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Blockchain-Enabled CSR Transparency: A Systematic Review

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ABSTRACT

Corporate Social Responsibility (CSR) reporting has become an important mechanism for organisations to communicate their environmental, social, and governance commitments to stakeholders. Although recent regulatory initiatives have sought to improve the consistency and reliability of CSR disclosures, concerns regarding transparency, data integrity, and reporting of credibility remain. In response to these challenges, blockchain technology has gained attention as a potential tool for strengthening CSR reporting practices. This study explores the role of blockchain in CSR reporting through a systematic review of 21 publications covering blockchain technology, smart contracts, and non-fungible tokens (NFTs). Drawing evidence from academic, technical, and industry sources, the review examines how these technologies can support greater transparency, accountability, and stakeholder trust while highlighting current implementation challenges and research gaps. The findings suggest that CSR reports can be recorded and verified as NFTs on a blockchain network, offering a secure and traceable approach to reporting. Unlike conventional NFTs used for digital assets, CSR-related NFTs possess distinctive characteristics, including non-transferability and the need for regulatory oversight during their creation and validation. This study contributes to the emerging literature by proposing a blockchain-based CSR reporting architecture that integrates smart contracts and NFT standards while recognising the roles of companies, verifiers, and regulatory authorities. The proposed framework also advances understanding of the practical and conceptual considerations associated with CSR-focused NFTs, providing a foundation for future research and implementation.

Keywords: Blockchain technology, CSR reporting, decentralisation, ERC721, NFT, smart contracts, sustainability, transparency

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INTRODUCTION

Corporate social responsibility (CSR) has become a central element of modern organisational strategies, amid growing pressures from investors, consumers, and regulators for transparency and sustainability. Traditional CSR reporting faces major challenges, each of which is supported by academic sources. According to Xu (2023), greenwashing and data manipulation involve exaggerating or falsifying sustainable performance in reports, eroding stakeholder trust through manipulated data. This distorts the true perception of CSR impact, leading to incorrect investment decisions. Another big problem is the lack of supply chain traceability, and without it, supply chains remain opaque, making it difficult to verify the ethics and sustainability of raw material sources. According to Chen (2022), many companies are uncertain about whether their supply chains are ethical because they lack effective traceability and transparency mechanisms, increasing the risk that unethical practices remain hidden. Moreover, traditional audits require independent third parties, resulting in high costs and delays in validating CSR data. Abbott and Monsen (2023) analyse the positive correlation between the intensity of CSR reporting and audit costs, attributed to the risks of greenwashing and the need for extensive verification. The process is inefficient, based on samples rather than on complete, real-time data. Also, the lack of unified standards makes cross-company reporting incomparable, complicating global assessments of CSR performance. The variety of methods leads to inconsistencies and skepticism about the data. Tschopp and Nastanski (2014) criticise the plurality of frameworks (GRI, SASB, IIRC) that generate incompatibility and stakeholder skepticism.

This study aims to develop a blockchain-based architecture for CSR reporting that integrates smart contracts and NFTs to enhance transparency, accountability, and stakeholder engagement. Through a Systematic Literature Review (SLR), the research identifies and structures the literature into several key thematic dimensions: enhancing transparency and accountability in CSR reporting through blockchain technologies; leveraging smart contracts and NFTs to enable decentralised CSR mechanisms; analysing the characteristics of NFTs in relation to CSR reporting; and proposing a blockchain architecture for CSR reporting. The latter represents a major element of originality, as it reflects the authors' significant contribution in designing a practical and innovative framework for CSR reporting.

To address the current gaps in the integration of blockchain technology with corporate social responsibility (CSR) reporting, this study poses the following research question:

- What are the specific regulatory requirements and technical considerations for architecting and implementing an effective blockchain-based CSR system that accurately represents, stores, verifies, and manages CSR reports, ensuring transparency, security, and compliance?

LITERATURE REVIEW

A non-financial report has qualitative and quantitative information about ESG (environmental, social and governance) pillars and describes how the company integrated them into business operations and outcomes (Daub, 2007). Since 2017, the European Commission has provided guidance on non-financial reporting to help companies disclose relevant non-financial information in a more standardised and uniform manner (European Commission, 2017). On January 5, 2023, the Corporate Sustainability Reporting Directive (CSRD) expanded the requirements for companies to report on social, climate change and other sustainability issues and this directive applies to a wider range of large companies, listed SMEs, and some non-EU companies with over EUR 150 million in EU market revenues. The enterprises are defined by the European Financial Reporting Advisory Group (EFRAG). Companies must report on a double materiality basis, detailing both how sustainability issues impact their business and the effects their activities have on people and the environment (European Commission, 2023).

In 2025, corporate social responsibility reporting was profoundly redefined by the implementation of the European Corporate Sustainability Reporting Directive (CSRD), which transformed sustainability reporting from a voluntary practice into a standardised legal obligation at the European Union level (European Parliament & Council of the European Union, 2022). The new regulation introduces the principle of dual materiality and imposes clear requirements for transparency into the impact of organisations on the environment and society, as well as on economic performance. The specialised literature confirms that CSRD represents a paradigm shift in sustainability reporting, and new legislative requirements increase the emphasis on the quality and external verification of reported data, thereby reducing the risk of greenwashing and strengthening the credibility of published information. (Mangiuc & Kagitci, 2025).

At the same time, digitalisation has become a key factor in transforming CSR communication. Recent studies indicate that organisations are increasingly using digital platforms and online reporting tools to improve transparency and stakeholder engagement (Kargbo et al., 2025). According to Chen and Wang (2024), digital transformation positively influences ESG performance in SMEs by enhancing transparency and integrating ESG practices into their operations. In parallel, there is a growing integration between ESG reporting and traditional financial reporting, supported by international standards such as the Global Reporting Initiative and the Sustainability Accounting Standards Board. This convergence reflects the recognition that sustainable performance directly influences the company's long-term value and the financial reporting framework (Baharom, 2025).

