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# Conceptual Design of a Green Technology Module for Accounting and Sustainable Financial Reporting: An Exploratory Literature-based Study

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## Abstract

*Rising industrial greenhouse gas emissions have posed critical challenges to the transparency and reliability of corporate carbon emission reporting within financial statements. Efforts to control these emissions are becoming increasingly urgent in line with global commitments to achieving the Sustainable Development Goals (SDGs) 2030 and Net Zero Emissions (NZE) 2060 targets. The integration of technology into financial reporting systems, especially through the Internet of Things (IoT), blockchain, and Artificial Intelligence (AI), offers concrete solutions for real-time, transparent monitoring, reporting, and verification of carbon emission data. This study aims to develop a Green Technology Module that integrates the Internet of Things for real-time emissions monitoring, a permissioned blockchain ledger for secure and immutable data storage, and artificial intelligence for emissions analysis and forecasting. A qualitative descriptive method was employed to examine digital technology integration in sustainable accounting. The study is conceptual and exploratory, it proposes a design and identifies practical implementation propositions rather than reporting a deployed system. Findings indicate that the proposed module could enhance reporting accuracy and timeliness, bolster stakeholder confidence through a tiered dashboard supported by stakeholder theory, and may support carbon trading processes and adherence to green reporting standards, subject to empirical validation. It also identifies implementation barriers (cost, technical capacity, data quality, cybersecurity, governance and assurance uncertainty) and outlines a prioritized research agenda (phased pilots, and assurance design) required to validate the module's operational effectiveness. Future research should explore the development of standardized frameworks for the integration of IoT, blockchain, AI technologies into carbon emission accounting and sustainable financial reporting to assess implementation challenges, digital capacity needs, and strengthening multi-stakeholder collaboration frameworks.*

***Keyword**: Green Accounting; Sustainable Finance; Artificial Intelligence; Green Blockchain; Internet of Things.*

## INTRODUCTION

Indonesia continues to face rising greenhouse gas (GHG) emissions, primarily from carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$), which have increased steadily from 2018 to 2022 (BPS, 2024a) (**Figure 1**). The rise in emissions has negatively affected air quality, triggered unstable climate patterns, and posed health risks to the population. The industrial sector, particularly mining and coal production—reaching 687.4 million tons in 2022—remains a significant contributor to these emissions (BPS, 2024b). This indicates that the Indonesian economy continues to rely on carbon-intensive sectors. Carbon emission reduction is a policy priority in achieving the Sustainable Development Goals (SDGs) 2030 and Net Zero Emission (NZE) 2060 targets. The SDGs serve as a global call to action to end poverty, protect the planet, and ensure peace and prosperity for all. These goals are a universal commitment for both developed and developing countries (Bappenas, 2020). The Government of Indonesia has issued Presidential Regulation No. 98 of 2021 concerning the Implementation of Carbon Economic Value for Achieving NDC Targets and GHG Emission Control in National Development, which mandates recording and reporting of Climate Change Mitigation and Adaptation Actions and frames carbon pricing policy locally (Mulyani & Octalica, 2023). Article 69, Paragraph 1 of the regulation mandates that all business actors must record and report Climate Change Mitigation and Adaptation Actions, including Carbon Economic Value implementation. This regulation serves as the legal foundation to support emission reduction, especially in the industrial sector.

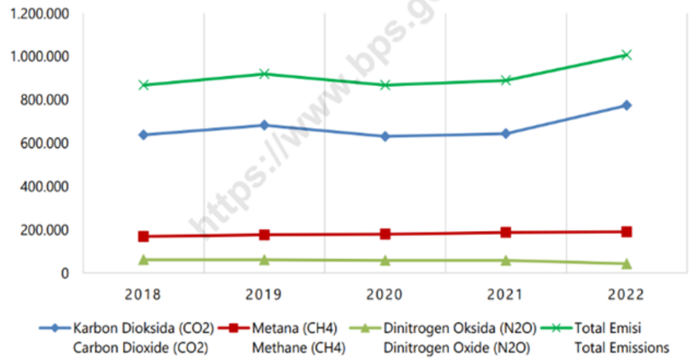


**Figure 1 Indonesia Greenhouse Gas Emissions (Gg CO2e), 2018-2022**

Source: BPS (2024a)

