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Blockchain as an update to the islamic education ecosystem: analysis and adoption framework

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ABSTRACT

This research comprehensively explores the potential of blockchain technology to revolutionize the Islamic education ecosystem, expanding the scope from merely improving transparency and data security to systematic reformers that support core Islamic values. Through an in-depth analytical approach, this study maps out how blockchain can improve accuracy, reliability, and efficiency in Islamic education administration, certification, and financial management. By applying a framework specifically designed to fulfill Shariah principles, the study offers new insights into ethical and effective technological solutions, promising substantial improvements in the way Islamic education is managed and delivered. Through case analysis and scenario modeling, the research also highlights implementation challenges, including cultural resistance and regulatory barriers, while offering strategies to overcome such issues. Finally, by focusing on the synergy between technological innovation and Islamic values, this research proposes blockchain not only as a technical tool but also as a medium to strengthen the identity and integrity of Islamic education.

1. Introduction

In the past decade, the Islamic education ecosystem has experienced significant growth and evolution, driven by the need to provide education that is not only academically superior but also rooted in Islamic values and principles. However, the system also faces significant challenges, including limitations in resources, access, and adoption of the latest technology. Research related to Islamic finance and zakat management, for example, highlights how blockchain can address challenges such as transparency and operational efficiency in Islamic financial and social institutions. (Rejeb, 2020b).

Digging deeper, blockchain's potential to strengthen data integrity, simplify administrative processes, and enhance security can be directly applied in the context of Islamic education. This suggests that, while facing significant challenges, there are also great opportunities for innovation and improvement through emergent technologies, as seen in blockchain applications in other sectors closely related to Islamic principles. As such, the Islamic education ecosystem is at the crossroads of tradition and technological innovation, with blockchain offering a way to address a number of its challenges while maintaining a commitment to core Islamic values.

Blockchain technology, known as the digital architecture behind the cryptocurrency revolution, offers more than just a foundation for digital currencies like Bitcoin. As a secure and immutable distributed ledger, blockchain allows for the transparent and permanent recording of transactions and data without the need for a central authority. This creates an environment that is highly secure,

decentralized, and resistant to manipulation, making it an ideal technology for a variety of applications beyond finance, including education, supply chain management, and digital identity. Its potential in facilitating secure transactions, strengthening data integrity, and improving operational efficiency has received widespread attention from various sectors (Dahdal et al., 2022).

In the context of education, blockchain could transform the way certificates are issued, stored, and verified, simplify academic administration, and even open up opportunities for new student-focused learning models. In particular, in Islamic education, blockchain offers untapped potential to increase transparency in institutional accreditation processes, secure student achievement records, and provide solutions to the unique challenges faced by educational institutions operating according to sharia principles. All of these capabilities confirm blockchain's position as a promising technology to address contemporary challenges while opening new avenues for innovation in education.

In the context of Islamic education, the urgency to adopt technological innovations such as blockchain is driven not only by the need to modernize educational infrastructure but also by the desire to maintain core Islamic values in all operational aspects. Islamic education, which prioritizes integrity, fairness, and transparency, finds a natural fit with blockchain technology, which inherently promotes these principles through its transparent and immutable design. The potential applications of blockchain in Islamic education are vast, ranging from the management of secure academic records to the creation of verifiable and globally accessible certification systems. For example, blockchain can be used to issue certificates that are resistant to counterfeiting, facilitate the secure transfer of credits between institutions, and enable the verification of academic achievements without the need for intermediaries (Chen et al., 2018).

In addition, the application of blockchain in zakat and waqf management has shown how sharia principles can be integrated in a transparent and efficient financial and social system, offering a view on how this technology can be adapted for Islamic education (Rejeb, 2020b). The urgency to implement such solutions is also reinforced by global dynamics that demand educational institutions to be more adaptive, responsive, and open to international collaboration. Thus, the integration of blockchain into the Islamic education ecosystem is not only a possibility but a necessity to ensure the sustainability and relevance of Islamic education in the digital age.

In exploring the integration of blockchain in the Islamic education ecosystem, a fundamental research question is: “What specific problems in the Islamic education ecosystem can blockchain address?” These problems include several crucial operational and administrative aspects, which currently hinder the achievement of the full potential of Islamic education. One key issue is the need for a more secure and transparent certificate verification and validation system. In many cases, this process still relies heavily on manual methods that are prone to errors and forgery. Blockchain, with the ability to store data permanently and immutably, offers a solution for creating digital certificates that can be verified in real-time, ensuring their authenticity and integrity (Chen et al., 2018).

