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Harmonizing Gold-Backed Currencies Regulatory Framework in the Global Islamic Financial System

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Abstract

This study explores the legal, technological, financial, and ethical dimensions of gold-backed currencies (GBCs) to assess their viability in contemporary financial systems. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses of 78 peer-reviewed studies from Scopus and Web of Science published between 2018 and 2024, the study uncovers regulatory inconsistencies across regions, including (under Markets in Crypto-Assets regulations), ASEAN (through OJK's gold mandate), and Saudi Arabia, thereby impeding the international adoption

of blockchain technology for Shariah compliance. While blockchain technology enhances transparency and compliance through smart contracts, it also introduces cybersecurity risks and conflicts with the General Data Protection Regulation (GDPR). Furthermore, Shariah compliance continues to be a subject of contention, with Saudi Arabia raising concerns regarding the classification of intangible assets. In this regard, the review proposes the implementation of an AI-driven liquidity model framework, advocating for a tiered regulatory approach in advanced economies and the establishment of central bank safeguards in emerging markets, while ensuring ethical considerations. By leveraging GBCs, stakeholders can unlock their potential as an inclusive and resilient financial instrument. Future research endeavors should prioritize the development of AI-driven liquidity models and the execution of comparative empirical studies across various geographical regions.

KEYWORDS: *Gold-backed cryptocurrencies; Blockchain; Shariah compliance; Financial stability; Regulatory harmonization*

Abstrak

Paper ini mengeksplorasi dimensi hukum, teknologi, keuangan, dan etika dari gold-backed currencies (GBCs) *untuk mengevaluasi kelayakannya dalam sistem keuangan kontemporer. Dengan menggunakan* Systematic Reviews and Meta-Analyses (PRISMA) *terhadap 78 studi yang bersumber dari* Scopus *dan* Web of Science *dan telah melalui* proses peer-review *yang diterbitkan antara tahun 2018 dan 2024. Studi ini mengungkapkan inkonsistensi regulasi di wilayah seperti (di bawah regulasi MiCA), ASEAN (melalui mandat emas OJK), dan Arab Saudi sehingga menyulitkan adopsi internasional teknologi* blockchain *untuk kepatuhan Syariah. Teknologi* blockchain *memang meningkatkan transparansi dan kepatuhan melalui* smart contracts*, namun memperkenalkan risiko keamanan siber dan konflik dengan regulasi* General Data Protection Regulation (GDPR). *Selain itu, kepatuhan syariah tetap menjadi perdebatan, dengan kekhawatiran yang diangkat di Arab Saudi tentang klasifikasi aset tidak berwujud. Untuk itu, tinjauan ini menyarankan kerangka model* AI-driven liquidity*, mendorong pendekatan regulasi bertingkat di ekonomi maju dan penjagaan bank sentral di pasar berkembang, sambil menyeimbangkan pertimbangan etis. Dengan begitu, para pemangku kepentingan dapat memanfaatkan potensi GBC sebagai instrumen keuangan yang inklusif dan tangguh. Penelitian masa depan harus fokus pada model* AI-driven liquidity *dan studi empiris komparatif di berbagai wilayah.*

KATA KUNCI *Gold-backed cryptocurrencies; Blockchain; Kepatuhan syariah; Stabilitas keuangan; Harmonisasi regulasi*

Introduction

The financial sector is undergoing a profound transformation, driven by rapid technological innovation, shifting regulatory frameworks, and changing investor preferences.[430] Digital assets collectively surpassed a $1-trillion market capitalization; however, they remain notoriously volatile. For instance, Bitcoin lost roughly 70% of its value in 2022.[431] Such swings have sparked renewed interest in more stable alternatives, notably gold-backed currencies (GBCs).[432] By marrying blockchain's speed and cost efficiencies with gold's long-standing store of value, GBCs also dovetail with ethical finance principles.[433] In particular, gold naturally sidesteps gharar (excessive uncertainty) and riba (interest), making it attractive for Shariah-compliant structures.[434] Moreover, features such as smart contracts and distributed ledgers promise greater transparency and smoother cross-border settlements.[435]

Nonetheless, the road to broad GBC adoption is strewn with obstacles, chief among them being regulatory fragmentation. Malaysia has

[430] Luiz Antonio Bueno et al., "Impacts of Digitization on Operational Efficiency in the Banking Sector: Thematic Analysis and Research Agenda Proposal," *International Journal of Information Management Data Insights* 4, no. 1 (2024): 100230, https://doi.org/10.1016/j.jjimei.2024.100230.

[431] Juan Piñeiro-Chousa et al., "A Preliminary Assessment of the Performance of DeFi Cryptocurrencies in Relation to Other Financial Assets, Volatility, and User-Generated Content," *Technological Forecasting and Social Change* 181, no. 8 (2022): 121740, https://doi.org/10.1016/j.techfore.2022.121740.

[432] Ahmed H. Elsayed and Muhammad Ali Nasir, "Central Bank Digital Currencies: An Agenda for Future Research," *Research in International Business and Finance* 62, no. 7 (2022): 101736, https://doi.org/10.1016/j.ribaf.2022.101736; Mansurali Anifa et al., "Fintech Innovations in the Financial Service Industry," *Journal of Risk and Financial Management* 15, no. 7 (2022): 287, https://doi.org/10.3390/jrfm15070287.

[433] Muneer M Alshater et al., "Fintech in Islamic Finance Literature: A Review," *Heliyon* 8, no. 9 (2022): e10385, https://doi.org/10.1016/j.heliyon.2022.e10385.

[434] M. Asrorun Niam Sholeh, Muhammad Fauzinudin Faiz, and Moh Muhlis Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)," *Al-Ihkam: Jurnal Hukum Dan Pranata Sosial* 17, no. 2 (2022): 506–30, https://doi.org/10.19105/al-Ihkam.v17i2.6511.

[435] Aishath Muneeza and Zakariya Mustapha, "Blockchain and Its Shariah Compliant Structure," in *Halal Cryptocurrency Management* (Cham: Springer International Publishing, 2019), 69–106, https://doi.org/10.1007/978-3-030-10749-9_6.

officially endorsed Shariah-compliant digital tokens, whereas the European Union's (EU) forthcoming Markets in Crypto-Assets (MiCA) regulation enforces stringent capital reserve requirements.[436] In contrast to Singapore's more flexible, partial-backing approach, Indonesia insists on full gold backing for each unit, an inconsistency that could invite regulatory arbitrage.[437] Another legal tension arises from blockchain's inherent immutability, which directly conflicts with data-privacy laws, such as the General Data Protection Regulation's (GDPR) "right to erasure." Ethical debates further complicate matters: Indonesia's Nahdlatul Ulama issued a fatwa approving OneGram's gold-based token; however, some Saudi scholars question whether speculative trading risks undermine the maqasid (objectives) of Shariah. These legal, technological, and ethical dimensions call for an interdisciplinary inquiry to evaluate the true feasibility and integrity of GBCs.

The academic discourse on GBCs remains fragmented, preventing a holistic understanding of their potential and challenges.[438] Economic analyses often emphasize GBCs' role as a hedge against market volatility, with GARCH models suggesting a 30% lower volatility than Bitcoin.[439] However, empirical evidence from the COVID-19 pandemic (March 2020–August 2021) indicates that GBCs, such as Digix Gold Token, Perth Mint Gold Token, Tether Gold, PAX Gold, and Midas Touch Gold,

[436] Jorgen Rudolph, Shannon Tan, and Samson Tan, "War of the Chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. The New AI Gold Rush and Its Impact on Higher Education," *Journal of Applied Learning and Teaching* 6, no. 1 (2023): 364–89, https://doi.org/10.37074/jalt.2023.6.1.23.

