

Legal Challenges Concerning Quantum Computing in Islamic Banking System under Islamic Law in Uganda

**Paul Atagamen Aidonojie^{1*}, Yusuf Abass Aleshinloye²,
Ismaila Hassan³, Obieshi Eregbuonye⁴, Ogoma Sunday Ani⁵**

^{1,3}School of Law Kampala International University, Kampala, Uganda

²Department of Computer Science, Prime University, Abuja Nigeria

^{4,5}Faculty of Law, Edo State University, Edo State, Nigeria

Email: ¹⁾ paul.aidonojie@kiu.ac.ug, ²⁾ yusuf.abas@primuniversity.edu.ng, ³⁾ ismala.hasan@kiu.ac.ug,

⁴⁾ obieshi.eregbuonye@edostateuniversity.edu.ng, ⁵⁾ ani.ogom@edouniversity.edu.ng

Received : 25 July - 2026

Accepted : 15 August - 2026

Published online : 21 August - 2026

Abstract

Quantum computing is an innovative technology that could revolutionize the operations of Islamic banking by improving computation, secure transactions, and risk management. Nevertheless, the inclusion of quantum computing in Islamic banking is subject to numerous legal and Sharia challenges especially in Uganda which is yet to develop a legal framework for Islamic banking. These challenges include questions on Sharia compliance, data security, validity of contracts, consumer protection, and ethical governance. This research aims to analyze the legal issues related to quantum computing in the Islamic banking system in Uganda from the Islamic law (Sharia) point of view and in relation to banking and technology laws of Uganda where appropriate. The research employs a qualitative doctrinal legal approach using Islamic legal sources such as the Qur'an, Sunnah, Ijma' and Qiyas as well as statutes, policies and other literature. The research establishes that while Islamic legal provisions could be used to regulate innovative technologies such as quantum computing, they should be contextually interpreted. The research concludes that the development of a Sharia compliant legal and regulatory framework for quantum computing in Uganda is recommended.

Keywords: Islamic Banking, Islamic Law, Quantum Computing, Uganda.

1. Introduction

“When a new key has the ability to open doors which could not even have been imagined by yesterday’s locks, the law must not only ask who holds the key, but whether the door was ever meant to be opened” (Lessig, 1999). Quantum computing represents an innovative technology with the potential to revolutionise the processing and use of information across society. Contrary to traditional computers, whose bits are represented by 0 and 1, quantum computers exploit the concepts of superposition and entanglement in order to perform complex calculations through quantum computing (Shafik, 2025). Possible uses for the quantum computing technology include financial modelling, optimisation, risk analysis, fraud detection, cybersecurity and handling of large databases (Ai et al., 2023; Yoganandham, 2024). In the field of finance, quantum computing might enhance the precision and speed of complex financial decisions and analysis (Ai et al., 2023; Aidonojie et al., 2024). Nevertheless, it also raises significant legal and security challenges due to the future ability of quantum technologies to breach current cryptographic techniques of securing information (Besigomwe, 2025; Mukhlis et al., 2023; Shafik, 2025). Thus, the emergence of quantum computing technology necessitates



reconsideration of cybersecurity, data protection, technological accountability and governance policies by legal systems (Balisane et al., 2024; Islam et al., 2025).

Quantum computing used in Islamic banking can result in numerous benefits with regards to enhancing efficiency and sophistication of Shariah-compliant banking and finance services. There are basic principles that prevent *riba*, *gharar* and *maysir*, but require such features as fairness, transparency, ethical investments and legitimate commercial transactions as the basis of Islamic banking operations (Amin, 2022; Edi et al., 2026; Foenna et al., 2020). In this regard, quantum computing can help Islamic financial institutions to perform complicated calculations in order to analyse risks, to forecast finances, to detect frauds and to optimise investments (Ai et al., 2023; Yoganandham, 2024). Moreover, this technology may help to develop advanced Islamic FinTech platforms and automated financial transactions through using such instruments as *murabahah*, *mudarabah*, *musharakah* and *ijara* (Allaymoun & Hamid, 2019; Hamid & Allaymoun, 2020). However, complexity of quantum computing systems can result in difficulties with explaining automated decision-making, verifying the results of calculations and ensuring compliance of technology-based transactions with Shariah requirements (Elmansy, 2024; Jufri et al., 2026). Therefore, use of quantum computing should be controlled by Shariah standards and legal framework (Aidonojie et al., 2024; Amin, 2022).

The possible integration of quantum computing in Islamic banking should be assessed through the context of Uganda's legal, financial and technological environment. In spite of the fact that Islamic banking has been traditionally practiced within the conventional financial framework, it has been proven possible to incorporate Islamic banking within the legal framework of Uganda (Aidonojie et al., 2025; Lujja et al., 2016). Furthermore, previous studies have explored the regulation, possibilities and challenges related to Islamic banking in Uganda, and recent research has noted the potential of automation and technological innovations in Islamic banking (Aidonojie et al., 2024; Natukunda, 2018). Quantum computing is capable of providing improvements in the areas of risk analysis, transaction verification, fraud prevention and optimisation of banking processes (Ai et al., 2023; Besigomwe, 2025). At the same time, this technology is capable of creating new risks related to cybersecurity and data protection since quantum computers pose a threat to the classical cryptography used for banking data protection (Balisane et al., 2024; Shafik, 2025). Therefore, the use of quantum computing poses the question about the adequacy of Uganda's legal and institutional framework to the regulation of quantum-assisted Islamic banking and customer protection (Aidonojie et al., 2024; Elmansy, 2024).

