Evaluating the Role of Artificial Intelligence on ESG Reporting : Evidence from India

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Abstract

Purpose : This paper investigated how artificial intelligence (AI) technologies influence ESG reporting by examining 253 selected publicly listed companies in India from 2016 to 2023.

Methodology : This study applied multiple regression analysis to measure the influence of artificial intelligence on ESG (Environmental, Social, and Governance) performance of the companies toward sustainability. The combined ESG scores and individual ESG pillar scores were derived from the Refinitiv database, and content analysis was employed to measure the artificial intelligence (AI) score.

Findings : The results indicated that AI positively and significantly influenced the overall ESG, environmental, and governance scores. However, results showed a negative relationship between AI and social score. Further, the results indicated that AI was positively influenced by board characteristics, such as the board of director's size, frequency of meetings, and board independence in strategic initiatives. In recent years, companies have become more informed about AI's adoption, benefits, and implications within business. Also, the low AI scores suggest that some companies are still in the early stages of adoption of AI.

Practical Implications : This study extended the existing literature and widened the scope of stakeholders' theory. By addressing stakeholder concerns through AI, companies can enhance trust, reputation, and long-term viability, ultimately reducing the likelihood and impact of adverse events.

Originality : This study extended the present-day literature by empirically testing how AI can influence the ESG performance of companies, including its potential impact on the individual dimensions or pillars of the overall ESG frameworks.

Keywords : **artificial intelligence, ESG reporting, ESG disclosure, sustainability, India**

JEL Classification Codes : G32, M14, O33, Q56

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In recent years, sustainable development has become the prominent global focus of all leading companies with the United Nation's SDG-2030 Agenda (Joshi & Joshi, 2024). Among many aspects of sustainability, environmental, social, and governance (ESG) reporting has emerged as a key performance indicator for communicating with its major stakeholders. The ESG reporting framework has grown from theory to practice, voluntary disclosure to mandatory compliance, and with a variety of measurement criteria, thus making it more comprehensive. Broadly, the ESG reports examine various aspects, including governance and leadership issues, ethical dimensions of managing business and people, impact on communities, etc. However, a few of the disadvantages of ESG reporting have been a lack of standardization, inconsistency in reporting, and challenges in validating the ESG data sources, based on which the inferences are drawn for various industry sectors (Dorfleitner et al., 2015; Mohapatra et al., 2024). Further, the current practices of ESG reporting have either been incomplete or inaccurate due to a variety of reporting methods as well as the inability of the existing system to validate the authenticity of reports (Kurucz et al., 2009; Narula et al., 2024; Nguyen et al., 2021; Oliveira et al., 2011).

ESG reporting has gathered predominance in recent years, especially because of enhanced demand from stakeholders asking for greater transparency of sustainability initiatives and how they are administered or governed (Matta et al., 2022). The conventional methods of ESG reporting have been saddled with challenges in the authenticity of data, timeliness in reporting, and the complexity of drawing meaningful interpretations. Given this context, artificial intelligence (AI) is a promising and enabling tech tool that can enhance the precision, reliability, and dependability of reports on ESG initiatives and sustainability interventions by companies. AI can facilitate automation, optimizing objectivity in data capturing, analysis, and meaningful interpretation. Further, AI can significantly enhance data-driven decision-making, helping leaders draw meaningful insights and devise actionable strategies (Burström et al., 2021; Cockburn et al., 2023; Patil & Kulkarni, 2019).

Generally, the traditional approaches of ESG data collection involve time-consuming, unstructured, and, at times, inefficient processes, especially by relying heavily on annual reports, sustainability reports, and regulatory reports (when their context is different). This non-dependability of data from various sources becomes more complex when it is aimed at collecting accurate and reliable data points on sustainability aspects, which is still evolving. It is also found that the accuracy and transparency of the information gathered in the ESG reports are often questioned when the ESG assurance process has not been defined comprehensively yet (Nguyen & Dang, 2023).

