

Harnessing Artificial Intelligence in Sustainable Investment: A Bird's Eye View

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Abstract

Harnessing Artificial Intelligence in Sustainable Investment has remarkably commanded growing interest in how Artificial Intelligence (AI) will also reach another milestone in strengthening the ESG practices in the modern market scenario at a global level. The current study explores the holistic contribution of AI in sustainable investment. The historical background of sustainable investment, ESG, and AI Integration at the national level and globally, various challenges and opportunities in AI integration with sustainable investment have also been discussed within the current study. On the opportunity side, AI strengthens ESG data analytics, demystifies regulatory risks, optimizes portfolio allocation, and unveils greenwashing. But on the other hand, the Adoption of AI in sustainable investment also has negative consequences, including inferior data quality, inappropriate standardized ESG metrics, high costs of implementing AI in sustainable investment and ESG data analytics, and challenges related to ethical and regulatory compliance. In the last of the current study, the need for a transparent AI algorithm-based mechanism, skill upgradation of finance persons, a strict regular mechanism for AI integration in sustainable investment, and ESG data analysis, as well as the transparent and strict ethical adoption, have also been discussed as the need of the hour in Harnessing Artificial Intelligence in Sustainable Investment. Overall, the current research study provides a bird's-eye view of AI integration in sustainable investment and ESG data analytics.

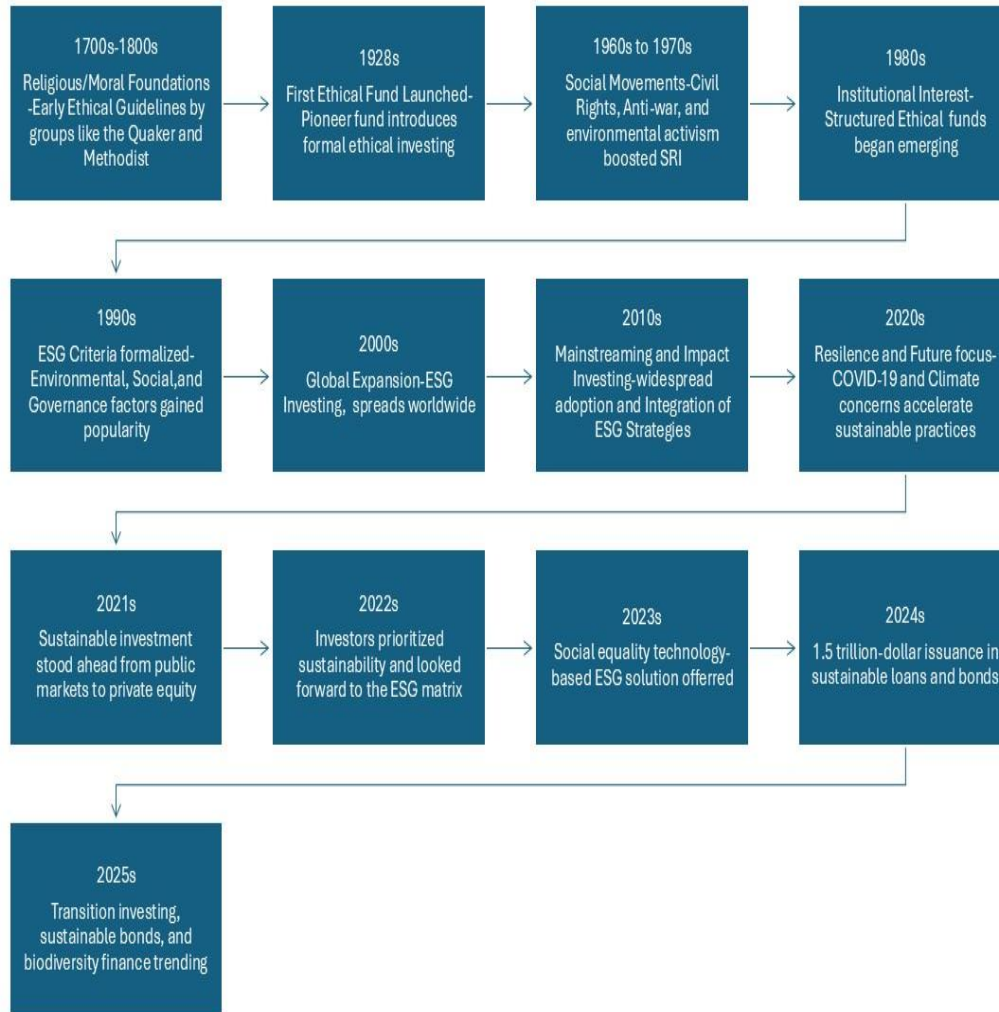
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Introductory Background of the Sustainable Investment

