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BLOCKCHAIN TECHNOLOGY IN THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS

The article is devoted to the analysis and systematization of the experience of implementing blockchain technology in the implementation of the Sustainable Development Goals. The purpose of the study is to analyse the role of blockchain technology in the implementation of the UN Sustainable Development Goals as of 2026, with an emphasis on financial, energy and climate mechanisms. The methodology is based on a systematic analysis of secondary data, as well as transaction cost theories and institutional theories. The article also uses a case study method to study specific cases of blockchain technology implementation and their results in the implementation of the Sustainable Development Goals. The results demonstrate the ability of blockchain to reduce transaction costs, increase transparency and provide reliable ESG verification. The practical significance is to support compliance with regulatory requirements, strengthen financial inclusion and improve sustainable resource management.

Keywords: *blockchain, sustainable development goals, SDGs, implementation, digitalization.*

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БЛОКЧЕЙН-ТЕХНОЛОГІЯ В РЕАЛІЗАЦІЇ ЦІЛЕЙ СТАЛОГО РОЗВИТКУ

Стаття присвячена дослідженню ролі блокчейн-технології у забезпеченні досягнення Цілей сталого розвитку в умовах зростаючої фінансової нестабільності, посилення регуляторних вимог та потреби у підвищенні прозорості економічних процесів. Актуальність теми зумовлена необхідністю пошуку інноваційних інструментів, здатних мінімізувати дефіцит фінансування, підвищити довіру до звітності щодо сталості та забезпечити ефективну координацію між державними, приватними та громадськими інституціями. Метою дослідження є комплексне обґрунтування потенціалу блокчейну як цифрової інфраструктури, що сприяє трансформації механізмів фінансування, енергетичного обміну та кліматичного регулювання у напрямі сталого розвитку. Методологічною основою дослідження є системний підхід, що дозволив розглядати блокчейн як багаторівневу соціально-економічну технологію, а також методи узагальнення, порівняльного аналізу, структуризації та моделювання. Застосування елементів інституційного та економічного аналізу забезпечило можливість оцінити вплив децентралізованих механізмів на зниження трансакційних витрат, підвищення прозорості операцій та формування нових моделей взаємодії між учасниками ринку. У результаті дослідження обґрунтовано, що використання розподілених реєстрів сприяє підвищенню достовірності даних, автоматизації контрольних процедур та скороченню часових витрат на верифікацію операцій. Визначено, що впровадження смарт-контрактів та токенізованих інструментів створює передумови для розвитку фінансової інклюзії, розширення доступу до відновлюваних джерел енергії та удосконалення механізмів екологічного обліку. Доведено, що цифровізація процесів управління на основі блокчейну формує новий рівень довіри між економічними агентами та забезпечує інтеграцію принципів сталості у повсякденну господарську діяльність. Практична цінність статті полягає у можливості використання отриманих результатів для розроблення стратегій цифрової трансформації органів державної влади, корпоративних структур і фінансових установ. Запропоновані підходи можуть бути застосовані при формуванні механізмів прозорої звітності, управління ланцюгами постачання, реалізації енергетичних проєктів та створенні інструментів кліматичного фінансування, що сприятиме підвищенню ефективності досягнення цілей сталого розвитку на національному та міжнародному рівнях.

Ключові слова: *блокчейн, цілі сталого розвитку, SDG, реалізація, цифровізація.*

Problem statement. The 2025 UN report on the implementation of the Sustainable Development Goals (SDGs) identifies a global financing gap of USD 4 trillion for developing countries. At the same time, debt servicing costs in low- and middle-income countries amounted to USD 1.4 trillion in 2023, effectively constraining their capacity to invest in green energy and social protection – critical components for achieving the SDGs [1].

In this context, blockchain technology emerges not merely as a technical innovation but as a capital optimization instrument enabling digital transformation, identified by the United Nations as one of the six priority areas for accelerating the 2030 Agenda. Blockchain technology facilitates the transformation of "declarations of intent" into "verified impact outcomes", which is essential for attracting private capital that requires high-precision ESG (Environmental, Social, and Governance) data [2].

As of 2026, the relevance of blockchain development is further reinforced by regulatory pressure, including mechanisms such as the Carbon Border Adjustment Mechanism (CBAM) and the Corporate Sustainability Reporting Directive (CSRD), compelling companies to adopt tools for

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immutable record-keeping and transparent auditing. Blockchain provides the necessary technological infrastructure to meet these requirements while minimizing the risks of "greenwashing" and fraud.