According to Baboukardos et al. (2023), there is a "multiverse" of non-financial reporting (NFR) regulations. NFR regulation encompasses a complex and diverse array of models, frameworks, and

approaches. Therefore, there is no single universally applicable way or framework in NFR, but several "universes" that co-exist, each with different rules, standards, and requirements, influenced by various factors (geographic, political, institutional, and cultural). Thus, instead of unitary regulation, there is a "multiverse" with multiple perspectives in the regulation of information on sustainability, social impact, and the environment, which reflects the complexity and continuous evolution of this field.

In addition to traditional reporting methods, the rise of digital platforms has transformed how companies communicate their CSR initiatives, allowing for more dynamic and engaging interactions with stakeholders. Social media enables organisations to share real-time updates and foster community dialogue, thereby enhancing transparency and building trust among consumers. Standardised frameworks such as the Global Reporting Initiative (GRI) provide a structured approach to CSR reporting, ensuring that companies not only report their activities but also do so in a way that is comparable and accountable (Kazanskaia, 2025).

CSR (Corporate Social Responsibility) activities can be reported through different methods and channels. In the Table 1, the

Table 1
The most common reporting methods and channels in CSR activities

Channel	Description	Advantages	Challenges
Annual CSR reports	Annual standalone documents detailing CSR activities, goals, performance, and plans with both quantitative and qualitative data. (Baier et al., 2020).	Provides a comprehensive overview of CSR activities; Establishes a formal record of CSR practices; Allows for detailed analysis and tracking over time.	Can be lengthy and complex, making it less accessible; Risk of becoming outdated quickly; Potential for selective disclosure or greenwashing.
Integrated reporting	Documents that combine financial and non-financial performance into a single report and reflect both sustainability outcomes and financial results (Shoaf et al., 2018).	Provides a holistic view of a company's performance; Connects financial results with sustainability outcomes; Aligns with strategic business objectives.	Requires a deep understanding of both financial and non-financial metrics; Can be complex to prepare; Integration challenges.
Company websites	Dedicated sections or pages on a company's website which can be updated in real time, providing CSR information through PDF (e.g. Annual CSR Reports, Integrated reporting and CSR Dashboard) or plain HTML (Hetze & Winistörfer, 2016).	Allows real-time updates and interactive content; Easily accessible to stakeholders; Customisable to the company's brand needs and priorities.	May become outdated quickly if not regularly maintained; Less formal structure; Risks inadequate disclosure; Changing or deleting the content may reduce transparency.

Table 1 *(continued)*

Channel	Description	Advantages	Challenges
Sustainability reporting platforms	Designed platforms for managing sustainability data, ensuring compliance, accuracy, and transparency (Bocken et al., 2016).	Data collection and management; Improves accuracy; Compliance with international standards.	Costly; Requires training; May face integration issues.
Social media and digital platforms	Communication platforms that engage stakeholders and promote transparency in real-time (Troise & Camilleri, 2021).	Enables real time updates and stakeholder engagement; Interactive and broad reach; Facilitates immediate feedback and dialogue.	Continuous management, content creation and monitoring; Risk of negative feedback and public scrutiny.

Source: The authors' own research based on the literature review

common ways that companies use to report their CSR activities reflect the recognition that sustainable performance directly influences the company's long-term value and the financial reporting framework (Baharom, 2025).

Nowadays, almost all businesses have a website, and for companies that report non-financial information, online disclosure has become a primary channel for communicating corporate social responsibility (CSR) activities. Thus, effective CSR reporting on websites not only helps companies meet regulatory and normative expectations but also aligns with the growing public demand for corporate accountability and transparent sustainability efforts.

Several studies suggest that blockchain can moderate the relationship between CSR and business performance, facilitating data management and communication with stakeholders (Chen, 2023). One key innovation in blockchain applications is the use of smart contracts. Nick Szabo, a computer scientist, cryptographer, and early pioneer of smart contracts, defined a "smart contract" as a set of promises, specified in digital form, including protocols within which the parties perform on these promises (Szabo, 1994).

Integrating blockchain technologies can significantly improve CSR (Corporate Social Responsibility) reports. Organisations can achieve greater transparency, accountability, and engagement in their CSR initiatives by utilising some of the latest blockchain innovations, such as NFTs and DAOs. This is particularly relevant given that the high costs of CSR initiatives can sometimes lead to greenwashing, yet blockchain offers a method to increase transparency and accountability across the supply chain (Yao et al., 2022). Moreover, blockchain's immutable shared ledger provides a trustworthy platform for stakeholders with limited prior confidence in corporate disclosures, addressing the limitations of traditional CSR reporting methods by enhancing transparency and traceability, as highlighted by Mohammad (2025).

According to Atanasov et al. (2023), the integration of digital technologies into CSR activities – including blockchain, artificial intelligence and IoT – allows for increased transparency, efficiency and social impact of corporate initiatives, while facilitating more active stakeholder involvement and improving managerial decisions. Similarly, Kshetri (2023) highlights that blockchain-enabled supply chain systems not only enhance traceability and compliance but also reinforce corporate sustainability practices by ensuring that CSR-related data is accurate, verifiable, and accessible to all relevant stakeholders, thereby strengthening trust and accountability.

METHODS

To answer the research question — What are the specific regulatory requirements and technical considerations for architecting and implementing an effective blockchain-based CSR system that accurately represents, stores, verifies, and manages CSR reports, ensuring transparency, security, and compliance? — a systematic literature review (SLR) was conducted to identify, code, and analyse relevant studies.

