

CARBON CREDIT TOKENIZATION IN ISLAMIC FINANCE: INTEGRATING SHARIA PRINCIPLES INTO CLIMATE ACTION MARKETS

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Abstract: This research investigates the incorporation of carbon credit tokenization within the framework of Islamic finance, focusing on Sharia-compliant mechanisms to advance environmental sustainability. It explores how Islamic financial principles can address global climate challenges through innovative frameworks, focusing on the integration of Sharia-compliant mechanisms in emerging carbon markets. A thorough literature review consolidates insights from scholarly examinations, institutional publications, and practical implementations, underscoring the role of blockchain technology in enhancing transparency, accountability, and efficiency within carbon markets. The paper presents a pioneering Sharia-compliant tokenization framework, integrating Islamic contracts such as wakalah and musyarakah while aligning with the objectives of maqasid al-sharia. Key findings reveal the transformative potential of blockchain in carbon markets, notwithstanding challenges such as scalability, security, and the varying interpretations of Sharia law. The discussion emphasizes actionable strategies for embedding Sharia principles into carbon markets, promoting cross-sector collaboration, and addressing governance deficiencies. While conceptual in nature, this study lays the groundwork for future empirical validation and practical application. By bridging Islamic finance with sustainable development, the research aims to enhance Islamic green finance and empower Muslim-majority countries to take the lead in ethical environmental practices. Future inquiries should concentrate on operationalizing this framework, tackling technical and regulatory challenges, and standardizing Sharia-compliant carbon markets on a global scale.

Keywords: Blockchain Technology, Carbon Credit, Islamic Finance Principles, Sharia-Compliant Carbon Markets, Sustainable Development

Introduction

The urgency of climate change has driven a global shift toward innovative financial mechanisms like carbon markets, which incentivize greenhouse gas reductions. However, their effectiveness depends on transparency, accountability, and inclusiveness—qualities often lacking in traditional systems. Integrating blockchain technology with Islamic finance offers a transformative solution, combining transparency with ethical stewardship rooted in Sharia principles.

Islamic finance emphasizes risk-sharing, fairness, and the prohibition of riba (interest) and gharar (excessive uncertainty), aligning naturally with sustainability goals. Blockchain's decentralized and transparent nature addresses challenges in carbon markets, such as inefficiencies and trust deficits. A key innovation is the tokenization of carbon credits, where digital tokens enable secure, low-cost trading while adhering to Sharia principles through

contracts like wakalah (agency) and musyarakah (partnership). These align with maqasid al-sharia, promoting environmental preservation and social justice.

Despite its promise, integrating blockchain and Islamic finance in carbon markets faces challenges, including jurisdictional variations in Sharia interpretation, scalability issues, and regulatory gaps. The absence of standardized guidelines highlights the need for further research and collaboration.

This paper explores the integration of blockchain, Islamic finance, and carbon markets, proposing a framework for Sharia-compliant climate strategies. By synthesizing literature and analyzing case studies, it aims to advance Islamic green finance and empower Muslim-majority countries to lead ethical, sustainable environmental practices aligned with global climate goals.

Literature Review

The Role of Fintech in Islamic Finance

The integration of Islamic finance with blockchain technology has emerged as a promising avenue for addressing sustainability challenges. This review synthesizes insights from 24 scholarly works, emphasizing their contributions to understanding the interplay between fintech innovations, Sharia compliance, and environmental sustainability. By analyzing these studies, we identify key themes and gaps that enhance the argumentation for integrating carbon credit tokenization within Islamic finance frameworks.

Fintech innovations have revolutionized Islamic finance by introducing digital ecosystems that align with Sharia principles. Alshater et al. (2022) provide a foundational review of fintech's transformative role, emphasizing its potential to increase financial inclusion and operational efficiency. Helmi et al. (2024) expand this perspective by detailing the technical applications of fintech in Islamic financial institutions, highlighting blockchain's role in ensuring compliance and transparency.

Minaz et al. (2023) illustrate how fintech has enhanced the Islamic banking sector in Sri Lanka, underscoring the technology's scalability in emerging markets. Similarly, Irfan et al. (2023) explore the applications of artificial intelligence and machine learning in Islamic finance, revealing significant improvements in risk assessment and decision-making processes.

Blockchain Technology and Sharia Compliance

Blockchain's decentralized and immutable nature makes it an ideal tool for ensuring Sharia compliance in financial transactions. Khan and Ahmad (2022) demonstrate its application in the DCarbonX decentralized platform, a case study that underscores the alignment of blockchain solutions with Islamic principles for addressing climate change. Udeh et al. (2024) highlight blockchain's role in enhancing transparency and trust in green finance markets, a critical aspect for aligning with Maqasid al-Sharia.

