

Smart Contract Verification for Shariah-Compliant Blockchain Applications

Muhammad Jidda Tom

Abstract

Smart contracts are the latest program used in Blockchain applications to offer verification and authenticity about Shariah compliance. The current study evaluates whether smart contracts are actually a significant part of financial practices in different countries and the challenges associated with them. The ultimate objective is to evaluate the utility, significance, and challenges faced in smart contract verification for blockchain applications in financial services. The study is based on qualitative analysis, using past literature and authentic sources to evaluate the utility, significance, and challenges associated with smart contract verification for Blockchain applications with Shariah compliance. It is based on the interpretivism philosophy to gather different opinions and develop conclusions. The key findings reveal that different countries, including Malaysia, Indonesia, UAE, and even the UK, have certain institutions that follow smart contracts verification in their Shariah compliance for Blockchain applications in financial institutions. However, at the same time, there is conflict on the basis of differences in their religious values. The article is useful because it contributes towards the understanding of the significant role played by Smart contract verification in financial transaction and the challenges that countries are still facing in it.

Keywords: Smart contracts, Blockchain, Smart contract verification, Shariah Compliance Financial technology

Introduction, background and statement of problem

Today there has been major concern regarding the financial technology and IT governance of the industry associated with Islamic finance mainly. There have been different technologies introduced globally that are changing the practice or operation of the financial industries and offering them more security of their operations. The Islamic finance industry has adopted the Blockchain technology as a major innovation which can

revolutionize the overall operations and transactions in effective and secure manner.¹ Upholding the Islamic virtues along with the business dealing has been made possible with the technological integration as well as it often offers transparency and the right utility of the data. Elimination of risk and detriments has been therefore made possible with the adoption of the shariah compliance with technological orientation.² One such technological revolution is the Blockchain technology that has been growing its roots in financial institutions and offering multiple benefits to the industry. Many countries have been recording success for negligible percentage of their overall trade financing related practices because of the non-compliance structures where the stiffness Islamic finance investment goals are evident.³ However the demand of Muslim investors still requires a proper technology driven trade financing practice where more transparency and security is offered. Financial institutions are incorporating technology driven trade products to project their performance accordingly.⁴ The acceptance of the innovative ideas and solutions into the Islamic finance industry is becoming a fast spreading and widely accepted phenomenon.⁵ The local as well as global ideas are improved and the decisive push from the national government and regulations have been observed, the international cooperation and technology oriented agents are becoming significant part of the financial institutions. Blockchain has completely transformed the Islamic finance services and enhanced the outlook of shariah compliance.⁶ Stronger end to end shariah compliance has been made possible with the adoption of the Blockchain and other technologies. The current study also focuses over the confirmation of the significant role played by Blockchain technology in developing smart contracts for the shariah compliance and the transformational impact of this technology.⁷

Blockchain technology comprise of different element including transaction, transaction record and the system for verification and storage of the transaction. In the case of verification, the use of smart contracts has been applied often in order to ensure that the

¹Kunhibava, S., Mustapha, Z., Muneeza, A., Sa'ad, A. A., & Karim, M. E. (2021). Şukūk on blockchain: a legal, regulatory and Sharī'ah review. *ISRA International Journal of Islamic Finance*, 13(1), 118-135.

²Zulkepli, M. I. S., Mohamad, M. T., & Azzuhri, S. R. (2023). Leveraging blockchain-based smart contract in Islamic financial institutions: Issue and relevant solution. *International Journal of Islamic Economics and Finance Research*, 6(1), 18-28.

³Laili, N. H., Khairi, K. F., & Ahmad, A. (2024). Blockchain Integration: Transforming Islamic Frozen Estate Management in Malaysia. In *Strategic Islamic Business and Management: Solutions for Sustainability* (pp. 35-54). Cham: Springer Nature Switzerland.

⁴El Koshiry, A., Eliwa, E., Abd El-Hafeez, T., & Shams, M. Y. (2023). Unlocking the power of blockchain in education: An overview of innovations and outcomes. *Blockchain: Research and Applications*, 100165.

⁵Shah, H. M. (2024). Asset Tokenization in Islamic Finance Historical Perspectives, Sukuk Innovations, and the Shariah Compliant Blockchain. *Pakistan Research Journal of Social Sciences*, 3(3).

⁶Zhong, B., Pan, X., Ding, L., Chen, Q., & Hu, X. (2023). Blockchain-driven integration technology for the AEC industry. *Automation in Construction*, 150, 104791.

