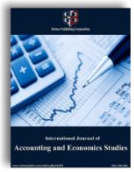
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Research paper



Harnessing Artificial Intelligence and Blockchain Technologies for Shariah-Compliant Accounting: A Critical Evaluation of Opportunities, Challenges, and Ethical Implications

Aysha N. AlSalih *

College of Business Administration, Accounting Department, Princess Nourah bint Abdulrahman University; Riyadh, Saudi Arabia
**Corresponding author E-mail: analsalih@pnu.edu.sa*

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Abstract

Purpose This study explores the integration of Artificial Intelligence (AI) and blockchain technologies in Shariah-compliant accounting systems, aiming to enhance transparency, operational efficiency, and adherence to Islamic ethical principles within the context of Islamic finance.
Design/Methodology/Approach A qualitative research design was adopted, utilizing thematic analysis and in-depth interviews with experts in Islamic finance, Shariah governance, and fintech across the Gulf Cooperation Council (GCC) countries and Southeast Asia.
Findings The study finds that blockchain's immutable ledger improves auditability and institutional trust, while AI supports real-time compliance monitoring and automation of complex financial processes. However, significant challenges remain, including regulatory ambiguity, ethical concerns around algorithmic bias and moral accountability, and infrastructural limitations within Islamic financial institutions.
Originality/Value This research provides a novel conceptual framework for integrating AI and blockchain in Shariah-compliant accounting. It emphasizes the necessity for harmonized regulatory standards, interdisciplinary collaboration, and ethical oversight to ensure alignment with Maqasid Al-Shariah (objectives of Islamic law).
Research Limitations/Implications The study is limited to qualitative insights from selected regions (GCC and Southeast Asia), which may not be fully generalized. Further empirical studies are needed to validate the proposed framework and explore its practical applications in different Islamic finance ecosystems.
Practical Implications The findings offer actionable insights for policymakers, financial institutions, and technology developers aiming to modernize Shariah-compliant accounting systems. The study highlights the need to align technological innovation with Islamic ethical norms and regulatory frameworks.

Keywords: *Artificial Intelligence; Blockchain; Shariah-Compliant Accounting; Islamic Finance; Maqasid Al-Shariah; Digital Transformation; Ethical FinTech.*

1. Introduction

Technological innovation is fundamentally transforming the global financial ecosystem, with Artificial Intelligence (AI) and blockchain technologies spearheading this digital revolution. These advancements are redefining how financial data is collected, processed, and secured streamlining operations and reducing dependency on human intervention. AI's capabilities in automating decision-making, anomaly detection, and predictive analytics, along with blockchain's potential to provide decentralized, immutable ledgers, make them particularly suited for enhancing accountability and transparency in accounting and audit functions (Dai & Vasarhelyi, 2017; Tapscott & Tapscott, 2018).

In the domain of Islamic finance, the incorporation of such technologies introduces additional layers of complexity and responsibility. Shariah-compliant accounting is not merely concerned with financial accuracy but also with aligning economic activities with Islamic ethical imperatives. These include the prohibition of interest "riba", speculative behaviour "gharar", and all other unethical practices (Archer & Abdel Karim, 2007). AI can enhance compliance by automating Shariah screenings and facilitating real-time audits, while blockchain ensures traceability and transparency elements that reinforce the goals of Maqasid al-Shariah, which emphasize justice, equity, and societal welfare (Kamla, 2009; Sarea & Hanefah, 2013).

Despite these prospects, the integration of AI and blockchain within Islamic financial institutions presents several unresolved challenges. Chiefs among these are the lack of standardized regulatory frameworks, ethical tensions surrounding AI autonomy, insufficient digital infrastructure in some jurisdictions, and concerns about data privacy and algorithmic transparency (Guermazi & Rejeb, 2023; Alomari et al., 2022). Moreover, the compatibility of algorithm-driven decisions with Shariah ethics continues to be a contentious subject.

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This paper aims to critically examine the interplay between AI, blockchain, and Shariah-compliant accounting by addressing both technological potential and normative constraints. Utilizing a qualitative methodology that includes thematic analysis and expert interviews. The study investigates how these emerging tools can be effectively and ethically integrated into Islamic financial systems. The findings intend to offer pragmatic insights for policymakers, Shariah scholars, financial institutions, and academic researchers engaged in the digital transformation of Islamic finance.

