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Crypto Asset Audits in the Era of Decentralized Finance (DeFi): A Global Systematic Review

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ABSTRACT

Background. This research explores global studies on crypto asset audits in Decentralized Finance (DeFi) from 2021 to 2025 through a systematic literature review (SLR) approach, highlighting technological advancements like machine learning and hybrid analytics that enhance audit accuracy, fraud detection, and scalability.

Purpose. Auditing practices have expanded to include smart contracts, compliance, security, and environmental audits. However, challenges persist, such as the lack of global regulatory standards, decentralized control, security risks, and instability within DeFi protocols.

Method. Despite advancements, effective audits in DeFi require aligning technological innovation with adaptable regulatory frameworks to ensure sustainability and trust.

Results. Managerially, DeFi platforms should integrate emerging technologies into auditing practices and collaborate with regulators to address compliance gaps, particularly in anti-money laundering (AML) and transparency.

Conclusion. Future research should focus on developing global DeFi regulations, exploring decentralized auditing methods, and investigating the impact of new financial systems like the metaverse on auditing practices.

KEYWORDS

Blockchain Analytics, Decentralized Finance, Regulatory Frameworks

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INTRODUCTION

The sudden emergence of decentralized finance (DeFi) has transformed the financial system of the world through peer-to-peer transactions without intermediation using blockchain technology (Barandi et al., 2020; Fiqri Najmuddien et al., 2023; Firmansyah et al., 2023; Meilita Rizkynanda et al., 2023; Valeria et al., 2022). The application of crypto assets—digital tokens of value and being traded on decentralized platforms—is the core of DeFi (Auer et al., 2024). As such, technologies transform financial systems; they also pose new challenges to oversight regulation, risk management, and financial transparency (Shavshukov & Zhuravleva, 2023).

In this evolving environment, crypto asset audits have become a critical instrument for establishing trust, securing assets, and ensuring compliance in an otherwise transparent and decentralized network (Hsieh & Brennan, 2022). Crypto asset audits differ from conventional financial audits in that they must take into account unique factors such as the integrity of smart contracts, governance of protocols, token liquidity, and cybersecurity risks (Dupuis et al., 2023). Moreover, the global nature of DeFi also presents jurisdictional and standardization challenges that complicate audit practices and frameworks (Harvey & Rabetti, 2024). Despite its growing relevance in crypto asset auditing, there is still scattered work throughout this subject at a global level (Hsieh & Brennan, 2022). As DeFi is of an interdisciplinary nature that extends to finance, information systems, cryptography, and law, this calls for systematic integration of available knowledge to present significant advancements, postulate audit processes, assess regulatory directions, and articulate new threats (Mabel et al., 2024).

This study aims to fill this gap by conducting a global systematic review of peer-reviewed literature of crypto asset audits in the DeFi environment. By analyzing studies published between 2021 and 2025, this review enlightens readers on audit practice, problems, and innovation at the current moment and proposes recommendations for future research, policy-making, and professional practice in an age of decentralized finance.

Research Questions

RQ1: What are the mainstream practices, frameworks, and challenges of auditing crypto assets in global decentralized finance (DeFi) communities, as evidenced by the Scopus database spanning 2021 to 2025?

RQ2: How have technological advancements and regulatory efforts influenced the progress and effectiveness of crypto asset audits in the DeFi space, according to the Scopus database spanning 2021 to 2025?