Given the aforementioned context, AI can become a significantly transformative tech tool that can nullify human errors or subjective biases. Simultaneously, it can enhance the data-driven decision-making capabilities, especially by leveraging the machine learning capabilities and natural language processing (NLP) of AI technologies by extracting and processing ESG data from multiple sources of information (Couchoro et al., 2021). Simply put, AI technology and its emerging tools can effectively analyze unstructured data from varied sources, such as companies' annual reports, regulatory filings, analysis of social media platforms, public reviews, stakeholder analysis, etc., to evaluate and assess the ESG performance of companies.

In other words, the intelligent adoption of AI tools can make the process of ESG reporting, analysis, and drawing actionable insights more robust and comprehensive, with speed, scale, accuracy, and reliability. Such mechanisms would also equip and facilitate the business leaders to make the company's sustainability practices more purposeful and impactful for a major section of the stakeholders. For instance, among the various AI-driven tools, the IoT (Internet of Things) sensors and satellite imaging facilities gather data on environmental metrics, such as carbon emissions, degradation to the biological ecosystem, assessment of deforestation, etc., almost in real-time. AI is expected to result in more accurate and transparent tracking of ESG goals, thereby enhancing its capability to analyze ESG data and improve the interpretation of ESG results or enhance the deeper insights for business leaders on sustainability performance and its related strategic interventions. These dimensions of AI application would overcome the challenges of traditional ESG reporting methods in scale and speed, as well as the reliability in reporting and results/actionable outcomes (Matta & Mohapatra, 2021).

Further, AI can also be leveraged for predictive analysis. In other words, AI models can predict the risks,

challenges, and opportunities based on the historical performance of the ESG data, such as business performance parameters, reputational risks, regulatory penalties or fines due to poor environmental practices. In addition, the AI tech tools can enable the evaluation of the ESG performance of the companies against their peers/competitors and industry benchmarks. They can also enumerate the areas that require improvement in sustainable practices by effectively utilizing machine learning algorithms. When utilized meticulously, this can help the leadership team make more data-driven, informed decisions and strategic planning in corporate governance. Moreoever, with AI, the business leaders will be equipped with improved business practices like financial analysis, investment models with ESG criteria, and comparative analysis of non-financial data with financial data for assessing the overall ESG performance of the company, which will help the leadership team/CXOs enhance the overall organizational performance.

For example, AI tools can harness the data in ESG reports with the stock performance, thus helping investors identify companies with higher scores of ESG performance and present substantial investment opportunities. This kind of integration can deeply widen the scope of "sustainable finance," where AI plays a significant risk in driving ESG-conscious investment decisions and keeping all the stakeholders updated. The AI tools can regularly monitor and evaluate business performance, social media platforms, news outlets, etc., to assess the real-time changes affecting the company's reputation and brand image due to emerging risks. Thus, a quicker and faster response mechanism can be designed to address the ESG-related risks, ensure predictive monitoring of the company's ESG performance (rather than just relying upon past and present ESG performance parameters), forecast the future ESG opportunities, formulate strategies to be adopted, and assess the impact of ESG on long-term company performance.

Given this context and the significantly evolving relevance of AI in ESG reporting, this study has investigated "how artificial intelligence (AI) can influence the ESG reporting of select publicly listed companies in India during the period 2016–2023?" The overall analysis of the results has indicated that artificial intelligence (AI) has a positive influence and considerably desirable impact on companies' ESG reporting.

It is needless to emphasize that companies have been playing a significant role in harnessing the power of AI tools in ESG reporting, enhancing governance matters, broadening the benefits of transparency to stakeholders, etc. In other words, AI-based ESG reporting systems can make reliable, data-driven decisions with accuracy or dependability, thereby significantly improving trust, long-term viability and profitability, enhancing company's reputation, reducing risks, and increasing transparency among key stakeholders.

Literature Review and Hypotheses Development

In the present globalized business ecosystem, measuring sustainability performance with objective parameters has become not only necessary but also significantly crucial from multiple perspectives (Kumar & Sudesh, 2019; Kumar et al., 2021). Within sustainability performance measurement, ESG reporting has emerged as a major criterion to assess the company's short-term, medium-term, and long-term sustainability, in general, and particularly, for making investment decisions based on sustainability practices adopted (Raar, 2002; Saha & Kabra, 2022).