Huurinainen (2024) delves into the intricacies of Sharia-compliant blockchain applications, emphasizing their potential to bridge trust deficits in Islamic finance. Furthermore, Asl et al. (2024) analyze the interplay between eco-friendly digital currencies and Islamic financial principles, presenting blockchain as a transformative tool for green investments.

Islamic Finance and Environmental Sustainability

Islamic finance's alignment with sustainability goals stems from its ethical principles, which prioritize environmental stewardship. Gueydi (2023) explores the integration of zakat with Sustainable Development Goals (SDGs), proposing fiscal reforms that align with Sharia

principles. Similarly, Mohamed (2024) introduces a comprehensive framework for integrating Shariah principles with Environmental, Social, and Governance (ESG) criteria, demonstrating the synergy between Islamic finance and sustainability.

Khokher (2021) examines the role of Islamic financial systems in building sustainable infrastructure, identifying key mechanisms such as sukuk for financing green projects. This aligns with Asl et al. (2024), who investigate the impact of green reforms on Islamic and traditional ventures, highlighting the sector's adaptability to environmental imperatives.

Carbon Credit Tokenization: Opportunities and Challenges

Tokenization of carbon credits represents a novel application of blockchain technology in Islamic finance. Mohammed et al. (2022) present the DCarbonX model as a case study, illustrating how blockchain can address governance deficiencies in carbon markets while adhering to Sharia principles. Chohan (2022) provides a thematic review of cryptocurrencies, offering insights into the scalability challenges and regulatory considerations for tokenized assets.

Fanea-Ivanovici and Baber (2024) emphasize the need for alternative finance models to support sustainable business practices, advocating for the integration of Islamic contracts such as wakalah and musyarakah in tokenized frameworks. This perspective is reinforced by Kismawadi (2024), who explores blockchain's potential to empower small businesses in Islamic finance.

Regulatory and Legal Implications

Regulatory frameworks play a pivotal role in operationalizing blockchain solutions in Islamic finance. Ghosh et al. (2025) analyze the legal implications of blockchain-digital twin fusion for sustainable investments, identifying critical gaps in existing regulations. Paesano and Siron (2022) extend this discussion by examining the regulatory landscape for cryptocurrencies in Asia, offering insights into the harmonization of Islamic and conventional financial systems.

Shehadeh et al. (2024) investigate the nexus between corporate governance and fintech disclosure in Islamic banks, highlighting the importance of transparency for regulatory compliance. These findings underscore the need for standardized Sharia-compliant guidelines for blockchain applications.

Challenges in Scaling Blockchain Solutions

Despite its potential, blockchain technology faces significant challenges in scalability and security. Asl et al. (2024) identify the short- and long-term contributions of digital ecosystems to Islamic sustainable equities, emphasizing the need for robust infrastructure. Xie et al. (2024) provide a comprehensive review of blockchain applications in fintech companies, highlighting technical bottlenecks that hinder widespread adoption.

Maklafi (2023) explores the use of NFTs in the hospitality sector, revealing limitations in adapting blockchain solutions to diverse industries. Addressing these challenges requires cross-sector collaboration and investments in research and development.

Future Directions and Research Gaps

The reviewed literature identifies several avenues for future research. Irfan et al. (2024) advocate for exploring the integration of artificial intelligence with blockchain in Islamic finance, emphasizing its potential to enhance decision-making processes. Nandhana et al. (2024) highlight the role of technological innovation in emerging markets, calling for studies on the socio-economic impact of blockchain adoption.

Yousop and Ab Razak (2023) propose a risk-based approach to ESG investments, identifying gaps in existing frameworks that can be addressed through blockchain-enabled solutions. These perspectives provide a roadmap for operationalizing carbon credit tokenization in Islamic finance.

Sharia-Compliant Pathways to Global Sustainability

The integration of blockchain technology with Islamic finance presents a transformative opportunity to address global sustainability challenges. By leveraging insights from 24 scholarly works, this review highlights the potential of carbon credit tokenization to align with Sharia principles, enhance transparency, and promote ethical environmental practices. Future research should focus on overcoming scalability challenges, standardizing regulatory frameworks, and operationalizing Sharia-compliant carbon markets on a global scale.

Method

This research adopts a qualitative approach to explore the integration of carbon credit tokenization within Islamic finance. It synthesizes existing knowledge, develops a conceptual framework, and offers actionable insights for implementing Sharia-compliant carbon markets. The methodology comprises a systematic literature review, analytical framework development, and expert consultation for validation and refinement.

