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Use of AI in the Enhancement of Green Accounting and Sustainability Reporting

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Abstract:

Artificial Intelligence (AI) is reshaping corporate sustainability reporting, green accounting, and the measurement, disclosure, and assurance of Environmental, Social, and Governance (ESG) impacts. As global regulatory frameworks such as the Global Reporting Initiative (GRI) Standards and the IFRS Sustainability Disclosure Standards (IFRS S1 and S2) increasingly demand higher-quality, comparable, and verifiable sustainability information, organizations are turning to AI systems to automate carbon accounting, environmental footprint analysis, and integrated sustainability reporting.

This paper critically examines the role of AI in enhancing sustainability reporting and green accounting, including the automation of climate disclosures, real-time environmental monitoring, carbon footprint measurement, and AI-assisted assurance. It reviews theoretical foundations, technological mechanisms, practical applications, and governance challenges surrounding responsible AI in sustainability reporting.

The findings indicate that although AI significantly improves the accuracy, timeliness, and decision-usefulness of sustainability information, concerns regarding data quality, algorithmic transparency, ethical risks, and governance gaps must be addressed to ensure the credibility and global acceptance of AI-enabled sustainability reporting.

Keywords: Artificial Intelligence, Green Accounting, Sustainability Reporting, ESG Disclosure, Automated Sustainability Disclosures, AI-Driven Data Analytics, IFRS Sustainability Standards

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Introduction

The international move to sustainable development and low-carbon transition has placed more pressure on the organizations to present their environmental and social performances with more specificity and openness. The sustainability reporting frameworks, including GRI Standards, IFRS Sustainability Disclosure Standards (IFRS S1 and S2), the Sustainability Accounting Standards Board (SASB), and the Task Force on Climate-related Financial Disclosures (TCFD), are increasingly compelling corporations to disclose specific, verifiable, and forward-looking information on the topic of climate risks, carbon emissions, and environmental performance (Adams and Abhayawansa, 2021). Artificial intelligence (AI) in that case has become one of the defining technologies that can allow organizations to gather, analyze, and report on sustainability information more effectively. Automated data extraction, carbon accounting, risk models, and predictive environmental analytics are automated by AI, thus moving traditional sustainability reporting towards a more dataless, compliance-based, manual process to a data-intensive, technology-enabled strategic procedure.

Green accounting or environmental accounting is the accounting scheme that compels companies to quantify and capitalize on the environmental expenses, natural resource usage, emissions, and ecological externalities within their financial reports (Schaltegger and Burritt, 2018). Nevertheless, the data requirements of green accounting have soared to new heights with regulators requiring accurate reporting of emissions, traceability of the supply-chain and combined corporate reporting. Sustainability data collection and reporting practices by use of manuals are usually time-consuming, errors, and not consistent among companies. Conversely, AI-based platforms have the potential to handle large amounts of structured and unstructured information and, therefore, conduct almost real-time environmental survey, automated emissions calculations, and enhanced sustainability decision-making analytics.

The paper presents a critical and academic discussion of the role of AI in improving green accounting and sustainability reporting. It looks at how AI automates sustainability disclosures, enhances carbon accounting, enhances integrated reporting, and assurance functions according to GRI, IFRS, and other related global standards of sustainability disclosures. It further assesses the restrictions, governance issues, and ethical risks of AI in measuring sustainability and its reports. The goal is to provide a holistic research-supported argument on the fact that, although AI promotes rigor and efficiency of sustainability reporting, robust governance and ethical-friendly AI systems are necessary to guarantee credible, unbiased, and ethically consistent sustainability information.

2. Theoretical Background: AI, Sustainability Reporting, and Green Accounting

Sustainability reporting has evolved into a core component of corporate accountability, reflecting an organization's environmental, social, and governance (ESG) impacts. It is guided by global frameworks such as the Global Reporting Initiative (GRI), the International Financial Reporting Standards for Sustainability (IFRS S1 and S2), and the Sustainability Accounting Standards Board (SASB). These frameworks provide the necessary structure for firms to disclose their climate-related risks, resource consumption, carbon emissions, and social performance (KPMG, 2022). Green accounting further deepens this agenda by integrating environmental costs—such as resource depletion, waste generation, and ecological externalities—into traditional financial accounting systems (Bebbington & Larrinaga, 2014). This ensures that financial statements reflect a more holistic view of corporate performance, one that includes both economic outcomes and environmental impacts.