⁷Labadi, H. (2024). *The Use of Blockchain Technology in the Development of the Islamic Financial Market: Case Study: Smart Sukuk* (Doctoral dissertation).

compliance has been followed. The open course application is a source of generating the blocks or records of information that can help developing secured hash and generate the account index, timestamp and other relevant data.⁸

Smart contracts are the computer programs that are often utilized in the Blockchain applications in order to implement a proper and secure Shariah-compliant transaction. It has been claimed to be offering shariah based transactions that are free from any interest. However, the major problem under consideration is that whether the adoption of the smart contracts in Blockchain technology has been observed in Islamic finance services to be authentic and significant enough as it claims.⁹ The key objectives associated with it are to perform a survey regarding the smart contract verification for Shariah compliance based Blockchain applications as well as to evaluate the level of value countries perceive towards the utility of smart contracts verification approach for Shariah compliance-based blockchain applications. In addition, the objective is to evaluate the challenges that are faced in reference to smart contracts verification for blockchain applications for Shariah Compliance.

Literature Review

Smart contracts in Blockchain Technology

Blockchain technology is a distributed public ledger which consists of the blocks that maintain the overall computer network and contain different verified transaction records without any central authority and third party intermediary. The smart contract is computer-based program which are used in the Blockchain applications to execute the automatic verification of the specific conditions, they are the way to automate the agreements and transactions without the need of any legal system and enforcement mechanism¹⁰. The key feature of smart contract is that it is immutable, once the Blockchain smart contract is published; it's permanent and visible information towards all the participants. Also it is tracked and cannot be reversed once its completed therefore no one can change it. The element of transparency makes it significant for the system and another major element is its self-executing property. ¹¹The concept of blockchain is often confused with the cryptocurrencies however it is important to understand that the

⁸Dong, S., Abbas, K., Li, M., & Kamruzzaman, J. (2023). Blockchain technology and application: an overview. *PeerJ Computer Science*, 9, e1705.

⁹Tyagi, A. K., & Tiwari, S. (2024). The future of artificial intelligence in blockchain applications. In *Machine learning algorithms using scikit and tensorflow environments* (pp. 346-373). IGI Global.

¹⁰Muneeza, A., & Mustapha, Z. (2019). Blockchain and its Shariah-compliant structure. *Halal cryptocurrency management*, 69-106.

¹¹Wu, C., Xiong, J., Xiong, H., Zhao, Y., & Yi, W. (2022). A review on recent progress of smart contract in blockchain. *IEEE Access*, 10, 50839-50863.

blockchain technology is used in bitcoin but its not the cryptocurrency.¹² The technology is only the basis of the cryptocurrency such as bitcoin and its utility is applied in account of transactions to offer anybody to get and confirm the information associated with the transaction therefore it plays a prominent part in the financial institutions¹³.

Shariah Compliance in Financial Transactions

The overall law of Shariah governs that the transaction of finance shall be ethica, moral and legal in nature. It prohibits the Riba, harar and Maysir in the financial transctions. Any guaranteed that is regarding the return on capital or lending money for the interest is considered to be forbidden in Islamic values. According to the Islamic principles of Shariah, the ambiguity regarding the transaction is also considered to be wrong and the chance based transctions are also prohibited. Also, it is not allowed to invest in any prohibited investment like the industries associated with alcohol, gambling, and other businesses¹⁴. Financial services to be considered are required to be following the compliance guidelines of Shariah and the role of smart contracts is programmable towards adopting this practice in the Islamic fianncia where the blockchain based transaction is ensured to be following the guidelines accordingly.¹⁵

The Role of Smart Contracts in Blockchain Applications

Smart contract is designed as the digital contract where the automatic enforcement of the terms and conditions is done for different agreements as per the predefined criteria. The contracts are operating without any intermediaries and the overall transparency is ensured. The transparency of the transaction help in aligning with the Islamic values of justified distribution of resources. The automated executions of the contract are useful in reducing the human error and ensure that all the parties meet their responsibilities without any further delay.¹⁶ The Blockchain technology is helpful in enabling the decentralized financial applications and allow direct transaction, the adoption of smart contracts avoid interest based banking systems called Riba. The verification process

¹²Arnone, G. (2024). Blockchain Technology: The Backbone of Cryptocurrencies. In *Navigating the World of Cryptocurrencies: Technology, Economics, Regulations, and Future Trends* (pp. 13-23). Cham: Springer Nature Switzerland.

¹³Taherdoost, H. (2023). Smart contracts in blockchain technology: A critical review. *Information*, 14(2), 117.