However, in practice, conventional reporting systems face limitations in real-time monitoring of carbon emissions data, making them vulnerable to errors and manipulation. The Volkswagen emissions scandal in 2015 is an illustrative example of how conventional systems may fail to prevent data falsification (Ticoalu & Agoes, 2023). The core problem addressed in this paper is that, despite policy drivers and component-level technological pilots, there is no widely adopted, audit-grade, end-to-end pipeline that links high-frequency sensor-derived GHG measurements to tamper-evident records and analytics outputs mapped directly to standardized disclosure items. This manifests as three measurable weaknesses: (1) reporting latency and data gaps that reduce timeliness of disclosures; (2) limited traceability that impedes external assurance; and (3) fragmented technical solutions that do not interoperate with accounting and audit workflows. These deficiencies undermine the usefulness of sustainability-related financial information for investors, regulators, and other stakeholders, motivating the conceptual development. This case illustrates the vulnerabilities of conventional systems and emphasizes the urgency of developing mechanisms for emission management and verification. Digital transformation is a critical component, particularly in the context of green economy implementation and carbon emission control. The financial reporting sector is one of the key areas in this transformation. Aligned with Society 5.0, the integration of information technology in



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financial accounting practices aims to produce more credible, accurate, and automated financial reports (Agunawan et al., 2023). Hence, digitalization in the financial sector can enhance transparency and accuracy in carbon reporting.

The growth of digital finance presents opportunities for adopting modern technologies such as Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT) via cloud computing. These technologies foster innovation and provide new avenues for improving transparency and efficiency, particularly through integration with blockchain. The combination of AI, Big Data, and IoT with blockchain concepts can significantly enhance the efficiency and accuracy of financial reporting systems (Zhou, 2022). Ultimately, these concepts can be applied to corporate financial reporting, particularly in the areas of green accounting and carbon trading. To address the challenges and capitalize on existing opportunities, a restorative economic policy approach is needed to mitigate the effects of carbon emissions. Therefore, this paper is exploratory and conceptual in nature: it proposes a Green Technology Module that integrates IoT (for real-time monitoring), a permissioned blockchain ledger (for secure and immutable storage), and AI (for analysis and forecasting), but does not present a developed or empirically tested prototype. This paper is explicitly exploratory, it presents design propositions and a prioritized empirical agenda rather than claims of a working, tested module. Unlike prior studies, that have only examined the integration of blockchain and AI (Adrian & Dewayanto, 2024), the use of AI and IoT in accounting systems (Susanti et al., 2024; Tariq & Rahim, 2024; Tan & Liu, 2023), or the impact of blockchain technology on environmental accounting (Sarhan, 2025; Mofatteh et al., 2024), this approach combines real-time sensor data collection with a secure, immutable ledger in blockchain, and AI-driven analytics. This initiative aims to contribute to the development of a theoretical framework and mechanism for technology-based sustainable financial reporting systems, analyze the implications of integrated systems on the efficiency and accuracy of carbon trading, and provide policy recommendations for regulators and industry stakeholders to adopt technology in support of the green economy.

## LITERATURE REVIEW

### Stakeholder Theory

Stakeholder theory holds that firms must recognize and balance the interests of all parties affected by their activities, ranging from direct contributors like employees and investors to indirect influencers such as regulators and civil-society groups (Gilbert & Rasche, 2008 in Nnadi & Mutyaba, 2025). In this framework, “real stakeholders” possess a legitimate claim and direct power over corporate decisions, whereas “stakewatchers” act as intermediaries or watchdogs on behalf of those stakeholders without holding a direct claim (Nnadi & Mutyaba, 2025). “Stakekeepers,” such as government bodies and media outlets, exercise external control through regulation and public scrutiny, even though they do not have a proprietary stake in the firm (Nnadi & Mutyaba, 2025). Effective stakeholder relations require firms to create and deliver value aligned with stakeholders’ expectations, particularly concerning environmental and social outcomes (Hatami & Firoozi, 2019). When organizations integrate sustainable accounting practices, such as a Green Technology Module combining blockchain, AI, and IoT, they signal responsiveness to stakeholder demands for transparency and accountability (Freudenreich et al., 2020). Consequently, demonstrating a genuine commitment to environmental, social, and governance (ESG) issues enhances stakeholder support and can drive wider adoption of green reporting systems (Mitchel, 2020). This study uses stakeholder theory to justify tiered access and dashboard transparency in the proposed module: increased transparency is expected to strengthen trust among regulators, investors, and the public, but the actual effects require empirical validation.

### SDGs 2030 and NZE 2060



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According to the United Nations (2015), the 2030 Sustainable Development Goals (SDGs) are a series of global agendas resolved by the United Nations (UN) in 2015. The 2030 SDGs have the main goal of ensuring that all human beings will prosper by aligning three main dimensions, namely economic, social and sustainability. The SDGs include 17 goals and 169 targets to support the UN's ambition for 2030.

On the other hand, Net Zero Emission (NZE) is a condition that indicates the quantity of carbon released in the air is smaller than that captured by the earth (Zahira & Fadillah, 2022). Based on the UN climate change conference or COP21, a number of countries in the world, including Indonesia, committed to achieving Net Zero Emission to limit average temperature rise to less than 2° C (Jatmiko, 2024). The Indonesian government has made efforts to support the achievement of this NZE, such as establishing regulations for the development of renewable energy for electricity supply, decarbonizing and mapping new green businesses in the business sector, and implementing carbon taxes to minimize carbon emissions (Zahira & Fadillah, 2022).