The legal regime governing this new field of study entails Ugandan law and institutional mechanisms which govern financial institutions, Islamic banking, electronic transactions, cybersecurity, and personal data protection. Legal development of Islamic banking in Uganda has laid the groundwork for Shariah-compliant services, although some scholars have highlighted the need to ensure that such services operate under an appropriate regulatory environment (Lujja et al., 2016; Natukunda, 2018). In this regard, the digital legal framework of Uganda has been providing security to electronic transactions, information systems, and personal data, whereas cybersecurity governance has been crucial for the protection of financial institutions against digital threats (Balisane et al., 2024; Islam et al., 2025). Nevertheless, existing legal frameworks have been mainly formulated prior to the development of quantum technology and, thus, lack provisions regarding quantum-based cyberattacks, post-quantum cryptography, quantum data processing, algorithmic accountability, and liability of quantum technologies (Besigomwe, 2025; Shafik, 2025). Consequently, the challenge is that the development of quantum computing will bring about legal and regulatory uncertainties concerning data privacy, cybersecurity, contractual validity,

liability, accountability, and Shariah compliance in Uganda's Islamic banking system (Elmansy, 2024; Aidonojie et al., 2024).

The current research is guided by two theories which serve as a foundation in the analysis of the legal issues surrounding quantum computing in the Ugandan Islamic banking sector. First, the Maqasid al-Shariah Theory plays a critical role in determining whether new technology fosters the primary objectives of Shariah Law, which include protecting religion, life, intellect, lineage, and wealth. The Maqasid al-Shariah Theory helps analyze legal issues related to quantum computing, such as cybersecurity, consumer protection, financial security, and harm avoidance. Secondly, the Regulatory Theory helps in analyzing how legal institutions develop legal rules in order to regulate emerging technologies. This theory will help analyze whether the current legal regulations in Uganda are able to regulate quantum technology-related risks and foster innovation.

The relevance of this research lies in the fast pace of development in the field of quantum computing and its possible transformation of the financial services industry, including the Islamic banking sector. Quantum computing might bring changes in transaction processing, risk management, and finance safety; however, it might also destroy the encryption system and pose threats in relation to data protection, cyber security, customer protection, and compliance with the Shariah. As far as Uganda is concerned, the legal regime of the Islamic banking has been created without taking into account the issues of quantum computing. Therefore, it is necessary to conduct such research in order to reveal legal and Shariah risks and assess whether there are enough legislation and regulatory mechanisms in place to deal with emerging threats.

Consequently, this research looks at the legal issues surrounding quantum computing in the Islamic banking system in relation to Islamic law in Uganda. The research is driven by the fact that the current legal and Shariah governance frameworks might not be sufficient in addressing the unique issues that are generated by quantum financial technologies (Amin, 2022; Elmansy, 2024; Jufri et al., 2026). There are specific issues of concern, such as customers' information privacy, bank systems security, legality and enforceability of contracts automated through the quantum process, liabilities for wrong or illegal decisions of quantum computation, among others (Balisane et al., 2024; Hadi et al., 2025; Aidonojie et al., 2024). Therefore, the purpose of the research is to investigate the legal issues relating to quantum computing in the Islamic banking system of Uganda, evaluate the sufficiency of the current legal and regulatory framework, and recommend appropriate legal and Shariah measures (Amin, 2022; Elmansy, 2024; Iqbal et al., 2025). This will ensure that innovation is promoted while maintaining Shariah principles, consumer protection, and financial stability in the Islamic banking sector of Uganda (Foenna et al., 2020; Lujja et al., 2016).

2. Literature Review

Quantum computing means the use of principles from quantum mechanics such as superposition and entanglement in order to process information in a manner that could surpass conventional computing systems. Quantum computing could help in the modelling, detection of fraud, risk management, cybersecurity, encryption, and creation of Sharia compliant financial products in Islamic banking. Nevertheless, it poses serious legal issues related to data protection, cybersecurity, accountability, regulation, technological sovereignty, and compliance with Sharia. Islamic banking follows rules banning *riba*, *gharar*, and *maysir* and promoting justice, transparency, asset backing, and risk sharing (Amin, 2022; Aidonojie et al., 2024). It means that besides being regarded as a technology, quantum computing must be examined in terms of its compliance with Sharia principles and the Ugandan legal system.

The term therefore incorporates a multidisciplinary approach of the connection between quantum technology, Sharia financial principles, banking regulation, cybersecurity, and legal responsibility. This multidisciplinary connection is especially relevant for Uganda since the Islamic banking sector is evolving within the secular legal system and faces certain regulatory issues (Natukunda, 2018; Mukhlis et al., 2023).