Literature Review

Crypto Asset Audits

Crypto asset audits are technical assurance processes designed to evaluate the integrity, security, and accuracy of digital assets and blockchain-based financial transactions (Kukman & Gričar, 2025). Unlike the traditional audits that focus on financial statements and internal controls of centralized institutions, crypto asset audits focus on the idiosyncrasies of blockchain technology and decentralized systems (Hsieh & Brennan, 2022). The core function of a crypto asset audit is to verify that digital assets—cryptocurrencies, tokens, and stablecoins—are properly accounted for, safely stored, and used according to protocol rules (Dupuis et al., 2023). This includes auditing smart contracts (self-executing blockchain code), checking the existence and value of token reserves, and verifying that there are security controls to prevent hacking, fraud, or mismanagement (OLADEJO, 2023). Cryptocurrency asset audits include a combination of manual code audits, automated vulnerability scanning, blockchain analysis, and validation of on-chain data (Hsieh & Brennan, 2022). Audits are especially important in decentralized finance (DeFi), where software executes without centralized control and is greatly reliant on smart contracts to regulate financial interactions (Bourveau et al., 2024). A bug in one smart contract can be very expensive financially, so audits are essential to ensuring risk management (El Haddouti et al., 2024).

The Decentralized Finance (DeFi)

The DeFi era is a paradigm shift in the global financial system, enabled by blockchain technology (Turi, 2023). Unlike the traditional finance of banks, stock exchanges, and payment processors, DeFi relies on decentralized networks to provide financial services directly between users, with no need for middlemen. This is made possible by smart contracts, which are self-

executing computer programs that run on blockchain platforms like Ethereum (Pradhan & Singh, 2021). During the DeFi period, individuals can borrow, lend, exchange, invest, and get interest on crypto assets, all via decentralized applications (dApps) (Auer et al., 2024). The platforms are open-source, available 24/7, and operate worldwide, making users more in control of their money (Baig et al., 2022). DeFi also offers new financial products such as liquidity pools, yield farming, and decentralized exchanges (DEXs), which enable quicker and more versatile financial transactions (Shah et al., 2023). But the DeFi period comes with challenges, too. It is not centrally regulated, and hence it is vulnerable to hacks, scams, and technical issues (Wronka, 2023). The users themselves must be responsible for their safety because there are no central agents to provide help or guarantees (Bodo & de Filippi, 2024). Despite all these perils, DeFi is rapidly growing and revolutionizing how people interact with money, giving a more open, inclusive, and programmable financial system to the digital era (Vasishta et al., 2025).

RESEARCH METHODOLOGY

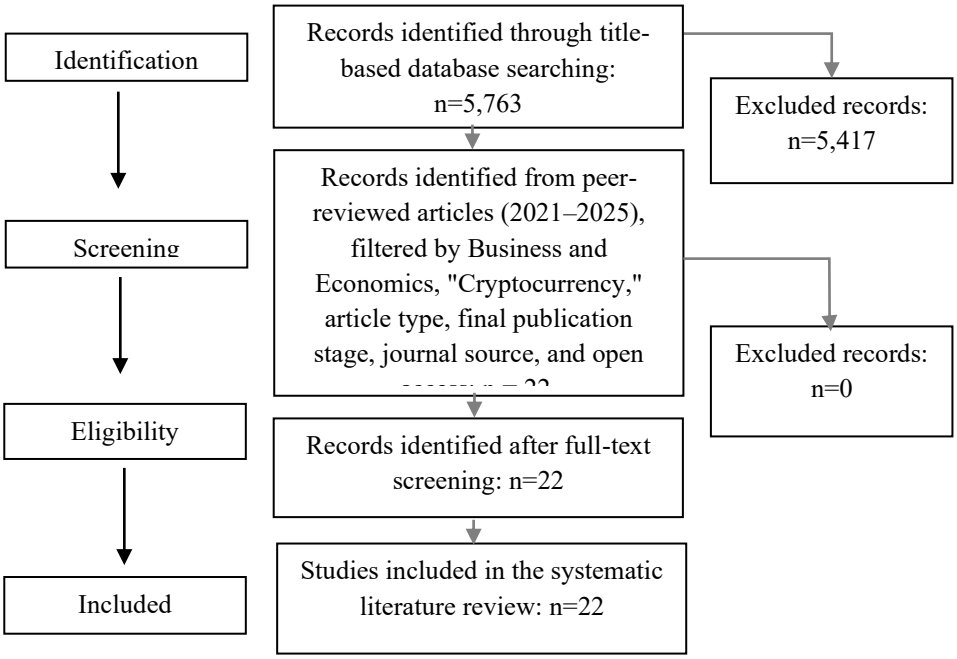
This research adopts a qualitative descriptive method using a systematic literature review (SLR) approach to comprehensively examine global studies related to crypto asset audits in the era of Decentralized Finance (DeFi). The SLR method ensures a structured, transparent, and replicable process for identifying, selecting, analyzing, and synthesizing existing academic literature. Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, the review adheres to high standards of methodological rigor and clarity. Data were collected from the Scopus database. The search strategy utilized Boolean operators and a predefined set of relevant keywords, including: "Auditing Frameworks," "Blockchain Analytics," "Blockchain Forensics," "Blockchain Integrity," "Blockchain Technology," "Crypto Asset Assurance," "Crypto Asset Audits," "Crypto Asset Risk Management," "Crypto Compliance," "Crypto Security Audits," "Cryptographic Auditing Tools," "DeFi Ecosystem Risks," "DeFi Financial Products," "DeFi Governance," "DeFi Protocols," "Decentralized Applications (dApps)," "Decentralized Financial Systems," "Decentralized Finance (DeFi)," "Digital Asset Transparency," "Financial Regulation in DeFi," "Risk Assessment in DeFi," "Regulatory Challenges in DeFi," "Smart Contract Auditing," "Smart Contract Security," and "Token Reserves Audit." The search was conducted on May 14, 2025, and initially yielded 5,763 papers. The review was limited to peer-reviewed journal articles published in English between 2021 and 2025, with further filtering based on subject areas (Business and Economics), exact keyword ("Cryptocurrency"), document type (article), publication stage (final), source type (journal), and open access status (all). The exact search string used in Scopus was:

