a means of fostering trust in the legitimacy and dependability of digital materials."

One respondent noted that:

> "Blockchain technology may be perceived by librarians as a means of improving access to digital resources via decentralized networks, thus expanding the reach of information and decreasing dependence on centralized authorities."

One respondent stated that:

> "In the context of handling academic credentials and intellectual property, blockchain technology is seen as a means of preventing unwanted access and tampering with sensitive information."

The study reveals that librarians hold a positive view of blockchain technology, recognizing its potential to transform digital archive management into academic libraries. Despite challenges in adoption, existing research highlights its promise for enhancing compliance monitoring, accountability, and repeatability in research workflows. Blockchain can

also improve ownership tracking, first-sale records, circulation, interlibrary loans, and e-lending systems. These benefits align with the favorable perceptions expressed by participants, reinforcing the technology's relevance in modern library operations.

5.3 Challenges in Adoption and Integration of Blockchain Technology

The librarians were asked to indicate whether there are challenges they envisage with the adoption and integration of blockchain to academic libraries for managing digital archives. The findings generally showed that while blockchain technology holds benefits for academic libraries, its adoption is accompanied by challenges.

One respondent explained that:

> "Librarians and archivists in an academic library may resist adopting blockchain technology due to a lack of understanding or fear of the technology's complexity. This resistance could slow down implementation and reduce the effectiveness of the new system. Significant training programs would be necessary to bring staff up to speed, which could also divert resources from other important library functions."

One respondent emphasized that:

> "If an academic library wants to use blockchain technology to store user information related to digital archives, it may encounter issues with GDPR compliance. For instance, GDPR requires that personal data be erasable upon request, but blockchain's immutable nature means that once data is entered, it cannot be easily deleted. This could lead to legal challenges and the need for complex workarounds, such as encrypting the data and securely managing the keys."

One respondent submitted that:

> "A consortium of academic libraries trying to create a shared blockchain technology for managing digital archives might face difficulties establishing a common governance model. Questions about who controls the blockchain technology, how updates are implemented, and how disputes are resolved could hinder collaboration and lead to fragmented implementations."

Blockchain technology holds great potential for managing digital archives in academic libraries, but its implementation faces significant challenges. These include scalability, cost, integration, data privacy, governance, energy use, and legal concerns. A major barrier is user adoption, often hindered by high implementation and maintenance costs (Jha, 2023). Overcoming these issues requires strategic planning and thoughtful execution.

6. Discussion

This study explored system librarians' awareness and perception of blockchain technology adoption for managing digital archives in academic libraries, particularly within the

context of the Fifth Industrial Revolution (5IR). The results indicate that all participating librarians demonstrated a clear understanding of blockchain technology and its relevance to library operations. This aligns with Jakati and Kumar (2022) who emphasized that blockchain's immutability and decentralized nature make it ideal for preserving digital records and enhancing trust in archival systems. Respondents acknowledged blockchain's potential to create tamper-proof, verifiable records that ensure the integrity of academic documents, historical materials, and cultural heritage assets. Its ability to maintain accessibility and authenticity over time, even as technology evolves, was seen as a major advantage. These findings support Jha (2023), who argued that blockchain can revolutionize digital preservation by offering distributed trust mechanisms and long-term data resilience.

The perception of blockchain technology among librarians was overwhelmingly positive. Many viewed it as a tool for improving access to digital resources through decentralized networks, reducing reliance on centralized authorities. Others highlighted its role in safeguarding academic credentials and intellectual property, preventing unauthorized access and manipulation. These perspectives echo Adigun, Ajani and Enakrire (2024), who noted that blockchain enhances accountability and transparency in digital environments. Despite the enthusiasm, the study also uncovered significant challenges. Key concerns included the complexity of implementation, scalability issues, and high maintenance costs. One respondent emphasized the need for extensive training to overcome resistance and ensure effective adoption—a concern echoed by Jha (2023), who identified user adoption and technical literacy as major barriers in blockchain integration. Legal and ethical considerations also emerged, particularly regarding data privacy and compliance with regulations like the General Data Protection Regulation (GDPR). The immutable nature of blockchain conflicts with GDPR's "right to be forgotten," posing dilemmas for libraries managing personal data.