The literature shows how the emerging technologies continue to revolutionize the financial industry, despite creating legal and regulatory problems. According to Yoganandham (2024), blockchain, artificial intelligence, big data analytics, and other emerging technologies have brought changes into the financial sector, improving the efficiency of transactions, risks management, frauds detection, and decision-making. In addition, Foenna et al. (2020) note that the Fourth Industrial Revolution provides opportunities for Islamic banking through fintech, blockchain, robo advisory, crowdfunding, peer-to-peer financing, and digital payment solutions. Nevertheless, their development is hindered by such barriers as regulatory challenges, insufficient finances, lacking technical skills, and human capital shortage. The problem of regulation is also important for the case of quantum computers since this technology necessitates the availability of advanced infrastructure, specialized knowledge, and strict regulations. Besigomwe (2025), analyzing the role of quantum computing in the financial audit system of Uganda, mentions the high cost of the implementation of quantum computer, staff shortage, difficulties with integration of the technology into existing processes, and the threat of conventional encryption to the attacks of the quantum computer.

Moreover, the literature also brings out the legal challenge posed by cybersecurity, privacy, and data protection regarding quantum computing. Quantum technologies may greatly improve financial security through enhanced computing capacity, but they may also pose a risk to current cryptography methods and the confidentiality of the financial data. According to Shafik (2025), quantum computing poses complex challenges concerning privacy, security, ethical considerations, and the appropriateness of current legal and regulatory frameworks. Likewise, Hadi et al. (2025) cite cyber attacks, technical limitations, lack of cybersecurity literacy, and poor data management as some of the challenges in the digital age. According to Balisane et al. (2024), an effective cybersecurity framework should have AI, machine learning, blockchain, real-time monitoring, and layered security measures as part of its strategy. The significance of the above considerations to Islamic banking is in the sensitive nature of customer and transactional data processed within financial institutions. The legal challenge for Uganda is in ensuring that quantum-enabled Islamic banking systems meet the laws on data protection, cybersecurity, e-transactions, and banking while putting liability on the use of quantum technologies for data breaches, unauthorized access, algorithmic problems, or financial losses.

Another group of literature looks at the connection between technological innovation and the rules of Islamic law, especially the need for multidisciplinary legal and religious interpretations. Elmansy (2024) notes that quantum computing could make Islamic banking better through complex financial modeling, encryption, and better management of complex financial products like sukuk and takaful. However, technological innovation must be aligned with Sharia rules. Amin (2022) states that the future is bright for Islamic fintech in Africa, but there is a need for Sharia standardization to guarantee consistency and trust from people. Gyagenda (2025) makes the same point, stating that modern Muslim scholars must use multidisciplinary methods in their work and engage professionals from other areas, such as science and technology. In Uganda, Natukunda (2018) identifies some legislative and regulatory challenges in Islamic banking and how the requirements of Sharia are related to the secular environment of Ugandan banking. While previous literature talks about Islamic banking regulation, fintech, cybersecurity, and quantum technology separately, few researchers have

studied how the issues are connected in Uganda. Thus, this study will look into the legal challenges of using quantum computing in Ugandan Islamic banking under Islamic law.

Despite there being literature on quantum computing, Islamic banking, fintech, cybersecurity, data protection, and new technologies, many research gaps exist concerning the interplay of these aspects in relation to the legal issues in Uganda. While works like Elmansy (2024) considered quantum computing and Islamic banking in Egypt, others like Besigomwe (2025) studied the application of quantum computing in financial auditing in Uganda. In addition, Natukunda (2018) has considered the regulations and challenges of Islamic banking in Uganda without taking into account quantum computing. Others have separately addressed cybersecurity, innovations in fintech, and Sharia law compliance; however, no comprehensive studies have been done concerning the legal challenges that arise from integrating quantum computing in the Islamic banking in Uganda under the Sharia law. This research is new since it has looked at all these aspects together in one research analysis.

3. Methods

This study utilises a qualitative doctrinal legal research methodology in examining the legal issues surrounding quantum computing in the Islamic banking system of Uganda. The doctrine research method is suitable in this case since it involves identification, interpretation, and critical analysis of the Islamic legal doctrines in relation to financial innovations and the Islamic banking. The data used was sourced mainly from the main sources of Islamic law, which include the Koran, *Sunnah* (Hadith), *Ijma'* (Islamic jurists consensus) and *Qiyas* (analogical deduction). In addition to the above sources, other sources used were those of Islamic law Fiqh, scholarly works, peer reviewed journals, books and reports on Islamic finance and financial technology. Where relevant, Ugandan laws of banking, finance and technology were also reviewed in order to see their relationship with the Islamic legal principles and how quantum computing is regulated in Uganda. The data collected was used to provide a detailed analysis of the information contained in the following figure 1.



Figure 1. Conceptual framework of quantum computing in Islamic banking in Uganda
Sources: Design by authors based on obtained data

The results obtained from the collection of the data were analyzed using qualitative doctrinal analysis and content analysis techniques. It involved analyzing the legal doctrines and legal jurisprudence related to Islamic law in order to understand the way in which the principles of Sharia law can govern the adoption and implementation of quantum computing in Islamic banks. The comparative doctrinal analysis was used further to analyze the recommendations from the international standard setting bodies and scholars regarding Islamic finance, technology and ethics in order to draw lessons applicable to Uganda. The research critically examined the compatibility of the legal framework of Uganda with the Sharia law and identified any legal or regulatory gaps in relation to the governance of quantum computing in Islamic banking.