Today's informed stakeholders demand higher transparency and greater accuracy of information and results from ESG frameworks (Raimo et al., 2021; Shiyyab et al., 2023), compelling companies to adopt such strategies appropriately. It is known that AI tools enable data aggregation and compilation, a variety of analyses, and measurement of risks and opportunities from ESG reporting matrices, along with prediction of future trends, keeping the stakeholders informed, making informed investment decisions, etc. Hackston and Milne (1996) identified that stakeholders make informed investment decisions by aligning their financial goals with the ESG goals of a company.

The usage and application of AI in ESG reporting have grown manifold, especially in the post-Covid period (Meiryani et al., 2022). The AI tools have been adopted to compile data from a variety of sources to track and

evaluate them and measure and monitor the impact of ESG performance indices of companies and large corporations (Anastasi et al., 2021; Burgess, 2018; Plastino & Purdy, 2018). The AI tech tools have enabled the stakeholders to assess the company's overall performance robustly and comprehensively with respect to ESG reporting (Han et al., 2020; Lichtenthaler, 2020). For instance, the natural language processing (NLP) algorithms can facilitate in-depth textual analysis, thereby improving ESG data's accuracy and increasing ESG reports' reliability (Jin & Kim, 2022; Nguyen & Dang, 2022).

The ESG reports can be generated by leveraging AI tools. These reports can ensure compliance with regulatory requirements or frameworks, and such standards consist of the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) (Kute et al., 2021). With and through automation using AI tools, companies and large multinational corporations can share real-time and reliable information, reports, and implications of ESG reporting to their stakeholders, thus enhancing trust and boosting confidence among stakeholders and investors. The AI has also been found to reduce the administrative pressures for timely compliance and meeting the requirements of regulatory agencies, hence avoiding the possibility of fines or penalties concerning ESG reporting systems. In addition, companies have been enhancing their corporate governance systems by integrating AI with ESG reporting frameworks since they offer advantages through optimizing cost, improving accuracy, ensuring timely submission, etc. It is also found that AI tools have been utilized for monitoring corporate practices, identifying risks and opportunities, and addressing compliance issues (Ratia et al., 2018; Sætra, 2021).

Rao and Tilt (2016) identified that owing to a lack of standard ESG reporting frameworks, there has been inconsistency in reporting sustainable practices. Further, Hwang and Kim (2021) revealed a few important findings: AI tools can enhance the accuracy and consistency of ESG-reported data; AI-based learning models have enabled recognition of specific ESG-related metrics, parameters, and keywords, thus making them more standardized, relevant, and meaningful across business sectors or geographical regions.

As a result, these AI-based applications have enhanced the comparative analysis of ESG reports, which meet regulatory compliance on the one hand and enhance the value or impact of the utility of the ESG reports on the other. Furthermore, the AI-enabled solutions have helped identify inconsistencies in ESG reporting by cross-verifying data from multiple sources, which would avoid the "greenwashing effect," where entities tend to misrepresent or provide inaccurate information to their stakeholders to add to the reputation and brand image of the company in the market (Nikitas et al., 2020).

The extensive application of AI in ESG reporting has many benefits and a variety of utilities; however, there are some ethical concerns in leveraging AI tools. One of the key concerns of AI use in ESG reporting encompasses the possibility of AI algorithm(s) being used to misrepresent ESG data at the analysis or interpretation stage. However, as researchers, policymakers, or governance champions, one should note that the newer and emerging AI tools can only be an enabler, but they cannot be the drivers of decision-making on strategic issues. Business leaders, regulators, government, or stakeholders should utilize AI-based ESG reporting with possible precautions until it is proven with a series of verifications and thorough validation.