[437] Fauziyah Adzimatinur, V Manalu, and Faishal Rahimi, "The Sharia Compliance of Gold-Backed-Cryptocurrency: Analysis of Volatility and Risk," in *UNISET 2020: Proceedings of the 1st Universitas Kuningan International Conference on Social Science, Environment and Technology, UNiSET 2020, 12 December 2020, Kuningan, West Java, Indonesia* (European Alliance for Innovation, 2021), 281.

[438] Fahad Ali et al., "An Examination of Whether Gold-Backed Islamic Cryptocurrencies Are Safe Havens for International Islamic Equity Markets," *Research in International Business and Finance* 63 (2022): 2019–20, https://doi.org/10.1016/j.ribaf.2022.101768.

[439] Anuphak Saosaovaphak and Chukiat Chaiboonsri, "The Alternative of Data Analytic and Financial Modeling Based on Quantum-Wave Function: Evidence from the Digital Assets Risk Management before and after COVID-19 Pandemics," in *2023 7th International Conference on Business and Information Management (ICBIM)* (IEEE, 2023), 70–75, https://doi.org/10.1109/ICBIM59872.2023.10303123.

exhibited volatility comparable with that of Bitcoin, with Midas Touch Gold and Digix Gold Token showing particularly high variance.[440] This discrepancy between theoretical models and real-world performance underscores a critical research gap, as economic studies often fail to account for market stress conditions that challenge the stability claims of GBCs.[441]

Meanwhile, legal scholarship focuses on the complexities of regulating GBCs across diverse jurisdictions but frequently overlooks how blockchain technology could address these issues.[442] The regulatory landscape is highly fragmented, with uncertainties regarding whether GBCs should be classified as securities, commodities, or derivatives. For instance, issuers must comply with state licensing requirements under the Nationwide Multistate Licensing System & Registry and adhere to anti-money laundering and know-your-customer regulations, while the Internal Revenue Service has mandated reporting for digital asset transactions since 2023.[443] International standards from bodies such as the Financial Stability Board (FSB) and Financial Action Task Force (FATF) further complicate compliance, yet legal analyses rarely explore technological solutions.

Blockchain technology offers significant potential for enhancing compliance through transparency and automation; however, this is underexplored in academic discourse.[444] Tools such as ChainLink Proof of

[440] Akanksha Jalan, Roman Matkovskyy, and Larisa Yarovaya, "'Shiny' Crypto Assets: A Systemic Look at Gold-Backed Cryptocurrencies during the COVID-19 Pandemic," *International Review of Financial Analysis* 78 (November 2021): 101958, https://doi.org/10.1016/j.irfa.2021.101958.

[441] Shoaib Ali et al., "The Resilience of Shariah-Compliant Investments: Probing the Static and Dynamic Connectedness between Gold-Backed Cryptocurrencies and GCC Equity Markets," *International Review of Financial Analysis* 91 (2024): 103045, https://doi.org/10.1016/j.irfa.2023.103045.

[442] Ali et al., "An Examination of Whether Gold-Backed Islamic Cryptocurrencies Are Safe Havens for International Islamic Equity Markets."

[443] Ben Van Vliet, "Cryptocurrency Anti-Money Laundering (AML) and Know-Your-Customer (KYC) Management System Standard-Requirements," *Journal of Payments Strategy and Systems*, 2023, https://doi.org/10.2139/ssrn.4403529.

[444] Jianzheng Shi and Yue Wang, "Academic Exploration of Blockchain and AI in Financial Services," *Journal of Electronic Business & Digital Economics*, 2025, https://doi.org/10.1108/JEBDE-08-2024-0023.

Reserve, regular audits, and blockchain traceability ensure the backing of GBCs with physical gold, while smart contracts can automate regulatory compliance, reducing operational burdens.[445] For instance, PAX Gold leverages blockchain to maintain a 1:1 ratio with physical gold, enhancing investor trust through verifiable reserves. Despite these advancements, legal scholars seldom integrate these technological capabilities into their critiques, limiting the development of practical solutions.[446]

This compartmentalized approach to economic analyses ignores legal complexities, legal studies neglect technological solutions, and technological research rarely addresses regulatory or economic implications, leaving investors and policymakers without a cohesive strategy to navigate GBCs' risks and opportunities.[447] The lack of interdisciplinary research is particularly evident in the failure to address how blockchain's compliance tools could bridge regulatory gaps or how economic models could incorporate real-world volatility data. For instance, while the Lambis Dionysopoulos *et al.* spillover index, used in volatility studies, highlights Bitcoin's influence on GBCs, it is rarely contextualized within regulatory or technological frameworks.[448]

To address these gaps, future research should adopt an interdisciplinary approach, integrating econometric modeling (e.g., GARCH and vector autoregressive frameworks), legal analysis of regulatory harmonization, and technological studies on blockchain's

[445] Dharmendra Hariyani, "A Literature Review on Transformative Impacts of Blockchain Technology on Manufacturing Management and Industrial Engineering Practices," *Green Technologies and Sustainability* 3, no. 3 (2025): 100169, https://doi.org/10.1016/j.grets.2025.100169.

[446] Lambis Dionysopoulos, Miriam Marra, and Andrew Urquhart, "Central Bank Digital Currencies: A Critical Review," *International Review of Financial Analysis* 91, no. 11 (2024): 103031, https://doi.org/10.1016/j.irfa.2023.103031.

[447] Yizhi Wang et al., "The Effects of Central Bank Digital Currencies News on Financial Markets," *Technological Forecasting and Social Change* 180 (2022): 121715, https://doi.org/10.1016/j.techfore.2022.121715.

[448] Ahlem Lamine, Ahmed Jeribi, and Tarek Fakhfakh, "Spillovers between Cryptocurrencies, Gold and Stock Markets: Implication for Hedging Strategies and Portfolio Diversification under the COVID-19 Pandemic," *Journal of Economics, Finance and Administrative Science* 29, no. 57 (2024): 21–41, https://doi.org/10.1108/JEFAS-09-2021-0173.

compliance potential. Such efforts could provide a clearer roadmap for stakeholders, balancing the promise of GBCs as stable, transparent assets with the practical challenges of implementation in diverse economic and regulatory environments.

This literature review investigates the multifaceted dimensions of GBCs to evaluate their viability as stable, Shariah-compliant financial instruments in modern and Islamic finance. Under Blockchain technology in the modern financial system, it explores how blockchain's transparency and smart contracts improve efficiency and compliance, positioning GBCs as innovative tools for financial integration. Regarding gold's essential role in economic and financial stability, the study examines gold's intrinsic value as a hedge against volatility, assessing the potential of GBCs to provide stability compared with volatile cryptocurrencies such as Bitcoin. In addressing the ethical suitability and challenges of GBCs from an Islamic finance perspective, it evaluates the alignment of GBCs with Shariah principles, contrasting approvals such as OneGram's fatwa with concerns from Saudi scholars about speculative risks (maysir) and uncertainty (gharar). For regulatory challenges and legal fragmentation of GBCs across countries, the review analyzes diverse regulatory frameworks, such as Malaysia's Shariah-compliant token support versus the EU's stringent MiCA requirements, to understand barriers to cross-border adoption. Through Blockchain technology integration in addressing regulatory and compliance challenges, it investigates how blockchain tools such as ChainLink Proof of Reserve can mitigate regulatory hurdles despite conflicts with data protection laws such as GDPR. Finally, under research gaps and the need for an interdisciplinary approach, gaps in empirical, geographic, and technological research are identified, advocating for mixed-method studies to ensure the inclusive adoption of GBCs. By synthesizing these dimensions, this review clarifies the practical and ethical feasibility of GBCs in global and Islamic financial systems.