The sample analysed in this Systematic Literature Review (SLR) consists of 21 studies, selected according to predefined inclusion and exclusion criteria. Sources were identified through structured keyword searches in databases and repositories, including Scopus, Web of Science, arXiv, SSRN, NIST publications, and verified media sources such as Forbes and Investopedia. Keywords included "Corporate Social Responsibility" OR "CSR reporting," "Blockchain" OR "Distributed Ledger Technology," "NFT" OR "Non-Fungible Token," "Smart Contracts," and "Decentralised Autonomous Organisation (DAO)," with Boolean operators (AND, OR) applied to focus on studies at the intersection of CSR, blockchain, and NFTs. An initial pool of 124 articles was identified and reviewed to ensure comprehensive coverage across academic journals, technical reports, industry studies, and media sources.

A small degree of subjectivity was applied to include studies that build on prior work, such as Ojog (2021, 2024), in order to maintain continuity and provide deeper insights into blockchain applications for CSR. Additional selection criteria included relevance to CSR and blockchain/NFTs, source type (peer-reviewed articles, books, whitepapers, technical documents, industry reports, or credible media), publication period (2014-2025), language (English), accessibility (full text available), and quality (preference for peer-reviewed or widely cited works and recognised technical sources).

All selected sources were coded (classified) according to their main theme, source type, and contribution, as summarised in Table 2. This thematic coding enables a systematic analysis of blockchain technologies in CSR reporting, the ability of blockchain-based NFTs to represent CSR reports, and the requirements of architecting an NFT-based CSR system. It provides a structured framework for understanding both current implementations and potential future developments.

Table 2
Selected sources analysed in Systematic Literature Review (SLR)

No.	Author(s), Year	Source Type	Main Theme	Purpose
1	Sarajoti et al., 2023	Peer-reviewed academic book chapter	Enhancing transparency and accountability in CSR reporting through blockchain	Explores blockchain integration in CSR reporting and data transparency
2	Sharma and Taherdoost, 2022	Peer-reviewed conference paper	Enhancing transparency and accountability in CSR reporting through blockchain	Examines the impact of blockchain on business development and CSR practices
3	Buterin, 2014	Foundational blockchain whitepaper	Leveraging smart contracts and NFTs to enable decentralised CSR mechanisms	Introduces Ethereum and smart contracts for decentralised applications
4	World Intellectual Property Organisation, 2022	International institutional policy report	NFT characteristics in regard to CSR Reporting	Discusses NFT regulation and intellectual property considerations for NFTs
5	Ethereum Foundation, 2021	Blockchain token standard specification (EIP)	NFT characteristics in regards to CSR Reporting	EIP-721 standard for NFTs, applicable to CSR-based NFTs
6	Interplanetary File System, 2025	Official technical platform documentation	NFT characteristics in regard to CSR Reporting	IPFS technology for decentralised NFT storage
7	SoluLab, 2023	Industry white paper	The proposed blockchain architecture for CSR reporting by authors	Examines the role of DAOs and NFTs in social and artistic ecosystems
8	Brown, 2021 (Forbes)	Business media article	Leveraging smart contracts and NFTs to enable decentralised CSR mechanisms	Demonstrates NFT applicability and stakeholder engagement
9	Tapscott and Tapscott, 2018	Academic book	The proposed blockchain architecture for CSR reporting by authors	Discusses blockchain's impact on business and corporate social responsibility
10	Anderson, 2022 (Investopedia)	Educational finance platform article	leveraging smart contracts and NFTs to enable decentralised CSR mechanisms	Analyses legal and regulatory aspects of blockchain based digital assets
11	Ojog, 2021	Peer-reviewed academic article	NFT characteristics in regard to CSR Reporting	Introduces DeFi concepts relevant to blockchain-based financial structures

Table 2 *(continued)*

No.	Author(s), Year	Source Type	Main Theme	Purpose
12	Ojog, 2024	Peer-reviewed academic article	(4) The proposed blockchain architecture for CSR reporting by authors	Explores blockchain applications in education and DApps linking to NFTs
13	Mukhopadhyay and Ghosh, 2021	Preprint (arXiv, non-peer-reviewed)	(3) NFT characteristics in regard to CSR Reporting	Analyses NFT market microstructure and transaction behavior
14	Dhillon et al. 2022	Academic book chapter	(4) The proposed blockchain architecture for CSR reporting by authors	Examines "The DAO Hacked" case and governance implications
15	Yaga et al. 2018	Government technical report (NIST)	Enhancing transparency and accountability in CSR reporting through blockchain	Provides a comprehensive overview of blockchain architecture and security considerations
16	Chandler et al. 2022	Preprint (SSRN)	(4) The proposed blockchain architecture for CSR reporting by authors	Analyses atomicity in DeFi flash loans and contrasts with traditional finance
17	Narayanan and Clark, 2017	Peer-reviewed academic article	Enhancing transparency and accountability in CSR reporting through blockchain	Provides a systematic analysis of smart contracts and associated vulnerabilities

Source: Authors' own work

After coding and organising the sources, the literature was analysed to extract four main themes, which guided the Results and Discussion sections: (1) enhancing transparency and accountability in CSR reporting through blockchain; (2) leveraging smart contracts and NFTs to enable decentralised CSR mechanisms; (3) NFT characteristics in regard to CSR Reporting, and (4) The proposed blockchain architecture for CSR reporting designed by the authors.

RESULTS AND DISCUSSION

Enhancing Transparency and Accountability in CSR Reporting Through Blockchain

Blockchain is immutable, append-only, ordered, time-stamped, transparent, and consistent. As Sarajoti et al. (2023) emphasised, these attributes make it suitable for CSR reporting. Moreover, it is secure regarding identification, authentication, and authorisation.