2. Literature Review

2.1. Foundations of shariah-compliant accounting

Shariah-compliant accounting emerges from the foundational principles of Islamic commercial jurisprudence "fiqh al-muamalat", which governs financial transactions in accordance with Islamic law. Unlike conventional accounting systems that prioritize profitability and shareholder value, Islamic accounting incorporates ethical, social, and spiritual dimensions rooted in the overarching objectives of Maqasid al-Shariah that promote justice, welfare, and equity (Haniffa & Hudaib, 2007). This paradigm mandates strict adherence to prohibitions on riba, gharar, and maysir (gambling), while encouraging transparency, risk sharing, and asset backed financing (Archer & Abdel Karim, 2007).

Financial reporting under Shariah principles also seeks to promote equitable treatment of stakeholders, including investors, customers, and the broader society. As such, Islamic financial institutions (IFIs) are expected to uphold values of accountability, social justice, and trustworthiness in their accounting and disclosure practices (Baydoun & Willett, 2002; Kamla, 2009). The Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) has developed specialized accounting standards that reflect these values and provide a basis for consistent application across jurisdictions (AAOIFI, 2017). Nevertheless, the implementation of these standards remains uneven, with varying levels of regulatory oversight and institutional commitment across Muslim majority countries.

Unlike conventional accounting systems that primarily emphasize efficiency, profitability, and shareholder value, Shariah-compliant accounting embeds ethical accountability, social justice, and religious compliance as intrinsic objectives. Consequently, the application of AI and blockchain in Islamic accounting requires additional governance layers to ensure moral accountability, whereas conventional frameworks often prioritize technological performance with limited ethical constraints.

2.2. The role of artificial intelligence in accounting

Artificial Intelligence is transforming the landscape of modern accounting using advanced algorithms, machine learning, natural language processing, and data analytics. These tools allow for the automation of traditional manual tasks such as data categorization, reconciliation, and anomaly detection, leading to improvements in speed, accuracy, and decision-making capabilities (Brynjolfsson & McAfee, 2017; Kokina & Davenport, 2017). In financial auditing, AI systems have been deployed to conduct continuous monitoring and risk assessments, thereby enhancing audit quality and reducing human error (Appelbaum et al., 2017).

In the Islamic finance sector, AI offers a unique opportunity to modernize operations while maintaining compliance with Shariah law. AI-enabled platforms can automate the screening of financial products and transactions against Shariah criteria, support real-time calculation of Zakat (form of almsgiving), and manage Waqf (charitable endowment) institutions efficiently (Alkhowaiter & Alsharif, 2022; Khattak et al., 2023). Furthermore, AI-driven chatbots and robo-advisors tailored for Islamic banking clients are being explored for their potential to deliver compliant financial advice while enhancing user experience (Arsyad et al., 2025).

However, the use of AI in religiously sensitive domains introduces significant ethical and operational challenges. Concerns around algorithmic transparency, fairness, and accountability are amplified in Islamic finance due to the moral imperatives associated with Shariah governance (Jobin et al., 2019; Raji et al., 2020). The potential for bias in AI systems whether due to flawed data, opaque algorithms, or cultural misalignment necessitates the presence of human oversight, especially in decisions related to religious compliance (O'Neil, 2020). To ensure ethical deployment, scholars have called for the integration of Islamic ethical principles into AI system design and the establishment of multidisciplinary oversight boards involving Shariah scholars, technologists, and ethicists (Guermazi et al., 2023).

2.3. Blockchain applications in accounting and Islamic finance

Blockchain technology characterized by its decentralized, immutable, and cryptographically secure structure has garnered increasing attention in the field of accounting and financial reporting. As a distributed ledger system, blockchain enables real-time, tamper proof recording of transactions, significantly enhancing transparency, traceability, and audit reliability (Dai & Vasarhelyi, 2017; Schmitz & Leoni, 2019). In traditional accounting, it facilitates streamlined reconciliation, reduces the need for third-party verification, and supports continuous auditing practices (Yermack, 2017).

In the context of Islamic finance, blockchain holds transformative potential to reinforce Shariah principles such as trust "amanah", transparency "bayyinah", and justice "adl". For instance, blockchain can be utilized to certify the halal status of goods by tracing supply chains and verifying certifications (Tan et al., 2022). Moreover, it enables the deployment of smart contracts to manage Islamic financial instruments like sukuk (Islamic bonds), allowing automated disbursement of returns in accordance with predefined Shariah rules (Hasan et al., 2023; Mousavi et al., 2025). Additionally, blockchain enhances the management of charitable funds such as Zakat and Waqf through real-time transparency and accountability, fostering public trust and donor engagement (Rejeb et al., 2021).