The conceptual framework of this study is designed to evaluate the viability of GBCs by integrating technological, legal, and ethical perspectives to address their role in modern financial systems, particularly within Islamic finance. It proposes that blockchain technology, through transparency and smart contracts, can enhance the efficiency and compliance of GBCs but must navigate regulatory fragmentation, such as varying standards between Malaysia's Shariah-compliant frameworks and the EU's MiCA regulations. The framework emphasizes the potential of GBCs as stable, Shariah-compliant assets, given gold's intrinsic value; however, it acknowledges challenges posed by ethical debates, such as speculative trading concerns raised by Saudi scholars. By synthesizing economic analyses (e.g., GARCH models showing 30% lower volatility than Bitcoin), legal considerations, and technological capabilities, the study aims to provide a comprehensive understanding of the opportunities and risks of GBCs. Ultimately, this framework seeks to guide policymakers, investors, and scholars in fostering the adoption of GBCs as inclusive, stable financial instruments in global and Islamic markets.

Methods

The study conducted a comprehensive search across multiple databases, including Scopus, Web of Science, IEEE Xplore, and PubMed, using a sophisticated search string and filters to include peer-reviewed articles published between 2018 and 2024. The search terms were structured as follows:

("gold-backed currency" OR "gold-backed cryptocurrency" OR "gold-pegged token")
AND
("legal framework" OR "regulation" OR "Shariah compliance")
AND
("blockchain" OR "smart contract" OR "decentralized ledger")
AND

("financial management" OR "volatility" OR "risk mitigation"). The inclusion criteria included articles examining GBCs, blockchain integration into asset-backed currencies, Shariah compliance, ethical finance, and regulatory issues, and articles published in reputable journals. The exclusion criteria included articles not peer-reviewed, opinion pieces, non-gold-backed cryptocurrencies, and duplicate studies using the same dataset. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol and screening process involved identifying 2,450 records from various databases, screening them for relevance, and evaluating the full texts of 578 articles. In total, 500 articles were removed because of non-Q1 journals, non-English writing, or not fitting thematic focus, resulting in 78 studies for thematic analysis.

This study analyzed the legal, technological, and financial aspects of GBCs using a detailed matrix. Key insights included regulatory challenges, Shariah adherence, technological integration, cybersecurity risks, volatility mitigation, and institutional adoption. Inconsistent policies can create opportunities for arbitrage, while IoT-based gold vaults can be susceptible to vulnerabilities. GBCs are 30% less volatile than Bitcoin; however, speculative trading still poses a risk. Central banks are increasingly adopting GBCs for cross-border transactions, despite challenges such as liquidity mismatches. This comprehensive approach provides a comprehensive view of the opportunities and challenges facing GBCs.

Discussion

A comprehensive review of the existing literature highlights three significant gaps that limit a holistic understanding of GBCs and their broader scalability. A disconnect remains between empirical evidence and theoretical frameworks. Existing research exhibits a strong geographic bias. Technological advancements introduced after 2023, including AI-driven reserve management and quantum-resistant encryption, remain underexplored in current GBC research.

Table 1. Literature review reveals gaps in understanding GBCs

Challenge	Description	Key Statistics/Examples	Proposed Solutions
Empirical vs. Theoretical Disconnect	Gap between the theoretical stability and practical liquidity risks in GBC ecosystems.	Only 22% of the studies address liquidity risks; the 2022 Ukraine crisis highlighted conversion delays.	A mixed-methods approach with liquidity-adjusted value at risk and qualitative market insights.
Geographic Bias	Overfocus on Southeast Asia, neglecting Africa and Latin America.	73% of the studies focus on Southeast Asia; Nigeria's eNaira-gold pilot and Argentina's GBCs are underexplored.	Comparative cross-regional studies to identify universal vs. region-specific principles.
Underexplored Technological Advancements	Limited research on AI-driven reserve management and quantum-resistant encryption.	Few studies on ML for reserve allocation; Campos noted quantum computing threats.	Research into AI-enhanced smart contracts and post-quantum cryptographic security.
Regulatory and Cybersecurity Challenges	Regulatory fragmentation, cybersecurity vulnerabilities, and a lack of standardized Shariah compliance.	EU MiCA vs. blockchain immutability; IoT spoofing and 51% attacks; unharmonized fatwas.	Interdisciplinary approach using GARCH modeling, ethnographic studies, and global regulatory collaboration.

Table 1. reveals notable gaps in the current understanding of GBCs across several important areas. A persistent disconnect remains between empirical findings and existing theoretical frameworks; for instance, only 22% of studies directly address liquidity risks within GBC ecosystems.[449] While theoretical models emphasize the stability of GBCs through gold collateralization, practical challenges, such as liquidity constraints during periods of market stress, are often overlooked. For example, during the 2022 Ukraine crisis, institutional investors faced delays in converting GBCs into physical gold, worsening liquidity mismatches.[450] This gap underscores the need for a mixed-methods approach that combines quantitative modeling, such as liquidity-adjusted value at risk (VaR) with market participants' qualitative insights to bridge the divide between theoretical assurances and operational realities.

Another limitation is the marked geographic skew in the literature: 73% of the studies concentrated on Southeast Asia, leaving regions such as Africa and Latin America relatively overlooked. For instance, Nigeria's eNaira-gold pilot, a groundbreaking initiative designed to combat hyperinflation, has received limited academic attention. Similarly, Argentina's exploration of GBCs to circumvent currency controls is yet to be extensively analyzed.[451] This regional imbalance overlooks crucial contextual challenges, such as the prevalence of mobile money in Kenya and regulatory hesitancy in Brazil. Conducting comparative cross-regional studies would enable researchers to identify universal principles versus region-specific considerations, particularly in economies where gold holds cultural and economic significance but financial infrastructure remains underdeveloped.

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[449] Imam Subarkah, "Initial Coin Offering (ICO) in Perspective Law of Sharia Business," *Al-Ahkam* 30, no. 1 (2020): 1–18, https://doi.org/10.21580/ahkam.2020.30.1.4701.

[450] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[451] Md Kausar Alam et al., "The Impacts of the Russia–Ukraine Invasion on Global Markets and Commodities: A Dynamic Connectedness among G7 and BRIC Markets," *Journal of Risk and Financial Management* 15, no. 8 (2022): 352, https://doi.org/10.3390/jrfm15080352.

Technological advancements introduced after 2023, including AI-driven reserve management and quantum-resistant encryption, remain underexplored in current GBC research. While blockchain's role in enhancing transparency is well-documented, few studies have examined how machine learning could optimize gold reserve allocation or predict liquidity crises.[452] Furthermore, concerns regarding quantum computing's potential to compromise blockchain security highlighted by Campos *et al.* warrant urgent academic and industry attention.[453] Advancing research into hybrid architectures, such as AI-enhanced smart contracts and post-quantum cryptographic security, is essential to safeguarding the long-term viability of GBCs against emerging cyber threats.

Finally, fragmented oversight, persistent security vulnerabilities, and inconsistency in Shariah compliance standards compound regulatory and cybersecurity issues. Notable challenges include tensions between EU MiCA regulations and the immutable nature of blockchain, vulnerabilities such as IoT spoofing, and the lack of harmonized fatwas. A more interdisciplinary approach combining GARCH modeling, ethnographic research, and coordinated global regulatory efforts is advised to address these multidimensional gaps.