**Green Accounting**

Green Accounting, also referred to as environmental accounting, is an accounting approach that incorporates environmental costs into the financial performance of an organization (Sudarminto & Harto, 2023). This framework involves assessing environmental indicators such as carbon emissions, natural resource consumption, and ecological impacts, thereby supporting sustainability-oriented decision-making in financial reporting. Green accounting, also called environmental accounting, integrates ecological costs and benefits into corporate financial statements by quantifying metrics such as carbon emissions, resource depletion, and ecological degradation (Sudarminto & Harto, 2023). By internalizing environmental externalities, green accounting enhances transparency and enables stakeholders to assess a firm's true economic and environmental performance (Ibrahim & Gangodawilage, 2024).

Empirical research demonstrates that firms adopting green accounting practices often achieve improved operational efficiency, stronger stakeholder trust, and enhanced market valuation (Setyawati & Rochmatullah, 2025). Furthermore, accurate carbon disclosure facilitates participation in carbon trading schemes, allowing companies to monetize emission reductions while contributing to national and global climate targets (Dixit & Bardiya, 2024),

**Blockchain**

Blockchain is defined as an open, distributed ledger technology that records transactions in a secure, verifiable, and immutable manner (Baidya et al., 2021). In the context of sustainability and finance, blockchain offers enhanced transparency, traceability, and trust in data management systems, including carbon accounting and environmental compliance. The literature commonly discusses blockchain's immutability and smart contract potentials; however, most studies focus on conceptual advantages or pilot implementations rather than large-scale integrations with accounting systems.

**Artificial Intelligence (AI)**

Artificial Intelligence (AI) refers to machines' capability to perform cognitive functions typically associated with the human mind, such as perception, reasoning, learning, interaction, problem-solving, decision-making, and creativity (Entezari et al., 2023). AI enables predictive analytics and intelligent automation in sustainability monitoring and reporting systems. Nevertheless, AI's effectiveness depends on data quality and availability, issues that must be addressed in any integrated module.

**Internet of Things (IoT)**

The Internet of Things (IoT) is a network of interconnected devices that utilize sensors and software to collect, exchange, and act upon data in real time (Selay et al., 2022). In the context of



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environmental reporting, IoT facilitates automated data acquisition on emissions, resource usage, and environmental conditions, thus improving the accuracy and efficiency of green accounting systems. The literature shows IoT's strengths in monitoring, but also highlights practical challenges such as sensor calibration, data integrity at source, and the need for preprocessing before integration into larger systems.

## RESEARCH METHOD

This study employs a qualitative descriptive method with a literatur study approach to explore digital technology integration in sustainable accounting. According to Sugiyono (2018), qualitative descriptive research aims to portray a phenomenon in rich detail and depth; here the method is used to produce a clear, contextualized account of how IoT, blockchain, and AI are proposed to integrate into carbon accounting and financial disclosure practices. This approach prioritizes in-depth understanding of meanings, contexts, and characteristics rather than numeric measurement or statistical generalization. Data for the study consist of textual sources, such as peer-reviewed articles, technical reports, regulatory documents, and industry whitepapers, whose contents are descriptively synthesized to reveal prevailing concepts, mechanisms, and limitations. Analytic procedures follow a straightforward descriptive interpretation aimed at generating definitive, evidence-based descriptions of practices, perceptions, and proposed technical flows (Suardi, 2017). Given the exploratory and conceptual nature of the topic, this method enables the formulation of informed design propositions while acknowledging the need for subsequent empirical validation.

To enrich and contextualize the analysis, the study also incorporated various complementary sources, including: (1) academic articles that broaden perspectives on tax evasion and AI implementation; (2) books and official publications, such as annual reports, to provide empirical and theoretical grounding; (3) reputable websites from government bodies and international organizations; and (4) public documents, such as regulatory frameworks and policy papers relevant to environmental accounting and technological adoption. All collected literature was categorized, coded, and analyzed to ensure methodological triangulation and to strengthen the validity of the findings. This comprehensive review forms the basis for proposing a technology-integrated green financial reporting module, along with policy recommendations designed to address sustainability reporting challenges in both developed and emerging contexts.

## RESULTS

### Integration of Technology in Financial Reporting Systems for Carbon Emission Disclosure and Green Accounting

The integration of technology into financial reporting systems plays a crucial role in enhancing transparency, accuracy, and efficiency, particularly in the context of carbon emission reporting and green accounting, such as carbon trading (Aditia et al., 2023; Kustiwi et al., 2024). Traditionally, carbon emission reporting was conducted manually or through conventional systems, which were vulnerable to errors and manipulation. However, with the advancement of technologies such as the Internet of Things (IoT), blockchain, and Artificial Intelligence (AI), financial reporting systems can now be automated and validated with greater precision.