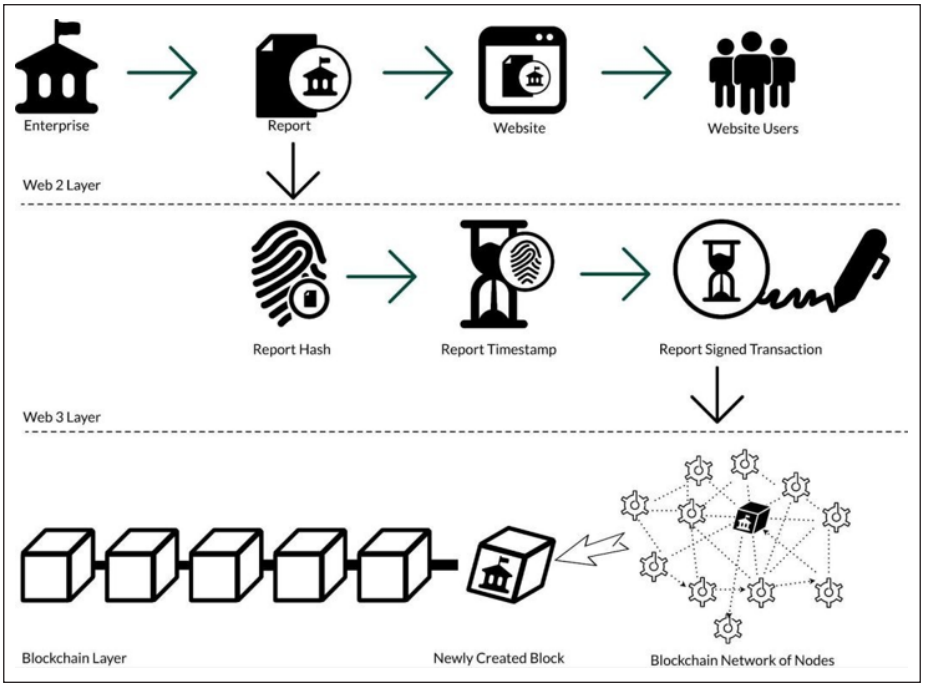

Figure 1. Blockchain data recording process - Authors' own creation

Figure 1 explains how blockchain can serve as a CSR reporting system by tracking reporting data such as sustainability metrics, recording compliance documents, verifying certifications, linking reports to unique identifiers, and sharing transparency data with stakeholders. A company can create a CSR report that it can post classically on its website to be available for users to read. The same report can also be hashed, which means the result of the hash function, along with the corresponding timestamp, can be inserted into the blockchain through a transaction. The transaction, accompanied by a signature using the private key of the issuer, will create a time-stamped fingerprint of the report that cannot be changed.

Cryptographic provenance standards, namely the hash functions, can reveal to consumers when, how, and by whom a particular piece of information was created (Narayanan & Clark, 2017). They can offer a practical, high-impact method for reducing disinformation in CSR reporting.

The same property and mechanism can be utilised to address challenges posed by AI-generated content. This becomes increasingly significant as the prevalence of AI usage grows, and there are ever more concerns about its intentional or unintentional contribution to spreading disinformation or misleading information. Transparency provided by blockchain can assist consumers in distinguishing between accurate data they receive and any that might have been manipulated (Sharma & Taherdoost, 2022).

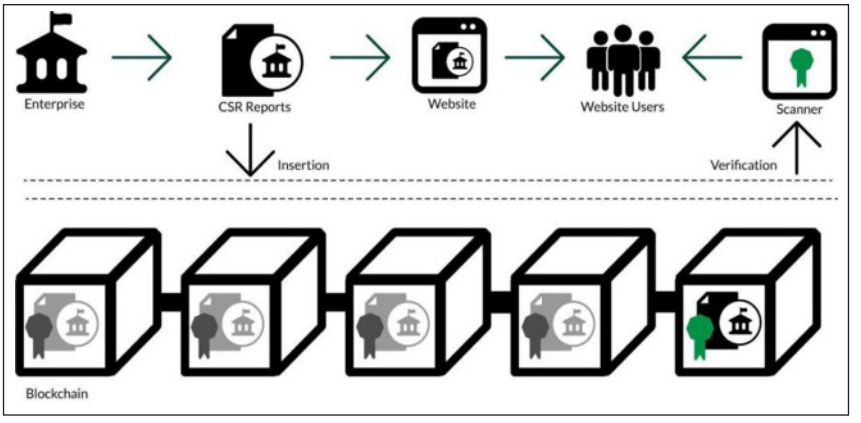

Figure 2. Blockchain entry verification - Authors' own creation

A hash function is a mathematical function that acts as a digital fingerprint. It creates a unique, fixed-size string of characters from any input data. This string, or hash, acts as a digital fingerprint, ensuring that each hashed data is uniquely identified. Any change in the input data will result in a completely different hash, which helps maintain data integrity and security. Additionally, since hash functions are one-way and infeasible to reverse, they prevent tampering by making it extremely difficult to alter the data without detection. The hash process is one-way and deterministic, meaning that the same input will always produce the same output. When data integrity is important, a hash value can be calculated over the original data and stored alongside it.

Figure 2 explains how the core resilience of blockchain technology is its decentralised and distributed structure. For example, a company can create a CSR report that it posts on its website and is available for users to view. The report, or more specifically, its fingerprint, will be inserted into the blockchain using the mechanism explained earlier. At the same time, these same users or any other stakeholders can verify the validity of the report by connecting to the blockchain and extracting the relevant information. The CSR becomes time-bound, tamper proof records, and the blockchain acts as a single source of truth because it provides an immutable and decentralised ledger that cannot be altered or deleted once data is recorded on it.