Against this backdrop, Artificial Intelligence has emerged as a transformative force that is reshaping sustainability reporting and green accounting. AI encompasses a wide spectrum of computational technologies, including machine learning (ML), natural language processing (NLP), robotic process automation (RPA), and computer vision—all of which enable organizations to process vast datasets with greater speed, accuracy, and reliability. AI's contribution in this field can be understood through three interrelated mechanisms. First, AI enhances data automation by extracting, classifying, and validating sustainability-related information from enterprise systems, IoT sensors, supply-chain networks, environmental databases, and unstructured documents. This resolves long-standing issues of manual data-entry errors and fragmented data sources. Second, AI strengthens analytical capabilities through advanced machine learning models that forecast emissions, simulate environmental performance, assess climate risks, and identify patterns that would be difficult to detect through human analysis alone. Third, AI supports strategic decision-making by connecting sustainability metrics with financial performance, risk exposure, and regulatory obligations. Through such decision augmentation, organizations can formulate more informed sustainability strategies, improve resource efficiency, and align operations with national and global climate commitments.

As sustainability reporting becomes increasingly mandatory across jurisdictions—especially with

the global adoption of IFRS S1/S2 and enhanced regulatory monitoring—AI provides the scalability, real-time processing, and analytical precision required to meet rising disclosure expectations. Thus, AI is not merely a technological supplement but a foundational enabler of the next generation of sustainability reporting and green accounting.

3. Artificial Intelligence and Automation of Sustainability Disclosures

Artificial Intelligence has become central to automating sustainability disclosures, especially as reporting frameworks like GRI and IFRS S1/S2 require organizations to consolidate data from diverse and often fragmented sources. Traditionally, sustainability information has been gathered manually through spreadsheets, audits, and supplier submissions, creating risks of inconsistencies, delays, and reporting inaccuracies. AI-driven data extraction technologies—including NLP, RPA, and computer vision—substantially reduce these challenges by capturing information from invoices, environmental logs, supplier documentation, regulatory filings, and IoT-generated datasets (Avery & Bergsteiner, 2021). Once extracted, AI algorithms automatically classify and structure the data in accordance with specific disclosure indicators, such as GRI topic standards or IFRS sustainability metrics, thereby ensuring consistency and accelerating the reporting cycle.

In addition to extraction, AI systems have begun to automate the mapping of sustainability data to global reporting frameworks. Using machine learning techniques, AI models can identify which dataset corresponds to which disclosure requirement, such as GRI 302 (Energy), GRI 303 (Water), GRI 305 (Emissions), or IFRS S2 (Climate-related Disclosures). This automated alignment not only minimizes human error but also improves comparability across companies and industries. As global regulations increasingly converge toward standardization, such automated mapping becomes indispensable for multinational corporations who must comply with multiple frameworks simultaneously. Furthermore, AI has transformed sustainability reporting from a static, periodic activity into a dynamic and continuous monitoring process. With IoT sensors embedded across manufacturing facilities, supply chains, and energy systems, real-time data flows feed into AI-powered dashboards, enabling organizations to monitor key environmental indicators such as emissions, waste generation, and energy consumption instantaneously (Eccles & Krzus, 2018). These dashboards facilitate proactive environmental management, early detection of inefficiencies, and rapid corrective actions, thereby improving both sustainability performance and regulatory compliance.

4. AI in Carbon Accounting and Carbon Footprint Measurement (Expanded in Paragraph Form)

Carbon accounting is one of the most complex dimensions of sustainability reporting, particularly when measuring Scope 3 emissions that extend across extensive and globalized supply chains. AI has revolutionized carbon accounting by automating the collection and analysis of emissions data from operational energy meters, transportation networks, procurement systems, satellite imagery, and IoT devices. By processing these large datasets, AI calculates emissions with greater precision, automatically selects appropriate emission factors, and reduces human error—leading to more robust and audit-ready carbon footprints (Wiedmann & Lenzen, 2018).