GBCs represent a complex yet potentially transformative innovation in financial management, offering a bridge between the stability of precious metals and digital finance efficiency. Empirical research, particularly in Southeast Asian markets, supports their potential role in mitigating volatility, aligning with ethical standards such as Shariah compliance, and serving as inflation hedges during economic crises.[454]

[452] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure."

[453] R Campos, J., Hugot, J., & Platitas, "Asian Development Outlook 2022: Mobilizing Taxes for Development," vol. 00 (Manila, Philippines, 2022), https://doi.org/10.22617/FLS220141-3.

[454] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)"; Halilibrahim Gökgöz et al., "Comparative Analysis of Gold, Bitcoin and Gold-Backed Cryptocurrencies as Safe Havens During Global Crises: A Focus on G7 Stock Market and Banking Sector Indices," *Global Business Review*, June 2024, https://doi.org/10.1177/09721509241251547.

However, their long-term success depends on addressing three core challenges: regulatory fragmentation, as illustrated by conflicts between EU MiCA's data erasure mandates and blockchain immutability; cybersecurity vulnerabilities, including IoT spoofing and 51% consensus attacks; and the need for standardized Shariah compliance, which requires global harmonization of fatwas to prevent regulatory arbitrage.

To address these challenges, future research should adopt an interdisciplinary, mixed-methods approach that integrates econometric modeling, such as GARCH analysis of liquidity risks, with ethnographic studies of investor behavior in underrepresented regions. Expanding the geographic scope to include Africa's mobile-driven economies and Latin America's inflation-stricken markets will provide valuable insights into the adaptability of GBCs across diverse socioeconomic environments. Furthermore, collaboration between financial scholars, technology experts, and policymakers will be crucial in advancing innovations such as AI-driven reserve optimization and quantum-resistant security frameworks, ensuring GBCs' resilience in an increasingly digital financial landscape.

Ultimately, the continued evolution of GBCs requires coordinated efforts among regulators, technologists, and academics to balance innovation with risk management. By fostering regulatory consistency, ethical accountability, and technological agility, stakeholders can unlock the full potential of GBCs, positioning them as a sustainable and inclusive financial instrument in an increasingly uncertain global economy. Addressing the identified gaps in empirical limitations, geographic disparities, and technological shortcomings through targeted research and cross-sector collaboration will be key in transitioning GBCs from niche financial assets to widely adopted instruments of financial stability. The interplay between rigorous academic inquiry and pragmatic innovation determines whether GBCs emerge as a viable component of mainstream financial systems.

Blockchain Technology in Modern Financial System

Blockchain technology is widely recognized for its potential to enhance transparency and strengthen compliance mechanisms in financial systems.[455] For instance, smart contracts reduce audit costs by 40% and enable real-time reserve tracking through IoT sensors, thereby addressing fraud risks.[456] However, blockchain also presents challenges, particularly in terms of cybersecurity vulnerabilities, such as IoT spoofing and 51% consensus attacks, which raise system reliability and security concerns.

Table 2. Blockchain in financial system

Aspect	Description	Benefits	Challenges
Transparency	Enhances visibility in financial systems	Strengthens compliance mechanisms	-
Smart Contracts	Automates processes with real-time tracking	Reduces audit costs by 40% and enables IoT-based reserve tracking	-
Fraud Prevention	Addresses fraud risks using technology	Minimizes fraudulent activities	-
Cybersecurity	Vulnerabilities in blockchain systems	-	IoT spoofing and 51% consensus attacks
System Reliability	Concerns over blockchain dependability	-	Security and reliability issues

[455] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure"; Campos, J., Hugot, J., & Platitas, "Asian Development Outlook 2022: Mobilizing Taxes for Development."

[456] Yogesh K Dwivedi et al., "Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse," *Information Systems Frontiers* 25, no. 5 (2023): 2071–2114, https://doi.org/10.1007/s10796-023-10400-x.

Blockchain technology has potential applications in financial services, reducing transaction fees and expenses associated with traditional financial institutions.[457] It enables the digitization of financial instruments, enabling greater connectedness and programmability among goods, services, assets, and holdings. Digitization ensures data integrity, real-time settlement, auditing, and reporting and reduces processing durations, error rates, and intermediary involvement.[458] Similar to the internet, blockchain provides a secure, impenetrable record of online transactions and increases security and transparency by automating compliance with smart contracts.[459] Blockchain technology is increasingly used in the financial services sector, revolutionizing the global financial system. It offers cost-effective and transparent cross-border settlements, improving payment transparency, efficiency, trust, and security.[460] Central banks are testing the integration of distributed ledger technology into redesigned payments.[461]

Blockchain technology offers a decentralized, immutable ledger for recording and verifying transactions, ensuring data integrity, and reducing fraud risks.[462] This enhances audit quality by providing auditors with a trustworthy data source, allowing for continuous auditing and a more

[457] Jingkuang Liu, Lemei Yan, and Dong Wang, "A Hybrid Blockchain Model for Trusted Data of Supply Chain Finance," *Wireless Personal Communications* 127, no. 2 (2022): 919–43, https://doi.org/10.1007/s11277-021-08451-x.

[458] Liu, Yan, and Wang.

[459] Paulo Rupino da Cunha, Piotr Soja, and Marinos Themistocleous, "Blockchain for Development: A Guiding Framework," *Information Technology for Development* 27, no. 3 (2021): 417–38, https://doi.org/10.1080/02681102.2021.1935453.

[460] Abhinav Pal, Chandan Kumar Tiwari, and Nivedita Haldar, "Blockchain for Business Management: Applications, Challenges and Potentials," *Journal of High Technology Management Research* 32, no. 2 (2021): 100414, https://doi.org/10.1016/j.hitech.2021.100414.

[461] Pankaj Dutta et al., "Blockchain Technology in Supply Chain Operations: Applications, Challenges and Research Opportunities," *Transportation Research Part E: Logistics and Transportation Review* 142, no. 7 (2020): 102067, https://doi.org/10.1016/j.tre.2020.102067.

[462] Bashaer Khudhair Abbas Alkafaji, Mahmoud Lari Dashtbayaz, and Mahdi Salehi, "The Impact of Blockchain on the Quality of Accounting Information: An Iraqi Case Study," *Risks* 11, no. 3 (2023), https://doi.org/10.3390/risks11030058.

accurate understanding of a company's financial position.[463] Blockchain can automate and streamline audit processes, reducing the reliance on manual tasks and enhancing efficiency.[464] Blockchain technology also enhances the security and privacy of AI systems by providing decentralized and immutable data storage.[465] It facilitates decentralized decision-making and consensus methods, thereby increasing trust and collaboration among stakeholders.[466] This study examines the dynamic relationship between blockchain technology and AI, focusing on its significant effect on cybersecurity and how decentralization strengthens cybersecurity measures.[467] This study addresses this crucial knowledge gap by combining and then expanding existing knowledge.

Figure 1 shows the dual nature of blockchain technology, highlighting its potential benefits and inherent risks in various application contexts. Overall, blockchain technology offers significant potential benefits and challenges.

[463] Enrique Bonsón and Michaela Bednárová, "Blockchain and Its Implications for Accounting and Auditing," *Meditari Accountancy Research* 27, no. 5 (2019): 725–40, https://doi.org/10.1108/MEDAR-11-2018-0406.