Multiple participants or "peers" operate the blockchain; they form the network of nodes, each with equal authority. If discrepancies arise between blockchains maintained by different peers—whether from tampering or other issues—the consensus is determined by the majority of hash, as the network collectively agrees (Yaga, et al., 2018). Hence, blockchain ensures that a saved CSR report is authentic, unchanged, timestamped, and can serve as a reliable reference for all involved parties.

Leveraging Smart Contracts and NFTs to Enable Decentralised CSR Mechanisms

Ethereum revolutionised the blockchain landscape by introducing smart contracts and self-executing agreements with the terms directly written into code. These smart contracts enable decentralised applications to function without intermediaries (Buterin, 2014). When a smart contract is deployed on the Ethereum blockchain, it is stored as a bytecode. This bytecode represents the compiled code of the smart contract and is recorded on the blockchain along with a timestamp, ensuring transparency and immutability. This setup allows for automated, trustless transactions and interactions, laying the groundwork for decentralised applications and digital assets (Ojog, 2024).

One of the most revolutionising use cases of smart contracts is the creation of non-fungible tokens or NFTs. A Non-Fungible Token (NFT) is a digital asset that represents ownership of a unique item or piece of content on a blockchain. Unlike cryptocurrencies like Bitcoin or Ethereum, which are fungible and can be exchanged for one another at equal value, each NFT has its own distinct identity and cannot be traded interchangeably with other tokens in the same collection.

Due to their distinct characteristics, NFTs have become popular for digital art and collectibles. In 2021, the NFT market experienced an extraordinary surge, with some of the most valuable NFTs reaching astonishing prices. Notably, the record-breaking sale of an NFT in that year was worth a staggering 69 million dollars (Brown, 2021). While the consequent crash attracted criticism and resistance from new investors, NFTs themselves are simply a standard that supports a wide range of applications.

The variety of NFT use cases continues to expand, but they are most commonly understood as unique digital assets or digital art. They continued to find new representations such as game assets, tradeable items in virtual worlds, records, or even access to services and events. Initial skepticism often questions the value of digital images, but NFTs offer more. They help artists gain proper recognition and compensation, addressing issues of digital ownership and attribution in an age where copying and sharing can undermine the value of their work (Anderson, 2022).

Ownership of a non-fungible token represents a distinct form of ownership in the digital environment, conferring various rights and privileges, but does not necessarily imply the rarity of the associated information. Digital content can be replicated and distributed indefinitely, which conceptually separates the rarity of information from ownership of an NFT.

The motivations behind the creation and acquisition of these digital assets vary considerably, from emotional attachment and the potential for financial gain, to access to exclusive communities and demonstration of membership or specialised knowledge. These factors are likely to be the distinguishing elements that will continue

to define the value of NFTs. Similar to the physical world, where the value of an authentic collectible signed autograph remains unaltered by the existence of copies or photographs of it.

The blockchain ecosystem operates on democratic and open-source principles. It allows the community to propose changes to methods and standards through "Improvement Proposals." These are known as "Ethereum Improvement Proposals" (EIPs) in the Ethereum network. A notable example is the ERC20 Token Standard, which outlines how to create and manage tokens on the Ethereum blockchain that represent money. Just like traditional currencies, ERC20 tokens can be used to purchase goods and services. On the other hand, Non-fungible Tokens (NFTs) are based on the ERC721 Token Standard which defines them as unique and non-interchangeable; each NFT is distinct and cannot be exchanged on a one-to-one basis with another (Ethereum Foundation, 2021). Token standards, such as ERC20 and ERC721, are established to promote a common understanding of how tokens should be created and interact on the blockchain, and to foster the interoperability between platforms that use the standards.

Of the two standards ERC20 and ERC721, the NFT standard is better suited to representing a CSR report. The standard ensures that NFTs can be created, managed, and transferred across the Ethereum network. Each token has a unique identifier that differentiates it from others. Nevertheless, a key difference from traditional art NFT is that CSR Reports do not require transfer.

NFT characteristics in regard to CSR Reporting

Since its beginning, NFT growth has been affected by market volatility, regulatory demands, intellectual property issues, security vulnerabilities, and storage infrastructure.

Non-fungible tokens for Corporate Social Responsibility Reporting are immune to the volatility of the conventional crypto market. A CSR based NFT is conceived solely as mechanisms for certifying and validating CSR reports. Since a company's activity cannot be sold to another company, a CSR report is not intended for trading, hence they are not generating speculative value. The absence of the trading element eliminates the main driver of volatility - fluctuations in supply and demand driven by investment behavior.

Established in the wake of the Securities and Exchange Commission v. W.J. Howey case, the legal doctrine known as the Howey Test establishes criteria for identifying investment contracts subject to financial regulation. This assessment examines four essential aspects: the existence of a monetary investment in a common enterprise, with the expectation of financial benefits generated by the efforts of persons other than the investor. In the context of unique digital tokens, the applicability of this test becomes crucial, as certain NFT transactions could be classified as regulated financial instruments. The assessment is made on a case-by-case basis, depending on the specific characteristics of the transaction and the fulfillment of the requirements of the test.

NFT market participants should be aware of the potential legal implications of their commercial activities in relation to this test and securities law (Mukhopadhyay, 2021).

CSR tokens are not subject to security regulations, because of the absence of an investment motive. They do not fit the definition of the Howey Test, as they are not designed to generate financial profit through trading, but function solely as mechanisms for certifying and verifying corporate responsibility activities. Examining the Howey Test criteria, an initial investment for the token issuance may arise, but the absence of a profit-oriented joint venture and, most importantly, the lack of expectations of financial gain precludes their classification as investment contracts.