4. Results and Discussion

4.1. Concept of Quantum Computing in Islamic Banking System in Uganda

The integration of quantum computing in Islamic banking is one of the new areas of opportunities and risks associated with the legal aspects if technology is deploy in Islamic banking in Uganda. Hence, this study is limited by the emerging nature of quantum computing, which is not yet widely deployed in Uganda's Islamic banking sector. Its analysis is therefore necessarily prospective and relies mainly on doctrinal sources rather than empirical evidence. The findings consequently identify potential legal and Shariah challenges requiring future empirical and regulatory assessment. The ability of the technology to solve complex computing problems can be beneficial in financial management, fraud detection, Sharia conformity, and cybersecurity.

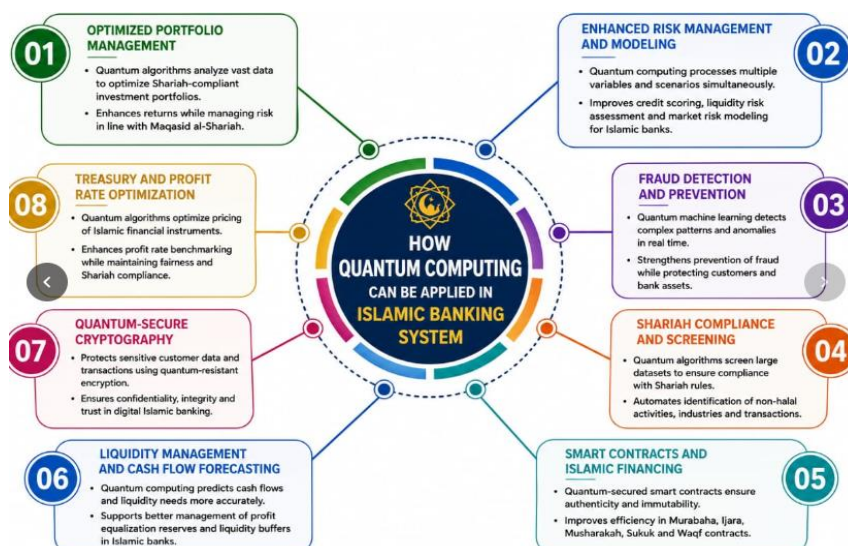


Figure 2. How quantum Computing can be applied in Islamic Banking

Source: Design by authors based on obtained data

The figure 2 shows how quantum computing can be utilized in the practice of Islamic banking through linking advanced computation ability with the basic needs of Islamic finance. Unlike traditional computing, quantum computing can be used for processing complex data sets, analysing complex variable, and solving complex financial problems faster than any traditional computer. In Uganda, which is an emerging market for Islamic banking, quantum computing can be used to improve the performance of banking services. The diagram indicates

that there are eight main areas where quantum computing can be applied in the field of Islamic banking: portfolio management, risk management, fraud detection, Shariah compliance, smart contracts, liquidity management, quantum cryptography, and treasury management.

Quantum computing could greatly improve the ability of Islamic banks in Uganda to manage portfolios, measure risks and make predictions about their financial state. Quantum-powered decision-supporting technologies would be able to analyze complex variables and support optimisation of investment decisions, risk measurement and financial modeling (Ai et al., 2023; Mutawalli et al., 2024). Investment decisions in Islamic banks should be consistent with Sharia rules, especially prohibition of *riba* (interest), *gharar* (excessive uncertainty), and *maysir* (gambling), and should focus on economically permissible investments (Amin, 2022; Foenna et al., 2020). Quantum algorithms could process extensive financial, market, and economic data to detect Sharia-compliant investment opportunities and optimize portfolios in terms of risks and returns. Quantum computing could also help with credit scoring, assessment of liquidity risks, market risk modeling, and stress testing through effective analysis of multiple variables and scenarios (Elmansy, 2024; Yoganandham, 2024). Quantum computing could be also used for cash flow prediction and management. However, the dependence on quantum-driven decisions poses significant legal issues in terms of transparency, explainability of algorithmic decisions, accuracy of the data processed by them and liability for financial losses caused by these automated decisions (Aidonojie et al., 2024; Shafik, 2025).

The second significant application of quantum computing in the Islamic banking system of Uganda relates to preventing fraud, Sharia compliance, and automation of Islamic financial transactions. The computational systems can be used to analyze the transactions and determine any abnormal behavior, thus facilitating the discovery of money laundering, cybercrimes, and other cases of financial crimes (Balisane et al., 2024; Onunka et al., 2023). Such an application is important for the Islamic banks since the fraudulent transaction may compromise financial integrity and Sharia compliance of the Islamic bank. Quantum computing may also be used to analyze large amounts of data and discover prohibited actions, transactions in industries that are not halal, and transactions which do not comply with Islamic laws (Amin, 2022; Elmansy, 2024). Concerning smart contracts, the technological systems may increase the speed and the safety of automation of *Murabaha*, *Ijara*, *Musharakah*, and *Sukuk* financial transactions by analyzing the compliance of the transactions (Allaymoun & Hamid, 2019; Hamid & Allaymoun, 2020). Automated systems raise legal issues regarding the legal status of algorithms' decisions, legal nature of the electronic contract, and liability for non-compliance resulting from technological errors (Aidonojie et al., 2024; Jufri et al., 2024; Swan, 2022).