¹⁴Lazim, A. M., & Mizuri, S. Z. S. (2022). A Shariah Compliance Integrated E-Commerce Transaction An Analysis of Shopee. com: A Literature Review. *Jurnal Kejuruteraan, Teknologi & Sains Sosial (JKTSS)*, 8(1), 148-158.

¹⁵Chong, F. H. L. (2021). Enhancing trust through digital Islamic finance and blockchain technology. *Qualitative Research in Financial Markets*, 13(3), 328-341.

¹⁶Imsar, I., & Dharma, B. (2024). Analysis of Opportunities and Challenges of Blockchain Technology in the Islamic Banking Industry (Case Study on the Use of Smart Contracts). *Jurnal Akuntansi, Keuangan, dan Manajemen*, 5(4), 481-489.

through the smart contracts is observed to be the multi-layered structure which involves both the legal as well as technical scrutiny in order to ensure that overall contract adheres to the Islamic financial principles. The overall process involves the legal and ethical review as the key step where the business model analysis is done and the transparency and the justice has been considered as important element to develop fairness and avoid any kind of exploitation of one party over the other¹⁷. Apart from this, it also involves the analysis of the risks and uncertainties in the overall transaction. It ensures that the contract is clear, understandable and based on clear principles of fairness to ensure that the confusion and disputes are avoided. Technical verification of the smart contracts is conducted with the help of the Shariah auditors. They are familiar with the financial principles of Islam and blockchain technologies, and they ensure that the prohibited activities are not part of the overall transaction¹⁸. The smart contracts are required to be secure, tamper-proofed and they are operated in a decentralized manner. The overall Blockchain immutability is focused on ensuring the smart contract execution and it cannot be altered later therefore the trust and reliability is provided. ¹⁹However engagement of the Shariah advisory boards is also important part of the overall smart contracts based compliance development. The correct implementation of the financial principles in the context of smart contracts helps in ensuring that all the Islamic principles are clearly met in the transaction. ²⁰

Also the Shariah compliance can offer the independent review of the smart contracts been developed with the help of the specialized auditing firms, they offer the service logical and ethical review of the overall transaction and ensure that the smart contracts based transactions are transparent and without any kind of ambiguity involved. ²¹AAOIFI that is the Accounting and auditing organization for Islamic financial institutions has put forward the standards for the overall practice of Islamic finance and shared the guidelines that need to be applied in the Blockchain structure with the use of smart contracts to ensure that the Islamic values are ensured throughout the transaction. ²²

¹⁷Iftikhar, S., & Saba, I. (2020). Blockchain Based Smart Sukuk as Shariah Compliant Investment Avenues for Islamic Financial Institutions in Pakistan. *Journal of Finance and Economics Research*, 5(1), 30-45.

¹⁸Hamza, O. (2020). Smart Sukuk structure from Sharia perspective and financing benefits: Proposed application of smart Sukuk through blockchain technology in Islamic banks within Turkey. *European Journal of Islamic Finance*.

¹⁹Khan, S., & Rabbani, M. R. (2022). In-depth analysis of blockchain, cryptocurrency and sharia compliance. *International Journal of Business Innovation and Research*, 29(1), 1-15.

²⁰Rabbani, M. R., Khan, S., & Thalassinou, E. I. (2020). FinTech, blockchain and Islamic finance: An extensive literature review.

²¹Gulyamov, S. (2024). Application of Computational Law and Artificial Intelligence Methods for Sharia Compliance Analysis of E-Waste Management Systems Based on Blockchain. *Suhuf*, 36(1), 21-32.

²²Kunhibava, S., Mustapha, Z., Muneeza, A., Sa'ad, A. A., & Karim, M. E. (2021). Şukūk on blockchain: a legal, regulatory and Shari'ah review. *ISRA International Journal of Islamic Finance*, 13(1), 118-135.