AI-driven systems also provide sophisticated tracking of Scope 1, Scope 2, and Scope 3 emissions. For Scope 3 emissions, which often represent the largest portion of a company's carbon impact, AI fills data gaps through predictive analytics, supplier modeling, and statistical estimation techniques (Huang et al., 2020). This level of detail enhances transparency, improves supplier accountability, and strengthens the credibility of sustainability disclosures.

Moreover, AI enables predictive emissions modeling, allowing organizations to simulate future emission scenarios based on potential regulatory changes, shifts in energy sources, production volumes, or technological innovations. These predictive emissions models (PEMs) assist firms in aligning with science-based targets and

long-term net-zero strategies. AI also accelerates Life Cycle Assessment (LCA) by analyzing environmental impacts across every stage of a product's lifecycle—from raw materials extraction and manufacturing to transportation, usage, and end-of-life disposal. This allows companies to generate more comprehensive disclosures in compliance with standards such as GRI 305 and IFRS S2.

5. AI in Integrated Reporting and Sustainability Performance Analysis

Integrated Reporting (<IR>) emphasizes the interconnectedness of financial and sustainability information, aiming to provide stakeholders with a holistic understanding of how organizations create value over time. AI significantly strengthens integrated reporting by identifying complex relationships between ESG indicators and financial outcomes. Through advanced analytical models, AI uncovers correlations between variables such as emissions intensity and profitability, resource efficiency and operational risk, or climate resilience and market valuation (de Villiers et al., 2020). These insights help investors and stakeholders evaluate long-term performance and risk exposure more effectively.

AI also contributes to improved materiality assessments, a critical requirement of both GRI and IFRS standards. Using NLP and machine learning, AI can analyze stakeholder sentiment, emerging regulatory trends, media coverage, industry risks, and global sustainability issues to identify which topics are most material to an organization. This ensures that sustainability reports remain relevant, stakeholder-oriented, and aligned with evolving expectations.

Additionally, AI strengthens climate-risk analytics by supporting scenario planning. Under IFRS S2 and the TCFD framework, companies must disclose their exposure to physical climate risks (such as floods, heatwaves, storms) and transition risks (such as carbon pricing or renewable energy shifts). AI models employ reinforcement learning and probabilistic forecasting to simulate these scenarios, thereby helping firms anticipate risks and optimize their resilience strategies.

Finally, AI assists in the preparation of sustainability narratives through automated report generation. Using advanced NLP techniques, AI systems convert structured data into coherent text that aligns with disclosure requirements. Although human oversight remains essential, this automation significantly reduces the time required to prepare GRI- and IFRS-aligned sustainability reports.

6. AI and Assurance of Sustainability Reporting

Assurance has become a critical component of sustainability reporting, as investors, regulators, and stakeholders demand credible and verifiable ESG information. AI enhances assurance processes by conducting automated data validation, anomaly detection, and consistency checks. Machine learning models can identify irregularities in emissions data, water usage figures, and waste metrics, flagging inconsistencies that may indicate reporting errors or manipulation.

AI also strengthens audit trail mechanisms by generating detailed metadata on data sources, transformations, and computational steps. This traceability is essential for auditors who must verify the accuracy and completeness of sustainability information. When integrated with blockchain, AI further enhances supply-chain traceability, allowing auditors to validate emission data across multiple tiers of suppliers (Crosby et al., 2016).

In addition, AI supports external assurance by cross-validating corporate sustainability disclosures against independent data sources such as satellite imagery, IoT sensor readings, and government databases. This multi-source verification significantly improves the reliability of sustainability reporting and reduces dependence on self-reported information.

7. Challenges and Ethical Issues in AI-Enabled Sustainability Reporting

Despite its advantages, AI introduces several challenges and ethical issues in sustainability reporting. One of the foremost concerns is data quality. Sustainability datasets are often

incomplete, unstructured, or inconsistent, and machine learning models trained on flawed data may amplify existing inaccuracies (Graham et al., 2020). This threatens the credibility of AI-generated sustainability insights and underscores the need for rigorous data governance.

Another major challenge is the lack of transparency in AI models, particularly those that function as "black boxes." The opacity of AI decision-making processes conflicts with sustainability principles that prioritize transparency and accountability. Stakeholders may hesitate to trust sustainability metrics generated by models whose inner workings are not interpretable.