The third aspect entails quantum-secured cryptography, treasury management, and overall governance through the law of the quantum-enhanced Islamic banking. Quantum computing has a double-edged implication as, while being useful in financial analysis and security purposes, sufficiently advanced quantum computers might be capable of breaking the classical encryption systems designed to protect customer data, banking processes, and communication (Shafik, 2025). Thus, Ugandan Islamic banks should consider implementing quantum-secured cryptosystems to guarantee security, integrity, and confidentiality of digital financial services (Balisane et al., 2024; Islam et al., 2025). Additionally, quantum algorithms will allow optimizing Islamic financial products, treasuries, profit rates, and profit equalization reserves, which should comply with Sharia principles (Elmansy, 2024; Yoganandham, 2024). However, such implementation presupposes an appropriate regulatory environment regarding cybersecurity, data protection, algorithmic accountability, electronic

transactions, consumer protection, and institutional liability (Lujja et al., 2016; Safi' et al., 2024; Swan, 2022). It is also important for the technology to remain in accordance with Islamic notions of justice, clarity, reduction of excessive uncertainties, and security of property (Amin, 2022). This means that any application of quantum computing in the Islamic banking system in Uganda in the future will have to be characterized by innovation in phases, readiness in regulation, capacity building in technology, and Shariah oversight (Foenna et al., 2020; Gyagenda, 2025).

4.2. Islamic Law Concerning Quantum Computing in Islamic Banking System in Uganda

Before the utilisation of quantum computing in the Islamic banking system of Uganda, it has to conform to the basic tenets of the Islamic commercial law (*fiqh al-mu'āmalāt*). These include the ban of *riba* (interest) in Qur'an 2:275, where the believer is ordered to desist from *riba* in Qur'an 2:278–279. They include prohibition of *maysir* (gambling) in Qur'an 5:90–91 and the necessity of honouring obligations under contract in Qur'an 5:1. This is because quantum computing can be used in investment optimization, financial modeling, risk evaluation, and automated pricing. In this case, the technology should not be used in interest-based transactions, excessive speculation, and any prohibited economic activities. In addition, Qur'an 4:29 forbids spending of wealth in a prohibited manner and allows mutual agreement in trade. Thus, the Islamic banking of quantum computing should uphold lawful exchange, transparency, and genuine consent. Being technology-neutral, the legality of quantum computing depends on its application. Its use should thus be evaluated in accordance with Sharia laws and current regulations (Amin, 2022; Elmansy, 2024; Foenna et al., 2020).

Another major issue related to Islamic law is that of *gharar* or undue uncertainty along with the demands of transparency, certainty of contracts, and protection of property. Qur'an 4:29 lays down the rule of mutual agreement in valid trade, while Qur'an 5:1 instructs Muslims to honour their commitments. Moreover, Qur'an 2:282, which is the longest verse of the Qur'an, highlights the need for documentation of deferred financial obligations and the significance of evidence. These principles become crucial when quantum computing technology is used to automate *Murabaha*, *Ijara*, *Musharakah*, *Mudarabah*, and *Sukuk* agreements. Any automated system has to accurately represent all the key aspects of the relevant Islamic contract such as the rights, obligations, property arrangement, and risk distribution of the parties involved. Quantum computing technology should not make the transaction uncertain in any way, thus making it impossible for the customer to understand the transaction or determine liability in case of any technological error. Similarly, research in relation to automated Islamic banking in Uganda shows the importance of making sure that technological advancement does not contradict Islamic banking principles and the pertinent law (Aidonojie et al., 2024; Allaymoun & Hamid, 2019; Hamid & Allaymoun, 2020).

Moreover, the Islamic laws also provide that the protection of wealth as well as the prevention of harm is essential. In terms of quantum cybersecurity and data protection, these are significant because the Qur'an emphasizes that people must not commit wrongdoing regarding appropriation of any property (Qur'an 4:29). It also highlights the significance of upholding justice and righteousness (Qur'an 16:90). Therefore, the protection of customers' financial details as well as the prevention of fraud can be justified through these principles. Quantum computing poses both advantages and threats to the Islamic banking system. It helps in enhancing the financial safety but at the same time it might endanger conventional encryption mechanisms and banking data (Shafik, 2025). Hence, the banks should apply necessary security measures and should make sure that technology used by them will not cause financial or any other type of risk to their customers. The Islamic concept of *maslahah* (public

interest) is formed based on Islamic *fiqh* and can be helpful in the adoption of quantum computing when it contributes to security, effectiveness, financial accessibility and economic welfare without being in contradiction with Sharia prohibitions.