Nonetheless, the adoption of blockchain in Islamic finance faces several hurdles. These include technical concerns such as scalability, interoperability between platforms, and energy efficiency (Casino et al., 2019). More critically, the Shariah acceptability of certain features, such as interest-bearing staking mechanisms or speculative token issuance remains ambiguous, necessitating further jurisprudential deliberation (Oseni & Adewale, 2019). The development of blockchain frameworks that are both technologically sound and religiously compliant is thus an ongoing research imperative.

2.4. Synergizing AI and blockchain for shariah compliance

The convergence of artificial intelligence and blockchain technologies presents a promising frontier for transforming Shariah-compliant financial ecosystems. AI's capabilities in data processing, pattern recognition, and predictive analytics can be effectively combined with blockchain's secure and immutable data infrastructure to enable real-time monitoring, automated compliance checks, and risk forecasting

(Hamadou et al., 2024; Ali et al., 2023). Together, these technologies can form an integrated architecture that supports continuous Shariah auditing, enhances transparency in financial products, and improves the operational agility of Islamic financial institutions.

Conceptual models have been proposed to leverage this integration in areas such as Islamic microfinance, crowdfunding, and Takaful (Islamic insurance) systems (Zainuddin et al., 2013; Omar et al., 2009). For example, AI algorithms may be used to screen transactions for Shariah compliance, while blockchain ensures the integrity and traceability of financial records. Smart contracts can further automate the execution of Islamic contracts (e.g., Ijarah, Murabaha, and Mudarabah) without violating religious principles, if contract logic strictly adheres to AAOIFI guidelines (Abdullah et al., 2024).

Notwithstanding this theoretical appeal, the practical implementation of integrated AI–blockchain systems within Islamic finance remains limited. Key challenges include fragmented regulatory environments, the absence of standardized compliance metrics, insufficient digital infrastructure; particularly in developing economies, ethical risks such as algorithmic bias and data misuse (Jobin et al., 2019; Rejeb et al., 2021). Addressing these challenges requires robust interdisciplinary collaboration among technologists, Islamic legal scholars, policymakers, and industry practitioners to co-develop adaptable and ethically grounded standards.

Moreover, despite broad agreement on the potential benefits of AI and blockchain, the literature reveals unresolved debates concerning algorithmic transparency, ethical delegation, and Shariah interpretability. While some scholars advocate automated compliance systems to enhance efficiency, others caution that opacity and data-driven bias may conflict with Islamic principles of justice and accountability. These tensions underscore the need for empirically grounded, jurisprudentially informed governance frameworks to ensure that technological innovation remains aligned with the objectives of Maqasid al-Shariah.

2.5. Research gaps and opportunities

Despite growing academic and industry interest, the empirical literature on the integration of artificial intelligence and blockchain within Shariah-compliant accounting remains underdeveloped. While conceptual models and exploratory case studies highlight the theoretical benefits of these technologies, there is a notable lack of empirical validation, particularly within operational Islamic financial institutions (Kamla, 2009; Zainuddin et al., 2019). Existing studies are often confined to theoretical discourse or isolated case analyses, thereby overlooking the diverse socio-economic, legal, and technological contexts that characterize Islamic economies.

Notably, comparative analyses across regions especially between the Gulf Cooperation Council (GCC) and Southeast Asian countries such as Malaysia and Indonesia remain scarce. Although both regions are active in Islamic finance, they exhibit distinct regulatory frameworks, levels of technological maturity, and jurisprudential interpretations, all of which significantly influence the feasibility and implementation of AI and blockchain solutions (Ali et al., 2020; Dusuki, 2022).

Another critical gap concerns the ethical and theological dimensions of automating Shariah compliance. Delegating religiously sensitive decisions to AI systems raises concerns related to transparency, interpretability, and accountability, particularly in contexts where human jurisprudential reasoning (ijtihad) plays a central role. Few studies have examined how AI systems might be designed to incorporate fiqh-based logic or how blockchain architectures can support religious audit trails while preserving privacy and data security (Rahman & Yusuf, 2021; Oseni et al., 2019).

Addressing these gaps presents a timely opportunity to advance a multidisciplinary research agenda that aligns technological adoption with Islamic ethical standards and sustainability objectives. Future research should prioritize empirical testing, stakeholder-centric system design, and cross-regional collaboration to develop robust, scalable, and Shariah-compliant technological frameworks for Islamic finance and accounting.