This study is grounded in a review of scholarly works, institutional publications, and case studies, focusing on three main areas. First, it explores the integration of blockchain and Islamic finance, examining how blockchain technology aligns with Sharia principles. Second, it analyzes the tokenization of carbon credits, investigating the mechanisms and case studies such as DCarbonX. Third, the study addresses the regulatory and operational challenges of combining blockchain with Islamic finance, particularly concerning scalability, governance, and compliance issues.

Building on these findings, the study proposes a framework for Sharia-compliant carbon credit tokenization, combining maqasid al-sharia (the objectives of Islamic law) with blockchain technology. This framework includes key components such as token design to ensure Sharia compliance in tokenized carbon credits, operational mechanisms that utilize blockchain to improve transparency and efficiency, and governance structures that aim to standardize guidelines and develop collaborative models to address regulatory and scalability challenges.

Result and Discussion

Integration of Blockchain in Carbon Markets

Blockchain technology addresses inefficiencies in traditional carbon markets, such as limited transparency, inconsistent records, and traceability issues, which undermine trust and scalability. Its decentralized and immutable ledger ensures secure and transparent tracking of carbon credits, from issuance to retirement, fostering accountability and trust (Khan & Ahmad, 2022; Udeh et al., 2024). Real-time traceability enables stakeholders to verify the origin, ownership, and usage of carbon credits, aligning with the ethical demands of Sharia-compliant markets (Huurinainen, 2024). By adhering to maqasid al-sharia, blockchain supports justice, transparency, and environmental stewardship (Mohamed, 2024).

Sharia-Compliant Framework for Tokenization

The proposed framework integrates blockchain with Sharia principles through wakalah (agency) and musyarakah (partnership) contracts. Wakalah ensures Sharia-compliant

management of carbon credits, eliminating riba and gharar while fostering ethical compliance (Fanea-Ivanovici & Baber, 2024; Chohan, 2022). Musyarakah facilitates collaborative investment, promoting equitable risk-sharing and social justice (Kismawadi, 2024). Tokenizing carbon credits enhances accessibility, liquidity, and inclusivity, enabling broader participation, especially in Muslim-majority countries (Asl et al., 2024). By combining Islamic contracts with blockchain's efficiency, the framework addresses market challenges, advances environmental preservation, and aligns with global sustainability goals (Ghosh et al., 2025).

Transformative Potential of Blockchain in Islamic Finance

Transparency and Trust

Blockchain's immutable ledger addresses riba (interest) and gharar (excessive uncertainty) by ensuring transparent, tamper-proof transactions, aligning with Sharia principles of clarity and fairness (Khan & Ahmad, 2022). In carbon markets, blockchain provides real-time visibility into the creation, trading, and retirement of carbon credits, reducing opacity and preventing fraudulent activities (Huurinainen, 2024). This transparency builds trust among participants, ensuring compliance with ethical and environmental guidelines while reinforcing confidence in Sharia-compliant financial transactions (Mohamed, 2024).

Efficiency Gains

Blockchain streamlines operations and reduces costs, addressing inefficiencies like high transaction fees and lengthy settlement times in traditional carbon markets. By automating processes through smart contracts, blockchain enables faster, cost-effective transactions, removing barriers for smaller players (Chohan, 2022). This inclusivity aligns with maqasid al-sharia by empowering diverse stakeholders, including small-scale investors and microfinance institutions, to participate in sustainable initiatives equitably (Asl et al., 2024).

Enhanced Accountability

Blockchain's auditable trail ensures strict adherence to Islamic ethical standards by providing a transparent history of transactions, critical for avoiding unethical practices and prioritizing environmental and social justice (Fanea-Ivanovici & Baber, 2024). In carbon markets, blockchain ensures that carbon credits are sourced and used consistently with Islamic values, such as reducing emissions and promoting sustainability (Ghosh et al., 2025). Its real-time monitoring capabilities enhance regulatory compliance and mitigate misconduct risks, underscoring its role as a governance tool in Islamic finance (Udeh et al., 2024).

Addressing Challenges in Implementation

Scalability and Security

Blockchain implementation in tokenized carbon markets faces challenges in scalability and security. Scalability involves handling increased transaction volumes without performance degradation, as seen in DCarbonX, where high volumes caused network congestion and elevated costs (Udeh et al., 2024). Security risks, including cyberattacks and smart contract vulnerabilities, are significant concerns; for example, coding errors in smart contracts could lead to unintended consequences or breaches (Huurinainen, 2024). Addressing these issues requires advanced solutions like layer-2 scaling, sharding, and robust cybersecurity measures such as regular audits and decentralized governance mechanisms (Asl et al., 2024).