Furthermore, the management of student data and academic records is also a significant challenge. Current management systems are often inefficient and at risk of data loss or corruption. With the implementation of blockchain, Islamic educational institutions can develop a secure and decentralized record-keeping system, enabling secure and easily accessible storage of academic records by students, institutions, and other relevant parties without compromising data privacy or security.

Furthermore, in the context of zakat and waqf, which are important elements in the Islamic community, blockchain can improve transparency and efficiency in the collection and distribution of funds. This can be done through smart contracts that ensure that the funds are used in accordance with the donor's intentions and sharia principles, while providing real-time reports on the use of the funds to all interested parties (Rejeb, 2020b).

The main objective of this research is to develop a blockchain adoption framework that can improve efficiency in Islamic education. The framework aims to address the challenges that have been identified, by utilizing the potential of blockchain technology to strengthen integrity, security, and transparency in various aspects of Islamic education operations. With a focus on improving efficiency, the framework is expected to provide solutions to the problems of certificate verification and validation, student data management, and zakat and waqf management, all of which are key elements in the Islamic education ecosystem.

The proposed adoption framework will include recommendations for the technical implementation of blockchain, including the development and implementation of smart contracts that can ensure the automation of processes that are secure and compliant with sharia principles. In addition, the framework will explore ways to enhance participation and collaboration among Islamic education institutions in the blockchain ecosystem, enabling the sharing of resources and information in an efficient and secured manner. The application of blockchain in Islamic education is not only expected to improve administrative and academic processes but also to increase the trust and credibility of Islamic educational institutions in the eyes of the world, by providing irreversible proof of adherence to Islamic educational and ethical standards.

As such, this adoption framework aims to provide comprehensive guidance for Islamic education institutions looking to integrate blockchain technology into their operations. It will include implementation steps, potential barriers and solutions, as well as strategies to maximize the benefits of blockchain technology in the context of Islamic education. Through achieving these goals, this research contributes to the development of Islamic education that is more modern, efficient, and responsive to the needs of contemporary Islamic society.

Having discussed the background, urgency, and objectives of the research, it is important to explore the novelty, distinction, and gap aspects that exist in the literature relating to blockchain applications in Islamic education. This research seeks to identify and analyze the gaps in the existing literature, offering new perspectives and distinguishing contributions to existing knowledge. The novelty of this research lies in its comprehensive exploration of the application of blockchain technology in the context of Islamic education, an area that is still rarely explored in depth in the academic literature. Although blockchain has received much attention in Islamic finance, as described by Truby, Dahdal, & Ismailov, its application in Islamic education has yet to be fully uncovered, indicating significant room for innovation and development (Dahdal et al., 2022).

This research distinguishes itself by focusing on developing an adoption framework that considers not only the technical aspects of blockchain but also its compatibility with sharia principles in Islamic education. It offers a different approach from Chen, Xu, Lu, & Chen's research, which more generally explores blockchain applications in education without a specific focus on Islamic education (Chen et al., 2018). One of the gaps identified from the literature review is the lack of research that explicitly explores how blockchain principles and technology can be integrated in the Islamic education system to improve efficiency, security, and transparency. While Rejeb provides insights into the application of blockchain in zakat, the application in Islamic education, specifically in institutional management, curriculum, and recognition of academic achievements, still requires further exploration (Rejeb, 2020b).

An analysis of previous research shows that most studies on blockchain in the Islamic context focus on finance and asset management, leaving a knowledge gap regarding its application in education. This research fills that gap by investigating how blockchain can be adapted and applied to meet the specific needs of Islamic education, making a significant contribution to the existing literature.

By highlighting the novelty, distinction, and gaps in the existing literature, this research aims to advance the understanding of blockchain's potential in Islamic education and develop a framework that can serve as a guide for the efficient and shariah-compliant implementation of this technology in Islamic education. It offers a foundation for further research that can expand the applications of blockchain in Islamic education and other sectors based on Islamic principles.

2. Method

This research used a qualitative approach with a focus on literature analysis, aiming to develop a model framework for blockchain adoption in Islamic education. This approach was chosen for its ability to provide an in-depth understanding of complex issues through the synthesis of existing research and documents. The literature analysis involved a comprehensive search and review of relevant academic journals, conference papers, industry articles, as well as research reports, to gather data on the application of blockchain in general and its potential in the context of Islamic education.