Drawing on the reviewed literature, this study adopts a conceptual framework in which AI functions as an analytical and monitoring layer, blockchain serves as a transparent and immutable accounting infrastructure, and Shariah governance mechanisms provide ethical oversight and normative validation. The interaction among these elements is mediated by regulatory standards, institutional capacity, and ethical safeguards, collectively shaping Shariah-compliant accounting outcomes aligned with the objectives of Maqasid al-Shariah.

3. Methodology

This study employs a qualitative research methodology to critically examine the integration of Artificial Intelligence and blockchain technologies into Shariah-compliant accounting practices. A qualitative approach is particularly suited for exploring complex, context-dependent issues where human interpretations, institutional dynamics, and cultural religious norms intersect (Creswell & Poth, 2018). Given the nascent state of technological integration in Islamic finance, qualitative methods offer rich insights into stakeholder perceptions, institutional constraints, and ethical considerations that may not be fully captured through quantitative techniques.

3.1. Data collection

Primary data were obtained through semi-structured interviews with fifteen experts across key domains, namely Islamic finance, Shariah governance, financial technology, and accounting. A purposive sampling strategy was adopted to ensure the inclusion of individuals with substantive expertise and firsthand experience in the adoption or evaluation of AI and blockchain technologies within Islamic financial institutions (IFIs) (Patton, 2015). Participants were drawn from leading institutions in the GCC and Southeast Asian countries, reflecting regional diversity and contrasting institutional contexts.

The participants comprised Shariah scholars, senior accounting professionals, Islamic finance practitioners, financial regulators, and fintech specialists. They possessed between ten and over twenty-five years of professional experience and held roles including Shariah board membership, senior management positions in Islamic financial institutions, regulatory advisory roles, and fintech development leadership. To ensure confidentiality, institutional affiliations are reported at an aggregate level only.

Data were collected using an interview protocol consisting of open-ended questions designed to elicit expert perspectives on the perceived benefits, risks, implementation challenges, and Shariah compliance implications of emerging technologies. Interviews were conducted virtually over a two-month period and were audio-recorded with participants' informed consent. Each interview lasted between forty-five and sixty minutes. The semi-structured format ensured methodological consistency while allowing adaptive probing to explore emerging themes in depth, thereby facilitating the generation of rich, context-specific insights (Kvale & Brinkmann, 2015).

The interview guide focused on several core areas, including the anticipated benefits and risks of integrating AI and blockchain into Islamic financial systems; technological, institutional, and regulatory barriers to implementation; and the compatibility of these technologies with the ethical and legal tenets of Shariah. All interviews were transcribed verbatim for subsequent analysis.

Data saturation was achieved after approximately the twelfth interview, as no substantively new themes emerged thereafter. The final sample of fifteen interviews was therefore deemed sufficient to ensure analytical depth, thematic robustness, and credibility, consistent with established qualitative research guidelines.

3.2. Data analysis

Data was analyzed using thematic analysis, a method suitable for systematically identifying, organizing, and interpreting patterns of meaning within qualitative data (Braun & Clarke, 2006). The analysis followed the six-phase approach: (1) familiarization with the data through repeated reading of transcripts, (2) generation of initial codes, (3) searching for meaningful themes, (4) reviewing and refining themes, (5) defining and naming the core themes, and (6) producing a coherent analytical narrative (Orb et al., 2001).

Data coding and analysis were facilitated using NVivo 12 software, which enabled systematic data management, efficient retrieval of coded segments, and traceability of analytical decisions. To ensure the trustworthiness of findings, member checking was conducted with a subset of interviewees to confirm the accuracy and resonance of interpretations (Lincoln & Guba, 1985). This process allowed participants to clarify or elaborate on key points, thereby enhancing the credibility of the analysis.

Additionally, triangulation was employed by cross-referencing interview data with relevant academic literature and industry reports. This methodological triangulation strengthened the contextual depth and validity of the study's findings by integrating diverse sources of evidence (Patton, 2015).

3.3. Ethical considerations

Ethical approval for this study was secured from the university's Scientific Board, in accordance with established research ethics protocols. All participants provided informed consent after receiving a detailed explanation of the study's aims, procedures, and confidentiality measures. To preserve anonymity, personal identifiers were removed from transcripts, and participants were assigned pseudonyms. Data were securely stored and used exclusively for scholarly purposes, aligning with ethical guidelines for qualitative research involving human subjects.