TITLE ("Auditing Frameworks" OR "Blockchain Analytics" OR "Blockchain Forensics" OR "Blockchain Integrity" OR "Blockchain Technology" OR "Crypto Asset Assurance" OR "Crypto Asset Audits" OR "Crypto Asset Risk Management" OR "Crypto Compliance" OR "Crypto Security Audits" OR "Cryptographic Auditing Tools" OR "DeFi Ecosystem Risks" OR "DeFi Financial Products" OR "DeFi Governance" OR "DeFi Protocols" OR "Decentralized Applications (dApps)" OR "Decentralized Financial Systems" OR "Decentralized Finance (DeFi)" OR "Digital Asset Transparency" OR "Financial Regulation in DeFi" OR "Risk Assessment in DeFi" OR "Regulatory Challenges in DeFi" OR "Smart Contract Auditing" OR "Smart Contract Security" OR "Token Reserves Audit") AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (EXACTKEYWORD , "Cryptocurrency")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (

SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (OA , "all"))

After applying these criteria, a total of 22 relevant articles were selected for detailed analysis. A thematic analysis was carried out to evaluate the selected studies based on variables such as geographic location, research methodology, audit type, and key findings. This process provided a rich understanding of the current landscape and challenges of crypto asset auditing within decentralized financial systems globally.

Figure 1. Literature Review Method



Source: (Sulistyowati & Husda, 2023a, 2023b; Sulistyowati & Sukati, 2024)

RESULT AND DISCUSSION

The compared research work shares several thematic similarities and main differences in approach, scope, and conclusions. One of the main similarities is that all the reviewed studies addressed trust, security, and regulatory environments in the context of DeFi and crypto assets. For example, Bhambhwani & Huang (2024), Benson et al. (2024), and Trozze et al. (2024) all address the role of audits—legal, forensic, or smart contract—in fostering trust, risk mitigation, and compliance in decentralized environments. Similarly, most studies, including Grassi et al. (2022), Drăgan et al. (2025), and Adamyk et al. (2025), highlight governance, drivers of behavior, and control mechanisms, highlighting that even though DeFi is decentralized, human and institutional elements are at the core of its operation.