The Uganda Constitution forms the key basis through which quantum computing can be used in Islamic banking. Privacy under Article 27 of the constitution will be very important in this case since quantum banking processes will involve vast amounts of personal, financial and transactional data. Equality and freedom from discrimination in Article 21 of the constitution will be vital in terms of making fair and unbiased automatic decisions through quantum. The equality principle is consistent with the Qur'anic principle of justice: "Indeed, Allah commands justice" (Qur'an 16:90), while the financial transactions should be done with full agreement and justice (Qur'an 4:29). The Financial Institutions Act will form the key framework for licensing, supervision, governance and risk management of the banking system in Uganda. It thus becomes necessary to ensure that quantum banking decision-making systems remain accountable and do not contravene the prohibition of *riba*, *gharar* and *maysir* in Sharia principles.

Both the Data Protection and Privacy Act, 2019, and the Computer Misuse Act, 2011 (as amended), play an equal role in the governance of quantum-based Islamic banking in Uganda. Quantum computing can deal with highly confidential information of customers and pose various cybersecurity challenges because the quantum computer that is strong enough can break all the traditional encryption system. Consequently, the banks need to guarantee the lawful, safe, and responsible processing of personal data as well as prevent any unauthorized access and misuse of such data, and any cybercrime. Indeed, according to the Koran, believers must execute their trust (Qur'an 4:58) and not take other people's property unjustly (Qur'an 2:188). Another issue related to quantum computing is that banks will have to establish liability for any damage, financial loss or harm caused by quantum decision-making. Thus, Uganda's legal system needs to be interpreted and developed to cover such issues as algorithmic accountability, quantum cybersecurity, electronic transactions, and consumer rights protection. Such kind of governance must uphold the Islamic values of justice, protecting property, transparency, and avoiding any harm (Balisane et al., 2024; Islam et al., 2025; Shafik, 2025; Swan, 2022).

4.3. Legal Issues Concerning Quantum Computing in Islamic Banking System in Uganda

The implementation of quantum computing in Uganda's Islamic banking system involves a number of legal issues because quantum computing brings about a sophisticated computational capacity which is not regulated by the current banking laws, technology laws, data protection laws, or Islamic finance laws. Although quantum computing can improve financial modeling, fraud detection, risk management, and Sharia-based automated transactions, there are issues associated with the interpretation and implementation of Sharia rules, protection of client data, cybersecurity, regulatory readiness, contract validity, and liability for technology-based decisions. These issues arise out of the fact that Islamic banking in Uganda is implemented within an immature legal framework, and emerging technologies may develop faster than the relevant laws. The incorporation of quantum computing in the Islamic banking system needs to be done through a legal framework which balances technological innovations with Sharia laws, constitutional principles, financial regulations, and ethics (Amin, 2022; Elmansy, 2024; Natukunda, 2018; Yoganandham, 2024). Table 1 illustrates that these legal issues are not merely theoretical but directly relevant to Uganda's Islamic banking sector, reinforcing the need for policy and scholarly attention

Table 1. Legal Issues Concerning Quantum Computing in the Islamic Banking System under Islamic Law in Uganda

Legal Issue	Nature of the Legal Challenge	Relevance to Islamic Banking and Uganda
Sharia Compliance Uncertainty	Quantum systems may generate investment, financing, or contractual decisions whose underlying computational processes are difficult for Sharia scholars to interpret or verify.	This raises uncertainty regarding compliance with the prohibitions of riba (interest), gharar (excessive uncertainty), and maysir (gambling/speculation). Standardised Sharia governance and continuous supervision are therefore necessary to ensure that quantum-enabled financial services remain consistent with Islamic principles (Amin, 2022; Elmansy, 2024).
Data Privacy and Security	Quantum computing can process enormous quantities of personal and financial information, creating risks of unauthorised access, excessive data processing, and misuse of customer information.	Islamic banking institutions must protect the confidentiality and integrity of customer data while complying with Uganda's data-protection requirements. The ethical protection of property and trust in Islamic law further strengthens the need for responsible data governance (Hadi et al., 2025; Shafik, 2025).
Cybersecurity Risks	Powerful quantum computers may eventually compromise traditional encryption systems, exposing banking transactions, customer records, and digital communications to sophisticated attacks.	Uganda's Islamic banks may need quantum-resistant cryptography and updated cybersecurity controls to protect financial systems. Failure to address post-security could undermine consumer trust and cause financial harm (Balisane et al., 2024; Besigomwe, 2025; Shafik, 2025).
Regulatory Gaps	Existing Ugandan banking and technology laws may not specifically regulate quantum computing, quantum-generated decisions, post-quantum cybersecurity, or quantum-enabled financial products.	The absence of specific rules may create uncertainty concerning regulatory supervision, licensing, technical standards, Sharia governance, and institutional compliance. Uganda may therefore require regulatory adaptation quantum capable of addressing emerging quantum technologies while supporting responsible Islamic financial innovation (Natukunda, 2018; Elmansy, 2024).
Contractual Validity	Automated quantum systems may generate or execute Murabaha, Ijara, Musharakah, and other Islamic financial transactions without direct human intervention.	Legal uncertainty may arise regarding consent, authentication, electronic signatures, error, algorithmic performance, and the validity of contracts formed or executed through automated systems. Contractual automation must therefore satisfy both applicable Ugandan law and the substantive requirements of Islamic commercial law (Foenna et al., 2020; Yoganandham, 2024).
Liability and Accountability	Quantum systems may make complex decisions that result in financial loss, discriminatory outcomes, security failures, or Sharia non-compliance.	A central legal question is whether liability should rest with the bank, developers, technology providers, data controllers, or other responsible actors. Clear accountability rules are necessary to ensure remedies for affected customers and to prevent technological complexity from undermining justice and responsibility (Elmansy, 2024; Shafik, 2025).