Challenges in Verifying Shariah-Compliant Smart Contracts

The verification of the Shariah compliance associated with smart contracts can also bring in certain challenges for instance the very first challenge is linked with subjectivity of the overall Shariah interpretation. The challenge of variability is there where different scholars or regions bring in their own interpretation of the Shariah compliance. The standardization of the overall compliance and assessment across different regions becomes a critical part, and it becomes difficult to verify smart contracts accordingly.²³ There are different third party agents to verify the standardization but there is not specific tool or technological structure which can help in verifying the overall transaction details. Apart from this, the block chain technology can bring in complexity due to the decentralized finance application and this can be difficult to involve different parties and make a smart contract remain based on Shariah compliance over time. Regulatory uncertainty is another major element, there is still significant lack of understanding and clarity about the regulations for Shariah compliant smart contracts. Different regulatory bodies bring in different interpretations and thus create a potential conflict or delays in its actual implementation with common ground.²⁴

Research Methodology

The method adopted for the current study is qualitative in nature. The overall review of the past paper as well as the secondary data associated with the smart contracts adoption for verification in Shariah compliance in Blockchain applications has been conducted. The study has been carried out in a systematic way. The three core objectives developed in the study have been considered as the key themes and the secondary data analysis as well as the literature review has been conducted in accordance with the key objectives that are linked with the significance, utility and challenges associated with the smart contracts verification in the Shariah Compliance for Blockchain applications. Different countries based data has been evaluated so that the utility of the Blockchain technology and specifically the smart contracts in the financial services can be evaluated and the key challenges if they face, can be identified to have a clear overview of the status of the countries and the common or different perspectives regarding the smart contracts and the status of its utility can be observed.

The core focus of the research is to evaluate the role and significance of smart contracts in Shariah compliance in different countries. Malaysia, Indonesia, UAE and even western

²³Arif, M. I. A. M., binti Ab Halim, A. H., & bin Ab Halim, M. (2024). Financial Technology: An Overview on Shariah and Legal Implication. *KnE Social Sciences*, 1027-1037.

²⁴Ahmad, A. A., Zain, M. N. M., & Zakaria, N. D. A. (2024). The Position of Smart Contracts in the Light of Islamic Contract Theory. *Samarah: Jurnal Hukum Keluarga dan Hukum Islam*, 8(1), 144-171.

region are considered as part of evaluation and their practice of smart contract and the challenges (If any) faced by them, are evaluated in the study. The current study therefore focuses over the interpretivism philosophy. The interpretivism is based on the concept that reality is embedded into the experiences of everyone differently, there is no definite reality, everyone will bring in their own unique experience and on basis of which the data is extracted in dispersed form from different experience holders and their multiple experience based different realities are gathered to generate a final conclusion about the concept²⁵. Thus different sources of secondary data and different countries experience and utility of Smart contracts has been discussed to offer different experiences about smart contracts.

It is ensured that the overall answered or arguments generated from the analysis are based on the ethical approach and there is no harm to anyone from the overall analysis. Furthermore it is important to ensure that the overall research is based on the authentic data extraction as its based on the secondary data because wrong depiction of data can lead towards the wrong interpretation development and the research can lead towards the wrong direction. Therefore adoption of the right and authentic platform or sources of data is very important to develop the right set of details about the topic of study. One of the key objectives of the study is to perform a survey regarding the smart contract verification for Shariah compliance based Blockchain applications; in this the literature review has been conducted to confirm if the smart contracts are useful tool in performing verification about the transactions on basis of Shariah Compliance. This analysis is more likely to ensure that the adoption of smart contracts verification is useful and beneficial for the Shariah compliance based transactions or not. However the next objectives are linked with utility and challenges associated with the smart contracts adoption in the Shariah compliance for Blockchain applications which offer the reflection about the utility and challenges associated with smart contracts in different countries context thus it highlights the differences between different countries and their Shariah guidelines adoption, secondary study has been conducted to gather practices and perception of the financial institution and government of different states in relation to the smart contracts adoption for verification.

The current study is based on inductive approach because there is no hypothesis present²⁶ in the study and it is purely based on the idea that there is no prior research based on the collective review of the smart contract verification in the global context that can offer comparison of the verification process of blockchain in different countries based

²⁵Lawler, J., & Waldner, D. (2023). Interpretivism versus Positivism in an Age of Causal Inference. *The Oxford Handbook of Philosophy of Political Science*, 221.

²⁶Mahouachi, S., Elarbi, M., Sethom, K., Bechikh, S., & Coello, C. A. C. (2024, June). A Bi-Level Evolutionary Model Tree Induction Approach for Regression. In *2024 IEEE Congress on Evolutionary Computation (CEC)* (pp. 1-9). IEEE.

on smart contract adoption. The study is more exploratory in nature because it is exploring about the concept in multiple context to offer a more diverse knowledge about the context.

