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Review Paper

Governance, Regulatory Readiness, and Accountability of AI Tools in Sustainable Finance: A Conceptual Review

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ABSTRACT

Artificial intelligence (AI) is reshaping sustainable finance by accelerating Environmental, Social, and Governance (ESG) assessments, climate-risk modelling, and sustainability reporting. However, the rapid adoption of AI has outpaced the development of governance mechanisms, raising concerns related to transparency, bias, explainability, data integrity, and regulatory readiness. This conceptual review examines how AI is applied within sustainable finance, evaluates the effectiveness of regulatory frameworks such as the Sustainable Finance Disclosure Regulation (SFDR), Corporate Sustainability Reporting Directive (CSRD), and the proposed EU AI Act, and identifies governance gaps that hinder responsible deployment. Findings indicate that while AI enhances analytical efficiency and enables deeper sustainability insights, fragmented ESG data, algorithmic opacity and inconsistent reporting standards continue to undermine the reliability of AI-generated outcomes. Current sustainability regulations do not sufficiently address AI-specific risks including explainability, data lineage, lifecycle accountability (the oversight of AI systems across design, deployment, monitoring and retirement) and algorithmic bias. To address these limitations, the study proposes a unified governance approach that aligns responsible-AI principles with sustainability regulations. Recommendations emphasise global ESG-data standardisation, enhanced transparency requirements for AI systems, ethics-based oversight structures and organisational capacity-building. The study contributes to emerging scholarship by presenting an integrated framework connecting regulatory, ethical and technical dimensions of AI use in sustainable finance.

Keywords: *Sustainable Finance, Artificial Intelligence (AI), ESG Reporting, AI Governance, Regulatory Frameworks*

Sustainable finance has evolved into a central pillar of global economic planning, driven by the urgent need to direct capital towards activities that address climate risks, social inequality and long-term environmental stability. ESG criteria, disclosure standards and climate-risk assessments are now embedded across investment portfolios and institutional strategies, reflecting growing regulatory, investor and societal expectations.

Parallel to this shift, artificial intelligence has emerged as a transformative technology within finance. AI systems process unstructured data, uncover complex patterns and

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automate decision-support tasks at unprecedented scale. In sustainability contexts, AI tools enhance the scope and quality of ESG analysis by monitoring emissions, evaluating governance practices, assessing supply-chain vulnerabilities and detecting environmental or social risks. Techniques such as natural-language processing (NLP), machine learning, computer-vision models and predictive analytics enable institutions to extract insights from disclosures, satellite imagery, sensor data and social-media content.

These technological advancements have strengthened confidence in sustainability-linked financial products, especially where timely, granular ESG information is essential. However, increasing dependence on AI raises concerns involving data quality, explainability, model opacity, accountability and fairness. Without robust governance, AI-generated ESG assessments may compromise sustainability outcomes. This reinforces the need for strong oversight frameworks regulating AI development, deployment, monitoring and use in sustainable finance.

AI in Sustainable Finance

AI-enabled technologies automate complex sustainability-related tasks across the financial sector. NLP models analyse sustainability disclosures, identify inconsistencies and detect potential indicators of greenwashing. Machine-learning models assess transition and physical-climate risks, forecast carbon-emissions trajectories and evaluate sustainability performance using diverse datasets.

AI reduces manual effort and allows analysts to focus on strategic interpretation. Computer-vision models detect deforestation, pollution events or land-use irregularities using remote-sensing data, while AI-enhanced risk models integrate meteorological, geospatial, and corporate datasets to produce more robust assessments than traditional methods.

However, ESG data remains inconsistent and non-standardized. AI systems trained on incomplete or biased data risk perpetuating inaccuracies in sustainability assessments. Black-box models further complicate verification and auditability. These limitations highlight the need for governance structures ensuring transparency, accountability, fairness and lifecycle oversight.

LITERATURE REVIEW

Studies widely recognize AI's transformative potential in financial analysis. Almaqtari (2024) and Hamdan et al. (2023) demonstrate that AI improves organisational efficiency and reporting accuracy. Abdulameer et al. (2022) find that although AI may initially displace routine roles, it ultimately stimulates innovation and job creation, necessitating new competencies in data analytics and critical thinking. Anomah et al. (2024) emphasise that human judgement remains indispensable for ethical oversight and contextual interpretation.
Parallel scholarship highlights ethical and governance concerns. Munoko et al. (2020) warn that dataset bias can distort ESG scoring, while Yoronova et al. (2025) identify cybersecurity threats, opacity and unclear accountability in AI-driven financial systems. These insights underscore the need for stronger governance to ensure reliable AI-based sustainability decisions.

A clear research gap exists regarding whether sustainability-reporting regulations sufficiently address AI-related risks. While existing studies analyze technological or ethical

dimensions separately, few examine how SFDR, CSRD, or emerging AI frameworks intersect. This review responds to that gap.

Research Gap

Although sustainable finance is becoming increasingly digitized, existing regulations (SFDR, CSRD) do not explicitly govern AI-based assessment tools. They lack provisions on explainability, algorithmic-bias mitigation, lifecycle accountability, and data-lineage documentation. This regulatory blind spot allows AI tools to influence sustainability outcomes without adequate oversight.

Research Objectives

1. To review current research and legal frameworks governing AI use in sustainable finance with emphasis on responsibility, ethics and transparency.
2. To evaluate whether SFDR and CSRD adequately address AI-specific risks including bias, explainability, data dependability and lifecycle accountability.
3. To identify governance gaps and propose measures supporting ethical, transparent and accountable AI integration.