If AI tools are explored on biased or incomplete ESG datasets, it may result in an incorrect assessment of the companies' ESG performance, resulting in incorrect decision-making and impacting the corporate reputation and image. Another concern is data privacy (Vijai et al., 2020). AI tools rely on a large volume of corporate data, raising concerns about data security and data privacy. The companies should ensure that data collected for ESG reporting is handled carefully and in compliance with the data protection rules and regulations in force.

The existing literature has primarily focused on AI's role in improving the company's ESG performance academically. Little empirical research has been undertaken to evaluate AI's impact on ESG reporting by companies, especially in growing companies with special reference to the Indian business ecosystem. This study extends the present literature by empirically testing how AI can influence the ESG performance of companies, including its potential impact on the individual dimensions or pillars of the overall ESG frameworks.

Based on the objective of the study, the following hypotheses are formulated:

- **H1 :** Artificial intelligence (AI) positively influences the combined ESG score.
- **H2 :** Artificial intelligence (AI) positively influences the environmental score.
- **H3 :** Artificial intelligence (AI) positively influences the social score.
- **H4 :** Artificial intelligence (AI) positively influences the governance score.

Research Methodology

Sources of Data Collection and Sample

In this study, the ESG disclosure score of 253 selected Indian companies for 2016–23 is taken from the Refinitiv database. The Refinitiv database assesses the sustainable performance of the companies from three dimensions: Environmental (E_Score), Social (S_Score), and Governance (G_Score), making an overall ESG Score (ESG_Score). This study measures the ESG scores of the companies in the range from 0.1 to 100. A higher ESG score indicates better performance and enhanced social responsibility. The authors further employed content analysis to assess the extent of AI technology used in the companies' annual reports. The use of AI-related keywords in annual reports indicates the awareness of AI tools and techniques and companies' ability to use AI within their business operations. An effort was made to count every statement that contains the relevant terminologies like "AI," "artificial intelligence," "machine learning," "big data," "cloud," "robot," "virtual agents," "fintech," "digital transformation," and "natural language processing," especially focusing on non-financial information. To measure the AI disclosure by companies in India, the researchers ascertained the AI score (AI_Score). The AI score was obtained by considering the number of sentences comprising at least one of the above mentioned keywords.

Model Specification

This study examined the impact of AI technology on the quality of ESG reporting by companies in India. The Environmental, Social, and Governance (ESG) score (ESG_Score) of 253 publicly listed companies in India of various types and across industry sectors is taken as the independent variable. The ESG scores are derived from the Refinitiv database, which measures the sustainable performance of the companies individually, that is, Environmental Score (E_Score), Social Score (S_Score), Governance Score (G_Score), and combined ESG Score (ESG_Score). These scores are computed from publicly available reports, such as sustainability reports, annual financial reports, corporate social responsibility (CSR) reports, and corporate websites of studied companies. These scores range between 0.10 and 100, where higher scores indicate greater social responsibility and governance.

Further, the dependent variable is the AI score (AI_Score), measured by the number of keywords related to AI disclosed in the company's annual reports. To increase the relevance of this study, the researchers added some control variables (refer to Table 1), such as the size of the board of directors (B_MEM), which is computed by the number of directors on the board; meetings (B_MEET) which are computed by the number of meetings of the board of directors during a financial year; board independence (B_IND), which is calculated by the number of independent directors in board; firm age (F_AGE), which is average age of the company and finally, net income (F_NI), which is computed as the percentage of net income earned divided by the total revenue of a financial year (Fariha et al., 2022; Fasihi & Barshad, 2023).