Sharia Interpretations

Jurisdictional variations in Sharia law interpretations complicate the implementation of blockchain-based carbon markets. Differences in rulings on compliance with Islamic principles like gharar and riba create inconsistencies, limiting scalability across Muslim-majority countries (Chohan, 2022). Collaborative efforts among Islamic scholars, regulators, and blockchain experts are vital. Establishing a global Sharia advisory board can harmonize interpretations, while flexible frameworks accommodating localized adaptations can bridge jurisdictional gaps (Kismawadi, 2024).

Regulatory Hurdles

The lack of comprehensive regulatory frameworks tailored to blockchain-based carbon markets poses a significant barrier. Existing regulations often fail to address digital asset legality, cross-border trading, and Sharia compliance integration (Fanea-Ivanovici & Baber, 2024). Developing inclusive regulations through collaborative governance involving policymakers, industry leaders, and Sharia scholars is essential. Standardized guidelines for auditing, smart contract protocols, and dispute resolution mechanisms can enhance clarity and confidence among participants, unlocking the potential of tokenized carbon markets to drive sustainable development (Ghosh et al., 2025).

Opportunities for Cross-Sector Collaboration

Public-Private Partnerships

Public-private partnerships (PPPs) are essential for operationalizing Sharia-compliant tokenized carbon credit systems by bridging policy and technology. Governments can create enabling environments through legal frameworks, incentives, and infrastructure development, while financial institutions ensure compliance with Sharia principles, adding credibility to the initiative (Chohan, 2022). Technology firms contribute by designing blockchain solutions that enhance transparency, traceability, and security (Fanea-Ivanovici & Baber, 2024). Successful PPPs, such as DCarbonX, demonstrate how collaboration addresses challenges like scalability and governance. Subsidizing initial development costs and fostering knowledge exchange further ensure accessibility and innovation (Ghosh et al., 2025).

Muslim-Majority Countries as Leaders

Muslim-majority countries, with strong Islamic finance sectors and ethical commitments, are well-positioned to lead the adoption of tokenized carbon credit systems. Nations like Malaysia, Indonesia, and the UAE have advanced Islamic finance integration with sustainability initiatives, such as Malaysia's green sukuk for environmentally friendly projects (Huurinainen, 2024). By leveraging blockchain for carbon credit tokenization, these countries can set global benchmarks for ethical environmental practices, aligning maqasid al-sharia with global sustainability goals (Asl et al., 2024). Their leadership can inspire broader adoption, fostering a ripple effect of ethical innovation and positioning them as transformative players in the global sustainability movement (Kismawadi, 2024).

Alignment with Sustainable Development Goals (SDGs)

Environmental Preservation

The proposed framework directly supports SDG 13: Climate Action by introducing innovative carbon market solutions that reduce emissions and incentivize environmental stewardship (Huurinainen, 2024). By enabling local communities and businesses to participate in climate mitigation, the framework fosters sustainability and promotes the adoption of green technologies and low-carbon practices (Ghosh et al., 2025). It also aligns

with the Paris Agreement by encouraging long-term investments in renewable energy, conservation, and sustainable agriculture, ensuring economic growth aligns with ecological health (Asl et al., 2024).

Social Equity

Rooted in Islamic finance principles, the framework advances SDG 10: Reduced Inequalities by emphasizing equitable wealth distribution, social justice, and economic inclusion (Kismawadi, 2024). Mechanisms such as zakat (almsgiving), waqf (endowments), and microfinance promote access to capital for marginalized communities, fostering entrepreneurship and improving access to education and healthcare (Fanea-Ivanovici & Baber, 2024). This approach bridges wealth gaps and ensures shared prosperity, creating a more just and socially responsible economic system (Chohan, 2022).

Legal and Capacity Frameworks for Sharia-Compliant Carbon Markets

Establishing Legal Frameworks

Robust legal frameworks are critical for integrating Sharia principles into blockchain-based carbon credit markets. Policymakers must develop enforceable regulations to support tokenized carbon credits, ensuring transparency, fairness, and adherence to Islamic values such as the prohibition of riba (interest) and gharar (excessive uncertainty) (Chohan, 2022). Collaborative efforts among financial regulators, environmental agencies, and Islamic scholars are necessary to create standards for the issuance, trading, and verification of carbon credits. These frameworks not only enhance market credibility but also promote growth aligned with sustainable development goals (Fanea-Ivanovici & Baber, 2024).