Furthermore, the strategy of this research is based on qualitative research; as the topic suggests, a detailed qualitative analysis of the topic of study is required; therefore, the qualitative study has been conducted to evaluate how countries have been valuing and what the challenges or limitations associated with the adoption of the smart contract verification in the Shariah compliance for blockchain technology. The overall study is based on systematic review but at the same time the current study holds certain limitations associated with the current study among which one core limitation is the sample. The study is based on very limited data about a few countries, which surely does not offer a universal overview of the adoption of smart contracts and their significance in Shariah compliance; therefore, it is recommended that in future studies, real-time interviews or more countries based detailed data shall be sourced in order to generate more improved overview about the smart contracts verification for Shariah compliance for Blockchain applications in those countries that will add up more knowledge.

Findings and Discussion

Countries have been using Smart contracts for the verification in block chain applications. The approach of Shariah compliance based smart contacts have been evident in the case of UAE and Saudi Arabia.²⁷ The legal system, regulatory environment, and interpretation of Islamic law have been considered very serious in the countries, and the government models of Shariah in these countries have been modeled around the establishment within the financial institutions and the jurisdictions like the Dubai Financial Service Authority DFSA and Abu Dhabi Global Market (ADGM) are considered as the major frameworks that are applied for the compliance assurance. The Middle Eastern countries collaborate with the blockchain projects in order to ensure proper compliance. UAE has a robust legal system which is focused on developing support for the widespread use of the blockchain technology in the transactions. However there are certain challenges associated with their utility and development of legislative framework. The current regulations in UAE do not cover the decentralized financial DEfi and non-fungible tokens which often lead towards the criminal activities and money laundering.²⁸ They do not have a common ground to be applied for the Shariah compliance; therefore the major conflict of regulation application and smart contracts verification has been

²⁷Alhejaili, M. O. M. (2024). Integrating smart contracts into the legal framework of Saudi Arabia. *International Journal of Law and Management*.

²⁸Wronka, C. (2022). Anti-money laundering regimes: A comparison between Germany, Switzerland and the UK with a focus on the crypto business. *Journal of Money Laundering Control*, 25(3), 656-670.

evident in the UAE. However there is dedicated institution in every country of UAE, Accounting and auditing organization for Islamic financial institution has designed certain standards for Islamic finances that the smart contracts are following to ensure that certain level of Shariah compliance is followed. However it is still done under certain supervision.²⁹

The next generation of blockchain applications like Ethereum has been useful in execution of smart contracts and development of the decentralized application on top of their network and it is perceived that the Ethereum virtual machine (EVM) acts as an execution support based software for the overall smart contract instructions that are developed in solidity. Although there are certain complexities but there are still approaches been focused towards improvement and finding ways through which the overall system can be made more transparent and offer more verification of the financial transactions. The issue of fragmentation has also been challenging part to ensure Shariah compliance in other part of the world including EU and USA. The Islamic banks operating in these regions are having smart contracts for verification but there is conflict regarding their verification procedure due to the conflict in the overall regulations and Islamic guidelines between the states of EU and USA. There is often necessity to adopt to the standard rules and regulations in order to be responsive towards the diverse transactions. However it is still believed in Dubai that the adoption of the smart contracts for the Shariah compliance is an authentic procedure and offers certain level of Islamic values. There is need for the Financial Action Task force that can ensure the common and right guidelines to be adopted for the smart contracts development in overall UAE region.³⁰

Contrary to this, the overall southeastern market has strong Islamic finance industry, Malaysia is a home for the larger Islamic finance industry where the institutions like Central bank of Malaysia (Bank Negara) provide comprehensive guidelines for the overall Shariah compliance in the fintech products and this also include the smart contracts development through the blockchain applications. The Shariah advisory council present in these banks are working closely with the blockchain projects in order to ensure the Shariah compliance following. Shariah Screening is based on two types in Malaysia, business activities screening and financial ratio screening. The complaint stocks are determined and the measurement of the overall business activities are done where the Shariah review is done in order to confirm that all the activities of the business are in alignment with the guidelines of the Islamic religion and ensure that there is no deviation

²⁹Al-Tawil, T. N. E. (2023). Anti-money laundering regulation of cryptocurrency: UAE and global approaches. *Journal of Money Laundering Control*, 26(6), 1150-1164.