CSR tokens are not vehicles for capital appreciation, but rather instruments of organisational transparency, with value derived from the credibility of certified information, not from their potential to increase market value. Therefore, they serve as a means to demonstrate an Organisation's commitment to social and environmental responsibility, and their worth is derived from the trustworthiness of the verified data provided, rather than from any potential monetary gains. This lack of potential for appreciation places them outside the securities regulation spectrum (World Intellectual Property Organisation, 2022).

CSR tokens inherit the vulnerabilities in the NFT ecosystem, such as the risks associated with smart contracts, the possibility of phishing, and the compromise of private keys. Nevertheless, an additional dimension of risk represents the issuing entity itself. This particularity derives from the potential interest of companies to manipulate or selectively present CSR reporting data to improve their public image. Unlike conventional NFTs, where the issuer and the owner often have aligned interests, a potential conflict of interest arises in the case of CSR tokens. The issuing company may have incentives to inaccurately represent its sustainability performance, thus distorting the fundamental purpose of the token: transparency and verifiability. This dynamic requires the implementation of a multi-layered security model, with independent external verifications and cross-reference validation mechanisms, to counterbalance the possible lack of trust in the issuing entity. Implementing an off-chain or on-chain identity system for CSR report issuers may become a requirement for the non-fungible token ecosystem for corporate responsibility. This identity infrastructure must allow for verification of the authenticity of the issuing entity, preventing report forgery by impersonating the organisation.

Another aspect worth noting is that while NFTs' unique identifiers and ownership information are stored on the Ethereum blockchain, the attributes and metadata are often stored off chain, mainly because of high transaction costs. Uploading media files or documents directly to the blockchain is prohibitively expensive due to their large size. The best practice is to store only a cryptographic reference (hash) on the blockchain, with the actual content hosted on alternative platforms

such as the InterPlanetary File System (2025), NFTStorage or Arweave. IPFS is a decentralised, peer-to-peer data storage protocol. It was created to streamline, secure, and democratise access to data. The IPFS architecture is based on a network of nodes, similar to blockchain, but unlike blockchain architecture, an IPFS node does not replicate the entire content. Each node can contain arbitrary data. The IPFS protocol allows data to be retrieved by generating a hash of the data or its content. This aspect of the protocol allows the same file to be saved and retrieved in and from multiple locations. This improves reliability and reduces the risk of data loss or corruption. However, IPFS has vulnerabilities regarding data persistence, with unused content susceptible to being removed to optimise space. Specialised services like Pinata remedy this problem by periodically accessing content, thus simulating continuous use.

The development of an ERC721-derived standard, with the express and irrevocable modification of the transfer functionality, represents the necessary technical foundation for CSR tokens. The corporate responsibility reports are not assets intended for trading, but rather certification documents belonging to the issuing entity. The modification of the standard should include the implementation of a permanent lock on the transferFrom() and safeTransferFrom() functions, along with structural alteration of the ownership mapping to reject any attempt to modify them after issuance (Ethereum Foundation, 2021). This design guarantees the perpetual association between the CSR token and the issuing entity, preventing scenarios in which reports could be transferred to evade accountability or manipulate public perception. Such a specialised standard would also facilitate the implementation of metadata update mechanisms, while maintain full traceability of changes and ensure the immutability of organisational attribution.

NFTs are also making significant strides in the world of DeFi (Decentralised Finance), which refers to financial services and products built on blockchain technology to operate without traditional intermediaries. Blockchain emerged during the 2008 financial crisis because people were looking for alternative ways to transact outside of traditional banking systems. The crisis highlighted some issues with these centralised systems: they can be slow, expensive, and not always transparent or accessible to all. DeFi allows users to lend, borrow, trade, and invest cryptocurrencies in a trustless and permissionless way. Within DeFi, NFTs are utilised in a variety of innovative ways. They can be involved in processes such as breeding, where NFTs are combined to create new assets; burning, where NFTs are permanently removed from circulation; merging, which allows NFTs to be combined into a new, more valuable token; fractional ownership, enabling multiple parties to own a share of a high-value NFT; staking, where NFTs are used to earn rewards in decentralised platforms; and airdrops, where NFTs are distributed to users as part of promotional

or incentive programs. The exploration and experimentation with these applications are ongoing, continually expanding the ways NFTs can interact with and enhance the DeFi ecosystem (Ojog, 2021).

The Proposed Blockchain Architecture for CSR Reporting

Figure 3 depicts an architecture of CSR Report using blockchain and the NFT ERC 721 standard with CSR data being saved on IPFS. A regulatory authority can create multiple identifiers for each company that needs to be regulated. Such a company will create a set of promises that will be compared with the final report. These identifiers, along with their corresponding timestamps, will be saved in the regulatory authority's contract. The promises will arrive in the form of hashes in a promise contract. They should not be revealed first. However, they will be used to validate the report. The report will be saved on IPFS to ensure transparency and accessibility for all parties involved. Additionally, using IPFS significantly reduces the high costs associated with saving the entire report on the blockchain. Only the link to the IPFS where the report is saved will be stored in the contract containing the report.

