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Challenges to Implementing and Integrating Blockchain Technology Practices in Academic Libraries

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Abstract

University libraries have the potential to substantially improve their users' experience through the implementation of sophisticated BCT tools. Despite these developments internationally, very little research has been undertaken thus far within academic libraries of Pakistani regarding their acceptance of new technologies and, more specifically, the adoption of BCT. Additionally, the study aims to identify the challenges faced by university librarians during the implementation of BCT. To achieve the study's objectives, a quantitative research approach was adopted. Similarly, descriptive statistics were used to find out correlation amongst various items of the BCT challenges. The study highlights several key obstacles that hinder university librarians from adopting BCT in their libraries, including legal & ethical challenges, technical challenges, knowledge and skills challenges and organizational challenges. The study concludes with several key recommendations, including closer collaboration between the library and different university's departments. These are specially including information technology department for technical support and assistance, improved financial support and ICT infrastructure to establish Blockchain technology-based library services, and training development plans for library staff. Insights gained from this study should contribute to the ability of university librarians of Pakistani and their staff to maximize the full potential of BCT within their institutions.

Keywords: Academic libraries, blockchain technology, challenges, implementation, LIS professionals, practices

Introduction

Blockchain is digitized, decentralized and highly distributed public ledger, can be accessed by everyone via Internet or privately through a restricted network. It functions similarly to an extensive virtual accounting ledger, recording the details of every transaction between two parties (Ndung'u, 2022) . The replicated and shared digital data structure is maintained through consensus protocols and is disseminated across multiple institutions, countries, and locations. Operating on a peer-to-peer network, it lacks

central control. Transactions on the blockchain utilize cryptographic keys, with public keys serving as addresses within the system and private keys used for signing transactions (Iqbal & Matulevičius, 2019). The digital data is organized into blocks that are sequentially linked, creating an immutable record once the data is recorded. This immutability persists unless a collusion among member nodes on the P2P structure occurs to alter the data (Shahzad et al., 2024) . All the blocks contain hash pointer that links it to preceding the block, as well as timestamp that indicates the creation time of block. From the numerous types relates to blockchain, each serves its distinct functions its purposes (Zeba et al., 2023)

Blockchain technology stores information in distributed tamper resistant environment. Blockchain technology is one of the most ideal applications relates to the preservation of scientific publications disseminated globally. (Naqvi and Hussain, 2020) blockchain can be understandable as an appended-only database upheld by the nodes within P2P network. Fundamental structure of Blockchain, consists three levels, first is the underlying P2P network, databases and various applications relates to the databases. P2P network facilitates to ensure effective communication among the nodes of blockchain. These nodes are distributed geographically which possesses equal privilege as participants in a network. There is no centralized server, each note performs both functions, as an information consumer and the provider. These nodes engage in the various processes of the network, it discovers and maintain the routing within a network, discovering and maintaining the connections with adjacent peers, propagating and verifying the transactions, and synchronizing the data blocks. In this context, transactions and blocks represents the core data structure of the Blockchain. This “flat” topology of P2P network is a fundamental aspect that reinforces decentralized nature of the blockchain technology (Feng et al., 2019).

Financial institutions have emerged as early adopters of blockchain technology, recognizing its transformative

potential despite its relatively nascent stage. According to a study by the World Economic Forum, banks and regulators around the globe were preparing to experiment with various blockchain prototypes as early as 2017. As of that time, over 90 central banks were actively engaged in discussions regarding blockchain applications, highlighting a significant interest in exploring the technology's implications for the financial landscape. Additionally, more than 2,500 patents related to blockchain technology were filed within a three-year period, indicating robust innovation in this area. Furthermore, it was anticipated that 80% of banks would initiate projects involving blockchain and distributed ledger technology (DLT) by 2017, suggesting a widespread commitment to integrating these technologies into their operations. These developments signal that blockchain technology is on the verge of becoming a standard within the financial services sector, improve security, efficiency and transparency to financial transactions. Prospective stance about financial institutions in embracing this technology underscores its anticipated significance in the evolution of the global financial ecosystem. (Binaifer Karanjia, Shankar Lakshman, 2017).