³⁰ur Rehman, M. H., Svetinovic, D., Salah, K., & Damiani, E. (Eds.). (2021). *Trust Models for Next-Generation Blockchain Ecosystems*. Springer International Publishing AG.

from the overall Islamic values³¹. However the financial ratio is dependent about the agreement of the Muslim scholars towards the interest bearing ratio and non-compliance ratio in the overall income of the countries. Malaysia's Shariah based government framework offers specific detailed guidelines to be practiced by all organizations and their smart contracts are required to be following those guidelines in authentication of the transactions as per the Islamic values. The integration of the Blockchain technologies and specially smart contracts has been helpful in recognizing Malaysia as the global leader in the Islamic finance services. ³²Indonesia Shariah Compliance products also go through the Blockchain based applications and they are governed by the financial services Authority OJK and National Shariah Board (DSN-MUI). The collaboration has been observed between the Islamic banks that are present in the overall Southeastern Asian region and they are offering a common design for smart contract solutions so that the area of Islamic banking products like Sukuk and Islamic bonds can be developed. ³³

Apart from this, western countries also have certain Islamic banks operating in it that are having regulatory flexibility framework for their shariah compliance blockchain application. For example the UK conduct Authority (FCA) has been focused and active towards exploring the fintech products and they are aligned with the Islamic finance principles and the smart contracts are significant part of their overall authentication of the religious values in each transaction conducted in the fintech context. ³⁴The government regulators in UK has highlighted that the UK unique position in Islamic finance is mainly because of the international standards been followed for its Shariah compliance in Islamic banks. Shariah-compliant bank in the UK for instance the Al Rayan Bank, Gatehouse Bank and BLME all of them adhere to the strict ethical guidelines that are outlined in the Islamic law and these banks have integrated blockchain applications based on smart contracts. The independent Shariah scholars and the advisory boards. The regulatory environment in UK is not tight enough but still it tries to maintain the link between different financial institutions to at least follow the same level of guidelines or basics while verifying the transactions. ³⁵

³¹Rahim, N. F., Bakri, M. H., & Yahaya, S. N. (2019). Fintech and Shariah principles in smart contracts. In *FinTech as a disruptive technology for financial institutions* (pp. 207-220). IGI Global.

³²Olowoyo, M. B. (2023). Assessing the Effect of Islamic Fintech on Financial Inclusion. *Available at SSRN 4746005*.

³³Aulia, M., Yustiardi, A. F., & Permatasari, R. O. (2020). An overview of Indonesian regulatory framework on Islamic financial technology (fintech). *Jurnal Ekonomi & Keuangan Islam*, 64-75.

³⁴Hamadien, A. M. (2022). *Understanding Factors Facilitating the Diffusion of Financial Technology (FinTech) A Case Study of the Gulf Cooperation Council* (Doctoral dissertation, University of Bradford).

³⁵TransferGo (2023). *The top Islamic banks in the UK*. TransferGo. <https://www.transfergo.com/islamic-banks-in-uk>

Significance

Blockchain technology underpins the decentralized finance along with the cryptocurrencies which is rapidly transforming the overall financial landscape. The transparency and immutable nature are a source of improving the overall efficiency and enhance the security level but at the same time it is important to know whether the use of the smart contracts offer a universal benefit for the financial institutions for their adoption of the Blockchain technology. The reduced transaction cost, increased efficiency are however another key benefit of adopting the technological integration in the financial services.³⁶ The Shariah principles are necessary for the Islamic finance activities but at the same time it is essential to know the role of the key features introduced through Blockchain to ensure its worth investment made in financial institutions. The current study is quite significant as it offers the realization about the prominent role of smart contracts. The global Islamic finance market is growing and valued in trillions of dollars so its expanding and integrating different Blockchain based solutions to unlock the potential and opportunities.³⁷ But at the same time the current study offers the comparison of the utility, value and challenges associated with the verification of the Shariah compliance through the adoption of smart contracts. The current study can offer insight about the key challenges that need special consideration in order to overcome the barriers towards the adoption of common smart contracts for the financial transactions. Also, the analysis of this context offers visibility and comparison of the different perceptions and adaptability of smart contracts verification by the countries.

Ethical and legal compliance with the Islamic principles have also been indicated to be important but at the same time the study has highlighted that the Shariah law dictates not only association with the religious practices but it also requires ethical and financial transactions for the Muslims. The study regarding the Shariah compliance linked with smart contracts is also significant for creating the identification of the sustainable Blockchain solutions that are identified by different financial institutions. It is helpful in understanding that the well-verified Shariah complaints smart contract system is not yet established, there is often some ambiguity associated with the common ground of Islamic values and Shariah guidelines followed. The smart contracts are, therefore, adopted differently in different regions depending on the principles they follow³⁸.

³⁶Jacobetty, P., & Orton-Johnson, K. (2023). Blockchain imaginaries and their metaphors: Organising principles in decentralised digital technologies. *Social Epistemology*, 37(1), 1-14.