RESEARCH METHODOLOGY

This study employs a **conceptual review methodology**, drawing exclusively on **secondary data sources** to examine the intersection of artificial intelligence and sustainable finance. The research design is non-empirical and interpretive, aiming to synthesize existing scholarly, regulatory, and industry knowledge rather than generate primary data. Academic literature was collected from databases including Scopus, Web of Science, Google Scholar, and JSTOR, focusing on publications from 2018 to 2025 to capture recent advancements in AI applications, ESG analytics, and sustainability regulations. Key regulatory texts—such as the SFDR, CSRD, and the proposed EU AI Act—were sourced from official EU repositories to ensure accuracy.

A **qualitative thematic analysis** was conducted in three phases. First, literature was organised into thematic clusters: AI applications in ESG assessment, regulatory frameworks, AI governance principles and ethical or technical risks. Second, cross-comparison was applied to identify convergence, divergence, and gaps across these themes. Third, insights were synthesised to evaluate whether existing sustainability regulations sufficiently address AI-specific risks and where governance misalignments persist.

Given its conceptual nature, the study does not involve statistical modelling or empirical testing; rather, it integrates multidisciplinary perspectives to construct an analytical framework. The methodology ensures rigor through comprehensive sourcing, structured thematic coding, and transparent interpretive analysis.

CONCEPTUAL FRAMEWORK

1. Key Concepts

Sustainable finance integrates ESG considerations into investment, lending and risk-assessment processes. AI in sustainable finance refers to computational systems that collect, process and interpret ESG-related data. ESG data spans environmental indicators, social metrics, and governance structures. AI governance covers ethical guidelines, oversight mechanisms, lifecycle-management tools and regulatory requirements, ensuring responsible deployment.

2. AI Governance Principles

Frameworks such as the OECD AI Principles and EU AI Act emphasise fairness, transparency, human oversight, robustness and accountability. Lifecycle governance—ensuring oversight across design, training, deployment, monitoring and retirement—has become a critical expectation. For sustainable finance, ethical AI governance is essential to maintain the integrity of ESG assessments.

3. Regulatory Landscape

- **SFDR**: Mandates sustainability-related disclosures but does not address AI methodologies, model transparency, or lifecycle documentation.
- **CSRD**: Expands reporting and mandates assurance of ESG data but lacks AI-specific standards for explainability, fairness or data lineage.
- **EU AI Act**: Provides risk-based rules requiring documentation, transparency, and mitigation controls—but is not designed to address ESG-data complexities or sustainability assessment models.

These frameworks reveal significant misalignment between AI governance and sustainability regulation.

4. Conceptual Alignment

Sustainability regulations define *what* must be disclosed, while AI governance defines *how* data is processed. As AI-generated insights increasingly drive sustainability assessments, the lack of regulation for algorithmic processes creates oversight gaps. An integrated governance approach is therefore essential.

FINDINGS AND ANALYSIS

1. AI Applications in Sustainable Finance

AI strengthens key sustainability functions:

- ESG scoring
- Climate-risk modelling
- Sustainability-report generation
- Supply-chain and environmental-risk monitoring

AI improves efficiency and comparability, but data-quality limitations and lack of standardisation constrain reliability.

2. Assessment of SFDR and CSRD in Addressing AI Risks

Findings indicate that:

- Neither SFDR nor CSRD regulates AI methodologies or lifecycle processes
- No explainability or fairness requirements exist
- No mandatory AI audits or bias testing
- No provisions for documenting ESG-data lineage
- AI-generated insights may be used without disclosure

Thus, despite improving corporate transparency, both frameworks fail to address AI-specific risks.

3. Identified Governance Gaps

a) **Fragmented Regulation**: Absence of global alignment leads to inconsistent standards and uncertainty.

b) **Transparency and Explainability Gap**: Black-box models limit verification of ESG scores and risk assessments.
c) **Data Integrity and Lifecycle Accountability Issues**: Non-standardized ESG data, undocumented model changes and weak monitoring introduce reliability risks.

4. Implications for Institutions

Institutions require:

- Independent AI audits and documentation
- Fairness-testing and lifecycle monitoring
- Data-governance frameworks
- Staff training to interpret AI outputs
- Transparent disclosure of AI's role and limitations

These steps ensure responsible, auditable AI adoption.

CONCLUSION AND POLICY RECOMMENDATIONS

Conclusion

AI significantly enhances ESG evaluation, climate-risk modelling and sustainability reporting; however, regulatory structures have not evolved proportionately. SFDR and CSRD strengthen transparency but do not address AI-specific risks including explainability, fairness, lifecycle documentation and data lineage. The EU AI Act provides a strong foundation but is not tailored to sustainable finance. This fragmented environment undermines trust in AI-driven sustainability assessments.

Integrated governance frameworks that merge sustainability regulation with responsible-AI principles are essential.

Policy Recommendations

1. **Develop AI Governance Maturity Models**: Incorporate documentation, explainability assessments, fairness testing and lifecycle oversight.
2. **Harmonise International Regulations**: Align ESG-reporting standards with AI-governance principles to reduce fragmentation.
3. **Strengthen ESG-Data Standardisation**: Implement unified taxonomies, templates and quality standards.
4. **Enhance Transparency Requirements**: Disclose AI methodologies, assumptions and limitations in sustainability assessments.
5. **Build Organisational Capacity**: Train regulators, auditors and finance professionals in responsible-AI practices.

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Conflict of Interest

The author(s) declared no conflict of interest.

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