Statement of the Problem

In the current digital environment, the introduction of new technologies is rapidly increasing over time. Many researchers internationally have indicated the implication of Blockchain Technology in the libraries as a theoretical perspective. These are available in the published literature. Hence, many Blockchain technologies can be used for library services (Pearce, 2019) . In national scenario, the literature about the use of Blockchain technology is available in so many fields of studies such as, the record management, cloud data management, supply chain management, protection of intellectual property and E-learning etc., but not for practices and Blockchain technology implication in libraries. In this framework. Hoy (2017a) highlighted the implication of these technologies in academic libraries. Existing literature indicates that there is no comprehensive study available to examine the

implications and applications of BCT in libraries in Pakistan. It is crucial to bridge this gap to understand the practices and implications of BCT within academic libraries in the country.

Significance of the Study

Due to modernization in the library services, it is necessary to acquire the latest modern technology to provide facilities to the library users. Provision of modern technology in the libraries is the way to better communicate and to provide the essential information in a quick way. In view of the importance of implication of Blockchain Technology, there is required to investigate its effectiveness in Academic libraries. Having investigated this research topic, it is apparent that there are few relevant national studies. It will contribute to fill literature gap and draw attention of organizations' administrators, library managers and policymakers to consider the importance and application of modern technologies. This study will highlight the need to develop or sharpen for better work environment and will also motivate to provide the latest beneficial technologies in the libraries.

The primary objective of this research study is to address the challenges / problems faced for implications of blockchain technology in academic libraries of Pakistan. This study will highlight the challenges for the applicability of modern technology and its vital role for better performance of a library. Findings of the study could be most helpful to address the challenges faced by the modern libraries for better facilitation to the users.

Blockchain Implementations in Libraries

(Hoy, 2017b) described that BCT has potential to serve as effective digital rights management (DRM) tool. Publishers could utilize blockchain agreements to impose restrictions on the printing of articles and book chapters. By linking printing permissions to the initial agreement within the blockchain, publishers would be able to control the distribution and reproduction of their works. This system could function effectively, provided that all parties involved adhere to transparent and cooperative practices. While the

decentralized nature of blockchain may complicate unauthorized access, it does not render the system impervious to malicious activities. Hoy highlights the possibility of hackers employing tactics such as ransom demands, whereby they could hold blockchain transactions hostage until their demands are met.

Furthermore, blockchain holds promise as the Digital Rights Management (DRM) tool within libraries. The integrally reproductible nature of digital resources creates significant challenges for both libraries and publishers. In response, publishers have often imposed stringent and, at times, impractical DRM systems to deter unauthorized copying of their materials. Blockchain technology, by virtue of its ability to generate unique and verifiable records accessible to all, could be leveraged to establish "provable scarcity" of digital resources. This would facilitate the unique identification, control, and transfer of digital materials. While such a system could reassure publishers that unauthorized copies are not being produced, the implications for pricing dynamics remain a subject of debate. Moreover, blockchain technology has broader implications for the field of education. Similar to the manner in which blockchain medical records empowers the patients to access them to control over their data. The blockchain education records could enables the students to maintain the history of their academic achievements which can be verified. This paradigm shift would place ownership of academic records directly in the hands of students. Notably, at least single organization is pursuing the development of such a system actively. In early 2016, Sony company announce plan to create blockchain infrastructure to secure and open sharing of academic progress and proficiencies (Sharples & Domingue, 2016).

Blockchain technology is creating new opportunities beyond its well-known applications in financial services. The potential for blockchain-based systems extends to various fields, including libraries. (Keiser, 2020) discussed an examination the impact of blockchain on library and its community. The project, awarded by Institute of Museum

and Library Services (IMLS), serve as platform for experts in the blockchain, as well as professionals in the information sector and related disciplines, to explore practical strategies for libraries to adopt this innovative technology to enhance the services. Initiative provides foundational framework to improve information communication and exchange within library systems and its communities (L. Zhang, 2019).