³⁷Gugueoth, V., Safavat, S., Shetty, S., & Rawat, D. (2023). A review of IoT security and privacy using decentralized blockchain techniques. *Computer Science Review*, 50, 100585.

³⁸Kismawadi, E. R., Hervasha, T., & Syahril, M. (2023). OPTIMIZING SHARIA PRINCIPLES THROUGH ARTIFICIAL INTELLIGENCE: A JURIDICAL-ECONOMIC INQUIRY INTO COMBATING FRAUD IN

Conclusion

Smart contracts are basically the computer programs that offer verification of different transactions in accordance with the Islamic values and Shariah guidelines. It plays a prominent role in the financial services delivery. The current study has been quite helpful in exploring its utility and significance in different countries. It has been observed that the countries have been also facing challenges at some point of time for example the case of UK and UAE where the states bring in different perceptions and religious values due to which the Shariah compliance is difference and this leads to conflicts of verification of Shariah compliance with the help of smart contracts. However it is also true that the adoption of the different authorities and third agents are adding up support for ensuring the compliance but it is also further complicating the process. The smart contracts are useful tool although for the Blockchain applications usage in financial institutions and almost all of the Islamic banks have adopted it to ensure the maximum possible level of transparency and Shariah bases transactions development which can develop customer trust and interest in their services.

References

1. Ahmad, A. A., Zain, M. N. M., & Zakaria, N. D. A. (2024). The Position of Smart Contracts in the Light of Islamic Contract Theory. *Samarah: Jurnal Hukum Keluarga dan Hukum Islam*, 8(1), 144-171.
2. Alhejaili, M. O. M. (2024). Integrating smart contracts into the legal framework of Saudi Arabia. *International Journal of Law and Management*.
3. Al-Tawil, T. N. E. (2023). Anti-money laundering regulation of cryptocurrency: UAE and global approaches. *Journal of Money Laundering Control*, 26(6), 1150-1164.
4. Arnone, G. (2024). Blockchain Technology: The Backbone of Cryptocurrencies. In *Navigating the World of Cryptocurrencies: Technology, Economics, Regulations, and Future Trends* (pp. 13-23). Cham: Springer Nature Switzerland.
5. Arif, M. I. A. M., binti Ab Halim, A. H., & bin Ab Halim, M. (2024). Financial Technology: An Overview on Shariah and Legal Implication. *KnE Social Sciences*, 1027-1037.
6. Aulia, M., Yustiardi, A. F., & Permatasari, R. O. (2020). An overview of Indonesian regulatory framework on Islamic financial technology (fintech). *Jurnal Ekonomi & Keuangan Islam*, 64-75.
7. Chong, F. H. L. (2021). Enhancing trust through digital Islamic finance and blockchain technology. *Qualitative Research in Financial Markets*, 13(3), 328-341.

8. Dong, S., Abbas, K., Li, M., & Kamruzzaman, J. (2023). Blockchain technology and application: an overview. *PeerJ Computer Science*, 9, e1705.
9. El Koshiry, A., Eliwa, E., Abd El-Hafeez, T., & Shams, M. Y. (2023). Unlocking the power of blockchain in education: An overview of innovations and outcomes. *Blockchain: Research and Applications*, 100165.
10. Gugueoth, V., Safavat, S., Shetty, S., & Rawat, D. (2023). A review of IoT security and privacy using decentralized blockchain techniques. *Computer Science Review*, 50, 100585.
11. Gulyamov, S. (2024). Application of Computational Law and Artificial Intelligence Methods for Sharia Compliance Analysis of E-Waste Management Systems Based on Blockchain. *Suhuf*, 36(1), 21-32.
12. Hamadien, A. M. (2022). Understanding Factors Facilitating the Diffusion of Financial Technology (FinTech) A Case Study of the Gulf Cooperation Council (Doctoral dissertation, University of Bradford).
13. Hamza, O. (2020). Smart Sukuk structure from Sharia perspective and financing benefits: Proposed application of smart Sukuk through blockchain technology in Islamic banks within Turkey. *European Journal of Islamic Finance*.
14. Iftikhar, S., & Saba, I. (2020). Blockchain Based Smart Sukuk as Shariah Compliant Investment Avenues for Islamic Financial Institutions in Pakistan. *Journal of Finance and Economics Research*, 5(1), 30-45.
15. Imsar, I., & Dharma, B. (2024). Analysis of Opportunities and Challenges of Blockchain Technology in the Islamic Banking Industry (Case Study on the Use of Smart Contracts). *Jurnal Akuntansi, Keuangan, dan Manajemen*, 5(4), 481-489.
16. Jacobetty, P., & Orton-Johnson, K. (2023). Blockchain imaginaries and their metaphors: Organising principles in decentralised digital technologies. *Social Epistemology*, 37(1), 1-14.
17. Khan, S., & Rabbani, M. R. (2022). In-depth analysis of blockchain, cryptocurrency and sharia compliance. *International Journal of Business Innovation and Research*, 29(1), 1-15.
18. Kunhibava, S., Mustapha, Z., Muneeza, A., Sa'ad, A. A., & Karim, M. E. (2021). Şukūk on blockchain: a legal, regulatory and Shari'ah review. *ISRA International Journal of Islamic Finance*, 13(1), 118-135.
19. Labadi, H. (2024). The Use of Blockchain Technology in the Development of the Islamic Financial Market: Case Study: Smart Sukuk (Doctoral dissertation).
20. Laili, N. H., Khairi, K. F., & Ahmad, A. (2024). Blockchain Integration: Transforming Islamic Frozen Estate Management in Malaysia. In *Strategic Islamic Business and Management: Solutions for Sustainability* (pp. 35-54). Cham: Springer Nature Switzerland.
21. Lawler, J., & Waldner, D. (2023). Interpretivism versus Positivism in an Age of Causal Inference. *The Oxford Handbook of Philosophy of Political Science*, 221.