The Internet of Things (IoT) refers to technologies that connect various devices via the internet to share data, communicate, and operate wirelessly using embedded sensors and software (Selay et al., 2022). IoT enables machine-to-machine (M2M) interactions, thereby improving efficiency and control. In the context of emission reporting and green accounting, such as carbon trading, IoT plays a vital role as a monitoring system that automatically connects and measures data in



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real-time. Real-time monitoring through IoT minimizes human error, ensures measurement, and enables continuous and more accurate analysis of emissions.

Blockchain, on the other hand, is defined as an open and distributed ledger that records transactions efficiently, permantoloently, and verifiably (Baidya et al., 2021). Blockchain architecture consists of interconnected blocks linked through cryptography, with each block containing the cryptographic hash of the previous one. It also employs time-stamping and Merkle trees (a type of data structure) to record transactional data (El-Rewini et al., 2020). A key advantage of blockchain is its immutability; any data modification requires the alteration of all subsequent blocks, making it tamper-resistant and secure.

Artificial Intelligence (AI) refers to the ability of machines to perform cognitive functions associated with the human mind, such as perception, reasoning, learning, interaction, problem-solving, decision-making, and creativity (Entezari et al., 2023). AI can be used in emission reporting to collect and analyze data in real time, allowing companies to monitor their environmental impact more accurately and efficiently. Moreover, AI contributes to improved transparency and accuracy in carbon reporting and aids in strategic decision-making concerning emission reductions.

The utilization of blockchain, AI, and IoT for efficient carbon emission management and reporting has shown significant benefits in several companies. Industry demonstrations indicate feasibility for components: Hyundai Motor Company and Kia have developed supplier-focused monitoring (SCEMS) that integrates ledger and AI elements for supplier emissions validation; Walmart applies AI-driven logistics optimization to reduce delivery emissions (Kim, 2023; Taylor, 2023). Walmart's AI-driven route-optimization technology, deployed at scale within its logistics operations and made available to third parties, has reportedly avoided 94 million pounds of $CO_2$ by eliminating some 30 million unnecessary miles, showing the potential of AI to reduce operational emissions (Walmart, 2024; Dive, 2024). In the nature-based carbon space, Verra's pilot with Pachama demonstrates how satellite imagery combined with machine-learning can deliver digital measurement, reporting and verification (dMRV) for forest carbon projects, signaling that AI and remote sensing can materially improve transparency in carbon accounting (World Bank, 2022; Pachama, 2024). Academic and policy reviews likewise find that blockchain solutions for carbon markets are maturing, dozens of pilots and tokenization projects exist, pointing to growing technological readiness for ledgered carbon tracking even as integration challenges remain (Sipthorpe, et al., 2022; Thanasi-Boce & Hoxha, 2025). These practical cases support feasibility at the component level but do not provide evidence of a full-stack, accounting-integrated module suitable for audit-grade financial disclosures.

While these component-level cases strengthen confidence in individual technologies, the claim that the proposed Green Technology Module will *per se* increase reporting accuracy, accelerate report preparation, and remove existing barriers through a dashboard is not yet empirically substantiated: peer-reviewed studies and systematic reviews show a persistent evidence gap for fully integrated, audit-grade pipelines that link sensors, ledger, AI, statutory disclosure and external assurance (Sipthorpe, et al., 2022; Thanasi-Boce & Hoxha, 2025). Moreover, adoption literature highlights practical obstacles, high upfront and ongoing costs, technical skills shortages, data-quality and interoperability issues, cybersecurity risks, and legal/assurance uncertainties, that can blunt or delay the expected benefits unless explicitly mitigated in pilots and governance design (Pachama, 2024; EUBlockchain, 2022). Consequently, the module's asserted performance improvements should be framed as testable hypotheses and validated via targeted practitioner interviews and phased pilots that collect concrete metrics (sensor accuracy/uptime, ledger latency and integrity, AI precision/recall, and assurance cost) before asserting firm-level/policy impacts.

However, the integration is currently fragmented. Most systems are limited either to monitoring



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(via IoT), validation (via blockchain), or prediction (via AI), but not to a comprehensive framework that unites the three technologies into a coherent, real-time reporting architecture embedded in financial reporting standards. This study introduces a "*Green Technology Module*" that consolidates real-time emission monitoring, secure data verification, and AI-driven analytics for integrated financial and environmental reporting. The proposed system builds upon a multi-tier data management structure using blockchain (Hyperledger Fabric), embedded IoT sensors for continuous emissions measurement, and AI-powered dashboards for strategic forecasting. The system emphasizes data security, transparency, and automated compliance with IFRS S1 and S2. The module emphasizes governance (role-based), evidence packages for assurance (calibration certificates, chain-of-custody logs), and staged implementation to manage costs and complexity.