Framework for Sharia-Compliant Carbon Markets

Comprehensive regulatory and operational guidelines are essential for tokenizing carbon credits in compliance with Islamic finance principles. Policymakers should structure tokenized carbon credits to avoid maysir (speculation) and gharar, ensuring ethical adherence throughout the process (Huurinainen, 2024). Leveraging blockchain's traceability and transparency, governments can establish mechanisms to verify the environmental impact of tokenized credits. Partnerships between Islamic financial institutions and tech developers can drive innovation and build infrastructure for these markets, facilitating sustainable and ethical climate action (Ghosh et al., 2025).

Capacity Building

To maximize the potential of blockchain in Islamic finance, capacity building is essential for stakeholders, including policymakers, financial institutions, and local communities. Educational programs should address both blockchain's technical aspects and its intersection with Islamic finance principles (Kismawadi, 2024). Tailored initiatives such as workshops, certification courses, and pilot projects can demystify the technology and showcase its applications in carbon credit markets. Collaborative efforts with academic institutions and industry leaders can equip stakeholders with the skills to develop and engage in Sharia-compliant carbon markets, fostering inclusivity and innovation in sustainable climate action (Asl et al., 2024).

Future Research Directions

Pilot Projects for Sharia-Compliant Carbon Credit Tokenization

Future research should prioritize testing Sharia-compliant carbon credit tokenization through pilot projects and case studies. These initiatives can evaluate the technical feasibility and economic impact of blockchain-based frameworks, especially in markets with limited access to traditional financial systems (Ahmed et al., 2024). Partnerships among Islamic financial institutions, environmental organizations, and regulatory bodies could provide critical insights into implementation challenges and best practices across diverse regions and sectors (Chohan, 2022). The feedback from these real-world tests will help refine the framework and guide its global scalability.

Operationalizing the Framework

To advance beyond conceptual models, researchers must focus on designing blockchain platforms that tokenize, trade, and verify carbon credits while adhering to Sharia principles such as fairness and transparency (Fanea-Ivanovici & Baber, 2024). Collaborations with industry leaders and environmental agencies are essential to prototype and evaluate these systems. Key features should include mechanisms to ensure carbon credits contribute to verified climate mitigation efforts, addressing both financial and environmental objectives (Ghosh et al., 2025).

Technological Innovations

Exploring technological advancements like Artificial Intelligence (AI) can enhance the efficiency and transparency of Sharia-compliant carbon markets. AI can optimize decision-making by predicting market trends, verifying environmental impacts, and automating processes, ensuring compliance with Islamic ethical standards (Kismawadi, 2024). Integrating AI into blockchain systems would streamline operations and improve accessibility for a wider range of stakeholders.

Standardization of Sharia-Compliant Carbon Markets

Developing internationally recognized standards for Sharia-compliant carbon credit tokenization is crucial for global adoption. These standards should address the issuance, trading, and verification of carbon credits, ensuring consistency and ethical integrity across markets (Huurinainen, 2024). Collaboration among Sharia scholars, regulators, environmental experts, and blockchain developers is necessary to establish guidelines that align with Islamic finance principles, fostering trust and scalability in tokenized carbon markets (Asl et al., 2024).

Conclusion

Integrating Sharia principles into carbon credit tokenization offers a unique opportunity to align ethical finance with climate action. As the world seeks innovative solutions for climate change, Islamic finance plays a key role in shaping sustainable, inclusive carbon markets. This paper explores how blockchain-based carbon credit systems can adhere to Islamic values such as fairness, transparency, and the prohibition of interest (riba), while promoting environmental sustainability and financial inclusion, particularly in underserved regions.

Blockchain enables transparent, efficient, and secure carbon credit trading, with traceable and verifiable transactions. The paper emphasizes the importance of legal frameworks that support these digital assets, allowing Islamic financial institutions to confidently engage in carbon markets. It also advocates for global standardization of Sharia-compliant systems to ensure consistency, trust, and scalability.

Future research should focus on pilot projects and real-world case studies to refine tokenization models, identify best practices, and overcome challenges. Incorporating AI to optimize trading and decision-making will further enhance the effectiveness of these markets.

In conclusion, the integration of Islamic finance with climate action offers a promising path for mitigating climate change, promoting social equity, and advancing financial inclusion. Sharia-compliant carbon credit tokenization has the potential to drive sustainable development while adhering to ethical financial principles, transforming both the financial and environmental sectors.

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