Table 1. ***Variable's Name and Definition***

Variable Name	Definition
Dependent Variable	
AI Score *(AI_Score)*	The number of sentences containing the keywords "AI," "artificial intelligence," "machine learning," "big data," "cloud," "robot," "virtual agents," "fintech," "digital transformation," and "natural language processing" in the company's annual reports.
Independent Variables	
Environmental, Social, and Governance Score *(ESG_Score)*	Combined ESG score derived from Refinitiv database.
Environmental Score *(E_Score)*	Environmental score derived from Refinitiv database.
Social Score *(S_Score)*	Social score derived from Refinitiv database.
Governance Score *(G_Score)*	Governance score derived from Refinitiv database.
Control Variables	
Board Size *(B_MEM)*	Number of directors on the board of directors (Allegrini & Greco, 2013).
Board's Meetings *(B_MEET)*	Frequency of meetings of the board (Singh et al., 2022)
Board's Independence *(B_IND)*	Number of independent directors on board (Abbott et al., 2000; Bronson et al., 2009).
Firm's Age *(F_AGE)*	Number of years of incorporation.
Firm's Net Income Margin *(F_NI)*	Net income margin earned during a financial year.

Ordinary least square (OLS) regression with robust standard errors was employed to test the hypotheses.

$$AI\_Score = \beta_0 + \beta_1 ESG\_Score + \beta_2 E\_Score + \beta_3 S\_Score + \beta_4 G\_Score + \beta_5 B\_MEM + \beta_6 B\_MEET + \beta_7 B\_IND + \beta_8 F\_AGE + \beta_9 F\_NI + e \quad \ldots\ldots (1)$$

where,
AI_Score = AI score,
β_0 = intercept,
ESG_Score = combined ESG score of the company,
E_Score = environmental score of the company,
S_Score = social score of the company,
G_Score = governance score of the company,
B_MEM = number of directors on board,
B_MEET = number of meetings of the board,
B_IND = number of independent directors on board,
F_AGE = age of the firm,
F_NI = net income margin of the firm,
and e = error term.

Analysis and Results

Content Analysis of Annual Reports

The researchers have employed content analysis to compute the dependent variable, i.e., AI Score (AI_Score). The study identified 18,564 sentences in the annual reports for 2016–23 with keywords related to AI, such as "AI,"

Table 2. ***AI Scores from 2016-2023 for 253 Companies in India***

Year	Frequency	In Percentage (%)
2016	557	3%
2017	743	4%
2018	1,114	6%
2019	1,671	9%
2020	2,785	15%
2021	3,342	18%
2022	3,898	21%
2023	4,455	24%
Total	**18,564**	**100%**

"artificial intelligence," "machine learning," "big data," "cloud," "robot," "virtual agents," "fintech," "digital transformation," and "natural language processing." It is observed that there has been a significant rise in the use of AI technology in the company's operations and activities (Table 2). However, during the last four years (2019–23), a sudden increase in the use of AI and digital technology is observed, representing over 70% of the sample. This shift describes how AI has evolved over the past five to six years and how companies have made it a part of their regular operations and activities. Furthermore, the learnings from the Covid-19 pandemic have led to the increasing relevance of adopting digital tools and AI technologies.

Descriptive Analysis

This section provides the descriptive statistics of the sample size. Table 3 shows that the AI score ranges from 12 to 105, with an average AI score of 47. This indicates that some companies employ and use more AI technologies in their operations than their competitors to earn early-mover advantages. Further, in terms of the ESG performance of the companies, the mean environmental score (E_Score) is 18, the mean social score (S_Score) is 21, and the mean governance score (G_Score) is 58. The combined ESG score (ESG_Score) is 37. The higher governance score indicates that companies are rated better on governance parameters when compared to the other two pillars. In terms of the control variables, the average number of directors on board is 6; in terms of the number of board meetings, the average frequency of meetings in a financial year is 9; in terms of the independent directors on

Table 3. ***Descriptive Statistics***

Variables	Mean	Std. Dev.	Min.	Max.
AI_Score	47.16	25.609	12	105
ESG_Score	37.12	3.210	12	52
E_Score	18.16	2.387	5	24
S_Score	21.44	0.985	6	32
G_Score	58.07	2.063	16	71
B_MEM	6.24	42.991	3	9
B_MEET	9.03	2.005	4	18
B_IND	4.11	0.846	3	5
F_AGE	61.98	1.437	13	108
F_NI	3.12	20.534	–32.41	48.93

board, an average is 4. Further, the average age of the firm is 62 years, and the average net income margin is 3.12% in a financial year.