**Implementation Mechanism of Technological Integration: The Green Technology Module**

The findings reinforce the theoretical propositions of stakeholder theory, which emphasizes the importance of firms addressing the interests and concerns of both internal and external stakeholders (Freudenreich et al., 2020; Nnadi & Mutyaba, 2025). By integrating IoT, blockchain, and AI into carbon reporting systems, organizations can fulfill their obligations to real stakeholders (e.g., regulators, investors) through enhanced transparency and accuracy, while also meeting the expectations of stakewatchers (Wardiyah et al., 2025).

Furthermore, the proposed Green Technology Module aligns with the SDGs 2030 and NZE 2060 agendas, specifically by supporting SDG 13 (Climate Action), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production). Through its technological convergence, the model also embodies the principle of green accounting (Sudarminto & Harto, 2023), internalizing environmental externalities and transforming them into measurable, verifiable data points within a firm's financial disclosures.

While the use of IoT in emission tracking has already been proven in large corporations, this study's novelty lies in designing an end-to-end, multi-stakeholder financial reporting system that also includes automated compliance mechanisms through smart contracts. Unlike previous studies that examined blockchain and AI separately (Adrian & Dewayanto, 2024; Sarhan, 2025), this study presents a unified architecture that reflects a systems-thinking approach to sustainability accounting. The AI layer, in particular, adds predictive capabilities and policy-oriented insights through scenario modeling, an aspect that remains underdeveloped in prior implementations.

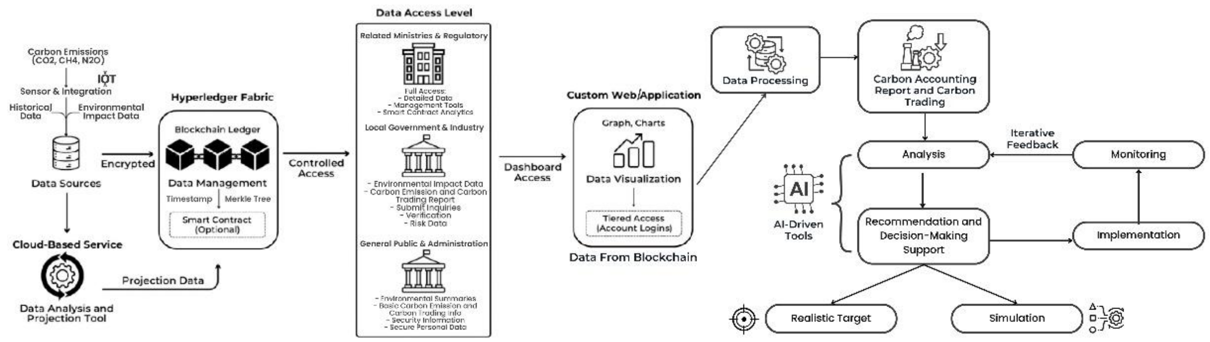


**Figure 2 Mechanism of Workflow System Integration of IoT, Blockchain, and AI**

Source: Processed by the Author (2025)

The system illustrated in **Figure 2** represents a concrete implementation of the convergence of the Sustainable Financial Reporting System within a Green Technology Module framework. The process begins with the collection of carbon emission data ($CO_2$, $CH_4$, $N_2O$) using Internet of Things (IoT) sensors, which are integrated to monitor real-time emission data. In addition, historical data (such as maintenance records and risk assessments) and environmental impact data are also input into the system as part of the data sources. All information is stored in encrypted



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databases to ensure data integrity and security. Moreover, the data sources are also backed by cloud-based services, which enable the processing and analysis of both historical and real-time data to produce projections that support long-term planning and decision-making.

Subsequently, the data is encrypted and managed using a blockchain ledger implemented through Hyperledger Fabric, a permissioned blockchain platform, for securely, transparently, and immutably storing and managing real-time data (Niveditha et al., 2020). This system utilizes timestamps and Merkle trees to verify the authenticity and sequence of the data, while smart contracts can optionally be implemented to automate specific processes based on predefined conditions (Liu & Wu, 2024; Taherdoost, 2023). The adoption of blockchain aligns with the "Green Blockchain" principle, which supports sustainable financial reporting by minimizing the carbon footprint of the reporting process.

A tiered access control mechanism facilitates transparency while maintaining data security for relevant stakeholders. Government ministries, such as the Ministry of Environment and Forestry, the Ministry of Energy and Mineral Resources, and the Ministry of Finance, as well as carbon emission regulatory bodies have full access to detailed data, management tools, and smart contract analytics. Local governments and industries are provided with access to environmental impact data, carbon emission reports, carbon trading platforms, emission inquiries in financial statements, verification tools, and relevant risk data. Finally, the general public and administrative entities have limited access to aggregated summaries of environmental impact, carbon emission and trading information, security insights, and personalized data dashboards for informational access.