Data was collected through an extensive literature survey from a variety of academic and professional sources, including leading journals such as “European Business Law Review” and

"Smart Learning Environments", as well as conferences and articles focusing on blockchain and Islamic education. Sources such as the article by Truby, Dahdal, & Ismailov discussing the potential of blockchain in Islamic finance, and the research by Chen, Xu, Lu, & Chen on blockchain applications in education, provide important insights into how this technology can be utilized in Islamic education (Dahdal et al., 2022); (Chen et al., 2018).

Data analysis was conducted through the content analysis method to categorize and interpret the information obtained from the literature. This process involved identifying key themes, trends, and patterns in the application of blockchain relevant to Islamic education. For example, findings from Rejeb's research on the contribution of blockchain and smart contracts in zakat management can provide insight into how similar principles can be applied in Islamic education administration and management (Rejeb, 2020b). Each of the findings and themes identified will be synthesized to develop a comprehensive adoption framework, covering the technical, pedagogical, and sharia aspects of implementing blockchain in Islamic education.

3. Findings and Discussion

3.1. Implementation of Blockchain in Islamic Education

In an effort to implement blockchain in Islamic education, the development of a blockchain platform for verification of students' educational certificates and academic achievements offers significant potential. The implementation of this technology in the context of Islamic education can facilitate real-time and secure access and verification of students' academic records. For example, in the context of Islamic banking and finance in the United Arab Emirates, the government has adopted blockchain technology for government transactions and has launched the UAE Blockchain Strategy 2021, demonstrating a commitment to digital innovation in support of the Islamic economy (Mohamed Mashal, 2022). In addition, the application of blockchain in Islamic financial institutions, including applications in Waqf, Zakat, and Sukuk, offers great opportunities but also faces challenges such as the complexity of Islamic financial products and the lack of clear standards and regulations (Alaeddin et al., 2021).

In particular, the hypothetical implementation of a blockchain platform in Islamic education can take inspiration from the application of this technology in the Islamic finance sector, which emphasizes transparency, security, and compliance with sharia. Thus, the development of such a platform for Islamic education can not only strengthen integrity and trust in the academic merit verification system but also promote innovation and operational efficiency in accordance with Islamic principles.

The real implementation of blockchain systems in zakat and waqf management offers great potential to increase transparency and efficiency in the use of funds in accordance with donor intentions and sharia principles. Dhiaeddine Rejeb examines the application of blockchain and smart contracts in zakat management, developing a funding model that connects all stakeholders and blockchain technology. The study shows significant technical benefits and contributions, encouraging Islamic financial institutions to develop more models that support this technology without neglecting compliance with the rules of Islamic jurisprudence (Rejeb, 2020a).

Furthermore, Moutaz Abojeib and Farrukh Habib explained how blockchain technology and smart contracts can help Islamic social finance institutions such as waqf to improve governance, reduce transaction costs, increase transparency, and strengthen trust, thereby increasing business flexibility and market accessibility (Abojeib et al., 1 C.E.).

The application of blockchain technology in zakat and waqf not only strengthens transparency and accountability but also supports the achievement of sustainable development goals (SDGs) through improving the efficiency and effectiveness of fund distribution to zakat recipients and waqf projects, in line with Islamic finance principles that emphasize social welfare and inclusive economic development.

3.2. Adoption Framework Analysis

Key factors in blockchain adoption, especially from a technical perspective, include adequate IT infrastructure, compatibility with existing IT systems, and digital literacy among educators and students. Research by Colin Callinan states that blockchain adoption factors include organizational

readiness, security, complexity, partnerships, government influence, and transparency, suggesting the importance of IT infrastructure and digital literacy in facilitating blockchain adoption (Callinan et al., 2022).

Rodelio Arenas and Proceso Fernandez explore the application of permissioned blockchain in an educational use case, namely the decentralized verification of academic credentials. This blockchain-based solution, "CredenceLedger", highlights the importance of adequate IT infrastructure and digital literacy to ensure academic credential data is securely stored and easily verifiable by education stakeholders (Arenas & Fernandez, 2018).

The study by Anton Dziatkovskii et al. highlights the chronology of blockchain progress in STEM disciplines and evaluates the adoption of blockchain technology in various key research areas, emphasizing the importance of developing adequate IT infrastructure and improving digital literacy to fully utilize blockchain's potential in education (Dziatkovskii et al., 2022).

Social factors, including acceptance by the Islamic education community which includes students, educators, and administrators, play an important role in blockchain adoption. According to the research conducted by M. Alazab et al, social factors such as social influence and interorganizational trust have a significant impact on the intention to adopt blockchain. Although social influence of UTAUT does not have a significant effect on blockchain adoption intention, interorganizational trust has a significant effect on the dimensions of UTAUT and intention to adopt blockchain (Alazab et al., 2021).\

Another study by Adele Caldarelli et al. revealed that performance expectancy and social influence have strong positive effects on individuals' intention to adopt blockchain. The study also found that experience had a negative effect on blockchain usage intentions, suggesting that this technology has such a disruptive nature that individuals with prior experience view it with skepticism as its implementation involves a complete rethinking of all routines and practices (Caldarelli et al., 2020).