Thus, global challenges in achieving the UN SDGs – including financing deficits, declining trust in ESG reporting, high cross-border transaction costs, fragmented supply chains, and energy poverty (with over 84% of the population in developing countries residing in rural areas) – necessitate the search for instruments capable of addressing these systemic issues. Blockchain technology represents one such transformative instrument.

Analysis of recent research and publications. Academic discourse on the application of blockchain technology to SDG implementation has evolved significantly, particularly across two distinct phases: 2015–2022, when research primarily focused on the social dimension, and 2023–2025, when emphasis shifted toward environmental sustainability.

A notable bibliometric contribution was made by María Mar Miralles-Quirós, José Luis Miralles-Quirós, and Azahara Gil-Corbacho (2025), who systematized scholarly publications and structured the principal research directions. However, their study remains analytical and review-based, without conducting an independent empirical assessment of blockchain's direct impact on SDG implementation [3].

Almasria et al. (2024) examined the indirect impact of Fintech innovations on sustainable development. Afroz and Raghutla investigated the influence of various financial resources on renewable energy production. Anwar, Waheed, and Aziz analysed the role of green finance in achieving carbon neutrality, using Australia as a case study [4, 5].

An important recent contribution is the development of an integrative dual framework that overlays four technical components of blockchain (data, network, consensus, application) onto institutional pressures and stakeholder engagement dynamics. This approach explains how technological characteristics such as data immutability and self-executing smart contracts are transformed into economic value and social trust.

Given the relevance and complexity of the topic, further in-depth and systematized research on blockchain technology in SDG implementation remains necessary.

Formulating the purposes of the article. The aim of this study is to provide a comprehensive analysis of the role of blockchain technology in implementing the UN Sustainable Development Goals as of 2026, with particular emphasis on financial, energy, and climate mechanisms.

The objectives include:

- Systematizing the potential of blockchain technology in achieving the SDGs;
- Analysing the impact of 2025 regulatory initiatives on blockchain adoption in corporate reporting;
- Providing specific examples and case studies of successful projects in financial inclusion, renewable energy, and climate action.

Methodology. The research methodology is based on systemic analysis of secondary data, including scientific publications indexed in Scopus and Web of Science, official reports of UN departments (UN DESA, UNDP), and technical proposals from regulatory authorities (SEC).

A case study method was applied to examine practical outcomes of blockchain implementation in large corporations and international assistance programs.

The analysis was conducted from the perspective of transaction cost theory and institutional theory, enabling the assessment of the economic efficiency of replacing traditional intermediaries with algorithmic consensus mechanisms inherent in blockchain technology.

Presentation of the main research material. Blockchain architecture based on immutability of data and consensus protocols has become the operational pillar for many sustainable development initiatives. It transforms trust from a subjective category into a verifiable asset and supports the implementation of SDGs related to financial inclusion, digital identity, affordable and clean energy, responsible consumption and production, and climate action. An example of the application of the potential of blockchain technology in the implementation of sustainable development goals is systematized in Table 1.

Blockchain demonstrates potential applicability in 11 out of the 17 SDGs, underscoring its systemic relevance.

SDGs 1 and 10: Financial Inclusion and Digital Identity. A major obstacle to poverty eradication (SDG 1) remains the absence of formal identification and access to banking services. As of 2024, 2.6 billion people were still offline, and an even larger number lacked access to modern financial instruments.

Blockchain addresses this challenge through self-sovereign identity (SSI). In 2025, the SEC proposed a regulatory framework for digital assets emphasizing inclusive digital financial identity infrastructure. Built on W3C standards, such systems allow individuals to control their personal data and participate in the economy without requiring a traditional bank account.

Table 1

The potential for blockchain technology in the implementation of the UN Sustainable Development Goals

№	Sustainable Development Goals	Possible use of blockchain
1	No poverty	Transparent social payments, microfinance
2	Zero hunger	Tracing food supply chains
3	Good health and well-being	Medical records with a guarantee of privacy
4	Quality education	Diploma certification, open educational resources
5	Gender equality	Financial services for women in developing countries
7	Affordable and clean energy	Accounting for the production and exchange of renewable energy
8	Decent work and economic growth	Tracing ethical supply chains
10	Reduced inequalities	Access to banking services and digital identification
12	Responsible consumption and production	Tracing the origin of goods
13	Climate action	Carbon credits, transparent data in ESG reports
16	Peace, justice and strong institutions	Anti-corruption systems, E-voting

Source: systematized by the author [1, 6, 7, 8, 9, 10, 11]

Blockchain-enabled mechanisms include decentralized identifiers (DIDs), stable coins for cross-border remittances, tokenized incentives for financial literacy, and smart-contract-based peer-to-peer microfinance platforms.