AI systems also raise concerns about algorithmic bias. Biases in training data may lead to distorted sustainability assessments—for example, underestimating emissions in certain geographical regions or misclassifying climate risks for particular suppliers (O'Neil, 2016). This can result in unfair reporting outcomes and weaken the integrity of sustainability disclosures.

Furthermore, ethical risks such as greenwashing may arise if AI is used to selectively highlight favorable data or obscure negative environmental performance. Without adequate governance, companies might misuse AI for impression management rather than accurate reporting. This risk is compounded by gaps in existing sustainability frameworks, most of which do not yet provide detailed guidelines for AI governance.

8. Governance of AI in Sustainability Reporting (Expanded in Paragraph Form)

Effective governance is essential to ensure that AI enhances rather than undermines sustainability reporting. AI systems must align with global standards such as ISO 14064 for greenhouse gas accounting, the GRI Standards, IFRS S1 and S2, the OECD AI Principles, and the EU AI Act. These frameworks provide the ethical and operational foundations necessary for responsible AI deployment.

Human-in-the-loop oversight remains crucial, as human judgment is needed to validate AI results, interpret outputs, and ensure contextual accuracy. Relying solely on automated systems increases the risk of undetected errors or biased outcomes. Similarly, organizations must prioritize algorithmic transparency through Explainable AI (XAI) techniques, which disclose how AI models classify data, calculate emissions, and assess risks. This transparency builds trust among stakeholders and enhances auditability.

Ethical AI audits are another important governance mechanism. Independent assessments help verify the fairness, accuracy, and robustness of AI systems, ensuring that they adhere to ethical norms and regulatory expectations. Finally, effective governance requires active stakeholder engagement. Auditors, regulators, NGOs, suppliers, and technology experts should be involved in shaping AI-based sustainability reporting systems to ensure inclusivity, accuracy, and alignment with stakeholder expectations.

9. Case Studies of AI in Sustainability Reporting (Expanded in Paragraph Form)

The use of AI in sustainability reporting is rapidly expanding across industries. In the manufacturing sector, AI and IoT systems are deployed to monitor emissions, waste output, and energy consumption in real time, allowing companies to respond quickly to inefficiencies and regulatory triggers. Energy companies use AI-driven tools to automate Scope 1 and Scope 2 carbon accounting, improving precision and compliance with emission standards. Retail firms rely on machine learning models to assess supply-chain emissions, identify human-rights risks, and evaluate environmental impacts in sourcing and logistics. In the financial services sector, AI-based ESG scoring models are increasingly adopted to evaluate corporate sustainability performance and inform responsible investment decisions. These real-world applications demonstrate AI's versatility, scalability, and impact in advancing sustainability reporting and green accounting.

10. Discussion

AI clearly transforms green accounting and sustainability reporting by automating data collection, enhancing emissions calculation, improving disclosure accuracy, and supporting assurance functions. The integration of AI with

sustainability frameworks such as GRI and IFRS reflects a paradigm shift from narrative-based reporting to data-driven, high-frequency disclosure. However, governance challenges related to transparency, bias, and ethics must be addressed to ensure that AI strengthens not undermines the credibility of sustainability reporting.

The transition from voluntary to mandatory sustainability disclosures globally means that AI will become indispensable. Yet its deployment must be accompanied by robust accountability frameworks, ethical oversight, and human supervision. AI should augment, not replace professional judgment in sustainability measurement and assurance.

11. Conclusion

Artificial intelligence plays an increasingly pivotal role in enhancing green accounting and sustainability reporting. By automating sustainability disclosures, improving carbon accounting accuracy, supporting integrated reporting, and enabling high-quality assurance, AI significantly strengthens corporate transparency and accountability. However, without careful governance and ethical oversight, AI may introduce new risks such as data errors, algorithmic bias, and opaque decision-making. Ultimately, AI has the potential to transform sustainability reporting into a rigorous, real-time, and decision-useful process aligned with GRI, IFRS, and other global sustainability standards. Organizations and regulators must therefore adopt responsible AI governance frameworks to ensure that AI-enabled sustainability reporting advances global sustainability goals in an ethical, transparent, and reliable manner.

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