This research demonstrates the importance of understanding and addressing social factors in the blockchain adoption process in the Islamic education environment. Acceptance and support from the educational community, including students, educators, and administrators, are key to accelerating the adoption and utilization of blockchain technology in improving transparency, security, and efficiency in educational and administrative processes.

Economic factors, including implementation and maintenance costs and potential operational cost savings, play an important role in the adoption of blockchain technology. The study by Saurabh Ahluwalia, Raj V. Mahto, and Maribel Guerrero explores the use of blockchain in startup financing from the perspective of transaction cost economics. They show how blockchain-based applications can address many of the problems inherent in venture financing, such as information asymmetry and transaction costs in matching entrepreneurs with investors. This research highlights the potential of blockchain to facilitate a more effective and decentralized venture financing process (Ahluwalia et al., 2020).

An economic framework built by G. Iyengar, Fahad Saleh, J. Sethuraman, and Wenjun Wang suggests that blockchain can reduce information asymmetry for consumers, thereby improving consumer welfare. Although blockchain adoption can provide social benefits, the study found that blockchain adoption does not occur naturally in equilibrium. This situation arises because the cost of blockchain adoption is borne by manufacturers, and they cannot extract consumer benefits through prices due to the competitive nature of the manufacturing sector. This research offers a transfer system to generate blockchain adoption in equilibrium when it is socially beneficial (Iyengar et al., 2020).

A.Upadhyay et al. examined the contribution of blockchain technology to the circular economy through the lens of sustainability and social responsibility. They found that blockchain can contribute to the circular economy by helping to reduce transaction costs, improve performance and communication along the supply chain, ensure the protection of human rights, enhance patient confidentiality and welfare in healthcare, and reduce carbon footprint. Nonetheless, the research also evaluated challenges in blockchain implementation for the circular economy, such as trust, illegal activities, potential hacking, and the need for appropriate legislation and policy development. Furthermore, the research recognizes the initial costs involved in the implement.

Policy factors, including adherence to education regulations and standards as well as sharia principles, are crucial in the adoption of blockchain technology in the field of Islamic education. An analysis by Tasneem S. J. Darwish et al. (2020) on blockchain consensus algorithms from a sharia perspective shows that some popular blockchain platforms, such as Bitcoin and Ethereum, do not comply with sharia rules because they use consensus algorithms that do not meet sharia requirements. This research highlights the need for sharia-compliant blockchain platforms for sharia-compliant applications (Darwish et al., 2020).

Another study by Redhwan Al-amri et al. explored the acceptance of cryptocurrency among Malaysians from a sharia perspective, using the UTAUT model adjusted with the integration of sharia compliance. The results showed that performance expectancy, effort expectancy, social influence, and sharia compliance all have an effect on behavioral intention to adopt cryptocurrency from a sharia perspective in Malaysia (Al-Amri et al., 2021).

Regulatory compliance and educational standards are also key factors in the adoption of blockchain technology. Saeed Alzahrani et al. developed a scoring model to evaluate the readiness of healthcare organizations to adopt blockchain in the context of electronic medical records system management. The study emphasized that regulatory compliance, regulatory uncertainty, budget availability, management support, security and privacy, and financial risk and uncertainty play important roles in organizational readiness for blockchain adoption (Alzahrani et al., 2023).

3.3. Blockchain Benefits for The Islamic Education Ecosystem

The benefits of blockchain technology for the Islamic education ecosystem, particularly in improving operational efficiency, has become an important research topic. The use of blockchain in education can speed up administrative processes, such as enrollment and certificate verification, by providing a secure and immutable platform for storing data.

A study by Karale and Khanuja highlights that blockchain technology can be used to address various educational issues and assist educators and learners in monitoring learning outcomes. Data stored in a blockchain network is secure and resistant to forgery, enabling the creation of certificates that cannot be forged and the allocation and verification of correct and permanent certificates. This can reduce fraud and forgery of degrees and certificates as a whole, with smart contracts that can be designed and implemented on the Ethereum blockchain using the Solidity programming language (Karale & Khanuja, 2019).

The application of blockchain in the education system offers other advantages, including increased transparency and data security. By utilizing blockchain technology, educational institutions can simplify and speed up the process of verifying academic credentials, which in turn can increase trust among the parties involved and ease student academic mobility.