Subsequently, data visualization is delivered through a dedicated application or web dashboard, which presents information in the form of graphs and charts. Access to this dashboard is regulated by user tiers via login authentication systems, providing a clearer understanding of emission trends and patterns and facilitating data-driven decision-making. The processed data then enters the advanced reporting phase, covering carbon emission reporting in financial statements, carbon trading processes, and ultimate decision-making. The integration of AI, as reflected in the “AI-Driven Tools” component, represents a major advancement in environmental data analytics. AI is employed to process blockchain-derived data, automatically generate carbon accounting reports, and deliver recommendations and insights for strategic decision-making.

The analysis results are subsequently used to set realistic emission targets and to simulate various scenarios. This process produces concrete recommendations that are then implemented, while continuous monitoring and iterative feedback loops enable ongoing improvement. The system allows industries to continuously adapt their strategies based on real-time data and accurate forecasting. Ultimately, this full integration of technology with the accounting system is designed to offer a comprehensive approach to industrial carbon emission management.

Compared to much prior research that treats blockchain, IoT, and AI as separate strands, this study proposes an *end-to-end* sensor, ledger, analytics pipeline that explicitly maps technical outputs to disclosure taxonomies and assurance evidence. Systematic reviews find that existing literature and pilot projects overwhelmingly cover component functions, IoT for monitoring, blockchain for tamper-evident records, or AI for forecasting, while rigorous, audit-grade integrations remain rare (Mulligan, et al., 2024; Lanfranchi, et al., 2025). For example, blockchain-for-sustainability reviews document many pilots and concept papers but note a gap in full operationalization into finance and assurance workflows; likewise, IoT and ML reviews report strong measurement and forecasting advances but little work demonstrating those advances feeding directly into statutory disclosures or external assurance (Mulligan, et al., 2024). Therefore, the novelty of the present module lies not only in technological combination but in designing the governance, metadata, and evidence packages that would be required to move component successes into accounting-grade practice (Ramanna, 2025).



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Practical deployments substantiate the feasibility of core components: Hyundai Motor Company publicly launched an AI-enabled, blockchain-backed Supplier $CO_2$ Emission Monitoring System to collect and validate supplier emissions data, demonstrating supplier-level data collection and ledgered validation at scale (Hyundai, 2023). Walmart's AI route-optimization has been credited with avoiding some 94 million pounds of $CO_2$ through large-scale operational improvements, showing clear emissions benefits to logistics (Loeb, 2024). In nature-based MRV (measurement, reporting, verification), Verra's and Pachama's dMRV pilots combine remote sensing and machine learning to accelerate verification of forest carbon projects, indicating that AI + remote sensing can materially improve transparency for specific carbon asset classes (World Bank, 2022; Pachama, 2024). Together these cases validate components of the proposed module. However, they stop short of demonstrating a continuous, auditable pipeline that directly supplies statutory financial disclosures and third-party assurance (Jenkins, et al., 2025).

Realizing an enterprise-grade Green Technology Module may faces well-documented barriers: high upfront and operating costs, scarcity of cross-disciplinary technical skills, persistent data-quality and interoperability issues (Scope definitions), cybersecurity and privacy exposures, and regulatory/assurance uncertainty about whether ledgered and AI-derived outputs meet audit standards (Tangsakul & Sureeyatanapas, 2024). Adoption literature and market commentary emphasize that these risks can blunt or delay benefits unless mitigated through careful governance, standards alignment, and staged investment (Tangsakul & Sureeyatanapas, 2024). Accordingly, the prioritized empirical agenda should begin with phased pilots (single-asset → enterprise → supplier chain), structured practitioner interviews (CFOs, sustainability leads, IT architects, auditors, regulators), and co-design with assurance providers to develop evidence packages (logs, chain-of-custody, ledger proofs) that auditors and regulators will accept (IAI, 2025). Only by coupling technical pilots with assurance design and CBA can the module's operational effectiveness and policy relevance be credibly demonstrated (Ramanna, 2025; Walmart, 2024).

**Analytical Mechanism of Green Accounting Reports using AI (Advanced Process)**

Carbon accounting differs fundamentally from financial accounting, as its primary focus is not on the financial impacts of an entity's activities, but rather on the measurement of greenhouse gas (GHG) emissions generated by corporations, governments, or individuals. As such, carbon accounting reports are a crucial step for businesses aiming to reduce their emissions. A carbon accounting report encompasses the calculation, analysis, measurement, and reporting of carbon emissions produced by an organization or industry (Normative, 2024).