Challenges of Blockchain Technology Implementation for Users and Library Resources

(Ojobor et al., 2022) presents the critically analysis of blockchain technology, exploring both the challenges and opportunities presents for library applications. An investigation was conducted within federal university libraries in Southeastern Nigeria, focusing on assessing the awareness of blockchain technology among library professionals, evaluating its relevance to library services and its operations, and identifying the barriers to its implementation. Utilizing a qualitative research design, the study targeted academic librarians across five federal university libraries in the region. It highlights various potential applications of blockchain within library contexts, including the development of an advanced metadata system, the facilitation of P2P resource sharing, and provision of a Digital Rights Management (DRM) solution. However, it also identified significant challenges to blockchain technology adoption, such as inconsistent power supply, inadequate funding, deficiency of skilled personnel, and limited broadband access. To address these challenges, various strategies aimed at promoting the adoption of this transformative technology in libraries has been proposed. (Rouhani and Deters, 2019) provides a comprehensive overview of the inherent problems in traditional access control mechanisms. It explored, how blockchain technology offers potential solutions. It also presents a comprehensive review of existing studies and proposed platforms across diverse sectors, highlighting the state of art in blockchain based access control system and discussing associated challenges. Blockchain technology integration into library resource access system promises

enhanced security, transparency, and efficiency. However, several challenges have been addressed to ensure successful implementation. Three primary challenges, Lack of privacy, inefficiency, and necessity of eliminating third-party involvement in access control systems are described here.

(Anwar et al., 2022) explores primary components of BCT encompass its various advantages for libraries, particularly in areas such as digital preservation, data tracking, and storage. Additionally, this discussion addresses the challenges associated with implementing blockchain in library settings, including its intricate architecture and initial financial investments. Nevertheless, despite challenges, potential benefits of integrating BCT into libraries are significant.

Literature Review

(Hao et al., 2023) described regarding blockchain technology that it is acknowledged as a prominent innovation within the field of educational information systems. Its distinctive attributes decentralization, traceability, multiparty consensus mechanisms, and enhanced trust render blockchain particularly effective to address critical challenges relates to information security and the prevailing trust crisis associated with online big data education. Moreover, the application of blockchain technology can significantly protect educational resources digitally, enhance the teaching material transparency, and streamline the copyright transaction process. These advancements, in turn, strengthen the scientific and technological innovation capabilities of educators.

(Gao et al., 2024) addresses several key issues in the realm of computer resource sharing, particularly in power systems. The main points derived from the paper's context are Imbalance in Resource Distribution. It has been also highlights the existing problems of imbalance between the distribution of computer resources and the demand for computing power in networks. This imbalance often leads to waste of resources, which the proposed model aims to mitigate. The critical aspects on the challenges of

traditional resource sharing systems and the innovative solutions proposed through blockchain technology are focused.

Challenges to implement Blockchain Technology in Academic Libraries

Implementation of blockchain technology within library systems faces many substantial challenges that hinder its effective adoption and utilization. Foremost among these challenges, is the issue of inadequate funding, which restricts the ability of the libraries to invest in required essential infrastructure and training required for such advanced technological integration. Additionally, the irregularity of power supply poses a critical obstacle, as consistent and reliable electricity is essential for the continuous operation of blockchain systems. Moreover, poor broadband connectivity presents a further complication, as a stable and high-speed internet connection is vital for the smooth operation of blockchain networks. Finally, there exists a notable shortage of competent personnel furnished with requisite knowledge and skills for its management and operate blockchain technology effectively within library settings. Collectively, these challenges create a complex environment that impedes the effective application of blockchain solutions in the libraries (Ojobor et al., 2022).

Primary challenge faced in application and adoption of blockchain within library systems encompass several critical dimensions. Firstly, the substantial financial investment required for maintenance and development of necessary infrastructure presents a significant barrier to entry for many institutions. Secondly, privacy concerns emerge as a paramount issue, particularly regarding the handling and protection of sensitive user data in a decentralized environment. Lastly, there exists a notable deficit in the understanding and familiarity with blockchain technology among librarians, which can impede effective utilization and integration of this innovative system into existing library practices. Addressing these multifaceted challenges is important for development a more robust and

informed approach to potential benefits of blockchain in the library context (Akintunde & Amuda, 2024).

