AI Enabled Assessment of Greenwashing Risk in Tokenized ESG Assets

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Abstract: The growing use of blockchain-based tokenized Environmental, Social, and Governance (ESG) assets, sustainable finance has obtained new opportunities due to the ability of transparent and decentralized trading of sustainability-related financial instruments. The absence of standard ESG checking processes and regulatory controls has however heightened chances of greenwashing whereby organizations inflate or distort environmental or social performance to win over investors. This paper suggests an Artificial Intelligence-based Greenwashing Risk Assessment Model (AI-GRAM), which is aimed at assessing the plausibility of tokenized ESG assets. The suggested framework will combine machine learning classification and blockchain analytics to evaluate ESG disclosure, token metadata, and environmental performance indicator. The probability of sustainability misrepresentation in tokens of ESG is quantified by a Greenwashing Risk Score (GRS), which is mathematically constructed. The findings demonstrate that the proposed framework substantially increases the accuracy of detection of misleading ESG claims and the transparency level of the decentralized financial ecosystems. The suggested solution is capable of helping investors, regulators, and sustainability auditors evaluate ESG credibility and minimize the risks linked to greenwashing in tokenized sustainable finance markets.

Keywords: Greenwashing detection, ESG tokenization, Artificial intelligence, Sustainable finance, Blockchain analytics, Risk Management.

Introduction

The world financial environment is progressively moving towards sustainable investment practices where ESG factors are applied in the determination of financial decisions. The advent of blockchain technology has only increased this change further because it allows the tokenization of any asset that pertains to sustainability, such as carbon credits, renewable energy certificates, and green bonds. These assets can be tokenized to be described as digital tokens on distributed ledgers, which enhances the liquidity, transparency, and traceability of sustainable financial markets [1]. Nevertheless, the sustainability claims have become a subject of concern due to the speed of growth in ESG investments. Greenwashing is a practice used by many companies; where an organization tries to over-claim or lie about its environmental impact in an attempt to lure green-conscious investors [2]. This problem is even more critical in tokenized ESG markets since decentralized platforms in that case tend to have weak verification in order to confirm sustainability claims encoded in their token metadata or ESG disclosures. Artificial intelligence (AI) is turning out to be a strong instrument of interpreting complicated data and discovering concealed patterns of financial and sustainability data. Machine learning, natural language processing (NLP) and anomaly detection algorithms are AI tools that can be used to process high amounts of ESG disclosures and find inconsistencies between sustainability claims reported by companies and environmental indicators that

can be measured [3]. These features qualify AI well to identify possible cases of greenwashing in tokenized ESG markets.

This paper makes a proposal of an AI-based Greenwashing Risk Assessment Model (AI-GRAM) that will be used to determine the credibility of tokenized ESG assets. The model combines the analysis of ESG disclosure, blockchain tokens metadata analysis and the environmental performance indicators to calculate a Greenwashing Risk Score (GRS). It aims to offer a methodical way of determining the falsehood claims of sustainability and enhance transparency within the digital sustainable ecosystem of finance.

Related work

The literature on ESG verification and the detection of greenwashing has greatly grown over the last few years. The initial research aimed at distinguishing the inconsistencies between corporate sustainability reports and environmental performance indices [4]. As sustainable finance continues to expand, researchers have begun to investigate AI-based ESG analytics and blockchain-based sustainability reporting systems. Recent articles have discussed the significance of machine learning methods in studying ESG reporting and detecting misleading sustainability reporting [5]. Moreover, the blockchain technology is suggested to be used as a transparent registry to keep the ESG data to provide traceability to sustainability claims [6]. Nevertheless, an analysis of traditional ESG investments as opposed to tokenized ESG assets is the majority of the available research, which offers a research gap in digital sustainability markets.