4. Results

The thematic analysis of expert interviews revealed nuanced insights into the integration of Artificial Intelligence (AI) and blockchain technologies within Shariah-compliant accounting. Two overarching themes emerged: (1) opportunities for enhancing Shariah governance and operational performance, and (2) challenges that hinder technological adoption. These themes were derived through iterative coding and supported by exact quotes and conceptual triangulation with existing literature.

4.1. Opportunities

4.1.1. Enhanced transparency and accountability

Blockchain technology was unanimously recognized by participants as a tool that can significantly improve transparency as an essential value in Islamic finance. Its distributed ledger mechanism enables secure, immutable, and time-stamped records, which participants noted could deter fraudulent activities and support ethical accountability in financial reporting. These attributes closely align with the Islamic tenets of truthfulness "Sidq" and trustworthiness "Amanah", both of which are foundational to Shariah compliant financial practices (Kamla et al., 2006; Kassem et al., 2021). An Islamic finance scholar stated:

"Blockchain gives us a system where every transaction is traceable and immutable, it's exactly what Shariah requires when it comes to accountability and transparency."

4.1.2. Improved operational efficiency

AI technologies, particularly those utilizing machine learning and robotic process automation, were perceived as instrumental in streamlining financial operations. Interviewees noted that AI can reduce human error, accelerate transaction processing, and support real-time compliance verification. In the context of Islamic finance, this translates to more efficient Zakat calculations, automated Shariah screening, and seamless reporting of profit-and-loss sharing contracts. These improvements were seen as critical to enhancing the scalability and responsiveness of IFIs, echoing findings from Brynjolfsson and McAfee (2017), Alkhowaiter and Alsharif (2022) and Omar (2009). An IFIs specialist noted:

"AI's ability to handle repetitive tasks frees up human resources to focus on more strategic and compliance related issues, which is vital for IFIs aiming for operational excellence."

4.1.3. Strengthened shariah compliance monitoring

Several participants highlighted the potential of AI algorithms to be programmed for real-time Shariah compliance auditing. By incorporating predefined rules derived from Islamic jurisprudence, AI systems can detect violations such as transactions involving interest or speculative contracts. This proactive monitoring could reduce reliance on retrospective manual audits and enhance the integrity of compliance systems resulting in enhancing accountability and upholding Shariah standards (Mohd Nor et al., 2020). One Shariah board member remarked:

"With AI, we can monitor and flag non-compliant transactions instantly, rather than waiting for quarterly reviews."

4.2. Challenges

4.2.1. Technical and resource constraints

A significant barrier identified was the technological and resource intensive nature of AI and blockchain implementation. Several participants highlighted that many Islamic financial institutions, particularly in emerging markets, face limitations in digital infrastructure, skilled

human capital, and financial investment necessary to adopt and sustain such advanced technologies (Hasan et al., 2023; Hamadou et al., 2024). This digital divide threatens to deepen disparities in technological modernization across the Islamic finance ecosystem, potentially marginalizing less-resourced institutions. A technology specialist noted:
"Without targeted capacity building and infrastructure development, many IFIs will struggle to harness the benefits of AI and blockchain."

4.2.2. Ethical concerns in AI decision-making

The delegation of decision-making authority to AI systems elicited cautious responses from participants. Experts underscored the imperative that AI applications within Islamic finance must not operate in a morally agnostic manner but should embody and uphold Islamic ethical frameworks (Zaidan et al., 2021; Alkhowaiter & Alsharif, 2022). Concerns were voiced regarding potential algorithmic biases that could contravene principles of justice "Adl" and fairness, as well as the erosion of human discretion in morally sensitive judgments. As one Shariah governance expert articulated:
"AI cannot replace the nuanced understanding that human scholars bring to Shariah compliance; thus, ethical governance frameworks must be established."

