Data & Metadata. 2023; 2:59
doi: 10.56294/dm202359

REVISIÓN

Application of blockchain technology to 21st century library services: Benefits and best practices

Aplicación de la tecnología blockchain a los servicios bibliotecarios del siglo XXI: Beneficios y mejores prácticas

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Cite as: Oluchi Emmanuel V, Efemini M, Oseni Yahaya D, David Oladokun B. Application of blockchain technology to 21st century library services: Benefits and best practices. Data & Metadata. 2023;2:59. https://doi.org/10.56294/dm202359

Submitted: 01-05-2023 **Revised:** 23-05-2023 **Accepted:** 11-07-2023 **Published:** 12-07-2023

Editor: Prof. Dr. Javier González Argote

ABSTRACT

The fourth industrial revolution has paved the way for emerging technologies, and among them, blockchain stands out for its unprecedented ability to create and trade value in library organizations. This research paper explores the potential application of blockchain technologies in 21st-century library services. By conducting a systematic analysis of the literature, this study examines how libraries can harness blockchain to support innovative services and meet global demands. The study suggests that the recent advancements in blockchain have led to a fourth generation of the technology, which possesses disruptive capabilities across diverse fields, including library and information science. The paper proposes that blockchain can enhance library services such as collection development, circulation services, research, data management, and storage. It is important to note that this paper represents the original ideas of the authors and does not rely on copyrighted materials. Furthermore, it highlights that blockchain remains a vast and underexplored area of research, presenting both challenges and opportunities for library professionals seeking to provide diverse library services.

Keywords: Fourth Industrial Revolution; Blockchain Technologies; Blockchain; Library; Services; 21st Century.

RESUMEN

La cuarta revolución industrial ha allanado el camino a las tecnologías emergentes y, entre ellas, destaca blockchain por su capacidad sin precedentes para crear e intercambiar valor en las organizaciones bibliotecarias. Este trabajo de investigación explora la aplicación potencial de las tecnologías blockchain en los servicios bibliotecarios del siglo XXI. Mediante la realización de un análisis sistemático de la literatura, este estudio examina cómo las bibliotecas pueden aprovechar blockchain para apoyar servicios innovadores y satisfacer las demandas globales. El estudio sugiere que los recientes avances en blockchain han dado lugar a una cuarta generación de la tecnología, que posee capacidades disruptivas en diversos campos, incluida la biblioteconomía y la ciencia de la información. El documento propone que blockchain puede mejorar los servicios bibliotecarios, como el desarrollo de colecciones, los servicios de circulación, la investigación, la gestión de datos y el almacenamiento. Es importante señalar que este documento representa las ideas originales de los autores y no se basa en materiales protegidos por derechos de autor. Además, destaca que blockchain sigue siendo un área de investigación vasta y poco explorada, que presenta tanto desafíos como oportunidades para los profesionales de las bibliotecas que buscan proporcionar diversos servicios bibliotecarios.

Palabras clave: Cuarta Revolución Industrial; Tecnologías Blockchain; Blockchain; Biblioteca; Servicios; Siglo XXI.

INTRODUCTION

The relationship between technology and libraries in the 20th century is deeply interconnected. One prominent technology that has emerged is blockchain, which serves as the fundamental system for various technological operations, including those related to Bitcoin. Blockchain, a relatively recent innovation, has the potential to revolutionize the way we collect and distribute information. It combines several technologies such as consensus processes, peer-to-peer networks, smart contracts, and cryptography to create a novel type of database.

Industries such as finance, healthcare, and government are currently investing significant resources in researching the transformative possibilities of blockchain. Moreover, alternative applications of blockchain are now being explored. Additionally, blockchain records essential transaction details like time, date, participant information, and relevant legal or contractual aspects. Both non-financial and financial sectors can benefit from utilizing blockchain technology. Consequently, blockchain might also stimulate the growth of libraries.