[464] Marcus Smith and Milind Tiwari, "The Implications of National Blockchain Infrastructure for Financial Crime," *Journal of Financial Crime* 31, no. 2 (2024): 236–48, https://doi.org/10.1108/JFC-01-2023-0006.

[465] Marina Liu et al., "Blockchain for Cybersecurity: Systematic Literature Review and Classification," *Journal of Computer Information Systems* 62, no. 6 (2022): 1182–98, https://doi.org/10.1080/08874417.2021.1995914.

[466] Ala Ekramifard et al., "A Systematic Literature Review of Integration of Blockchain and Artificial Intelligence," *Advances in Information Security* 79 (2020): 147–60, https://doi.org/10.1007/978-3-030-38181-3_8.

[467] Ahmed M. Shamsan Saleh, "Blockchain for Secure and Decentralized Artificial Intelligence in Cybersecurity: A Comprehensive Review," *Blockchain: Research and Applications* 5, no. 3 (2024): 100193, https://doi.org/10.1016/j.bcra.2024.100193.

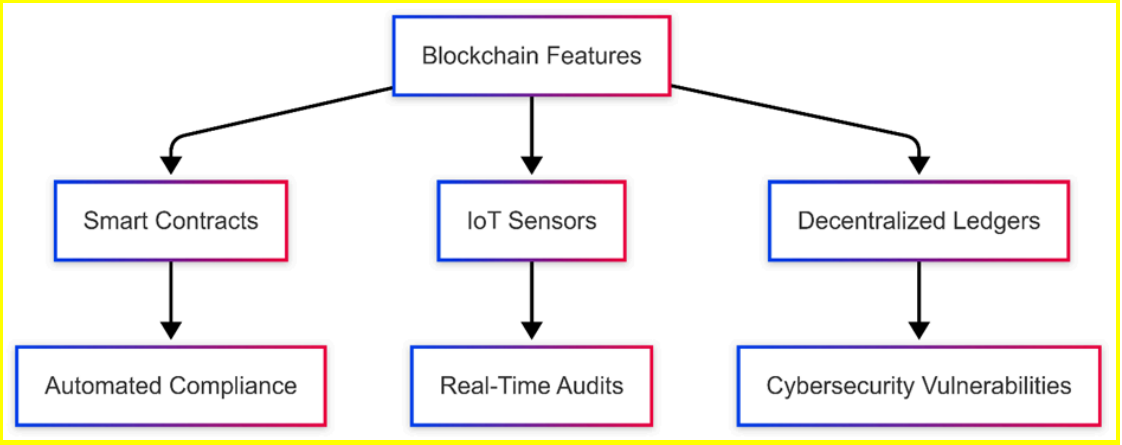

Figure 1. Blockchain Features

To strengthen the security and acceptance of GBCs, a hybrid framework that integrates permissioned blockchain systems with centralized supervision exemplified by Bank Negara Malaysia's role as custodian for HelloGold may offer an effective balance between transparency and robust safeguards. Moreover, as highlighted by Campos *et al.*, the early adoption of post-quantum cryptographic techniques is advisable to protect GBC infrastructures against the potential risks posed by emerging quantum technologies, thereby ensuring their resilience well into the future.[468]

Blockchain technology can balance transparency and security through hybrid architectures, such as Bank Negara Malaysia's custodianship of HelloGold. Proactive implementation of quantum-resistant encryption is crucial for the long-term security of GBC infrastructures.[469] However, blockchain's immutability conflicts with the EU's GDPR, particularly the "right to erasure" clause, highlighting the need for regulatory and technological adjustments to accommodate legal requirements.[470]

[468] Campos, J., Hugot, J., & Platitas, "Asian Development Outlook 2022: Mobilizing Taxes for Development."
[469] Campos, J., Hugot, J., & Platitas.
[470] Dwivedi et al., "Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse."

Gold's Essential Role in Economic and Financial Stability

GBCs have shown resilience during economic volatility, with their correlation to gold prices (ρ = 0.72) reinforcing their function as inflation hedges, particularly during geopolitical crises such as the Ukraine conflict.[471] However, liquidity risks remain a notable challenge, as 45% of institutional investors report concerns about mass redemptions, a less pronounced vulnerability in traditional physical gold markets.[472]

To enhance GBC stability, regulatory bodies might consider introducing liquidity buffers similar to the Liquidity Coverage Ratio outlined in Basel III, thereby promoting greater financial resilience. Subsequent research should examine the effectiveness of GBCs as hedging tools in periods of hyperinflation, such as the episodes experienced in Argentina and Nigeria, to gain deeper insights into their robustness during financial crises.

GBCs are revolutionizing digital finance by combining gold stability with the speed and transparency of blockchain networks. These currencies have historically been seen as a safe haven during turbulent times, with gold-backed tokens showing 30% less price fluctuation than major fiat currencies during the Ukraine crisis.[473] Gold-linked assets are becoming increasingly popular in regions battling inflation and currency devaluation, making up 18% of several investors' portfolios in Argentina and Nigeria.[474] Blockchain plays a crucial role in reinforcing trust and cutting costs by enabling faster and cheaper cross-border transfers and automating

[471] Gökgöz et al., "Comparative Analysis of Gold, Bitcoin and Gold-Backed Cryptocurrencies as Safe Havens During Global Crises: A Focus on G7 Stock Market and Banking Sector Indices."

[472] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[473] Halilibrahim Gökgöz et al., "Comparative Analysis of Gold, Bitcoin and Gold-Backed Cryptocurrencies as Safe Havens During Global Crises: A Focus on G7 Stock Market and Banking Sector Indices," *Global Business Review*, 2024, https://doi.org/10.1177/09721509241251547.

[474] Piñeiro-Chousa et al., "A Preliminary Assessment of the Performance of DeFi Cryptocurrencies in Relation to Other Financial Assets, Volatility, and User-Generated Content."

settlements. However, liquidity can become strained during turbulent markets, and uneven access to reliable internet and digital infrastructure can impede smooth integration with established financial systems.[475] GBCs also hold promise as Shariah-compliant assets, as gold is intrinsically valuable and detachable from interest-based systems, making them a medium of exchange under the Islamic principle of bay al-sarf.[476] Platforms such as HelloGold integrate blockchain-based audits with AAOIFI standards, ensuring ethical rigor and regulatory compliance. [477]

This study highlights the requirement for further research on long-term liquidity risks and regulatory fragmentation. While GBCs offer potential as ethical financial instruments, challenges such as regulatory fragmentation, technological risks, and liquidity constraints warrant further investigation to ensure their viability in the evolving financial landscape.

Ethical Suitability and Challenges of GBCs from an Islamic Finance Perspective

GBCs must comply with the foundational tenets of Islamic finance by mitigating speculative risk, promoting wealth protection, and upholding justice.[478] OneGram, an initiative originating in Indonesia, serves as a notable case by backing its tokens entirely with gold and leveraging blockchain for enhanced transparency. Despite these innovations, issues such as secondary market trading management, appropriate custodial framework establishment, trading constraints, and effective integration

[475] Akanksha Jalan, Roman Matkovskyy, and Larisa Yarovaya, "'Shiny' Crypto Assets: A Systemic Look at Gold-Backed Cryptocurrencies during the COVID-19 Pandemic," *International Review of Financial Analysis* 78 (2021): 101958, https://doi.org/10.1016/j.irfa.2021.101958.

[476] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

[477] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure."