5. Conclusion

In summary, quantum computing has immense potential to revolutionize the Islamic banking sector in Uganda in terms of financial analysis, risk management, fraud detection, cybersecurity, and automation of Islamic financial transactions. Nevertheless, the implementation of quantum computing technology also brings in legal issues such as Sharia compliance, data privacy, cybersecurity issues, regulation gaps, contract validity, and liability for automated decisions. In light of this, it is important for Uganda to adopt a phased approach to the use of quantum computing in the Islamic banking sector. It is recommended that the Bank of Uganda in collaboration with technocrats, legal experts, and Sharia scholars develop regulatory guidelines concerning quantum technology, algorithmic accountability, data protection, and quantum-proof cybersecurity. In addition, Islamic financial institutions need to implement continuous Sharia supervisory mechanisms to ensure that all quantum-based transactions do not contravene the prohibitions of *riba*, *gharar*, and *maysir*.

5.1. Acknowledgments

The author appreciates their respective institution for providing the enabling environment in conducting academic research. We also appreciate the editorial board of the journal for their classic editorial process in adding value and originality to the manuscript.

5.2. Competing interests

There is no competing interest

5.3. Funding

No funding was obtained

6. References

- Ai, R., Zheng, Y., Yüksel, S., & Dinçer, H. (2023). Investigating the components of fintech ecosystem for distributed energy investments with an integrated quantum spherical decision support system. *Financial Innovation*, 9(1), 1–28. <https://doi.org/10.1186/s40854-022-00442-6>
- Aidonojie, P. A., Adebayo, A. K., Eregbuonye, O., Mukhlis, M. M., & Ibeh, S. (2024). Legal and Socio-Economic Issues of Automated Islamic Banking in Uganda: Lesson from Indonesia. *Diponegoro Law Review*, 9(2), 204–222. <https://doi.org/10.14710/dilrev.9.2.2024.204-222>
- Aidonojie, P. A., Mugabe, G. M., Antai, G. O., Eregbuonye, O., & Aidonojie, E. C. (2025). Protection of Patients' Constitutional Rights in Telemedicine Practice Based on Sharia Principles. *Jurnal Hukum Islam*, 23(2), 501–540. <https://doi.org/10.28918/jhi.v23i2.05>
- Allaymoun, M. H., & Hamid, O. A. H. (2019). Integrated System (E-Murabaha) A new Approach to E-Commerce. In *2019 International Conference on Fourth Industrial Revolution (ICFIR)* (pp. 1–6). IEEE. <https://doi.org/10.1109/icfir.2019.8894779>
- Amin, U. A. (2022). Prospects of the Islamic Fintech revolution in Africa and the role of standardised Shariah principles. In *The potential of cash waqf for poverty alleviation in Somalia* (pp. 101–114). Edward Elgar Publishing. <https://doi.org/10.4337/9781802209907.00016>
- Balisane, H., Egho-Promise, E. I., Lyada, E., & Aina, F. (2024). Towards Improved Threat Mitigation in Digital Environments: A Comprehensive Framework for Cybersecurity Enhancement. *International Journal of Research -GRANTHAALAYAH*, 12(5), 108–123. <https://doi.org/10.29121/granthaalayah.v12.i5.2024.5655>
- Besigomwe, K. (2025). Enhancing the Uganda Revenue Authority's Financial Auditing Systems through Quantum Computing: Securing and Verifying Transactions in a Post-