Blockchains differ from the internet in several ways: they are distributed rather than centralized, open rather than exclusive, immutable rather than changeable, and secure. This technology introduces unprecedented opportunities for generating and exchanging value within society.[1]

The revolution brought about by blockchain technology can be categorized into three distinct phases, commonly known as Blockchain 1.0, Blockchain 2.0, and Blockchain 3.0, much like other technological advancements.[1]

Blockchain 1.0 primarily involves the use of cryptocurrency, which relates to everyday digital payment systems. Moving forward, Blockchain 2.0 expands the scope of blockchain technology to encompass the entire financial system, allowing for the inclusion of traditional financial transactions such as bonds, stocks, and shares. On the other hand, Blockchain 3.0 represents applications that fall beyond the scope of Blockchain 1.0, 2.0, and 3.0, including e-governance, digital health records, electronic voting, science, literacy, culture, and digital art.[2]

One of the key attributes of blockchain technology is its tamper-proof nature. Once a transaction is recorded on the blockchain, it becomes immutable and cannot be altered or deleted. Consequently, blockchain provides transparency and immutability to all historical transactions.[1]

DEVELOPMENT

The feasibility of Blockchain Technology

Blockchain technology utilizes a distributed database, where multiple devices are connected rather than being linked to a single processor. This database organizes data into records called blocks, which are validated through cryptography, timestamped, and linked to previous records. Only individuals possessing the encryption keys have the ability to modify these files. In simple terms, digital data is stored in a publicly accessible database.[3]

The functioning of blockchain technology relies on a network of computers, referred to as nodes, with each node maintaining a ledger of data in the form of blocks.[4] These nodes perform various tasks as the building blocks of the blockchain. They relay transaction data, store copies of blocks, and participate in transaction verification and validation. When a new transaction is created, a node broadcasts it to the network. Other nodes in the network then verify the transaction, and if it meets the required criteria, it is combined with other transactions to form a new block. The first node to successfully create a new block, according to the consensus protocol, broadcasts it to the network. Peer nodes validate the block and, if it conforms to the rules, add it to the existing blockchain.

The blockchain network is connected to millions of computers, and all transactions occurring on the network undergo thorough verification by these computers. As a result, information records that have been verified with minimal human involvement tend to be highly accurate. Jakati et al.[5] pointed out list of advantages of blockchain for adoption in libraries:

✓ User-friendly technology: because blockchain technology is an open source project, no middlemen are needed to manage the software, allowing developers and users to have more power over technological decisions.[6]

✓ Distributed database: blockchain lacks a central repository for data storage. More precisely, it operates on distributed database systems.[7]

✓ Translucent but personal: although the Blockchain technology is open source software, it is incredibly

difficult to alter data with it. Because the technology is open source, anyone on the blockchain network can modify the code as necessary. All users can see the transactions made on the blockchain, which aids in information retrieval, but no personally identifying data is maintained.[8]

✓ Unalterable Transaction: alterations in data is not possible which facilitates an efficient and costeffective audit process.[9]

✓ No intermediaries required: the immutability and security of the records recorded in blockchain eliminate the need for third-party verification, which lowers transaction costs.[10]

✓ Adaptable*:* blockchain technology can be used to securely store any data that can be stored digitally.[10]

✓ Security: to protect the integrity of transactions Blockchain uses consensus mechanisms, hashing, and cryptography to provide the highest level of security for the data stored. If a transaction is logged, all of the network's computers will verify the authenticity of the transaction. The enormous difficulty of changing information on the blockchain without notice is made more difficult by this discrepancy.

Leveraging blockchain technologies to library services

The potential utilization of blockchain technology as a record-keeping system has the potential to enhance accuracy and reduce the risk of information loss due to disasters or deliberate sabotage. However, implementing blockchain would require not only adding new records to the network but also digitizing existing records for effective record-keeping.[11]

As blockchain enables more secure and reliable documentation, its adoption in formal and informal learning within academic, public, and specialized libraries may increase.[12] Several startups have already begun employing blockchain as a commercial solution. Through blockchain technology, programmers can establish "smart contracts" capable of recording debt registries or executing specific instructions at predetermined times or in response to certain conditions.[8]

In the field of education, blockchain technology has the potential to revolutionize how academic institutions store student data, including registration records, attendance records, grades, and even previous teachers' lesson plans. This information can be easily transferred between academic institutions as students transfer or graduate to new institutions. Additionally, blockchain has various applications in the business sector.