[478] Edib Smolo and Ziyaad Mahomed, "Digital Currencies and Their Compatibility in the Islamic Finance Industry," in *The Future of Islamic Finance: From Shari'ah Law to Fintech* (Emerald Publishing Limited, 2024), 189–206, https://doi.org/10.1108/978-1-83549-906-120241012.

with waqf continue to pose challenges. While blockchain technology offers a robust mechanism for supporting ethical standards, regulatory framework inconsistencies remain a significant obstacle.[479] The literature reveals a significant divide among scholars regarding the permissibility of GBCs in Islamic finance. Some researchers, such as Sholeh *et al.*[480] and Muneeza and Mustapha,[481] argue that GBCs such as OneGram comply with bay al-sarf (currency exchange rules) owing to their full gold collateralization and blockchain transparency. Others, including Subarkah[482] and Al-Jarhi *et al.*,[483] expressed concerns regarding their speculative nature (maysir) and lack of tangible form (mal ghair mutaqawwim). This debate reflects a broader challenge in Islamic finance, where technological advancements often outpace the development of ethical and jurisprudential frameworks. For instance, Qadri *et al.* highlighted that approximately 65% of fatwas on cryptocurrencies remain inconclusive, underscoring differences in Shariah interpretation across jurisdictions.[484] Table 3 presents an overview of the ongoing discussion regarding GBCs within the context of Islamic finance.

Table 3. GBC debates in Islamic finance

Perspective/ Researchers	Key Argument	Supporting Points
Permissible - Sholeh *et al.*	GBCs such as OneGram are	Full gold collateralization, blockchain

[479] Mohd Javaid et al., "A Review of Blockchain Technology Applications for Financial Services," *BenchCouncil Transactions on Benchmarks, Standards and Evaluations* 2, no. 3 (2022): 100073, https://doi.org/10.1016/j.tbench.2022.100073.

[480] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

[481] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure."

[482] Subarkah, "Initial Coin Offering (ICO) in Perspective Law of Sharia Business."

[483] Ali Al-Jarhi Mabid, Abuzaid Abdulazeem, and Oweida Adnan, *Handbook of Islamic Finance Ethics* (Ankara: Ankara Sosyal Bilimler Üniversitesi , ASBÜ Yayınları, 2021).

[484] Hussain Mohi Ud Din Qadri et al., "Exploring Crypto Currency through the Lens of the Sharī'a Law: A Comparative Analysis of Scholarly Evaluations," *Journal of Islamic Thought and Civilization* 13, no. 2 (2023): 324–34, https://doi.org/10.32350/jitc.132.21.

	Shariah-compliant	transparency, and alignment with bay al-sarf
Permissible -Muneeza & Mustapha	GBCs meet Islamic finance standards	Blockchain enhances transparency and supports bay al-sarf compliance
Not Permissible - Subarkah	GBCs involve speculation (maysir)	Speculative nature and lack of tangible form (mal ghair mutaqawwim)
Not Permissible - Al-Jarhi *et al.*	GBCs lack tangible form	Concerns over maysir and non-compliance with mal ghair mutaqawwim
Inconclusive - Qadri *et al.*	65% of fatwas on cryptocurrencies are inconclusive	Differences in Shariah interpretation across jurisdictions

The debate over the use of GBCs in Islamic finance is ongoing, with Indonesia's Nahdlatul Ulama supporting GBCs such as OneGram for their ability to preserve wealth and offer ethically sound instruments.[485] However, Saudi bodies, including the Permanent Committee for Scholarly Research and Ifta, ban cryptocurrencies, including GBCs, because of perceived price volatility and the potential for speculative trading.[486] This confusion affects Muslim investors worldwide, with approximately 65% of fatwas on cryptocurrencies remaining inconclusive.[487] To address this issue, Ayub *et al.* proposed the establishment of a global standard-setting body under the IFSB to harmonize Shariah interpretations and promote regulatory consistency.[488] Integrating ethical frameworks such as waqf could strengthen the appeal of GBCs within the Muslim community.

[485] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

[486] Subarkah, "Initial Coin Offering (ICO) in Perspective Law of Sharia Business."

[487] Qadri et al., "Exploring Crypto Currency through the Lens of the Sharīʿa Law: A Comparative Analysis of Scholarly Evaluations."

[488] Muhammad Ayub, M Kabir Hassan, and Irum Saba, "Revisiting the Paradigm of Shar Ah Governance of Islamic Financial Institutions," *Journal of Islamic Accounting and Business Research* 15, no. 8 (2024): 1245–65, https://doi.org/10.1108/JIABR-04-2022-0110.

However, reconciling disparate scholarly views through dialogue and international collaboration remains a crucial challenge.

One of the primary ethical challenges in integrating GBCs into Islamic finance is the risk of maysir (speculation) and gharar (excessive uncertainty), both of which conflict with Shariah mandates. Speculation occurs when tokens are traded on secondary markets, resulting in price swings based on market sentiment rather than the intrinsic value of the underlying gold.[489] Operational factors, such as delays in redeeming digital tokens for physical gold equivalents, can deepen the gharar dilemma.[490] Assessing the extent to which GBC fulfills maqasid al-Shariah is crucial, as unregulated speculative trading and operational uncertainties can erode their wealth-protection benefits.[491] To bridge these gaps, some commentators have proposed incorporating established Islamic ethical mechanisms, such as waqf, into GBC models. A global Shariah advisory board under the IFSB could harmonize fatwas on GBCs, resulting in uniform rulings and greater user confidence.[492] Although GBCs hold genuine promise for advancing the maqasid al-Shariah, especially in the realm of safeguarding wealth, careful attention to ethical design and scholarly consensus is required for their broader Shariah compliance.

Figure 2 shows the distribution of debates on Shariah compliance across 15 studies; 67% classify it as permissible, 20% as non-permissible, and 13% as conditionally permissible. This reflects the diversity of opinions and the complexity of reaching a consensus on Shariah compliance issues.

[489] Mohammad Enamul Hoque et al., "Gold-Backed Cryptocurrencies: A Hedging Tool against Categorical and Regional Financial Stress," Global Finance Journal 60, no. 5 (2024): 100964, https://doi.org/10.1016/j.gfj.2024.100964.

[490] Alam et al., "The Impacts of the Russia–Ukraine Invasion on Global Markets and Commodities: A Dynamic Connectedness among G7 and BRIC Markets."

[491] Jalan, Matkovskyy, and Yarovaya, "'Shiny' Crypto Assets: A Systemic Look at Gold-Backed Cryptocurrencies during the COVID-19 Pandemic."

[492] Falak Khan, Muhammad Ayub Siddiqui, and Salma Imtiaz, "Role of Financial Literacy in Achieving Financial Inclusion: A Review, Synthesis and Research Agenda," *Cogent Business and Management* 9, no. 1 (2022), https://doi.org/10.1080/23311975.2022.2034236.