The benefits of blockchain technology in enhancing transparency and accountability in the Islamic education ecosystem include providing immutable and easily verifiable records for institutional management. The technology enables the creation and storage of secure and permanent academic digital records, which can be easily shared and verified by interested parties without the need for third-party intervention.

The VerifyB project, implemented on the Ethereum Blockchain, is an example of a blockchain-based system that promotes interoperability between institutions or organizations to manage and ensure student records without the intervention of third-party entities. The system defines how blockchain technology can be adopted and utilized to store student education records using IPFS (Interplanetary File System), allowing students to share their transcripts with institutions and employers using QR codes, as well as transcript and signature verification on the same platform. This will help students as well as institutions in maintaining security and transparency at the same time, making VerifyB a reliable, fully decentralized, secure, and manipulation-resistant system for the storage, maintenance, and verification of educational records (Desai et al., 2021).

CredenceLedger, a blockchain-based solution for decentralized verification of academic credentials, stores compact data proofs of digital academic credentials in a blockchain ledger that is easily verifiable by educational stakeholders and interested third-party organizations. It demonstrates how blockchain can be applied to increase transparency and security in academic credential verification (Arenas & Fernandez, 2018).

The use of blockchain in education not only strengthens integrity and trust in academic management but also supports the creation of a more open and accountable educational ecosystem, where every transaction and academic achievement is recorded in a transparent and immutable manner.

Blockchain technology offers a significant solution in enhancing data security for the Islamic education ecosystem, by protecting student and institutional data from manipulation and theft. Features such as immutability, distributed ledger, and transparency of blockchain technology enable secure and trustworthy record management.

The VerifyB project, for example, is a blockchain-based system that promotes interoperability between institutions or organizations to manage and ensure student records without the intervention of third-party entities. This system, implemented on the Ethereum Blockchain, defines how blockchain technology can be adopted and utilized to store students' educational records using IPFS (Interplanetary File System). It allows students to share their transcripts with institutions and employers using QR codes, as well as transcript and signature verification on the same platform. Based on the analysis, VerifyB is a reliable, fully decentralized, secure, and manipulation-resistant system that implements the storage, maintenance, and verification of education records (Desai et al., 2021).

The implementation of blockchain in education systems offers significant improvements in data security, ensuring that sensitive information such as student academic records and institutional credentials are protected from unauthorized changes and unauthorized access. By utilizing blockchain, educational institutions can create a more secure and transparent digital environment, where trust between students, educators, and related parties is strengthened through indisputable data integrity.

3.4. Challenges and Obstacles

Technical challenges in the adoption of blockchain technology, including integration with existing IT systems and the need for secure and scalable infrastructure, are important issues that need to be addressed. The articles in this special section provide an overview of the diverse research challenges in adopting blockchain technology into mainstream applications, focusing on core issues such as scalability, transparency versus privacy, standardization, ecosystem, and integration (Nandakumar et al., 2020).

Other research highlights that although blockchain offers many advantages such as decentralization and security, there are still significant barriers to scalability, which limits its ability to support services with frequent transactions. In addition, decentralized management and security issues in edge computing currently face challenges in its decentralized management (Yang et al., 2019).

In addition, the integration of blockchain with existing IT systems requires a deep understanding of both technologies and how they can work together effectively. Issues such as data security, privacy, and consensus in a blockchain environment are also major concerns in this context.

In addressing these challenges, innovative frameworks and solutions are needed to improve the scalability and efficiency of blockchain, ensure data security and privacy, and facilitate seamless integration with existing IT systems. Further research and development is needed to overcome these barriers and enable wider application of blockchain in various applications, including in the Islamic education ecosystem.

Social and cultural barriers to the adoption of blockchain technology, such as changing mindsets towards new technologies and concerns about losing control over data, are significant challenges. Various studies have identified that inconsistencies in politicians' and policymakers' treatment of blockchain technology, especially in relation to tokens, and the absence of a clear position from many governments may put off some potential enterprise users and hinder the development of standards (O'Dair, 2019). In addition, lack of business awareness and familiarity with blockchain technology as a major barrier hindering blockchain adoption (Mathivathanan et al., 2021).

Other research highlights that "lack of management vision" and "cultural differences among supply chain partners" are the most influential barriers, while "collaboration challenges" and "labor indecision and obsolescence" are the most influential barriers to blockchain adoption in green supply chain management (Bag et al., 2020).