The challenges related to integration of blockchain into digital library management are multifaceted and encompass several critical dimensions. Foremost among these challenges is the imperative to ensure robust data security, as decentralized and complicate protection of sensitive information (Khan et al., 2023) . Additionally, maintaining service reliability is essential, as users expect consistent access to digital resources without interruption; any disruptions could undermine user trust and engagement. Furthermore, the pursuit of efficiency in digital library operations is crucial, as the implementation of blockchain solutions must not only streamline processes but also minimize resource consumption and operational costs. Thus, addressing these interconnected challenges needed comprehensive approach that balances technological innovation with practical considerations in the management of digital libraries (Gunawan et al., 2024),

Effective application of blockchain in libraries is subject to a variety of challenges that can significantly impede its adoption and utilization. Specifically, technological barriers may arise due to the need for specialized infrastructure and expertise to integrate blockchain systems into existing library frameworks. Financial challenges are also prominent, as the initial investment required for blockchain implementation can be substantial, potentially diverting resources from other critical areas of library operations. Moreover, legal challenges, including concerns related to data privacy, intellectual property, and compliance with regulatory frameworks, may further complicate the deployment of this innovative technology (K. Ahmad et al., 2019) . Finally, challenges relate to social norms, such as resistance with change by staff of library and patrons, as well as lack of understanding about blockchain's potential benefits, can hinder its acceptance and integration. Collectively, these multifaceted obstacles can significantly impact libraries' ability to realization about transformative advantages that

blockchain offers, such as enhanced transparency, improved resource management, and greater accessibility to information (Bashir & Warraich, 2023).

The blockchain technology implementation in libraries significantly hindered by variety of interrelated challenges. These obstacles include, but are not limited to, constrained financial resources, which restrict the capacity for investment in new technologies; inadequate electricity supply, which can disrupt the operational efficiency necessary for such advanced systems; and a notable deficiency in the requisite skills among librarians, who may lack the technical expertise needed to effectively utilize blockchain applications. Furthermore, slow internet connections pose a considerable barrier to the seamless functioning of blockchain networks, thereby impeding real-time data accessibility and transaction efficiency (K. Ahmad et al., 2020) . Finally, a widespread reluctance to change within library institutions can impede the adoption of innovative technologies, as stakeholders may be reluctant to shift from traditional methods to a more decentralized and technologically sophisticated framework (Rafi et al., 2020) . Collectively, these factors contribute to a complex landscape that presents considerable challenges to the successful integration of blockchain technology in library environments (Tella, 2023).

Implementation of blockchain technology in library systems presents several open challenges that warrant careful consideration and examination. Among these challenges, data security emerges as a paramount concern, the decentralized blockchain must be balanced with the need to safeguard information of sensitive nature against potential breaches and unauthorized access. Additionally, user privacy remains a critical issue, necessitating the development of robust mechanisms that protect the identities and transactional data of library patrons (Islam et al., 2024) . Moreover, the integration of blockchain with existing library management systems poses significant obstacles, requiring a comprehensive understanding of both the technical and operational frameworks currently in place.

This integration must ensure seamless interoperability while enhancing the overall functionality of library services. Furthermore, the establishment of standardized protocols and consensus algorithms is essential for fostering collaboration and consistency across different blockchain implementations within the library sector. Without such standards, the latent benefits of blockchain may hindered, ultimately affecting efficiency and library operations reliability (Hota et al., 2022).

Blockchain technology implementation in libraries encounters numerous significant challenges must be addressed to enable the successful integration and utilization of this technology. These challenges include the necessity of seamless integration with existing library management systems, which often involves considerable technical adjustments and compatibility considerations. Additionally, ensuring robust data security is paramount, as the sensitive nature of library records and user information necessitates the establishment of stringent safeguards against potential breaches and unauthorized access. Furthermore, there is an imperative need for comprehensive staff training to prepare library personnel with the fundamental knowledge and skills required for the effective functioning of blockchain systems. Equally important is fostering user acceptance, as patrons must be educated about benefits and blockchain technology functionalities to encourage its adoption and use within library services. Collectively, these factors underscore the complexity of integrating blockchain technology into library environments and highlight the need for strategic planning and resources to overcome these hurdles (Yuan & Zhou, 2023).

Implementation of blockchain technology in libraries presents complex array of significant challenges, particularly in the realms of privacy protection, performance enhancement, and adherence to existing laws and regulations. Privacy protection is paramount, as decentralized nature of blockchain technology can create vulnerabilities in safeguarding sensitive user information and institutional data. Furthermore, performance

enhancement remains critical concerns, as scalability and speed of blockchain transactions must be optimized to meet the operational demands of library services without compromising efficiency. Additionally, compliance with an evolving landscape of legal frameworks and regulatory standards poses another formidable challenge, requiring libraries to navigate intricate legal obligations while ensuring blockchain technology adoption align with ethical practices and institutional policies. Collectively, these factors underscore the multifaceted hurdles that libraries must address in order to successfully integrate blockchain solutions into their systems and services (Xu & Shang, 2024).