To avoid being disrupted, libraries need to actively engage in determining how this technology is employed to create, store, and distribute content. Decentralized libraries, where user data is stored on a blockchain rather than a centralized database, may become more common in the near future. In such libraries, users can have control over their circulation records and manage their borrowing histories. Furthermore, new economies may develop, offering incentives for library users to share their data with libraries. According to Chingath et al.[13], the rise of blockchain technology has triggered libraries to utilize these edge-cutting technologies enhance services delivery:

a) Publishing e-books and to protect digital right: when utilizing e-books, there is often interference from third parties, and both libraries and users are required to pay for the entire package rather than just the portions they use. Additionally, authors do not have complete control over the production process. However, these challenges can be overcome with the help of Publica, a platform that allows anyone to publish their own book. Authors can use this platform to define the terms and conditions for using their book by creating a smart contract. Through the smart contract, an Ethereum network is established, enabling anyone to purchase the book using book tokens. Publica has introduced a new feature called crowdfunding or Book ICO, which allows creators to pre-sell their tokens and raise funds for initial payments.

b) Research Institutions Network on Blockchain: all library institutions can share research via a private blockchain. Grey literature, lab reports, and other materials that are essential to conducting the research but are not in a format suitable for publication as an article or book can be published via this method. Instead of conducting parallel studies, if someone invented something, they could share their findings with all libraries via blockchain, allowing everyone to access it. They can also add to such research in various ways. They don't have to worry about data erasure, data theft, or digital rights throughout the entire process.

c) Library to user loan: the ability to lend a book to a user or another library without physically going to the library is the other most advantageous use of blockchain. The Distributed Library Management System (LibChain), which is built on blockchain technology, envisions updated methods for borrowing books from libraries. Via Libchain, users can lend library books directly to other readers without returning the original copy to the library. The client must be a current library member in order to qualify. The system also facilitates interlibrary borrowing practises. LibChain intends to expand well-known library services and provide a library ecosystem where users can access the services they want quickly, easily, and securely.

d) Scholarly publications and digital rights management: the current publishing model is publisher-centered, meaning that the publisher holds all of the rights and that the author must always remain anonymous. For instance, everyone is aware of the well-known journal, but no one is concerned about the author. All of these problems can be solved on the Orvium platform by transferring scholarly publishing to a high-tech

upgraded blockchain platform. Using the Orvium GUI, anyone can register themselves, and the student can do so using their ORCiD ID. As a result, the creator receives tokens when their work is published on Orvium. These tokens can be used to cover the cost of peer review, which can be either blind or open. Blockchain technology can be used by the library to store information in tamper-resistant environments, and this technology can also be investigated in the area of research publication and communication. Journal article time-stamped verifiable copies can likewise be produced using blockchain technology. Owing to its enormous potential, blockchain technology is used in libraries' digital rights management systems because it generates a single, independently verified record that is open to all. It could be applied as a method to demonstrate a resource's verifiable scarcity after being linked to digital content.

One of the widely recognized applications of blockchain technology is in supply chain management, which involves the coordinated planning, organization, and oversight of all business processes and activities among different entities involved in delivering value to consumers. The aim is to meet consumer demands more effectively, at reduced costs, while satisfying the requirements of all stakeholders in the supply chain.[14]

Implementing blockchain-enabled supply chain management can enhance various aspects of library operations and services, including the charging and discharging of library materials, interlibrary loans, and collection development processes such as selection, ordering, acquisition, supply, and payment for library resources.

For example, the administration and tracking of borrowed or loaned library items can be significantly improved through this technology. From the moment a material is checked out or loaned to a user, until the due date when the borrower returns it, the movement, storage, operations, and involved parties in charging and discharging library resources are all part of the supply chain management process. By utilizing blockchain-enabled supply chain management, it becomes possible to trace and track the status of borrowed or loaned library resources in real-time, while maintaining an immutable and permanent distributed ledger of these operations.[7]

In essence, the system enables efficient tracking of each item borrowed by library users. Additionally, the selection, ordering, procurement, monitoring, distribution, and transportation of library resources between libraries and publishers/book vendors can be facilitated through the use of blockchain-enabled supply chain management in the collection creation process.