- Quantum World. *Cognizance Journal of Multidisciplinary Studies*, 5(3), 110–123. <https://doi.org/10.47760/cognizance.2025.v05i03.009>
- Edi, P. D. G., Farma, R. M. I., Putra, P. I. K. S. L., Aidonojie, P. A., & Asonibare, A. S. (2026). The Future of Bali's Kerauhan Tradition: Legal Pluralism, Reforms, and Conflict Adjudication Challenges. *Journal of Sustainable Development and Regulatory Issues (JSDERI)*, 4(1), 118–137. <https://doi.org/10.53955/jsderi.v4i1.149>
- Elmansy, A. M. (2024). Quantum Computing and Islamic Banking: Legal Framework for Transforming Egypt's Financial Sector. *Manchester Journal of Transnational Islamic Law & Practice*, 20(3), 369–374. <file:///C:/Users/Transpublika/Downloads/MJTILPVol20Iss3-Complete.pdf>
- Foenna, A., Kamal, S., Ating, R., Foenna, A., & Kamal, S. (2020). The impact of industrial revolution 4.0 and its manifestation in Islamic finance industry. *International Journal of Accounting, Finance and Business*, 5(26), 70–90. <https://www.academia.edu/download/62762416/IJAFB-2020-26-03-09-220200402-38756-1kjarp4.pdf>
- Gyagenda, A. (2025). The Contribution Of Muslim Scholars Towards Science, Technology And Knowledge: A Historical Perspective. *Journal of Islamic Studies and Arabic Language*, 3(2), 85–104. <https://doi.org/10.53449/cndaz942>
- Hadi, S., Purnasari, E., Hidayat, R., Lukitaningsih, A., Kirana, K. C., & Siripipatthanakul, S. (2025). Challenges and Management Practices in Protecting Employee Personal Data in the Digital Era. In *Privacy and Security Management Practices for Organizations* (pp. 89–116). IGI Global. <https://doi.org/10.4018/979-8-3693-9720-6.ch004>
- Hamid, O. A. H., & Allaymoun, M. H. (2020). Murabaha application for electronic commerce internet of things utilisation in Islamic fin-tech. *International Journal of Electronic Banking*, 2(3), 212. <https://doi.org/10.1504/ijebank.2020.111429>
- Iqbal, M., Pamuji, Sari, A. P., Fernandho, & Aidonojie, P. A. (2025). Maqashid Sharia Approaches in Pension Fund Programs: Bank Muamalat Indonesia and Taspen Comparison. *Asy-Syari'ah*, 27(2), 212–238. <https://doi.org/10.15575/as.v27i2.45295>
- Islam, E., Rudolph, C., & Oliver, G. (2025). Managing cyber harm: a survey of challenges, practices, and opportunities. *Information Security Journal: A Global Perspective*, 34(5), 424–454. <https://doi.org/10.1080/19393555.2025.2484348>
- Jufri, M., Aidonojie, P. A., Abdullah, S., Erebuonye, O., & Ekpenisi, C. (2026). Legal And Socio-Economic Issues of Islamic Banking System in Uganda: Learning From The Indonesian Experience. *Al-Mazaahib: Jurnal Perbandingan Hukum*, 14(1), 1–28. <https://doi.org/10.14421/al-mazaahib.v14i1.4456>
- Jufri, M., Safi, S., Aidonojie, P. A., Zaini, Z., & Arowosaiye, Y. I. (2024). Religion and State in Islamic Constitutional Law: The Role of Pesantren in Strengthening Symbiotic Islam and the State in Madura. *Justicia Islamica*, 21(2), 221–246. <https://doi.org/10.21154/justicia.v21i2.9283>
- Lessig, L. (1999). The Law of the Horse: What Cyberlaw Might Teach. *Harvard Law Review*, 113(2), 501. <https://doi.org/10.2307/1342331>
- Lujja, S., Mohammad, M. O., Hassan, R. B., & Oseni, U. A. (2016). The feasibility of adopting Islamic Banking system under the existing laws in Uganda. *International Journal of Islamic and Middle Eastern Finance and Management*, 9(3), 417–434. <https://doi.org/10.1108/imefm-09-2014-0084>
- Mukhlis, M., Jackson-Ortiz, R. D., Jufri, M., Garunja, E., & Aidonojie, P. A. (2023). Rejection of Former Shia Community in Sampang Perspective on Human Rights Law: Discourse of Religious Rights and Freedom in Indonesia. *Lex Scientia Law Review*, 7(2), 959–994. <https://doi.org/10.15294/lesrev.v7i2.72156>
- Mutawalli, M., Masum, A., Aidonojie, P. A., & Adebayo, A. K. (2024). Filling Members of the Financial Audit Board: Constitutional Review and Legislative Intervention. *Al-'Adl*, 17(1), 55–72. <https://doi.org/10.31332/aladl.v17i1.7707>

- Natukunda, M. (2018). *Towards Islamic banking in Uganda: an analysis of its regulation, prospects and challenges in a secular legal environment* [Kamapala International University]. <https://ir.kiu.ac.ug/handle/20.500.12306/1196>
- Onunka, O., Maxwell Alabi, A., Marius Okafor, C., Obiki -Osafiele, A. N., Onunka, T., & Daraojimba, C. (2023). Cybersecurity in U.S. and Nigeria Banking and Financial Institutions: Review and Assessing Risks and Economic Impacts. *Acta Informatica Malaysia*, 7(1), 54–62. <https://doi.org/10.26480/aim.01.2023.54.62>
- Safi', S., Aidonojie, P. A., Jufri, M., & Garunja, E. (2024). Bhag-Rembhag Sabhala'an as a Method of Resolving Religious Conflicts in the Madura Legal Tradition. *El-Mashlahah*, 14(1), 95–126. <https://doi.org/10.23971/el-mashlahah.v14i1.7819>
- Shafik, W. (2025). Quantum Computing and Generative Adversarial Networks (GANs): Navigating Ethical and Security Challenges. In *Quantum Computing, Cyber Security and Cryptography* (pp. 371–406). Springer Nature Singapore. https://doi.org/10.1007/978-981-96-4948-8_15
- Swan, E. J. (2022). *Internet law: A concise guide to regulation around the world*. Kluwer Law International BV.
- Yoganandham, G. (2024). Revolutionizing Financial Services: The Role of Emerging Technologies and E-Masters in Financial Technology and Management. *Science, Technology and Development*, 8(2), 128–142. https://www.researchgate.net/publication/378495932_REVOLUTIONIZING_FINANCIAL_SERVICES_THE_ROLE_OF_EMERGING_TECHNOLOGIES_AND_E-MASTERS_IN_FINANCIAL_TECHNOLOGY_AND_MANAGEMENT