5. Discussion

The findings affirm that AI and blockchain technologies hold substantial promise for enhancing Shariah compliant accounting by advancing transparency "Shafafiyyah", accountability "Mas'uliyyah", and justice "Adl", which are foundational to Islamic finance. Nonetheless, their adoption entails multifaceted challenges that necessitate a balanced and nuanced approach.
While several experts viewed AI-enabled compliance systems as an efficiency-enhancing tool, others expressed concern regarding the delegation of interpretive authority to algorithmic systems. More conservative Shariah perspectives caution that excessive automation may undermine human moral reasoning (ijtihad), particularly in complex or novel financial transactions. In contrast, adaptive interpretations emphasize AI's role as a decision-support mechanism rather than a substitute for Shariah judgment. These divergent viewpoints highlight unresolved jurisprudential tensions regarding accountability, autonomy, and ethical agency in technologically mediated compliance systems.
Foremost among these is the imperative for regulatory bodies; particularly Shariah supervisory boards and Islamic financial standard-setters such as AAOIFI and IFSB, to formulate comprehensive technology specific guidelines. Such frameworks must harmonize technological innovation with Shariah jurisprudence to mitigate risks of non-compliance and divergent interpretations. The absence of such standards currently generates regulatory ambiguity, potentially undermining the credibility and stability of AI and blockchain enabled financial practices (Dusuki, 2022; Ali et al., 2023).
Ethical considerations remain paramount in the deployment of AI-driven compliance and decision-making systems. These technologies must embody Islamic ethical frameworks by mitigating algorithmic biases, ensuring transparency in automated processes, and preserving essential human oversight. This is especially crucial in upholding principles of social justice and equitable stakeholder treatment, which are central to Shariah governance (Jobin et al., 2019; Zaidan et al., 2021).
From an operational standpoint, the findings underscore the critical necessity of investing in both human capital and technological infrastructure. A significant proportion of Islamic financial institutions (IFIs) currently lack the requisite in-house expertise to effectively implement and sustain sophisticated AI and blockchain solutions. Consequently, targeted capacity-building initiatives including specialized training programs and fostering interdisciplinary collaboration between Shariah scholars and technology professionals are imperative to bridge this skills gap and promote sustainable innovation (Hasan et al., 2023; Hamadou et al., 2024).
Overall, this study contributes to the growing discourse on the digital transformation of Islamic finance by clarifying both the opportunities and constraints inherent in adopting AI and blockchain within Shariah-compliant accounting. The integration of AI and blockchain technologies represents a transformative opportunity for Shariah-compliant accounting, its success hinges on coordinated and collaborative efforts. Policymakers, scholars, technologists, and industry practitioners must collectively address the multifaceted regulatory, ethical, and operational challenges to realize the full potential of these innovations within Islamic finance.

6. Conclusion

This study critically examined the convergence of Artificial Intelligence and blockchain technologies with Shariah-compliant accounting frameworks. The analysis reveals that these technologies offer substantial potential to enhance transparency, operational efficiency, and Shariah compliance. However, their effective adoption is contingent upon resolving regulatory ambiguities, embedding ethical safeguards aligned with Islamic values, and overcoming infrastructural and expertise related barriers.
To harness the full potential of AI and blockchain in Islamic finance, coordinated efforts are required to develop clear regulatory standards that reconcile technological capabilities with Shariah principles. Ethical frameworks must ensure that AI systems reflect Islamic moral values and preserve human oversight in sensitive decision-making processes. Furthermore, investment in technological infrastructure and human capital development is essential to bridge the existing digital divide among Islamic financial institutions.
Future research endeavors should build upon this exploratory study by conducting empirical investigations, such as in-depth case studies of institutions actively piloting AI and blockchain solutions, and comparative analyses across different regulatory environments. Such research will be critical in advancing the development of globally coherent, Shariah-compliant digital financial ecosystems that uphold both technological innovation and Islamic ethical standards.
Finaly, the convergence of AI and blockchain technologies with Islamic finance presents a transformative opportunity to modernize Shariah-compliant accounting practices if innovation is carefully balanced with ethical stewardship, regulatory clarity, and capacity building within Islamic financial institutions.

Author Contributions

The sole author (A.A.) was responsible for all aspects of the study, including conceptualization, research design, methodology, data collection, data analysis, interpretation of results, manuscript drafting, and revision. The author also ensured compliance with ethical standards and prepared all submission materials.

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Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Declarations

Ethics Approval and Consent to Participate

Ethical approval for this study was secured from the university's Scientific Counsil at Princess Nourah bint Abdulrahman University. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision) and the university's ethical guidelines for research involving human participants. Nonetheless, the aims and objectives of this research were conveyed to the respondents during the data gathering process. Informed consent was obtained from all subjects involved in the study on March 2025, in person or electronically via Teams, depending on participant preference. All participants were provided with information about the purpose of the study and their right to withdraw.

Ethical Guidelines

The author confirms that all methods were carried out in accordance with relevant guidelines and regulations.

Consent for Publication

Not applicable.

Competing Interests

The author declares no competing interest.

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