We systematize the components of digital inclusion with the mechanism for their implementation based on blockchain and the expected results from their implementation in Table 2.

Practical implementations include blockchain-based financial bridges for farmers in India and platforms such as BanQu, which provides digital identity solutions for refugees. These mechanisms reduce remittance costs from 6–7% to below 1% and expand access to financial services for 1.7 billion unbanked individuals.

SDG 7: Affordable and Clean Energy. In 2025–2026, decentralized energy systems became key drivers of the transition to sustainable energy. Blockchain plays a critical role in the development of the Internet of Energy (IoE), enabling communities to produce, consume, and trade energy without reliance on monopolistic utilities.

Key technological directions include:

- ***Peer-to-peer energy trading,*** allowing solar panel owners to sell surplus electricity in real time, reducing transmission losses (6–8% globally).
- ***Smart contracts for microgrids,*** particularly in African countries such as Nigeria, where blockchain-based mini-grids provide energy access to rural communities.
- ***Blockchain Levelised Cost of Energy (BLCOE)*** models demonstrating reduced transaction costs and increased transparency in renewable energy auctions.

As of 2026, solar energy accounts for nearly 80% of global renewable capacity growth, with blockchain functioning as the digital backbone coordinating decentralized generation sources [4].

For example, the platform Power Ledger enables households to trade surplus solar energy, tokenize carbon credits, and ensure transparent renewable energy tracking.

Table 2

Ensuring digital inclusion based on blockchain technology

Digital inclusion component	Blockchain mechanism	Expected result after 2026 year
Identity registration (SSI)	Decentralized Identifiers (DIDs) and Cryptography	Access to social benefits and loans without intermediaries
Cross-border transfers	Decentralized ledgers and stable coins	Reducing the cost of transfers below 3% (SDG 10)
Financial education	Educational Loyalty Tokens (EduTokens)	Promoting digital literacy through non-material rewards
Microfinance	Smart contracts and P2P lending	Automated creditworthiness assessment based on alternative data

Source: systematized by the author based on [1, 4, 5, 9]

SDG 12: Responsible Consumption and Production. Blockchain has demonstrated significant impact in combating "greenwashing" and unethical supply chain practices.

Projects such as SSA Impact Chain, recognized by the UN in 2025, integrate suppliers, buyers, and financial institutions into unified blockchain-based supply networks, ensuring immutable recording of each production stage [7, 11].

Blockchain facilitates origin verification, enabling companies to prove compliance with labor and environmental standards. Modeling indicates that when on-chain data quality reaches 85%, data manipulation decreases by 47% due to cross-verification mechanisms.

Pharmaceutical pilot projects in 2025 demonstrated the ability to reduce drug traceability time from 16 weeks to 2 seconds, significantly mitigating counterfeit risks [8].

SDG 13: Climate Action. Carbon markets have historically faced criticism for opacity and double counting. By 2026, blockchain-based carbon credit platforms have become standard in voluntary markets.

In one Fortune 500 case (2024–2026), blockchain integration with satellite data and IoT sensors reduced verification time by 94% (from 127 days to 7 days), eliminated double-counting incidents, and automated regulatory reporting processes [11].

Technically, such systems combine IoT-based emissions measurement with smart contracts for automated token issuance. Each token possesses a unique digital identifier, preventing reuse after retirement.

Conclusions. As of 2026, blockchain technology has transitioned from conceptual experimentation to industrial-scale deployment, particularly in carbon markets and supply chain transparency. It has become a key instrument for compliance with international regulatory frameworks such as CBAM and CSRD.

Blockchain significantly reduces transaction costs, enhances verification efficiency, and democratizes access to green finance by enabling small-scale producers to monetize environmental impact through impact tokens.

Future research directions include:

- Integration of blockchain with artificial intelligence and digital twins for predictive resource management;
- Scalability and energy efficiency improvements through Proof-of-Stake and Layer 2 solutions;
- Development of international legal standards ensuring interoperability across blockchain platforms.

Overall, by 2026 blockchain technology has established itself as a reliable digital foundation for the 2030 Agenda. It not only enhances the efficiency of existing processes but also creates fundamentally new models of economic interaction in which sustainable development becomes a transparent and economically viable asset.

Further integration of blockchain into public governance and corporate strategy will be decisive for the success of the global sustainable development agenda over the next five years.

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