Sustainable investment encompasses three core areas: environmental, social, and governance, with an emphasis on investing in environmentally friendly firms. (Sustainable Investing, n.d.). In contemporary times, the trend toward sustainable investment is increasingly relevant and popular. Dynamic environmental, social, and governance concerns have fueled the need for modern 21st-century sustainable investment practices. More precisely, investors use positive and negative screening criteria to classify firms that perform well from an ESG perspective. The journey of sustainable investment began in the 1700s-1800s, when moral and religious guidelines were set by Quaker and Methodist groups. Then, in the year 1928, the very first ethical fund was launched to introduce the formal ethical investing process. After several decades, in the time period of the decade from the 1960s to the 1970s, the social movement gained prominence, leading to civil rights, anti-war, and environmental activism, which in turn boosted Socially Responsible Investing

(SRI). Later in the 1980s, a more precise institutional interest-based ethical funds system began. Then, during the 1990s, the ESG factor-based criteria emerged as the predecessor of modern sustainable investment. In the 2000s, the ESG concept became widely popular among firms and investors worldwide.

Image 1. Historical Background of Sustainable Investment



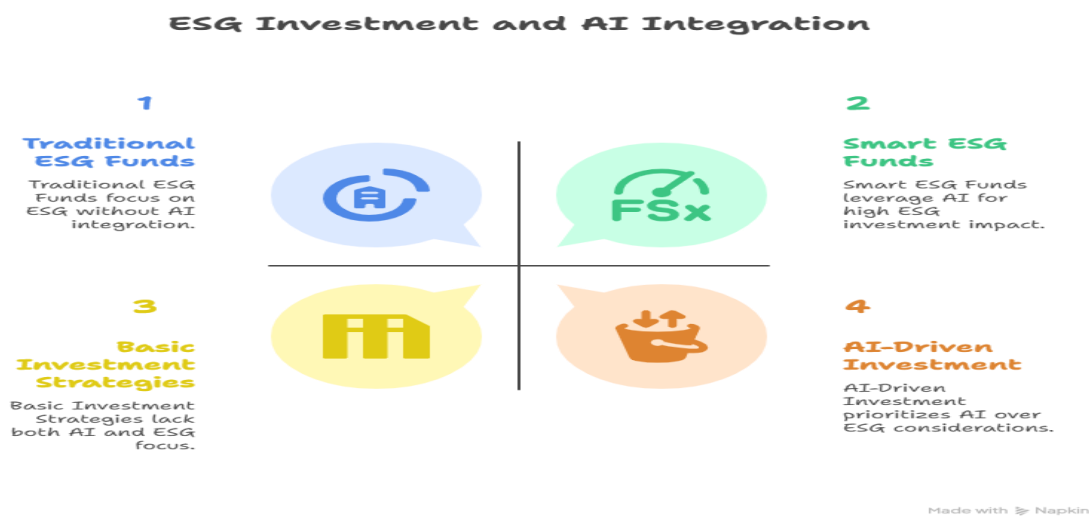
(Sources: Compiled by the authors from various secondary sources)