A verifiable connection mechanism between companies' prospective

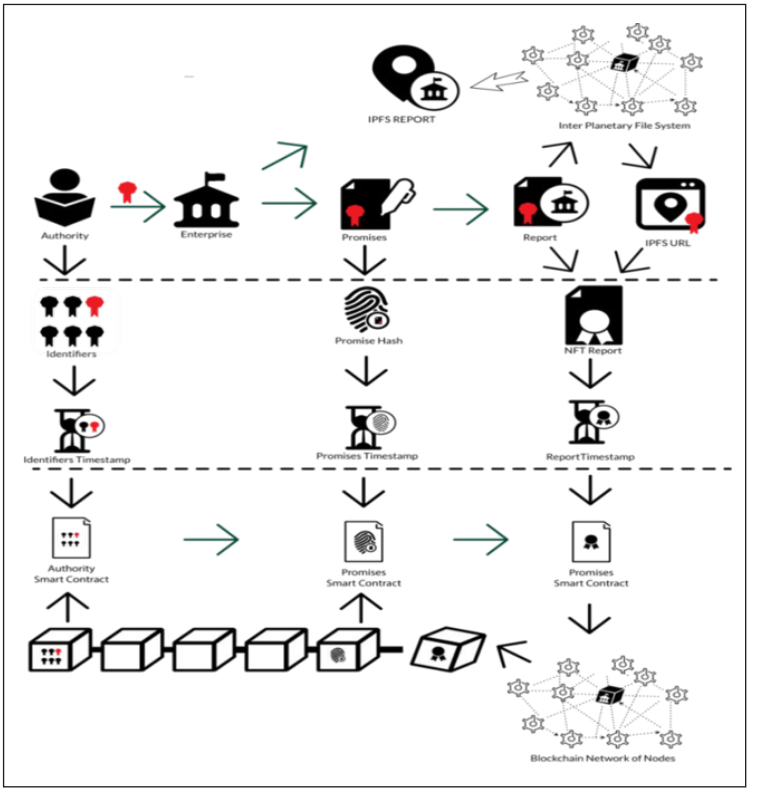

Figure 3. Blockchain-based NFT CSR report - Authors' own design

commitments and the actual results reported in CSR tokens is needed in order to build credibility of this instrument. Technologically, this link can be implemented through smart contracts with temporal monitoring capabilities, which immutably record initial promises and facilitate automatic comparison with subsequent results. Such a system, also called "commit-and-reveal" is a two-phase mechanism: the commitment phase and the reveal phase. It involves saving hashes of promises on the blockchain at the time of formulation and ensuring that companies fulfill those promises. Hashes are cryptographic primitives that ensure data integrity. They ensure that promises can only be viewed at the time of their disclosure, but also that they are the same from the time of their conception. They work similarly to votes that are saved in a box for their subsequent disclosure. Such an approach can be beneficial for anyone who wants to analyse the implementation of companies' commitments. Another aspect that needs to be considered is how to ensure that promises are not hidden by the company, in case they do not become reality.

Therefore, a new component needs to be introduced into the architecture that ensures the traceability of companies' identities. This component can be a self-sovereign identity model or a centralised component, represented by a regulatory entity, to ensure the quality control of the CSR token issuance process. Therefore, the optimal implementation of CSR tokens requires a hybrid model, which combines the advantages of centralisation and decentralisation in a complementary architecture. The centralised component, represented by a regulatory entity, ensures the quality control of the issuance process, preventing the arbitrary generation of CSR tokens without substance or verifiability. This authority can implement prior validation mechanisms, imposing minimum standards for the content of reports, and verifying the organisational identity of the issuer. At the same time, the decentralised infrastructure ensures transparency, immutability, and global accessibility of data. This hybrid model must also integrate robust security measures for smart contracts, including emergency stop mechanisms (circuit breakers) in case of critical vulnerabilities and predefined technical update paths. The possibility of controlled upgrade of smart contracts, by implementing proxy patterns or multi-signature governance systems, is a necessity to adapt to technological and regulatory developments, without compromising the historical integrity of already recorded data.

Currently, non-fungible tokens are mostly in the form of image, but the essence of this technology is to establish digital ownership over a diverse range of assets. They can incorporate dynamic elements that evolve over time and interactive code-based components (Tapscott & Tapscott, 2018).

NFTs can be effectively integrated with DAOs (Decentralised Autonomous Organisations), are self-governing organisations that operate on blockchain technology without central authority. They are governed by smart contracts and managed collectively by their members through a

voting mechanism. The first significant decentralised autonomous Organisation is built one year into Ethereum's inception in 2016. Unfortunately, in an incident called "the DAO hack" a third of the total ether that had been invested in has been stolen. This event is considered one of the earliest major incidents that highlighted vulnerabilities within smart contracts and decentralised systems (Dhillon, et al., 2022).

By leveraging NFTs within DAOs, organisations can represent ownership stakes, voting rights, or unique membership statuses as digital tokens. This integration can enhance transparency and engagement, as NFTs can provide verifiable proof of participation and contribution. The use of NFTs in the voting system of a DAO is often preferred overusing fungible tokens because NFTs are not susceptible to flash loan attacks. Flash Loans are short-term unsecured loans that allow users to borrow large amounts of cryptocurrency without providing collateral, provided that the loan is repaid along with fees within the same transaction (Chandler, et al., 2022).

When comparing ERC20 based DAOs with NFT-based DAOs, the latter offer notable benefits. Identity and access control are more effective in NFT-based DAOs as each NFT represents a unique member, making them less susceptible to Sybil attacks if NFTs are difficult to acquire. Furthermore, a 'one-NFT-one-vote' voting system can help prevent vote concentration among members if NFTs are distributed with limited availability (SoluLab, 2023).

In the world of CSR (Corporate Social Responsibility) reporting, DAOs using NFTs offer a novel approach to tracking and verifying contributions and impact. Without transferability, the unique membership represented by each NFT cannot be diluted, making NFT-based DAOs even more resilient against Sybil attacks. NFTs can record and showcase CSR initiatives, reward stakeholders for their involvement, and ensure accurate and tamper-proof reporting. This synergy between NFTs and DAOs holds potential for more accountable and transparent CSR practices, allowing organisations to demonstrate their commitment to social and environmental goals in a decentralised and verifiable manner.