Blockchain-based currencies like Bitcoin offer intriguing opportunities for libraries to make payments to book vendors and publishers using cryptocurrency, thus avoiding issues related to exchange rates.[15]

By leveraging blockchain in libraries and information centers, currency volatility can be mitigated, stabilizing the library's budget. Academic and research libraries gather publications from around the world, including books, journals, and other knowledge sources. Users pay annual subscription fees to access internet databases for current and high-quality scholarly works across various academic disciplines. Currency fluctuations can significantly impact library funding. However, the financial applications of blockchain provide possibilities for libraries and information centers to embrace blockchain-based currencies, such as Bitcoin, for financial transactions with publishers or vendors, eliminating exchange rate concerns when subscribing to or purchasing new resources.[16] Additionally, smart contracts, as mentioned by Coghill[12], can be employed to facilitate payment for digital resources within legal boundaries.

Furthermore, blockchain can be employed in libraries and information centers to store and track vital library documents where provenance, integrity, and validity are crucial.[17] Blockchain can verify the origin and integrity of all library information, particularly when shared across networked libraries. This technology simplifies tasks such as charging and discharging materials (both print and electronic) and interlibrary borrowing. Supply chain management can be utilized to trace the origin and destination of specific documentation. Given their commitment to preserving and archiving unique and authoritative collections that require provenance and authenticity tracking, law libraries, medical libraries, research libraries, and academic libraries are particularly significant spaces for implementing blockchain technology in libraries and information centers. Blockchain can contribute to document archiving by providing immutable provenance metadata assets for tracking purposes. Consequently, blockchain technology can generate time-stamped, verifiable versions of library holdings, such as journal articles, books, conference proceedings, theses, and dissertations.[18] This capability enables auditing and verification of the validity, legitimacy, and provenance of scientific literature. Assigning a unique digital identifier to each digital material allows for its unique identification, management, and transfer. This aspect of blockchain can assist libraries, publishers, and authors in enforcing and detecting copyright infringement.[6] In such a scenario, no digital material would be copied without the consent of publishers or libraries, as these entities uphold copyright laws.

Libraries are employing blockchain technology in research data management as a means to secure and preserve patrons' research data for future generations. Academic and research libraries, in particular, offer research data management services that encompass the planning, organization, storage, protection, security, curation, and support of research data throughout scholarly works and open scientific workflows.[19] By

leveraging blockchain, libraries can enhance research data handling through open accountability, improved security, and protection of ownership rights. This approach reduces duplication of research efforts through open-source initiatives and the sharing of well-managed research data, thus increasing the long-term value of existing research data by making it accessible for further high-quality research and reducing duplication of research efforts.[12] Furthermore, blockchain's immutable time-stamp metadata enables easier identification of the origins and originality of each research data, which is valuable for acknowledging and defending the intellectual property of creators, when applicable.

Moreover, blockchain technology has the potential to impact other library and information center services such as cataloging, classification, indexing, and abstracting. Libraries, publishers, and indexing/abstracting service providers can collaborate to create a blockchain-based network for managing bibliographic information related to published books. When books are published and confirmed by the network's libraries, publishers, and indexing/abstracting services, cataloging entries or classification numbers, known as CIPs (Cataloging In Publication), can be added to the blockchain record (block). This decentralized and distributed ledger system for cataloging entries of books by various entities facilitates technical services in libraries and information centers by enabling collaboration through a shared, distributed, and trusted dataset.[13]

In summary, blockchain technology is being utilized by libraries in research data management, leading to enhanced security, ownership rights protection, and reduced duplication of research efforts. Additionally, blockchain has the potential to revolutionize cataloging and other library services by facilitating collaboration and creating a trusted system for managing bibliographic information.[20]

CONCLUSIONS

Blockchain technology is an innovative solution that provides a reliable method to verify transactions, including the involved parties, submission time and date, and transaction details, all without the need for intermediaries. Despite being relatively new, blockchain technology holds great potential, and researchers in academia are actively exploring its various applications. Among the emerging technologies, blockchain has the ability to revolutionize libraries, transforming them into smart libraries. Libraries are dedicated to collecting, preserving, and sharing accurate information, and blockchain can contribute to these goals by utilizing a distributed and timestamp-based approach, ensuring the authenticity and ownership of records. Although the adoption of new technologies in academic and library environments may lag behind the tech industry, embracing cutting-edge technology is crucial for advancing the library culture. Blockchain represents a vast and largely unexplored area of research, presenting both opportunities and challenges for library professionals as they strive to enhance and expand their range of services.

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FINANCING

No financing.

CONFLICT OF INTEREST

None.

AUTHORSHIP CONTRIBUTION

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