Others also overlap when it comes to technology reviews, primarily performance and consistency of blockchain networks. For instance, Park & Youm (2022) and Chemaya & Liu (2024) both address technical audit concerns—crypto-CBDC transfer and transaction prediction accuracy with past models. Secondly, sustainability matters crop up in research like Zhang et al. (2023) and Bogomolov (2025), both addressing the ecological price of crypto and demanding greener models or laws.

Conversely, the variation lies in audit type, geographic emphasis, and approach. Some of the studies are macro policy or conceptual in design—e.g., Kumar et al. (2024) and Tommerdahl (2025)—offering system-level design or theoretical discord among governments and DeFi. Others, e.g., Nguyen & Nguyen (2024) or Namachivayam et al. (2024), are behavioral and configurational

in design, examining user motivation and socio-economic drivers of crypto take-up. Second, the audit subject varies: while some are focused on asset performance (Gadi & Sicilia, 2022), others are focused on legal compliance (Benson et al., 2024), environmental audit (Zhang et al., 2023), or internal governance (Nguyen et al., 2025). Methodologically, some use machine learning or fsQCA, and others that use conceptual, historical, or econometric models, as is fitting with discipline variety.

Table 1. Articles on Crypto Asset Audits in Scopus (2021–2025)

No.	Author (Year)	Country	Scope	Type of Audit	Finding	Citation
1	(Zhang et al., 2023)	China	Bitcoin mining energy & environmental impact	Environmental Risk Audit	Bitcoin mining contributes significantly to CO_2 emissions; recommends energy-efficient consensus algorithms for DeFi sustainability.	62
2	Grassi et al. (2022)	Italy	Role of intermediation in DeFi	Intermediation & Governance Audit	DeFi still requires human intermediation; decentralization reduces monopolies but creates oversight risks.	60
3	(Piñeiro-Chousa et al., 2022)	Spain	DeFi token behavior vs. traditional assets	Investment Asset Evaluation	DeFi tokens act as a haven; user-generated content significantly affects returns. Twitter data is less impactful than Telegram.	58
4	(Kumar et al., 2024)	Global	Integration of DeFi with the metaverse	Conceptual/Financial System Review	Proposes a design for integrating DeFi into virtual worlds and highlights gaps and future directions in digital finance.	17
5	(L. T. M. Nguyen & Nguyen, 2024)	Vietnam	Crypto/DeFi adoption	Configurational audit	Adoption driven by social/economic/cultural factors; political and tech factors are less influential.	10
6	(Bhambhwani & Huang, 2024)	USA	DeFi audits	Smart contract audit	More audits and higher audit quality increase DeFi investment trust and resilience post-crisis.	10
7	(Benson, Turksen,	UK	Regulatory response	Legal/Regulato	Identifies blind spots in DeFi used by criminals and proposes	7

No.	Author (Year)	Country	Scope	Type of Audit	Finding	Citation
	et al., 2024)		to DeFi and AML	ry Audit	regulatory strategies for AML compliance in decentralized finance.	
8	(Gadi & Sicilia, 2022)	Spain	Crypto hedging and diversification properties	Financial Performance Audit	Stablecoins retain hedge properties across G7/BRICS; the impact of tech type and COVID-19 phase highlighted in asset classification.	7
9	(Park & Youm, 2022)	South Korea	Blockchain-CBDC interoperability	System Security Audit	Proposes architecture for crypto/CBDC transfer; outlines key security risks and requirements for implementation.	6
10	(Benson, Adamyk, et al., 2024)	Europe	Crypto regulation	Regulatory audit	EU lacks unified crypto framework; MiCA improvements and global standards recommended.	5
11	(Drăgan et al., 2025)	Romania/Germany	Sustainable crypto	Behavioral audit	Regulation, trust, and sustainability are key to adoption; fsQCA shows complex decision paths.	4
12	(Sakas et al., 2023)	Greece	Crypto analytics for stock prediction	Financial Forecasting	Cryptocurrency web analytics (e.g., Bitcoin traffic) help predict fertilizer industry stock prices; it uses hybrid modeling.	4
13	(Trozze et al., 2024)	UK	DeFi code compliance	Forensic audit	ML (80% F1 score) detects code-level violations; SafeMath use partially explains detection.	3
14	(Fantacci & Lorenzini, 2024)	Italy	DLT vs historical finance	Comparative audit	DeFi resembles early peer-lending; questions about whether DLT is a true financial paradigm shift.	3
15	(Chemaya & Liu, 2024)	USA/China	Performance of Uniswap V3 using V2 models	Technical Audit	V2 model accurately predicts 97.1% of V3 transactions; findings suggest suitability for certain liquidity environments.	3
16	(Ozeran & Gura, 2020)	Ukraine	Audit of cryptoassets in financial statements	Financial Statement Audit	Provides audit model linking crypto risks and controls; emphasizes the need for experience with crypto auditing and control testing.	3