Implementation of blockchain technology within library systems presents a series of significant challenges, particularly in relation to its alignment with the foundational principles of archival science. These challenges particularly pronounced in context of Indonesia, where integration of this emerging technology may lead to inconsistencies concerning the reliability of archival records. Moreover, adherence to established archival concepts such as authenticity, provenance, and the long-term preservation of digital information may be compromised when blockchain systems are not fully aligned with the nuanced requirements of archival practices. This misalignment raises critical questions about the efficacy and sustainability of blockchain as a tool for enhancing information management in libraries, necessitating a thorough examination of both technological capabilities and the theoretical frameworks that govern archival science (Dimas Wijaksono et al., 2022).

Implementation of blockchain in libraries is hindered by several substantial challenges, including insufficient financial resources, a shortage of skilled technicians, and inadequate broadband connectivity. These factors collectively hinder the ability of libraries to effectively adopt and integrate blockchain solutions. Specifically, poor funding limits the capacity for investment in necessary infrastructure and training programs, while the lack of qualified personnel restricts the expertise required to navigate the complexities of blockchain systems.

Furthermore, inadequate broadband connectivity poses a significant barrier to the efficient operation and utilization of such technologies, as robust internet access is essential for the seamless functionality and real-time data exchange that blockchain applications necessitate. Consequently, tackling these interconnected challenges is vital for fostering the successful implementation of blockchain technology within the library sector (Yuan & Zhou, 2023).

Research Method

The current study has adopted the descriptive research approach in quantitative research. According to H. Zhang (2022) , the survey research method is an effective and appropriate tool for learning about a respondent's behavior, attitude, feelings, approaches, and beliefs about a specific situation or phenomenon. Its findings can be extrapolated to the entire population. This method is said to be appropriate for exploratory, explanatory, and descriptive research (Bhattacherjee, 2012) . Challenges faced for implementation of Blockchain technology examined under the distribution of Legal & Ethical challenges, technical challenges, Knowledge and Skills, and organizational challenges also measured by using a 5-point Likert scale (1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly disagree) with help of different statements. Comments / suggestions about Blockchain technology used in academic libraries was required by the respondents at the conclusion of instrument. Questions about the demographical information of the respondents, i.e. gender, Academic Qualification, institution name, type of institution, Year of establishment, and professional experience asked in the instrument. Convenience sampling has been used for collection of research data. The researcher attempted to contact all the current 255 HEC recognized universities and DAIs in Pakistan. The researcher approached all the universities through personal contacts, social media, and email between the periods of 03 May 2021 to 06 March 2022, 228 out of 255 university responses were received. The response rate of universities was 89.41%. Convenience sampling has been used for collection of research data. The

researcher attempted to contact all the current 255 HEC recognized universities and DAIs in Pakistan. The researcher approached all the universities through personal contacts, social media, and email between the periods of 03 May 2021 to 06 March 2022, 228 out of 255 university responses were received. The response rate of universities was 89.41%. The study includes the limitation of population of Sindh, Punjab, Khyber Pakhtunkhwa, Baluchistan, Azad Jammu & Kashmir and Islamabad Federal Territory universities and Degree Awarding Institutions recognized by the HEC. Only the university LIS professional cadres are part of this study. Correlation is used to identify the casual relationship amongst problems to know the practical implication.

Data Analysis and Results

Table-1: Legal & Ethical, Technical, and Knowledge and Skills challenges

Items	Copyright	Privacy	Security	Use	Hardware	Storage	Recov	Struct	Manag	Retri	Clean	Utili	Kno
Copyright													
Privacy	.839** .000												
Security	.732** .000	.782** .000											
Use	.516** .000	.513** .000	.636* .000										
Hardware	.433** .000	.413** .000	.454* .000	.531** .000									
Storage	.345** .000	.344** .000	.457* .000	.544** .000	.926** .000								
Recovery	.341** .000	.339** .000	.411* .000	.431** .000	.810** .000	.824** .000							
Structure	.377**	.373**	.521*	.571**	.751**	.746**	.852**						