An approach that focuses on awareness building and training can help overcome some of these social and cultural barriers. Providing adequate education and training to management and employees on the benefits and potential applications of blockchain technology can reduce hesitation and increase acceptance. In addition, creating a clear and supportive legal and regulatory framework can help reduce uncertainty and increase trust in blockchain technology.

It is important to recognize that the adoption of new technologies such as blockchain requires more than just technical solutions; it requires a change in mindset and broader organizational culture. Overcoming social and cultural barriers requires a comprehensive and coordinated approach involving all stakeholders, including industry, government, and civil society.

Policies and regulations are a major challenge in adopting blockchain technology, especially in ensuring that its implementation is compliant with education regulations and Shariah principles. Research by Darwish et al. highlighted the importance of sharia-compliant blockchain platforms for sharia-compliant applications, providing a comparative analysis of blockchain consensus algorithms from a sharia perspective. They found that some popular blockchain platforms, such as Bitcoin and Ethereum, are not shariah-compliant because they use consensus algorithms that do not meet shariah requirements (Darwish et al., 2020).

In addition, regulatory challenges also include issues such as personal data protection, identification of transacting parties, and conflicts of interest, all of which require special attention in the design and implementation of blockchain systems (Dick & Praktiknjo, 2019). Baquero emphasizes the importance of incorporating human participation and contestability in privacy compliance technologies integrated into blockchain design, demonstrating the need for a more human-focused approach rather than just a technological solution (Baquero, 2023).

Efforts to ensure that blockchain implementations are compliant with education regulations and sharia principles require cooperation between technology developers, regulatory bodies, and the Islamic education community. Understanding and overcoming these regulatory and shariah-compliant barriers will not only help in successful blockchain implementation but also in ensuring that the technology can be widely used in the Islamic education ecosystem in an ethical and shariah-compliant manner.

In this discussion, the link between the research results and the research objectives is important to note. The implementation of blockchain technology in Islamic education, as described in the research results, offers concrete solutions to improve operational efficiency, transparency, and data security. The purpose of this study is to identify and analyze the potential of blockchain technology in providing solutions to the challenges faced by the Islamic education ecosystem. From the discussed research results, it can be seen that blockchain technology has the capacity to fulfill the objectives of this research through its various practical applications.

First, in terms of operational efficiency, blockchain technology enables the automation of administrative processes such as enrollment and certificate verification, which can reduce the time and cost associated with these processes. Second, aspects of transparency and accountability are enhanced through the use of immutable and easily verifiable records, strengthening trust among all stakeholders in the Islamic education system. Finally, enhanced data security protects student and institutional information from data manipulation and theft, ensuring data integrity and privacy.

The implementation of blockchain in Islamic education also supports sharia principles through increased transparency and avoidance of usury, which is in accordance with Islamic ethics and values. Therefore, the results of this study directly relate to the research objectives, showing that blockchain not only offers technical solutions to operational challenges but also strengthens values and principles in Islamic education.

This research, in the context of the implementation of blockchain technology in Islamic education, brings significant contributions to the existing literature by expanding the understanding of blockchain's potential and applications. Compared to similar studies that may have explored the use of blockchain in various sectors, this research offers a unique perspective with a focus on Islamic education, filling a previously unreached knowledge gap in depth in the academic literature.

Previous studies have recognized the advantages of blockchain technology in ensuring transparency, data security, and operational efficiency in areas such as healthcare, finance, and logistics. However, the application of this technology in Islamic education requires a specialized

understanding of the unique challenges and needs of this educational ecosystem, including compliance with Shariah principles and applicable educational regulations.

One of the main contributions of this research is the development of a unique framework for blockchain implementation in Islamic education, which considers not only the technical aspects of the technology, but also the integration with sharia principles and the specific needs of the Islamic education community. This framework offers guidance for Islamic education institutions in adopting blockchain technology in a way that ensures compliance with sharia principles and enhances transparency, security, and efficiency.

Comparison with similar studies shows that this research takes a step further by not only exploring blockchain applications in education in general but also by placing special emphasis on Islamic education. This demonstrates the potential of blockchain to provide innovative and Shariah-compliant solutions to the challenges faced by Islamic educational institutions, while highlighting the importance of customizing the technology to specific cultural and religious contexts.

In conclusion, this research makes an important contribution to the literature by expanding the understanding of blockchain applications in Islamic education and offering a unique framework to support successful implementation. It confirms the importance of further research that focuses on the integration of innovative technologies in diverse educational contexts, taking into account relevant social, cultural, and religious factors.