No.	Author (Year)	Country	Scope	Type of Audit	Finding	Citation
17	(Hanneke et al., 2025)	Germany	Metaverse economies	Economic audit	Exchange rates are central to growth; metaverse economics are shaped by actor behavior and asset scarcity.	2
18	(Adamyk et al., 2025)	Ukraine/UK	DeFi platforms	Compliance audit	DeFi platforms vary in compliance and analytics; a user-centric design is needed for effective regulation.	1
19	(M. H. Nguyen et al., 2025)	Vietnam	DeFi lending	Internal audit	Algorithmic interest rates fail to stabilize; low deposit concentration worsens liquidity risk.	0
20	(Tommerdahl, 2025)	USA	Government vs. DeFi	Conceptual/Policy	Tension between centralized control and DeFi innovation highlights future regulatory conflicts.	0
21	(Bogomolov, 2025)	Russia	Crypto environmental impact	Impact audit	Cryptocurrencies are resource-intensive, challenges to sustainability and public finance.	0
22	(Namachivayam et al., 2024)	India	Trading behavior in Beldex cryptocurrency	Behavioral/Market Audit	Trading intentions are driven by financial and technological motivations, high influence from risk management and earning desires.	0

Source: Scopus, as of May 14, 2025

RQ1: What are the mainstream practices, frameworks, and challenges of auditing crypto assets in global decentralized finance (DeFi) communities, as evidenced by the Scopus database spanning 2021 to 2025?

Auditability of crypto assets in global DeFi communities depends on a convergence of new emerging practices, nascent frameworks that are maturing, and overall key challenges. Mainstream auditing practices nowadays include smart contract auditing (Bhambhwani & Huang, 2024; Trozze et al., 2024), compliance and regulatory auditing (Benson et al., 2024; Adamyk et al., 2025), and technical security auditing (Park & Youm, 2022; Chemaya & Liu, 2024), all aimed at building trust, minimizing risk, and maximizing system resilience. Environmental and sustainability audits are also popular, as observed in Zhang et al. (2023) and Bogomolov (2025), highlighting the high energy consumption of crypto networks and calling for cleaner consensus mechanisms. Audits on financial performance and statements (Gadi & Sicilia, 2022; Ozeran & Gura, 2020) give insights into hedging capacity and needs of qualified audit personnel in dealing with crypto's complexity.

Frameworks employed are extremely varied, from legal and regulatory frameworks such as the EU's MiCA (Benson et al., 2024) to configurational and behavioral frameworks (Nguyen &

Nguyen, 2024; Drăgan et al., 2025), and even conceptual and historical perspectives (Fantacci & Lorenzini, 2024; Tommerdahl, 2025). Other studies, such as Kumar et al. (2024) and Hanneke et al., address prospective DeFi incorporation in the metaverse and virtual asset economics and suggest the need for adaptive audit methods that extend beyond conventional finance. Technology-based solutions like machine learning (Trozze et al., 2024) and hybrid analytics (Sakas et al., 2023) are increasingly used for fraud detection and predictive modeling, suggesting a data-driven auditing trend.