	.000	.000	.000	.000	.000	.000							
Management	.366**	.411**	.406*	.347**	.630**	.603**	.708**	.626**					
	.000	.000	.000	.000	.000	.000	.000	.000					
Retrieval	.402**	.427**	.479*	.348**	.540**	.500**	.572**	.549**	.777**				
	.000	.000	.000	.000	.000	.000	.000	.000	.000				
Cleansing	.382**	.406**	.533*	.427**	.527**	.501**	.653**	.689**	.857**	.782**			
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000			
Utilizing	.350**	.354**	.458*	.434**	.562**	.529**	.627**	.660**	.702**	.646**	.701**		
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		
Knowledge	.323**	.301**	.475*	.481**	.651**	.667**	.773**	.739**	.822**	.701**	.785**	.762**	
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
Adoption	.325**	.345**	.425*	.392**	.515**	.557**	.634**	.629**	.623**	.668**	.638**	.843**	.749**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

* Correlation is significant at the 0.01 level (2-tailed).
Level of significance (P<0.05), **represents significance Variable

Table-1 demonstrates that a significant correlation exists among all 14 variables of challenges for implementation of Blockchain technology. It is based on the variable that relate to the challenges for implementation of the technology in libraries. In this context, the research reveals. The following details of the correlation among 14 variables of the challenges are-

- The legal & ethical challenges (1) copyright laws with (1) Personal data privacy and confidentiality (2) Issues for data security (3) Fair use, Technical challenges (4) Lack of proper software and hardware (5) Lack of storage devices (6) Data recovery issues (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake

(Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries. The second variable Personal data privacy and confidentiality (2) also significantly correlate with (1) copyright laws (2) Issues for data security (3) Fair use, Technical challenges (4) Lack of proper software and hardware (5) Lack of storage devices (6) Data recovery issues (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Shi et al., 2021).

- Issues for data security (3) is strongly correlates with the (1) copyright laws (2) Personal data privacy and confidentiality (3) Fair use, Technical challenges (4) Lack of proper software and hardware (5) Lack of storage devices (6) Data recovery issues (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Jha, 2023).
- The variable (4) Fair use, Technical challenges interoperability robustly correlates with other variables such as (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Lack of proper software and hardware (5) Lack of storage devices (6) Data recovery issues (7) Variation in data types (structure, un-

structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Bashir & Warraich, 2023).

- Lack of proper software and hardware is a big challenge for blockchain technology with is also significant correlated with (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of storage devices (6) Data recovery issues (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Opele, 2023).
- In academic institutes storage devices has its own importance. Lack of storage devices has a significant correlation with other variables, i.e. (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Data recovery issues (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Mojjada, 2023).
- Data recovery issues (7) are a vital element in

blockchain technology. A significant correlation is found with 1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Rafi et al., 2020).

- The challenge of Variation in data types (structure, un-structured and semi structured) and Knowledge & skills in blockchain technology (8) also has a significant correlation with oher challenges such as (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Lack of data management skills by library staff (9) Lake (Lack) of data retrieval by users (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Anwar et al., 2022).
- Data management skills in library staff are essential for blockchain technology. The challenges relates to Lack of data management skills by library staff (9) also has a significant relation with other challenges such as, (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lake (Lack) of data retrieval by users

(10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Panda & Kaur, 2023).

- Lake (Lack) of data retrieval by users (10) is a challenge relates to knowledge and skills with has a significant correlation with other variables of blockchain technology challenges such as (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lack of data management skills by library staff (10) Data cleansing (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Islam et al., 2020).
- Data cleansing challenges (11) involved in blockchain technology has significant correlation with (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lack of data management skills by library staff (10) Lake (Lack) of data retrieval by users (11) LIS professions don't have the interest in learning and utilizing the Block chain technology tools (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries
- Interest in learning and utilization he blockchain technology by LIS professionals has its importance The challenge that the LIS professions don't have the interest in

learning and utilizing the Block chain technology tools (12) has a significant correlation with (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lack of data management skills by library staff (10) Lake (Lack) of data retrieval by users (11) Data cleansing (12) Lack of knowledge about Blockchain technology availability to the Library community and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Islam et al., 2022).