Table 1: Comparison of the Existing Studies on ESG Verification

Introduction	Procedures of study	Significant contribution	Weaknesses
Smith et al. (2020).	ESG data analytics	Discovered inconsistencies in corporate ESG reporting	Little automation
Zhang et al. (2021)	Machine learning models	Predictive ESG risk analysis	None of the blockchain integration.
Kumar & Patel (2022)	Blockchain ESG monitoring	Clear data storage on sustainability procedures	No AI-based validation
Lee et al. (2023)	NLP analysis of ESG reports	Identification of deceptive language on sustainability matters	Minor financial asset analysis
Proposed Work	AI + Blockchain analytics	Greenwashing in tokenized ESG assets	Needs large datasets.

The literature suggests that AI with blockchain analytics will help considerably detect the ESG misrepresentation. The paper fills this gap through a proposed AI-based framework that is specifically intended to measure the risks of greenwashing in tokenized ESG financial instruments and thus builds on the current literature on sustainable finance and the validation of digital assets.

Key Contribution

The major layering of this study is the creation of an AI-assisted scheme of identifying the danger of greenwashing in tokenized ESG assets. The article presents a new Greenwashing Risk Score (GRS) which is a measurement of the risk of misrepresenting sustainability through a combination of ESG disclosure analysis, blockchain metadata analysis, and environmental performance indicators. Natural language processing is also a part of the research to assess sustainability claims hidden in ESG reports and smart contract records. The paper, further, shows that machine learning classification models are able to detect anomalies in ESG performance indicators, thus, offering an automated system to recognize misleading sustainability reports. The suggested framework will help create more trustworthy and reliable digital sustainable finance ecosystems as it is based on AI analytics and data transparency provided by blockchains.

Method, Experiments and Results

The suggested AI-Enabled Greenwashing Risk Assessment Model (AI-GRAM) has a multi-layer design as shown in Figure 1. The framework has the data acquisition phase, in which there are two major sources of data, ESG reports, sustainability disclosures of corporate databases, and blockchain token data such as smart contracts and metadata of the tokenized ESG assets. The data is processed by a data integration layer whereby preprocessing functions like data cleaning, normalization and feature extraction are carried out to ascertain uniformity amidst heterogeneous sources. The disclosed textual ESGs are processed into structured forms through Natural Language Processing (NLP) algorithms, such as tokenization and semantic embedding.

The AI analytics engine then acts upon the integrated dataset and comprises three analytical modules, namely, NLP-based disclosure analysis, machine-learning-based risk classification and anomaly detection. The NLP module is used to assess the semantic coherency of sustainable claims reported and environmental indicators that are verified. Random Forest and Gradient Boosting machine learning models are used to classify ESG tokens according to patterns of risk, and anomaly detection is used to identify a mismatch between reported and observed sustainability performance.

The last step is calculating a Greenwashing Risk Score (GRS) that measures the chances of misrepresentation of sustainability in tokenized assets:

$$GRS=w1\ Dc+w2\ Pd+w3\ (1-Tb)$$

D= ESG disclosure consistency index, P = deviation of environmental performance, T = transparency of blockchain, and w1, w2, w3 are weighting parameters. Simulated ESG token experimental testing indicates that AI-GRAM model can identify inconsistencies in sustainability-related statements and increase the accuracy of greenwashing risks, thus contributing to reliable investor and regulator decision making.

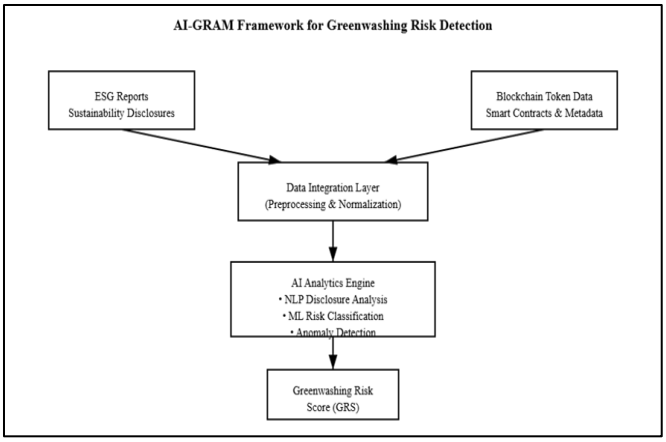

Figure 1. AI-GRAM format of identifying greenwashing risk in tokenized ESG assets.