22. Lazim, A. M., & Mizuri, S. Z. S. (2022). A Shariah Compliance Integrated E-Commerce Transaction An Analysis of Shopee. com: A Literature Review. *Jurnal Kejuruteraan, Teknologi & Sains Sosial (JKTSS)*, 8(1), 148-158.
23. Mahouachi, S., Elarbi, M., Sethom, K., Bechikh, S., & Coello, C. A. C. (2024, June). A Bi-Level Evolutionary Model Tree Induction Approach for Regression. In 2024 IEEE Congress on Evolutionary Computation (CEC) (pp. 1-9). IEEE.
24. Muneeza, A., & Mustapha, Z. (2019). Blockchain and its Shariah-compliant structure. *Halal cryptocurrency management*, 69-106.
25. Olowoyo, M. B. (2023). Assessing the Effect of Islamic Fintech on Financial Inclusion. Available at SSRN 4746005.
26. Rabbani, M. R., Khan, S., & Thalassinou, E. I. (2020). FinTech, blockchain and Islamic finance: An extensive literature review.
27. Rahim, N. F., Bakri, M. H., & Yahaya, S. N. (2019). Fintech and Shariah principles in smart contracts. In *FinTech as a disruptive technology for financial institutions* (pp. 207-220). IGI Global.
28. Shah, H. M. (2024). Asset Tokenization in Islamic Finance Historical Perspectives, Sukuk Innovations, and the Shariah Compliant Blockchain. *Pakistan Research Journal of Social Sciences*, 3(3).
29. Taherdoost, H. (2023). Smart contracts in blockchain technology: A critical review. *Information*, 14(2), 117.
30. TransferGo (2023). The top Islamic banks in the UK. TransferGo. www.transfergo.com
31. Tyagi, A. K., & Tiwari, S. (2024). The future of artificial intelligence in blockchain applications. In *Machine learning algorithms using scikit and tensorflow environments* (pp. 346-373). IGI Global.
32. ur Rehman, M. H., Svetinovic, D., Salah, K., & Damiani, E. (Eds.). (2021). *Trust Models for Next-Generation Blockchain Ecosystems*. Springer International Publishing AG.
33. Wronka, C. (2022). Anti-money laundering regimes: A comparison between Germany, Switzerland and the UK with a focus on the crypto business. *Journal of Money Laundering Control*, 25(3), 656-670.
34. Wu, C., Xiong, J., Xiong, H., Zhao, Y., & Yi, W. (2022). A review on recent progress of smart contract in blockchain. *IEEE Access*, 10, 50839-50863.
35. Zhong, B., Pan, X., Ding, L., Chen, Q., & Hu, X. (2023). Blockchain-driven integration technology for the AEC industry. *Automation in Construction*, 150, 104791.
36. Zulkepli, M. I. S., Mohamad, M. T., & Azzuhri, S. R. (2023). Leveraging blockchain-based smart contract in Islamic financial institutions: Issue and relevant solution. *International Journal of Islamic Economics and Finance Research*, 6(1), 18-28.