CONCLUSION

A novel architecture based on blockchain, the ERC-721 NFT standard, and IPFS has been proposed for CSR report management. While the initial vision of Satoshi Nakamoto (2008), the creator of blockchain technology and Bitcoin, was to create a fully decentralised system where all transactions were carried out without any intermediaries, new trends are leading us towards a hybrid model that combines both centralisation and decentralisation. In the proposed model, a centralised CSR regulatory authority can assign unique identifiers to companies, along with corresponding timestamps, to monitor and regulate CSR commitments. This approach allows for the benefits of both systems to be harnessed while also addressing some of the limitations or drawbacks associated with each one individually. For example, fully

decentralised networks can offer increased security and transparency, but they may not be as scalable or efficient as centralised ones. Hybrid models seek to strike a balance between these two approaches by maintaining certain aspects of both in order to create more robust and practical systems. Centralised regulatory entities ensure qualitative control, while decentralised systems guarantee transparency and global accessibility.

Furthermore, the architecture proposes a two-phase approach, a "commit-and-reveal" mechanism for verifying a company's prospective commitments against actual reported CSR results. In the first phase, promises are stored as hashes in a promise contract, ensuring initial confidentiality while immutably recording the data for verification purposes. In the second phase, reports are saved on IPFS, reducing blockchain storage costs and maintaining transparency and accessibility. This approach ensures that CSR activities are documented, immutable, and transparent, and that stakeholders have a clear and accurate view of a company's social and environmental impact. Ultimately, these innovations can lead to more credible and effective CSR reporting, fostering trust, and demonstrating a genuine commitment to responsible and ethical practices. This two-phase approach ensures the integrity of promises through cryptographic hashes, while preventing premature disclosure.

NFTs provide verifiable records of contributions and achievements, while DAOs can facilitate decentralised decision-making and stakeholder involvement. NFT-based DAOs offer tremendous potential for advancement but face technical security limitations, such as flash loan vulnerabilities. Upon implementation, one must conduct further research on secure voting systems within NFT-based DAOs, focusing on mechanisms that prevent Sybil attacks and ensure equitable participation.

IMPLICATION OF THE STUDY

The findings of this study have important theoretical and practical implications. From a theoretical perspective, the research contributes to a better understanding of how blockchain technologies, smart contracts, and NFTs can transform CSR reporting by improving transparency, accountability, and stakeholder engagement. It bridges gaps in the literature by connecting CSR practices with emerging blockchain mechanisms, showing how decentralised architectures can support sustainable business practices.

From a practical standpoint, the study provides guidance for businesses, CSR practitioners, and policymakers seeking to implement blockchain-based solutions. The proposed architectures and use of NFTs and DAOs offer concrete pathways to digitise and decentralise CSR reporting, enhancing trust and traceability. Organisations can leverage these insights to design more robust CSR strategies that are transparent, auditable, and inclusive of multiple stakeholders.

Moreover, the study highlights the importance of considering technical, regulatory, and governance aspects when adopting blockchain for CSR, ensuring

that implementation is not only innovative but also compliant and sustainable. This can influence decision-making in corporate governance, legal frameworks, and digital asset management within CSR initiatives. Finally, by mapping current applications and identifying gaps in practice, the study encourages further research and innovation, guiding future work on scalable, secure, and efficient blockchain solutions for socially responsible business practices.

LIMITATION AND RECOMMENDATION FOR FUTURE RESEARCH

A key limitation of this study is the subjectivity in source selection, as some articles were included to maintain continuity with previous work, particularly the research by Ojog (2021, 2024). While this approach provides deeper insights into blockchain applications for CSR and ensures longitudinal consistency, it may introduce bias toward certain perspectives or methodologies. Additionally, most of the studies reviewed are conceptual or theoretical, with limited empirical validation of the proposed blockchain architectures and NFT/DAO mechanisms in real organisational contexts.

Future work should test and refine the blockchain architectures for CSR reporting proposed by the authors by implementing them in real organisational contexts. Such studies would provide practical evidence of their feasibility, scalability, and effectiveness, while also identifying potential challenges in integrating smart contracts, NFTs, and decentralised governance mechanisms into CSR operations.

Driving the mainstream adoption of blockchain presents several significant challenges. Firstly, integrating digital currencies into everyday financial systems and convincing the general public to adopt them remains a significant hurdle.

Improving the user experience is also crucial, as the current management of private keys can be cumbersome and intimidating for many users, impacting practical usability. Additionally, blockchain systems face scalability issues, struggling with limited throughput and network congestion as transaction volumes increase.

Coordination within decentralised networks like Ethereum is complicated by the need for a central authority to make executive decisions, leading to potential delays and disagreements. Another vital aspect is represented by the blockchain security management, namely, the smart contract security. If the contracts that govern the NFTs or any other part of the blockchain architecture are not secured, it could lead to incorrect or unauthorised actions being carried out. The trust can be compromised, leading to potential losses and damage to reputations.

Finally, legislation poses challenges, as some existing rulings may slow progress by imposing restrictive measures that stifle innovation in the blockchain space. To overcome these obstacles and continue its progress, the industry needs a proactive approach with more implementations and prototypes to tackle existing challenges

and ensure future-proof solutions. Simultaneously, addressing legislative hurdles through collaborative efforts with policymakers and adapting to regulatory changes are also essential for sustainable growth in the blockchain space. This will be essential in demonstrating viable alternatives to existing challenges, thereby paving the way for a more robust and secure blockchain ecosystem.

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