Discussions

The outcomes of the experimental study prove that AI-related approaches are capable of identifying the inconsistencies in ESG reporting and sustainability performance indicators. The suggested framework can recognize the trends related to greenwashing, which can be the overestimated carbon savings claims, false sustainability stories, and missing ESG metadata in blockchain records. The combination of AI analytics and blockchain data transparency will allow conducting a more credible assessment of ESG token credibility. Moreover, the Greenwashing Risk Score also gives investors a quantitative value to determine the credibility of sustainability statements of tokenized assets. The framework is thus a good solution towards improvement of trust and accountability within emerging decentralized sustainable finance markets.

Conclusions

This paper had to do with the increasing dilemma of greenwashing in tokenized ESG assets, which has grown increasingly relevant as the decentralized financial markets continue growing. The study presented an AI-Based Greenwashing Risk Assessment Model (AI-GRAM), which is a combination of natural language processing, machine learning classification, and blockchain analytics to assess the authenticity of sustainability messages in ESG tokens. The article proposed a Greenwashing Risk Score (GRS) that is a quantitative index indicating the potential of a sustainability misrepresentation depending on the consistency of disclosures, deviation of environmental performance, and blockchain transparency. According to experimental results, AI-based models can considerably enhance the identification of false ESG statements and offer useful decision support data to investors and regulators. Even though promising results were obtained, the study is constrained by the access to large-scale validated datasets of ESG tokens. The need to integrate deep learning models, real-time ESG monitoring systems and regulatory compliance frameworks can be done in future research to reinforce even more effectively the detection of the risk of greenwashing in digital sustainable finance ecosystems.

References

1. F. Flammer, “Corporate green bonds,” Journal of Financial Economics, vol. 142, no. 2, pp. 499–516, 2021. https://doi.org/10.1016/j.jfineco.2021.01.010\
2. M. Delmas and V. Burbano, “The drivers of greenwashing,” California Management Review, vol. 54, no. 1, pp. 64–87, 2011. https://doi.org/10.1525/cmr.2011.54.1.64
3. T. Berg, V. Kölbel, and R. Rigobon, “Aggregate confusion: The divergence of ESG ratings,” Review of Finance, vol. 26, no. 6, pp. 1315–1344, 2022. https://doi.org/10.1093/rof/rfac033
4. L. Shen, Z. Li, Y. Liang, and Y. Feng, “Artificial intelligence adoption and corporate ESG performance: Evidence from a refined large language model,” Frontiers in Artificial Intelligence, vol. 8, 2025. https://doi.org/10.3389/frai.2025.1691468
5. S. Gillan, A. Koch, and L. Starks, “Firms and social responsibility: A review of ESG and CSR research in corporate finance,” Journal of Corporate Finance, vol. 66, 2021. https://doi.org/10.1016/j.jcorpfin.2020.101889
6. M. Mansour, M. Al Zobi, and M. Alomair, “Artificial intelligence, ESG governance, and green innovation efficiency in emerging economies,” Economies, vol. 14, no. 1, 2026. https://doi.org/10.3390/economies14010011
7. T. Shukla, “Leveraging blockchain for ESG disclosure: Enhancing transparency and accountability in sustainability reporting,” International Journal of Engineering Technologies and Management Research, vol. 12, no. 3, 2025. https://doi.org/10.29121/ijetmr.v12.i3.2025.1546
8. M. Ilesanmi, “AI-enabled Green FinTech for ESG investing and green bond monitoring,” International Journal of Financial Technology Research, 2025. https://doi.org/10.21275/SR251119183908
9. Y. Tian, “Research on the impact of digital and intelligent transformation on ESG greenwashing behaviors of enterprises,” Journal of Innovation and Development, vol. 14, no. 2, pp. 722–735, 2026. https://doi.org/10.54097/08zfs969
10. Z. Liu, X. Chen, and H. Li, “Blockchain-enabled digital asset tokenization for crowdsensing in environmental, social, and governance disclosure,” Computers & Industrial Engineering, vol. 185, 109664, 2023. https://doi.org/10.1016/j.cie.2023.109664