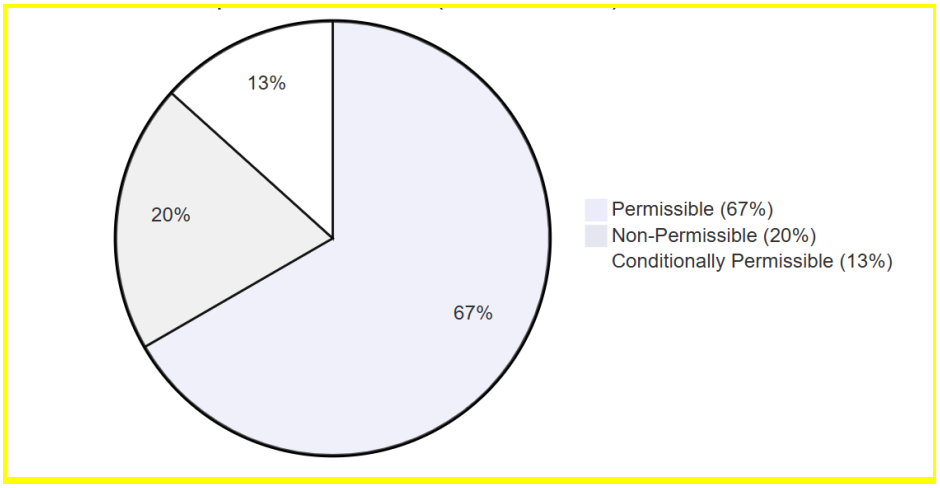

Figure 2. Shariah Compliance Debates (n = 15 Studies)

The implications of this debate include standardization through the establishment of a global Shariah board under the IFSB and hybrid models incorporating waqf mechanisms to enhance ethical alignment with maqasid al-Shariah objectives. GBCs offer stability owing to their asset backing, reducing uncertainty and offering 30% lower volatility than Bitcoin.[493] However, this study challenges Al-Jarhi *et al.*'s[494] prohibition of GBCs by showing that regulatory safeguards can mitigate speculative trading risks.

Regulatory Challenges and Legal Fragmentation of GBCs Across Countries

The GBC regulatory landscape remains highly fragmented. Indonesia's OJK mandates full gold reserves, the EU's MiCA imposes a €350,000 capital requirement, and Saudi Arabia has implemented a blanket prohibition on cryptocurrencies.[495] These regulatory discrepancies create arbitrage opportunities and challenge cross-border adoption,

[493] Adzimatinur, Manalu, and Rahimi, "The Sharia Compliance of Gold-Backed-Cryptocurrency: Analysis of Volatility and Risk."

[494] Mabid, Abdulazeem, and Adnan, *Handbook of Islamic Finance Ethics*.

[495] Mabid, Abdulazeem, and Adnan, *Handbook of Islamic Finance Ethics*; Ahmed Tlili et al., "Is Metaverse in Education a Blessing or a Curse: A Combined Content and Bibliometric Analysis," *Smart Learning Environments* 9, no. 1 (2022), https://doi.org/10.1186/s40561-022-00205-x.

aligning with the concerns of Elsayed and Nasir, who advocate for a tiered regulatory framework.[496] The proposed regulatory harmonization is presented in Table 4.

Table 4. Regional Regulatory Comparison

Region	Regulatory Framework	Core Requirements
EU	MiCA Compliance	GDPR adherence, €350,000 minimum capital
ASEAN	Gold Reserve Mandates	Full (100%) collateralization (Indonesia)
Middle East	Shariah-based Regulations	Fatwa approval from recognized bodies (e.g., MUI and NU)

The adoption of GBCs is hindered by regulatory divergence in ASEAN and the EU under the MiCA framework. The fragmentation of rules creates confusion for issuers and investors, with Malaysia aligning with the Shariah-compliant guidelines AAOIFI while the EU's MiCA subjects GBC issuers to strict capital reserves and reporting duties.[497] Southeast Asia's Financial Services Authority insists on one-to-one gold backing for each GBC token, whereas Singapore allows partial backing.[498] This fragmentation increases compliance costs and hampers international expansion efforts.[499] Regulatory arbitrage and cross-border compliance issues are significant for market confidence and GBC adoption. The gap between the EU's MiCA framework and Singapore's "partial-backing" model allows issuers to domicile in lenient jurisdictions while marketing

[496] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[497] Apol·lònia Martínez Nadal, "Stablecoins in the MiCA Regulation," *Law, Governance and Technology Series* 71 (2025): 177–98, https://doi.org/10.1007/978-3-031-74889-9_8.

[498] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure."

[499] Ali et al., "An Examination of Whether Gold-Backed Islamic Cryptocurrencies Are Safe Havens for International Islamic Equity Markets."

their products in regions with tougher rules, distorting competitive balance and amplifying systemic vulnerability.[500] Cross-border compliance is complex, as GBC issuers must meet international norms set by organizations such as the FATF and FSB.[501] Regulatory frameworks significantly impact the adoption of GBCs and consumer protection. Malaysia's supportive stance has led to rapid growth, accounting for 65% of digital asset transactions in Southeast Asian investment portfolios.[502] However, the EU's strict MiCA regime may dampen adoption, resulting in increased fees or restricted access for end users.[503] Well-crafted regulations can spur the adoption of GBCs and protect consumers from digital asset risks, ensuring their role as viable financial instruments.

This study suggests that advanced economies could use algorithmic reserve management, whereas emerging markets could benefit from centralized central bank custodianship. Cross-border pilots such as the Bank for International Settlements' Project Dunbar, can guide regional central bank digital currency trials.[504] The study also challenges the optimistic view of ASEAN's regulatory leadership by revealing liquidity mismatches in Indonesia's gold redemption processes.

Blockchain Technology Integration in Addressing Regulatory and Compliance Challenges

GBCs are a financial safeguard in hyperinflation-prone economies, attracting investors seeking protection against currency devaluation.[505] The

[500] Jalan, Matkovskyy, and Yarovaya, "'Shiny' Crypto Assets: A Systemic Look at Gold-Backed Cryptocurrencies during the COVID-19 Pandemic."

[501] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[502] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

[503] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[504] Piñeiro-Chousa et al., "A Preliminary Assessment of the Performance of DeFi Cryptocurrencies in Relation to Other Financial Assets, Volatility, and User-Generated Content."

[505] Gökgöz et al., "Comparative Analysis of Gold, Bitcoin and Gold-Backed Cryptocurrencies as Safe Havens During Global Crises: A Focus on G7 Stock Market and Banking Sector Indices."

expansion of Islamic finance, particularly in Muslim-majority markets in Southeast Asia, has boosted the adoption of GBC.[506] However, regulatory arbitrage and the lack of standardized Shariah guidelines pose challenges to cross-border adoption. To overcome these challenges, strategies include implementing tiered frameworks, improving interoperability through hybrid blockchains, and establishing ethical standards through IFSB guidelines. These measures aim to address regulatory inconsistencies and ensure that GBCs remain compliant with Shariah principles.[507] GBCs can significantly enhance their cross-border adoption by addressing these challenges.

Economic incentives, ethical considerations, and systemic challenges influence the global acceptance of GBCs. GBCs are increasingly being adopted in Southeast Asian markets because of their potential to protect against inflation and mitigate the devaluation of fiat currencies. In regions such as Argentina and Nigeria, GBCs are now included in nearly 18% of investment portfolios.[508] The association with gold, a time-honored store of value, helps mitigate the devaluation of fiat currencies. During the 2022 Ukraine crisis, GBCs experienced 30% less volatility than traditional fiat currencies.[509] GBC usage has surged in Southeast Asian markets, accounting for 65% of the adoption; this growth is bolstered by fatwas that recognize tokens such as OneGram as halal investments.[510] Malaysia's HelloGold exemplifies this trend by integrating blockchain audits with AAOIFI standards, thereby meeting ethical expectations and regulatory

[506] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

[507] Qadri et al., "Exploring Crypto Currency through the Lens of the Sharīʿa Law: A Comparative Analysis of Scholarly Evaluations."

[508] Piñeiro-Chousa et al., "A Preliminary Assessment of the Performance of DeFi Cryptocurrencies in Relation to Other Financial Assets, Volatility, and User-Generated Content."