Later in the 2010s, ESG gained widespread adoption and was integrated with a firm's core strategies to a large extent. In the 2020s, amid COVID-19 and climate concerns, sustainable practices took a hit. In 2021, according to some published research reports, sustainable investment outpaced public markets in private equity. That could be a good opportunity for private equity investors to go for sustainable brands. Later in 2022, investors prioritized sustainability and looked forward to incorporating the ESG matrix into their investment portfolios. But some of the challenges also arose along the investment sector's path, i.e., stakeholders' higher expectations regarding sustainability and a rigid/complex regulatory framework. In 2023, social equality and education, regulatory and standardized procedures, and technology-based ESG solutions were in the picture. The concept of sustainable finance remained relevant in 2024, with 1.5 trillion dollars in sustainable loan and bond issuance. In the current year, i.e., 2025, sustainable investing has key trends, i.e., transition investing, sustainable bonds, and biodiversity finance. (Bioy, H., 2024).

Sustainable Investment and Artificial Intelligence (AI)

In the age of artificial intelligence, ESG investing appeared with two different characteristics, i.e. First, ESG investments entail funding intelligent technologies that systematically enhance the financial, social, and environmental aspects of corporate operations. (Minkkinen et al. 2022). The second is that innovative technologies, such as blockchain, are used to support ESG investments. (Alkaraan et al. 2022). In the period of artificial intelligence, ESG procedures are rooted in innovative technology automation tools and techniques, such as robots and autonomous vehicles, integrated with AI and the IoT.

Image 2. ESG Investment and AI Integration



(Source: Drafted based on secondary data text sources by the researcher with Napkin AI) Thanks to the modern age of technology, especially the embedded Artificial Intelligence (AI) in investing mechanism, the Investors are now capable of have intelligent analytics for investment projects at a single click in form of more precise relationship in between the profitability and associated risk, categorized, and grouped with ESG compliances as well as the firm’s contribution and add value for various SDGs.

By maintaining unwavering AI communication with external stakeholders, a firm may attract more Environmental, Social, and Governance (ESG) investments and improve its returns. (Shahzad et al. 2020). Though the ESG investment and AI firm’s presence is gradually increasing, some disparities still exist, such as differences in the degree of automation adoption between developing and developed nations.

Research Methodology

The current study employs an exploratory method-based analysis, involving a review of related literature, key insights, trends, regulatory compliances, challenges, and opportunities regarding the effect of AI on sustainable investment, drawn from various secondary data sources.

Research Objectives

1. To critically assess the impact of AI on sustainable investment.
2. To uncover obstacles hindering AI integration, including technological, regulatory, ethical, and operational concerns in sustainable investment.
3. To suggest a road ahead for AI integration with sustainable investment practices.

Review of Literature

Adeoye et al. (2024) said that AI is a vital factor in ESG-based investing, portfolio management, and sustainable finance. In the ESG space, artificial intelligence is a powerful tool for helping investors identify relevant ESG factors from large datasets using AI-driven algorithms and make sustainable investment decisions accordingly.

Oyewole et al. (2024) discussed the dramatic change and adoption of artificial intelligence (AI) in sustainable finance (SF), aiming to bring significant reforms to recent financial practices in line with recent ESG compliance.

Oyewole and the team conducted a systematic literature review (SLR) to gain a deeper understanding of recent practices in the adoption of artificial intelligence (AI) in financial management, with a particular focus on potential challenges and the strategic framework ahead and also aiming to provide stakeholders with better insights into sustainable finance and the resilient financial system.

Constantinos Challoumis - Κωνσταντίνος Χαλλουμής (2025), based on a machine learning mechanism in their research, discovered that precision-macro size for investment strategy prediction can be further improved with a Euclidean lattice. There are different modelling methodologies shown in the picture, but the 2-line linear models, like those used in this research, are the most widely considered.

Petkovic M. (2025) discussed the embedded role of AI with sustainable finance, based on 56 articles from EBSCOhost, in a qualitative manner. Based on the analysis, the researcher revealed five different thematic categories, i.e., Innovation, Learning Environment, Relationship, and AI models, and proposed a new model named “IRAML Model (Innovation-Relationship-AI Model-Learning)”.