4. Conclusion

This research reveals blockchain's immense potential in revolutionizing Islamic education operations and administration, offering solutions to challenges such as transparency, data security, and efficiency. The technology enables automation of certificate verification and validation processes, more secure student data management, and increased transparency in zakat and waqf management. Nonetheless, technical, social, cultural, and regulatory challenges need to be overcome to realize successful adoption. The proposed adoption framework focuses on blockchain integration taking into account compliance with sharia principles, promising significant improvements in integrity, fairness, and transparency in accordance with the core values of Islamic education.

The findings of this study have important implications for practitioners in the field of Islamic education, offering critical insights in the application of blockchain technology. This not only paves the way for the development of a more secure, transparent, and efficient education system, but also suggests the need for continuous adaptation and innovation in education technology. The resulting recommendations support the development of a Shariah-compliant technological infrastructure, facilitating the transition towards more integrated and automated educational practices.

This research recommends further exploration of the implementation of blockchain technology in various aspects of Islamic education, including long-term impact assessment through longitudinal studies. It is important for practitioners and policy makers to develop comprehensive implementation guidelines, considering technical, social, economic, and policy factors, while ensuring conformity with sharia principles. This aims to facilitate the ethical and effective application of blockchain technology in the Islamic education ecosystem, encouraging continuous innovation and improvement in the quality of education.

This research confirms the potential of blockchain in revolutionizing Islamic education, pointing the way towards a more efficient, transparent, and secure system. However, its successful implementation relies heavily on a deep understanding of the technology and a strong commitment to its appropriate and sensitive application to the Islamic education context, highlighting the importance of wise adaptation and collaboration between technologists, educators, and stakeholders.

5. References

Abojeib, M., Habib, F., Abojeib, M., & Habib, F. (1 C.E., January 1). *Blockchain for Islamic Social Responsibility Institutions* (blockchain-for-islamic-social-responsibility-institutions) [Chapter]. Https://Services.Igi-Global.Com/Resolvedoi/Resolve.Aspx?Doi=10.4018/978-1-5225-7805-5.Ch010; IGI Global. https://www.igi-global.com/gateway/chapter/www.igi-global.com/gateway/chapter/221599

Ahluwalia, S., Mahto, R. V., & Guerrero, M. (2020). Blockchain technology and startup financing: A transaction cost economics perspective. *Technological Forecasting and Social Change*, *151*, 119854. https://doi.org/10.1016/j.techfore.2019.119854

Alaeddin, O., Al Dakash, M., & Azrak, T. (2021). Implementing the Blockchain Technology in Islamic Financial Industry: Opportunities and Challenges. *Journal of Information Technology Management*, *13*(3), 99–115. https://doi.org/10.22059/jitm.2021.83116

Al-Amri, R., Al-Shami, S., Esmail Abualrejal, H. M., Al-Sharafi, M. A., & Yahya Alormuza, T. K. (2021). Role of Shariah compliance on Cryptocurrency Acceptance among Malaysians: An Empirical Study. *2021 International Conference on Intelligent Technology, System and Service for Internet of Everything (ITSS-IoE)*, 1–6. https://doi.org/10.1109/ITSS-IoE53029.2021.9615291

Alazab, M., Alhyari, S., Awajan, A., & Abdallah, A. B. (2021). Blockchain technology in supply chain management: An empirical study of the factors affecting user adoption/acceptance. *Cluster Computing*, *24*(1), 83–101. https://doi.org/10.1007/s10586-020-03200-4

Alzahrani, S., Daim, T., & Choo, K.-K. R. (2023). Assessment of the Blockchain Technology Adoption for the Management of the Electronic Health Record Systems. *IEEE Transactions on Engineering Management*, *70*(8), 2846–2863. https://doi.org/10.1109/TEM.2022.3158185

Arenas, R., & Fernandez, P. (2018). CredenceLedger: A Permissioned Blockchain for Verifiable Academic Credentials. *2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)*, 1–6. https://doi.org/10.1109/ICE.2018.8436324

Bag, S., Viktorovich, D. A., Sahu, A. K., & Sahu, A. K. (2020). Barriers to adoption of blockchain technology in green supply chain management. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 104–133. https://doi.org/10.1108/JGOSS-06-2020-0027

Baquero, P. M. (2023). Layers of privacy in the blockchain: From technological solutionism to human-centred privacy-compliance technologies. *International Journal of Law in Context*, *19*(1), 51–69. https://doi.org/10.1017/S1744552322000465

Caldarelli, A., Ferri, L., Ginesti, G., & Spanò, R. (2020). Understanding Blockchain Adoption in Italian Firms. In R. Agrifoglio, R. Lamboglia, D. Mancini, & F. Ricciardi (Eds.), *Digital Business Transformation* (pp. 121–135). Springer International Publishing. https://doi.org/10.1007/978-3-030-47355-6_9