With the advancement of technology, the utilization of Artificial Intelligence (AI) in managing carbon reporting represents a significant breakthrough in supporting environmental sustainability efforts. AI can automate the collection and analysis of emission data more efficiently and accurately, thereby assisting organizations in understanding the environmental impacts of their operations. Furthermore, AI's ability to detect patterns and forecast emission trends enables companies to formulate more effective emission reduction strategies. In this way, AI plays a pivotal role in accelerating the achievement of global sustainability goals and mitigating the impacts of climate change (**Figure 3**).

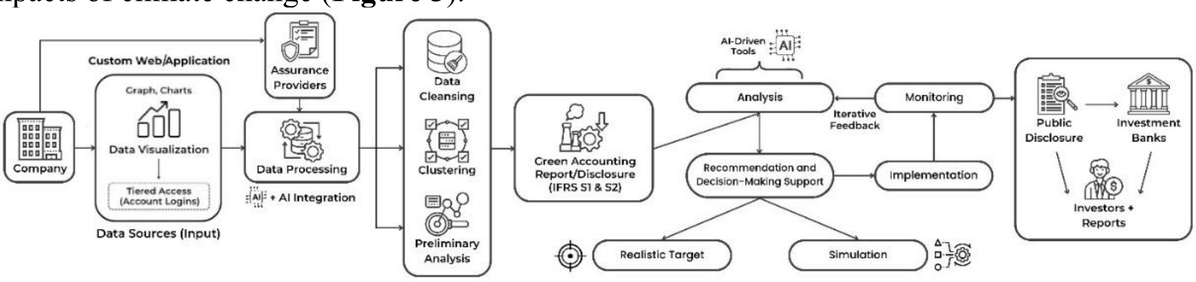




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**Figure 3 Advanced Process Mechanism of Reporting with AI**

Source: Processed by the Author (2025)

The system begins with input data from companies, which can be visualized through dashboards processed via dedicated web or mobile applications. These dashboards present data in graphical formats and charts, facilitating a better understanding of data trends and patterns. Access to the dashboard is governed by user-level permissions (based on data access levels) through a secure login system, thus supporting informed and data-driven decision-making.

Following data input, the system proceeds through a series of AI-enhanced processing stages comprising three core components: data cleansing to eliminate inconsistencies and errors; data clustering to identify patterns and trends; and preliminary analysis as a foundation for strategic decision-making. Additionally, companies can collaborate with independent assurance providers to enhance the credibility and data accuracy. With third-party validation, firms can ensure that the sustainability information disclosed meets established standards of transparency and compliance.

Subsequently, data undergoes advanced processing, specifically in the context of generating green accounting reports and disclosures aligned with IFRS S1 and S2 standards, as well as facilitating final decision-making. The integration of AI-driven tools within the system represents a significant advancement in environmental data analytics. AI can be employed to automatically generate sustainability reports in compliance with IFRS S1 and S2, while also providing actionable recommendations derived from analytical insights.

Until very recently Indonesia only had exposure drafts for national sustainability disclosure standards (PSPK 1 & PSPK 2) issued by the Institute of Indonesia Chartered Accountants (IAI), and those drafts have been the subject of consultation and staged ratification rather than immediate legal mandate (IAI, 2025). While Perpres 98/2021 establishes a carbon-pricing policy framework and strengthens the policy case for verifiable emissions data, it does not by itself constitute technical disclosure requirements or an assurance regime that would automatically recognize blockchain-backed or AI-derived evidence as audit-grade (Climate Laws, 2021). Industry guidance and trackers indicate PSPK exposure drafts were designed to align with IFRS S1/S2 and are expected to become effective on a future timetable (with proposals pointing to 1 January 2027 and early adoption options), but final texts, regulator acceptance and implementation guidance (including what constitutes acceptable assurance evidence) remain in progress (PwC, 2025). Consequently, claims of immediate compliance or seamless support for carbon trading should be framed as conditional: the module's outputs will need to be demonstrated, accepted by regulators and audit firms, and incorporated into final PSPK/implementation rules before the system can reliably serve statutory reporting or carbon-market compliance purposes.

The outcomes of such analyses are then used to set realistic targets and simulate various future scenarios. This process generates concrete recommendations, which can be implemented and continuously monitored through iterative feedback loops to enable ongoing improvement. The system allows industries to dynamically adapt their strategies based on real-time data and accurate forecasts. Ultimately, the integration of technology within this ecosystem offers a holistic approach to industrial sustainability reporting while ensuring accurate and transparent data for the public, investors, and investment banks (IAI, 2025; Deloitte, 2025).