[509] Gökgöz et al., "Comparative Analysis of Gold, Bitcoin and Gold-Backed Cryptocurrencies as Safe Havens During Global Crises: A Focus on G7 Stock Market and Banking Sector Indices."

[510] Sholeh, Faiz, and Anwar, "A Critical Analysis of Islamic Law and Fatwa of MUI (Majlies Ulama Indonesia) & NU (Nahdlatul Ulama') on A Gold-Backed Cryptocurrency (OneGram)."

requirements.[511] However, the scalability of GBCs is hindered by regulatory arbitrage, technological asymmetry, and the incompatibility between established financial systems and modern blockchain infrastructures.[512] Regulatory arbitration, varying Shariah interpretations, and technological asymmetry create uncertainty for institutional investors.[513] Issues such as 51% consensus attacks and IoT spoofing further erode trust in areas lacking robust cybersecurity protocols.[514]

To address these challenges, a tiered approach, including algorithmic reserve management systems, central bank oversight, hybrid blockchain models, and ethical consistency, could help reconcile jurisdictional differences and promote smoother integration. Advanced economies may implement algorithmic reserve management systems, whereas emerging markets should have central bank oversight. Hybrid blockchain models, quantum-resistant encryption, and standardized APIs could facilitate smoother integration of GBCs, especially in Africa and Latin America.[515]

Overcoming regulatory and technological challenges will require coordinated efforts among policymakers, technologists, and academia. By working toward harmonized regulatory frameworks, enhanced interoperability, and consistent ethical standards, stakeholders can unlock the full potential of GBCs as resilient and inclusive financial instruments in a globalized economy.

Harmonized regulatory framework and interdisciplinary research needs. GBCs face fragmented research, with economic studies often ignoring legal complexities and legal scholarship underexploring technological solutions. Economic models position GBCs as stabilizers against market volatility; however, only 22% address liquidity risks, as

[511] Muneeza and Mustapha, "Blockchain and Its Shariah Compliant Structure."
[512] Tlili et al., "Is Metaverse in Education a Blessing or a Curse: A Combined Content and Bibliometric Analysis."
[513] Mabid, Abdulazeem, and Adnan, *Handbook of Islamic Finance Ethics*.
[514] Dwivedi et al., "Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse."
[515] Rudolph, Tan, and Tan, "War of the Chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. The New AI Gold Rush and Its Impact on Higher Education."

seen in the 2022 Ukraine crisis where conversion delays exposed vulnerabilities.[516] Legal research fixates on classification challenges (e.g., securities vs. commodities), while blockchain tools, such as smart contracts, could streamline compliance. Geographic bias skews 73% of studies toward Southeast Asia, neglecting Africa and Latin America, where initiatives such as Nigeria's eNaira-gold pilot remain understudied.[517] Post-2023 innovations, such as AI-driven reserve management and quantum-resistant encryption, are largely ignored.[518]

Regulatory harmonization is crucial for addressing fragmentation. Disparate frameworks, such as Indonesia's full gold reserve mandate, the EU's MiCA with €250,000 non-compliance penalties, and Saudi Arabia's crypto ban, create arbitrage risks and hinder cross-border adoption.[519] Harmonization could be driven by individual countries aligning bilaterally; however, a global initiative led by bodies such as the FSB or IFSB would be more effective. The IFSB could standardize Shariah-compliant guidelines, while FSB's Project Dunbar offers a model for cross-border pilots. Advanced economies may adopt algorithmic reserve systems, whereas emerging markets may rely on central bank oversight.

A cross-disciplinary approach is essential, integrating econometric models (e.g., GARCH), legal analysis of regulatory convergence, and technological advancements such as hybrid blockchains. Mixed-method studies combining volatility data, AI-driven liquidity models, and regional analyses of Africa and Latin America can bridge these gaps.[520] Collaboration among academics, regulators, and technologists is vital to

[516] Subarkah, "Initial Coin Offering (ICO) in Perspective Law of Sharia Business."
[517] Alam et al., "The Impacts of the Russia–Ukraine Invasion on Global Markets and Commodities: A Dynamic Connectedness among G7 and BRIC Markets."
[518] Alam et al.
[519] Ahmed Tlili et al., "Is Metaverse in Education a Blessing or a Curse: A Combined Content and Bibliometric Analysis," *Smart Learning Environments* 9, no. 1 (2022): 1–31, https://doi.org/10.1186/s40561-022-00205-x.
[520] R Campos, J., Hugot, J., & Platitas, "Asian Development Outlook 2022: Mobilizing Taxes for Development," vol. 00 (Manila, Philippines, April 2022), https://doi.org/10.22617/FLS220141-3.

translate insights into cohesive policies, ensuring the stability and inclusivity of GBCs in global and Islamic finance.

Research Gaps and the Need for an Interdisciplinary Approach

Research on GBCs is often fragmented, with economic studies often overlooking legal intricacies and legal scholarship rarely engaging with technological fixes. Economic models often portray GBCs as instruments for dampening market turbulence; however, only 22% of these studies investigate liquidity risks.[521] Legal research focuses on classification hurdles, whereas blockchain features may facilitate compliance.[522] Geographic bias contributes to this fragmentation, with 73% of studies focusing on Southeast Asia, leaving regions such as Africa and Latin America unexamined.[523] Post-2023 advances, such as AI-driven reserve management and quantum-resistant encryption, have attracted scant scholarly attention.[524] A cross-disciplinary framework that combines economic modeling, legal inquiry, and technological innovation is crucial for safer and more inclusive GBC adoption.[525] Mixed-method designs integrating actual volatility patterns, emerging technologies, AI-driven reserve management systems, and sub-Saharan Africa and Latin America can enrich our understanding of GBC adaptation.[526] Collaboration among academics, regulators, and technologists is essential for translating these insights into actionable policies.

[521] Muhammad Irfan et al., "Performance Analysis of Gold- and Fiat-Backed Cryptocurrencies: Risk-Based Choice for a Portfolio," *Journal of Risk and Financial Management* 16, no. 2 (2023), https://doi.org/10.3390/jrfm16020099.

[522] Elsayed and Nasir, "Central Bank Digital Currencies: An Agenda for Future Research."

[523] Alam et al., "The Impacts of the Russia–Ukraine Invasion on Global Markets and Commodities: A Dynamic Connectedness among G7 and BRIC Markets."

[524] Alam et al.

[525] Alam et al.

[526] Campos, J., Hugot, J., & Platitas, "Asian Development Outlook 2022: Mobilizing Taxes for Development."

Conclusion

GBCs represent a promising yet complex innovation within the digital finance landscape. Their potential to offer financial stability through gold collateralization is tempered by challenges related to the fragmented regulatory environment and ethical concerns. By adopting tiered regulatory approaches, promoting ethical and technological integration, and extending research to underrepresented regions, stakeholders can better harness the potential of GBCs as inclusive and resilient financial instruments.

This study has limitations, as it focuses on studies published before 2024, excluding recent advancements such as Ethereum's Shanghai upgrade and AI-based reserve management systems. The rapid evolution of blockchain technology may render some findings outdated. The review uses various methodological approaches, complicating comparisons. Future research should standardize metrics such as liquidity-adjusted VaR. The literature on GBCs in regions such as Africa and Latin America is limited because of the unique economic conditions and regulatory environments.

Future research includes combining quantitative and qualitative analyses of regulatory preparedness and cultural receptivity in African and Latin American markets, developing AI-driven liquidity risk models, exploring post-quantum cryptography and hybrid blockchain solutions, and enhancing ethical-tech integration to align GBCs with maqasid al-Shariah.

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