- Knowledge about the technology to the community is very essential for its development Lack of knowledge about Blockchain technology availability to the Library community (13) is a challenge for the community with is also correlates with (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lack of data management skills by library staff (10) Lake (Lack) of data retrieval by users (11) Data cleansing (12) LIS professions don't have the interest in learning and utilizing the Block chain technology tools and (13) Lack of interest by Library staff toward adoption of technology in academic libraries (Tella et al., 2022).

Lack of interest by Library staff toward adoption of technology in academic libraries is an knowledge / skills challenge for blockchain technology which has significant correlation with other challenges of the study such as (1) copyright laws (2) Personal data privacy and confidentiality (3) Issues for data security (4) Fair use, Technical challenges (5) Lack of proper software and hardware (6) Lack of storage devices (7) Data recovery issues (8) Variation in data types (structure, un-structured and semi structured) and Knowledge & skills (9) Lack of data management skills by

library staff (10) Lake (Lack) of data retrieval by users (11) Data cleansing (12) LIS professions don't have the interest in learning and utilizing the Block chain technology tools and (13) Lack of knowledge about Blockchain technology availability to the Library community (Khan et al., 2022).

Table-2: Organizational Challenges

Items	Funding	Training	Policy	Barriers	Cooperation	Support	Infrastructural	Staff
Funding								
Training	.764** .000							
Policy	.766** .000	.814** .000						
Barriers	.713** .000	.711** .000	.758* .000					
Cooperation	.704** .000	.786** .000	.807* .000	.825* .000				
Support	.722** .000	.714** .000	.733* .000	.865* .000	.852** .000			
Infrastructural	.724** .000	.803** .000	.816* .000	.874* .000	.854** .000	.831** .000		
Staff	.578** .000	.673** .000	.728* .000	.652* .000	.786** .000	.671** .000	.786** .000	

* Correlation is significant at the 0.01 level (2-tailed).
Level of significance (P<0.05), **represents significance

Table-2 demonstrates that a significant correlation exists among all 8 variables of organizational challenges for implementation of Blockchain technology. It is based on the variable that relate to the organizational challenges for implementation of the technology in libraries. The following details of the correlation among 8 variables of the

challenges are-

- Inadequate funding for the Block chain project (1) is an organizational challenge which is correlated with other challenges such as (1) There is no provision of training opportunities for LIS professionals (2) Lack of Block chain technology management policy (3) Administrative barriers (4) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (5) Lack of Organization support for implementation of technology (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Naqvi & Hussain, 2020).
- The blockchain technology has a challenge that There is no provision of training opportunities for LIS professionals (2) in organizations which has significant correlation with other organizational challenges such as (1) Inadequate funding for the Block chain project (2) Lack of Block chain technology management policy (3) Administrative barriers (4) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (Azam & Ahmad, 2023). (5) Lack of Organization support for implementation of technology (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Holotescu, 2018).
- Lack of Block chain technology management policy(3) has la significant correlation with other organizational challenges such as (1) Inadequate funding for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Administrative barriers (4) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (5) Lack of Organization support for implementation of technology (Zakria et al., 2024) (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Kouhizadeh et al., 2021).
- Administrative barriers (4) create difficulties to

implement technology. Such as the administrative barriers for implementation of blockchain technology has correlation with other administrative issues such as (1) Inadequate funding for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Lack of Block chain technology management policy (4) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc.(M. Ahmad et al., 2023) (5) Lack of Organization support for implementation of technology (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Chuang et al., 2019).

- Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (5) are the significant issues for implementation of blockchain technology in an organization which has significant correlation with (1) Inadequate funding for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Lack of Block chain technology management policy (4) Administrative barriers (5) Lack of Organization support for implementation of technology (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Akram et al., 2020).
- In the organizational challenges, the Lack of Organization support for implementation of technology (6) has the significant correlation with its other challenges such as (1) Inadequate funding for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Lack of Block chain technology management policy (4) Administrative barriers (5) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (6) Infrastructural issues due to rapid technological changes and (7) Lack of skilled staff and unaware users for the technology (Munkvold, 1999).
- Infrastructural issues due to rapid technological changes (7) in an organization is a challenge with has correlation with other challenges i.e. (1) Inadequate funding

for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Lack of Block chain technology management policy (4) Administrative barriers (5) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (6) Lack of Organization support for implementation of technology and (7) Lack of skilled staff and unaware users for the technology (Rafi et al., 2022).