**Environmental and Economic Implications**

The application of Green Blockchain, Internet of Things (IoT), and Artificial Intelligence (AI) in financial reporting has significant environmental implications. First, the implementation of these technologies facilitates more accurate and automated monitoring of carbon emissions, thereby encouraging companies to adopt more environmentally friendly policies. Second, the reduction in carbon emissions contributes directly to improvements in the Air Quality Index (AQI), as it leads to decreased air pollution. Third, lower emission levels help maintain climate



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balance and mitigate the effects of global warming, which is a major driver of climate change (Patrianti et al., 2020). Fourth, such technological integration accelerates the transition to renewable energy and motivates companies to shift toward green energy such as solar and wind.

From an economic perspective, the implementation of these technologies also yields positive outcomes. First, enhanced transparency and efficiency in financial reporting and green accounting, such as carbon trading can boost corporate profitability. Second, improved information disclosure strengthens investor confidence and generates new employment opportunities, thereby contributing to a reduction in unemployment rates (Trionesia & Iriansyah, 2022). Third, greater transparency and data-driven decision-making support an increase in firm market value on stock exchanges. Fourth, digital-based Green Blockchain integration helps reduce operational risks and enhances data security, which in turn promotes corporate efficiency and national economic growth (Fajrul & Room, 2023). Lastly, more transparent carbon trading and taxation systems, enabled by real-time data monitoring, can increase government revenue through improved tax compliance and oversight (Rahma et al., 2023).

## CONCLUSION, LIMITATION, AND SUGGESTION

### Conclusion

The urgent need to enhance transparency and reliability in carbon emission disclosure led to the development of a Conceptual Design Green Technology Module that embeds real-time IoT monitoring, permissioned blockchain storage, and AI-driven analytics directly into financial reporting systems. By shifting from manual, periodic reporting to a continuously synchronized data architecture, this study addresses critical vulnerabilities in existing green accounting frameworks and aligns technological innovation with regulatory mandates.

The review finds that these technologies offer complementary capabilities, IoT for high-frequency facility-level measurement, permissioned ledgers for tamper-evident recordkeeping and governed data sharing, and AI for data cleansing, anomaly detection, clustering and forecasting, but the empirical record remains largely component- and pilot-level rather than demonstrating sustained, audit-grade end-to-end integrations. The proposed staged architecture (sensor ingestion, secure buffering with metadata and calibration logs, permissioned blockchain recording, AI analytics, and tiered dashboards with role-based access) addresses key governance and evidentiary requirements by design, yet its operational success is conditional on resolving practical barriers: substantial upfront and operating costs, interdisciplinary technical capacity, sensor calibration and interoperability standards, cybersecurity and privacy protections, and regulatory and assurance acceptance of ledgered and AI-derived evidence. Consequently, the pathway from technical plausibility to credible practice requires phased pilots (single-asset → enterprise → supplier chain), structured practitioner interviews (CFOs, sustainability leads, IT architects, auditors, regulators), and co-design with assurance providers to develop evidence packages and performance metrics that auditors and regulators will accept.

These technologies can enhance transparency in carbon trading and emissions disclosure in financial statements, thereby supporting corporate efforts to achieve carbon reduction targets. From an environmental perspective, this system contributes to reducing carbon emissions, improving air quality, and stabilizing the global climate. From an economic standpoint, the adoption of such digital technologies increases operational efficiency, drives corporate profitability, enhances investor confidence, and ultimately supports aggregate economic growth. Furthermore, this system can accelerate the transition to renewable energy and foster the creation of new green jobs, thus contributing to long-term sustainable economic development.



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**Limitation**

Although this study proposes a comprehensive Green Technology Module, it has not yet been tested in real-world case studies to validate its performance across diverse industrial settings. The absence of empirical pilots limits insights into interoperability challenges among IoT, blockchain, and AI under actual regulatory frameworks. Without standardized integration guidelines, the model's scalability and stakeholder adoption remain speculative. This study is limited by the absence of pilot deployments to assess the digital competencies and capacity-building requirements necessary for effective implementation. Furthermore, it has not tested multi-stakeholder collaboration mechanisms in practice, restricting its ability to offer concrete guidance for policymakers and industry actors.

**Suggestion**

Future research should explore the development of standardized frameworks for the integration of IoT, blockchain, and AI technologies into carbon emission accounting and sustainable financial reporting. In particular, interdisciplinary studies are needed to examine the interoperability of these technologies within existing environmental and financial regulatory structures. Further investigation is also warranted into capacity-building models and best practices for equipping industry actors with the necessary digital competencies to utilize these systems effectively. Additionally, future research should assess the socio-economic impact of technology-driven carbon reporting systems, including their role in promoting renewable energy transitions, enhancing investor trust, and creating green employment opportunities. Strengthened multi-stakeholder collaboration frameworks—encompassing government regulators, industries, financial institutions, and civil society—also present a promising area for in-depth analysis to ensure transparency and accountability in carbon markets and green finance.



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