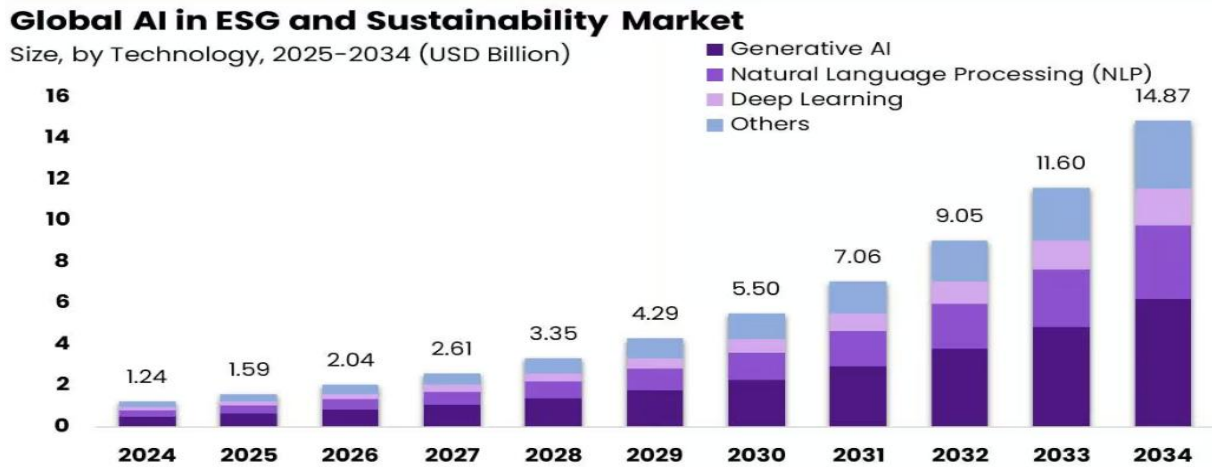
The study also stresses that Novelty is the primary stimulant of AI adoption in digital finance, sustainable investment, and ESG applications. Human-AI collaboration and precise regulatory frameworks will support AI in enabling sustainable investment strategies.

AI in ESG and Sustainability Market: A Global Overview

According to the report published by the market.us research agency (AI in ESG and Sustainability Market, 2025), the Global artificial intelligence (AI) in ESG and Sustainability Market bracket is about to be valued at around USD 14.87 Billion By the end of year 2034, from the USD 1.24 Billion value in the year 2024, with a growing at a compound annual growth rate(CAGR) of 28.20% during the projection period from the year 2025 to year end of 2034.

Artificial intelligence (AI) in ESG and sustainability excels in supporting business firms to improve their ESG reporting practices. Through detailed data analysis, AI can provide valuable insights for sustainable investment, sustainable finance, transparent reporting, risk mitigation, and compliance. According to this report, key drivers of AI adoption in ESG and sustainability analytics include specific regulatory frameworks, e.g., the U.S.A. SEC and E.U. SFDR, etc., which advocate for data transparency and the amalgamation of compliance requirements in ESG report datasets.

Image 3. Global AI in ESG and Sustainability Market



(Source: Adapted from AI in ESG and Sustainability Market research report by Market.us, 2025)

Image 4. AI in ESG and Sustainability Market: Regional Analysis in 2024



(Source: Adapted from AI in ESG and Sustainability Market research report by Market.us, 2025)

As shown in Image 4, in the year 2024, the North America region held a proven and dominant leading market position in the AI in ESG and sustainability sector, with a secured figure of 43.8% (as shown in image 4) with a stunning 0.54 billion USD revenue. This is possible in the North America region compared to other areas of the world because of the latest technologies, strong regulatory support for ESG, federal initiatives on climate reporting and disclosure, ethical corporate governance, carbon neutrality, and a robust, modern, state-of-the-art digital infrastructure. Typically, American region-based companies apply artificial intelligence (AI) to automate ESG reporting, drive sustainability strategies, and monitor environmental impact. This kind of sound work also encourages remaining global firms to adopt ESG analytics in their BRSR reporting procedure.