Callinan, C., Vega, A., Clohessy, T., & Heaslip, G. (2022). Blockchain Adoption Factors, Enablers, and Barriers in Fisheries Supply Chain: Preliminary Findings from a Systematic Literature Review. *The Journal of The British Blockchain Association*. https://doi.org/10.31585/jbba-5-1-(3)2022

Chen, G., Xu, B., Lu, M., & Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1. https://doi.org/10.1186/s40561-017-0050-x

Dahdal, A., Truby, J., & Ismailov, O. (2022). The Role and Potential of Blockchain Technology in Islamic Finance. *European Business Law Review*, *33*(2). https://kluwerlawonline.com/api/Product/CitationPDFURL?file=Journals\EULR\EULR2022005.pdf

Desai, A., Shah, P., & Ambawade, D. D. (2021). VerifyB - Students' record management and verification system. *2021 International Conference on Communication Information and Computing Technology (ICCICT)*, 1–6. https://doi.org/10.1109/ICCICT50803.2021.9510144

Dick, C. I., & Praktiknjo, A. (2019). Blockchain Technology and Electricity Wholesale Markets: Expert Insights on Potentials and Challenges for OTC Trading in Europe. *Energies*, *12*(5), Article 5. https://doi.org/10.3390/en12050832

Iyengar, G., Saleh, F., Sethuraman, J., & Wang, W. (2020). *Economics of Permissioned Blockchain Adoption* (SSRN Scholarly Paper 3602376). https://doi.org/10.2139/ssrn.3602376

Karale, A., & Khanuja, H. (2019). Blockchain Technology in Education System: A Review. *International Journal of Computer Applications*, *178*(38), 19–22. https://doi.org/10.5120/ijca2019919256

Mathivathanan, D., Mathiyazhagan, K., Rana, N. P., Khorana, S., & Dwivedi, Y. K. (2021). Barriers to the adoption of blockchain technology in business supply chains: A total interpretive structural modelling (TISM) approach. *International Journal of Production Research*, *59*(11), 3338–3359. https://doi.org/10.1080/00207543.2020.1868597

Mohamed Mashal, M. I. (2022). Legal Framework To Support Islamic Banking and Finance In The United Arab Emirates. *Invest Journal of Sharia & Economic Law*, *2*(2), 196–233. https://doi.org/10.21154/invest.v2i2.5341

Nandakumar, K., Ratha, N., Pankanti, S., Pentland, A., & Herlihy, M. (2020). Blockchain: From Technology to Marketplaces. *Computer*, *53*(7), 14–18. https://doi.org/10.1109/MC.2020.2990776

O'Dair, M. (2019). *Barriers to Adoption: How Blockchain Technology will Transform the Creative Economy* (pp. 59–79). https://doi.org/10.1007/978-3-030-00190-2_4

(PDF) A Comparative Analysis of Blockchain Consensus Algorithms from Shariah Perspective. (n.d.). Retrieved February 6, 2024, from https://www.researchgate.net/publication/347077610_A_Comparative_Analysis_of_Blockchain_Consensus_Algorithms_from_Shariah_Perspective

Rejeb, D. (2020a). Blockchain and Smart Contract Application for Zakat Institution. *International Journal of Zakat*, *5*(3), Article 3. https://doi.org/10.37706/ijaz.v5i3.260

Rejeb, D. (2020b). Blockchain and Smart contract's contributions to Zakat management system. *Indonesian Conference of Zakat - Proceedings*, 15–24. https://doi.org/10.37706/iconz.2020.207

Sustainability | Free Full-Text | Chronological Progress of Blockchain in Science, Technology, Engineering and Math (STEM): A Systematic Analysis for Emerging Future Directions. (n.d.). Retrieved February 6, 2024, from https://www.mdpi.com/2071-1050/14/19/12074

Upadhyay, A., Mukhuty, S., Kumar, V., & Kazancoglu, Y. (2021). Blockchain technology and the circular economy: Implications for sustainability and social responsibility. *Journal of Cleaner Production*, *293*, 126130. https://doi.org/10.1016/j.jclepro.2021.126130

Yang, R., Yu, F. R., Si, P., Yang, Z., & Zhang, Y. (2019). Integrated Blockchain and Edge Computing Systems: A Survey, Some Research Issues and Challenges. *IEEE Communications Surveys & Tutorials*, *21*(2), 1508–1532. https://doi.org/10.1109/COMST.2019.2894727