- For use of the technology, it is essential to aware the users with the technology and the staff having competent skills to use it. Lack of skilled staff and unaware users for the technology (8) is a barrier to implement the blockchain technology in institutes. The challenge has significant correlation with other organizational challenges such as (1) Inadequate funding for the Block chain project (2) There is no provision of training opportunities for LIS professionals (3) Lack of Block chain technology management policy (4) Administrative barriers (5) Lack of involvement and cooperation among organizational departments such as research board, I.T, and library etc. (6) Lack of Organization support for implementation of technology and (7) Infrastructural issues due to rapid technological changes (Khan et al., 2023).

There are many challenges faced by the Blockchain technology by the academic libraries. These challenges are including technological awareness among the librarians. Librarian learning attitude are also matter about the adoption of technology as indicated (Sabry et al., 2019) . Financial constraint/funding issue of the academic libraries also a big challenge to implementation of Blockchain Technology. Library infrastructure of Pakistan is very poor and basic needs of the libraries are struggling to acquire the technology needs university management and staff face problem the approval library infrastructure. Convincing the library administration and leader is very big challenges (Rafi et al., 2020).

Discussion

There are many challenges faced by the Blockchain technology by ~~the~~ academic libraries. These challenges

include technological awareness among the librarians. As indicated by Ali et al., (2016) , librarians' attitude toward learning is also important in the adoption of new technologies. Financial constraint/funding issue of the academic libraries also a big challenge in the implementation of blockchain technology. Given that Pakistan is economically challenged, libraries struggle to fulfill basic needs. Therefore, acquiring approval for needed infrastructure can be problematic for library management. Convincing the library administration and leader is very big challenges.

Research Implications

The findings of this study yield several significant implications for practitioners and decision-makers within the field. The research suggests that Blockchain Technology (BCT) encompasses more than the mere investment in technology and the accumulation of extensive data sets, it necessitates the cultivation of an organizational learning culture, the recruitment of individuals possessing robust technical and managerial expertise in Blockchain Technology, and the integration of data-driven decision-making with the sustainability of library services (Khan et al., 2024) . The application of BCT by Library and Information Science (LIS) professionals not only enhances professional practices but also improves library resources and services.

While BCT is an emerging trend acknowledged by LIS experts, it is essential to provide adequate training and guidance for effective implementation. Librarians can utilize Blockchain Technology to identify specific user needs, deliver relevant resources and services in a timely manner, and refine library offerings based on user feedback. It is imperative for professional librarians to acquire new perspectives and state-of-the-art techniques. The adoption of Blockchain Technology could significantly expand the range of services available to library patrons in libraries. Moreover, the role of top management within institutions is pivotal in facilitating the adoption of BCT technologies. It is therefore recommended that academic libraries initiate the

implementation of Blockchain Technology (BCT) to enhance library services and resources. By engaging in training programs focused on BCT, librarians can significantly augment their knowledge and skills in this critical area. The effective management of Blockchain Technology necessitates substantial technology capacity and an upgrade of the existing information technology infrastructure. To facilitate the successful implementation of BCT, it is essential to establish a comprehensive management policy for Blockchain Technology.

Conclusion

The study evaluated blockchain technology in Pakistani university libraries. The research investigates the perceptions of librarians regarding technology use, their behaviors, skills, and the organizational challenges they face, as well as the impact of these factors on academic libraries in Pakistan. The findings reveal that university libraries in Pakistan are currently in a poor position to effectively adopt advanced technologies. Specifically, these libraries are struggling to implement and adopt blockchain technology. Despite this, there is a growing awareness of its potential, as indicated by various initiatives aimed at raising awareness about emerging technologies. The results highlight the critical need for additional resources, training, and professional development opportunities for librarians to improve their technological proficiency. Without these, the adoption of blockchain and similar technologies remains a significant challenge. The study suggests that universities and relevant stakeholders must prioritize the provision of training programs, infrastructure development, and financial support to ensure that libraries are equipped to integrate such technologies successfully. Furthermore, the research calls for a more structured approach to technology adoption, one that involves collaboration between academic institutions, librarians, and technology experts. This would help create a conducive environment for the growth and implementation of blockchain technology in academic libraries across Pakistan. By addressing these challenges, Pakistani university libraries

can potentially transform their services, enhance data security, and improve overall library management through the integration of advanced technological solution.

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