Opportunities for AI Integration in Sustainable Investment

Augmenting ESG Reporting’s Precision and Efficiency: The ESG reporting data collection and its reporting procedure have become more manageable with its clubbing with AI-based technologies. The AI assisted the corporates in several ways, along with advancing accuracy and precision, and on time

reporting with proper compliance and regulations. By an effective interaction between the investor's psychology and ESG-dataset will give more clarity for ESG reporting mechanism (Ali et al., 2025).

Efficient Energy Efficiency and Carbon Reduction Mechanism: The use of AI also made efficient energy management and the carbon reduction mechanism easier. The related works, such as predictive analytics and real-time sustainable investment data monitoring, will also be simplified further than before. Such a procedure helps with optimized energy use, diminishing carbon emissions and related costs, with a proper focus on a brighter environmental footprint.

Evolving Climate Risk Assessment: The proper use of AI may easily analyze climate sustainability data and its possible associated risks, too. Such analysis allows firms to unveil the potential climate-based affect of different operations.

Preventing Fraudulent Activities: Artificial Intelligence (AI) made the pavement smoother and fraud-free. AI mechanisms can easily detect repeated patterns of suspicious behaviour in transaction data and can stop or put on hold transactions to protect users.

Challenges for AI Integration in Sustainable Investment

- 1. Ethical Concerns:** The prime challenge is that in some cases, the trained AI systems on past time data records may depict built-in biases. For example, the AI may create conflict by sanctioning or denying loans to some communities/groups based on its own analysis of historical data. This is why AI systems should always be transparent and free from bias.
- 2. Data Concealment and Safety:** In reference to the financial institutions, which are mainly involved in lending secured/unsecured loans, they carry a huge confidential and sensitive information database of their customers, i.e., their personal and financial transactions datasets, etc. AI algorithms make the work of financial institutions easier, but in the event of an error, the consequences of a cyberattack may also occur. So, substantial security measures need to be implemented to prevent such incidents.
- 3. Compliance Gaps:** The technological world is changing at the fastest pace. Every day, advanced AI technologies emerge. The governing and compliance rules for regulating AI are not being updated at the same pace. The cases of rule violations in loan lending and customer data misuse are also increasing in the absence of a transparent, robust, and effective regulatory framework for AI compliance.
- 4. Misleading ESG Data and Greenwashing Complexity:** In the attraction of high Environmental, Social, and Governance (ESG) and green audit ratings, some firms may mislead the regulatory and approval agencies by providing them with self-generated, favorable, self-reported, and non-standardized data with the help of AI algorithms. Such misleading AI-generated data and greenwashing practices fail to meet the required sustainability standards.
- 5. Excessive Costs & Technical Hurdles:** In the development of a sound AI system for sustainable investment and sustainable finance purposes, a considerable investment amount is needed, along with a skill set and sound infrastructural facilities. On the other hand, in the journey toward adopting artificial intelligence (AI) for sustainable investment decisions, technical glitches may also occur, disrupting specific processes.

Road Ahead

Calibration of ESG Dataset and Regulatory Compliance: The appropriate alignment of international ESG reporting standards with India's BRSR and the US SEC's compliance requirements will surely be a

gold milestone in diminishing the compliance-related risks.

Responsible AI and Collaborative Ecosystems: Ethics and transparency are the two essential sides of a sustainable investment ecosystem aligned with a responsible AI mechanism.

Conclusion

AI helps investors uncover hidden patterns in sustainable investing data by analyzing vast datasets, identifying correlations, and revealing trends that traditional methods might overlook, enabling more informed and accurate decision-making for long-term sustainable performance. Real-time, reliable ESG insights are obtained by combining multimodal inputs, including satellite imagery, IoT sensor feeds, and NLP-driven text analysis, with automated anomaly detection. Accountability is ensured by integrating blockchain for tamper-proof reporting and striking a balance between algorithmic outputs and human knowledge, enabling investors to make data-driven, ethical, lucrative, and sustainable investing decisions.

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