This challenge has been discussed in depth by Jha (2023), who proposed encryption and key management as potential workarounds. Governance was another critical issue, especially for libraries considering consortium-based blockchain systems. Questions around control, updates, and dispute resolution could hinder collaboration and lead to fragmented implementations. As Shah et al. (2024) suggest, establishing clear governance frameworks is essential for successful blockchain deployment in multi-institutional settings. In conclusion, while blockchain technology offers transformative potential for managing digital archives in academic libraries, its adoption must be approached with strategic planning, policy alignment, and capacity building. The insights from this study contribute to a growing body of literature advocating for thoughtful integration of emerging technologies in library and information science.

7. Conclusion

This study examined system librarians' awareness and perception of blockchain technology for managing digital archives in academic libraries within the context of the Fifth Industrial Revolution (5IR). The findings reveal that librarians are not only aware of blockchain technology but also perceive it positively due to its potential to enhance transparency, accountability, and the integrity of digital records. Blockchain's ability to support immutable, verifiable transactions aligns well with the core values of academic libraries and offers promising applications in areas such as circulation, ownership tracking, and research data management. However, the study also highlights significant challenges to adoption, including technical complexity, cost, legal compliance, and user resistance. These barriers underscore the need for strategic planning, capacity building, and policy development to ensure successful implementation. As academic libraries continue to evolve in response to technological advancements, blockchain presents a compelling opportunity to rethink and strengthen digital archiving practices. Future efforts must focus on addressing the identified limitations and fostering collaborative, sustainable models for blockchain integration in library systems.

8. Recommendations

Based on the findings of this study, the following recommendations are proposed to support the effective adoption of blockchain technology for managing digital archives in academic libraries:

- Academic libraries should invest in continuous professional development for librarians, focusing on blockchain literacy, digital archiving, and emerging technologies. This will reduce resistance and build confidence in implementation.
- Institutions are encouraged to initiate small-scale pilot programs to test blockchain applications in digital archiving. These pilots can serve as learning models and help identify context-specific challenges before full-scale deployment.
- Libraries must establish robust policies addressing data governance, privacy, and legal compliance, especially in relation to regulations like GDPR. These frameworks should guide ethical and secure blockchain use.
- Forming consortia among academic libraries can facilitate shared infrastructure, reduce costs, and promote standardization in blockchain deployment. Collaboration also enhances knowledge exchange and innovation.

- Blockchain solutions should be designed to complement existing library management systems. Seamless integration will ensure continuity of services and minimize disruption during transition.

- Awareness campaigns targeting faculty, students, and administrators should highlight the benefits and limitations of blockchain technology. This will foster institutional support and user engagement.

- Libraries must evaluate the long-term sustainability of blockchain systems, considering energy consumption, scalability, and maintenance. Strategic planning is essential to ensure enduring value.

- Academic institutions should support interdisciplinary research into blockchain applications in LIS, including comparative studies, user experience analysis, and impact assessments.

9. Limitations and Suggestions for Further Studies

This study was limited by its qualitative scope and small sample size, involving only ten system librarians from five academic libraries in Nigeria's Southwest geopolitical zone. While their insights were rich and informative, the findings may not be generalizable to other regions or library types. Additionally, the study relied on self-reported data, which may be influenced by personal bias or limited practical exposure to blockchain technology. The absence of comparative data from libraries that have successfully implemented blockchain systems also restricts the depth of analysis regarding real-world outcomes.

In view of the limitations above, several avenues for further research are suggested:

- Future research should consider expanding the sample to include librarians from diverse geopolitical zones and different types of libraries (e.g., public, special, and private academic libraries).

- A mixed-methods approach combining qualitative interviews with quantitative surveys could offer a more comprehensive understanding of blockchain adoption trends.

- Longitudinal studies tracking implementation over time would help assess the sustainability and impact of blockchain systems in digital archiving.

- Moreover, comparative studies between institutions that have adopted blockchain and those that have not could reveal critical success factors and barriers. Finally, exploring user perspectives—such as students and faculty—would enrich the discourse on adoption and usability.

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