Despite these advancements, issues are severe. These are the absence of consistent global regulations (Benson et al., 2024), complex security risks (Park & Youm, 2022), loopholes in transparency and regulation (Adamyk et al., 2025), and unstable algorithmic systems (Nguyen et al., 2025). In addition, the decentralized nature of DeFi creates oversight challenges (Grassi et al., 2022) and introduces new risks related to human behavior and trust (Drăgan et al., 2025; Namachivayam et al., 2024). Overall, although auditing frameworks are evolving at a rapid rate in DeFi systems, they are still fragmented, and their effectiveness depends heavily on technological innovation, coordination of the regulatory authority, and auditor skills.

RQ2: How have technological advancements and regulatory efforts influenced the progress and effectiveness of crypto asset audits in the DeFi space, according to the Scopus database spanning 2021 to 2025?

The Scopus database research from 2021 to 2025 shows how technological advancements and policies of governments have played a central role in dictating the progress and effectiveness of crypto asset audits among the decentralized finance (DeFi) society. Technologically, machine learning and data analysis have revolutionized the audit process. Studies like Trozze et al. (2024) illustrated that machine learning models were capable of detecting smart contract violations quite successfully, while Sakas et al. (2023) highlighted the way web analytics, applied to cryptocurrency data, can predict stock price direction. Additionally, Chemaya & Liu (2024) emphasized that models derived from historical DeFi transactions could be utilized to simulate new environments and enhance audit reliability even more. These advances, combined with the transparency of blockchain technology, have made auditing processes more scalable and efficient while reducing the potential for fraud and increasing overall audit accuracy.

Regulationally, an effort has been made to close compliance loopholes and strengthen regulation. For instance, Benson et al. (2024) referred to vulnerabilities of DeFi sites that were being exploited for money laundering and called for expert anti-money laundering (AML) measures for decentralized finance. Adamyk et al. (2024) identified disparities in compliance on sites and encouraged regulatory mechanisms considering user-centric designs. Benson et al. (2024) also emphasized the importance of a harmonized regulatory framework in the EU, urging the updating of current regulations such as MiCA and the standardization of crypto regulations on a global scale. In addition, researchers like Drăgan et al. (2025) and Tommerdahl (2025) pointed out the conflict between the decentralized spirit of DeFi and the centralized nature of current regulatory frameworks, posing difficulties for the effective implementation of audits.

Challenges persist despite these developments. For example, Zhang et al. (2023) and Bogomolov (2025) identified the massive energy consumption of cryptocurrencies and expressed concerns about the future sustainability of the industry in environmental terms. Kumar et al. (2024) and Hanneke et al. (2024) identified the coming integration of DeFi with virtual economies like the metaverse, posing auditors with increased complexity in tracking the new financial systems. Furthermore, Nguyen et al. (2025) also established that algorithmic instability of DeFi lending models exacerbates liquidity risks, having a failure to conduct accurate risk assessments.

CONCLUSION

The Scopus database research works of the years 2021 to 2025 detect significant advancements in auditing crypto assets in the decentralized finance (DeFi) space through technological innovation and shifting regulatory efforts. Conventional auditing techniques have diversified into smart contract, compliance, security, and environmental audits, with machine learning and hybrid analytics as new technologies that are central to improving fraud detection, audit accuracy, and scalability. Despite these advancements, there are hurdles like the lack of standard worldwide regulations, decentralized control, complex security risks, and algorithmic model instability within DeFi protocols. Attempts at regulation have come in the form of bridging compliance gaps, particularly in anti-money laundering (AML) rules and transparency, but the tension between the decentralized nature of DeFi and central regulatory frameworks remains a significant deterrent. As DeFi grows, especially with the integration of virtual economies like the metaverse, auditors must adapt with increasingly developed financial systems despite improved audit capabilities thanks to technology. Technological advancement has, in general, made auditing capabilities stronger, but effective auditing in DeFi remains dependent on aligning innovative technologies with adaptable and robust regulatory frameworks for the purposes of promoting sustainability and trust in the ecosystem.

AUTHORS' CONTRIBUTION

Look this example below:

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

Author 5: Supervision; Validation.

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