Correlation Analysis

Table 4 provides the correlation matrix between the variables. The results show that the AI score positively correlates with the overall ESG score. This indicates that the greater use of AI technology positively influences the sustainable performance of the entities. In terms of individual scores, the AI score is positively linked with E_Score and G_Score because AI technology can help reduce and monitor carbon emissions and predict climate change to enable entities to make long-term strategies. In governance, AI enables effective decision-making through automation, transparency, and accuracy of ESG data, resulting in more ethical practices.

However, the social score is negatively correlated with AI because, with the growth of AI within the corporate culture, there would be increasing chances of job displacement, growing concerns for data privacy, change in workplace dynamics through less involvement of humans and ethical issues impacting social reputation. Further, the correlation analysis shows a positive correlation between the AI scores and net income margin. This indicates that a higher net income margin increases the firm's ability to invest in AI tools and techniques and utilize them in business activities.

Table 4. ***Correlation Analysis***

	AI_Score	*ESG_Score*	*E_Score*	*S_Score*	*G_Score*	*B_MEM*	*B_MEET*	*B_IND*	*F_AGE*	*F_NI*
AI_Score	1									
ESG_Score	0.1985*	1								
E_Score	0.1621	0.4338	1							
S_Score	–0.0504*	0.7271	0.2888	1						
G_Score	0.1415	0.1602	0.4041	0.6853*	1					
B_MEM	0.0189*	0.0222	0.0528*	0.0652	0.0262	1				
B_MEET	0.0314	0.0047	0.1475*	0.0681	0.0019	0.1684	1			
B_IND	0.0400	0.0842	0.1600	0.1140	0.0810	0.5839*	0.0484	1		
F_AGE	0.0189	0.0222	0.0528	0.0611	0.0262	0.0784*	0.5413	0.4213	1	
F_NI	0.2339	0.0461	0.0160	0.1103	0.0339	0.7336	0.0329	0.1934	0.5353	1

Note. *significant at the 5% level.

Regression Analysis and Findings

This section provides the multiple regression results of the study (Table 5). The model is significant, based on the results of adjusted R^2 0.4712 with an F-statistic of 9.57 and p-value 0.000. The regression results measure the impact of AI technology on the ESG performance of the business entities. The results show a positive and significant relationship between AI and ESG scores at $p < 0.05$ (H1). Hence, H1 is accepted. This also suggests that AI helps improve information asymmetry by increasing the transparency and accuracy of ESG data, reducing agency costs, and helping to optimize energy use efficiently. Further, there exists a positive and significant relationship between AI and environmental score (E_Score) at $p < 0.05$ (H2). Hence, H2 is accepted. This suggests that AI helps reduce carbon footprints, optimize the use of resources and energy, monitor and reduce waste, enhance sustainability footprint, etc. However, the results suggest that there exists a negative and significant relationship between AI and social score (S_Score) at $p < 0.05$ (H3). The results do not support the hypothesis. Hence, H3 is rejected. This may be because of increasing social concerns related to the use of AI, such as data privacy, unethical practices, and data breaches, and reducing the role of AI, particularly at a tactical level in an

Table 5. ***OLS Regression Results***

Statistics	Coefficient	Standard Error	*p*-value
Cons.	64.8155	23.2027	0.000*
AI_Score	20.3154	4.3855	0.000*
ESG_Score	0.9058	1.2515	0.000*
E_Score	13.3908	3.6357	0.000*
S_Score	–24.6659	6.5087	0.000*
G_Score	6.6981	0.0820	0.002*
B_MEM	1.1963	1.5538	0.001*
B_MEET	4.0674	4.8530	0.003*
B_IND	6.6981	2.6021	0.041**
F_AGE	0.7983	0.1741	0.000*
F_NI	0.8002	0.0182	0.000*
Adjusted R^2	0.4712		
F-Statistics	9.5765		
Observation	253		

Note. *significant at the 1% level, **significant at the 5% level.

organization. Further, the results show that there exists a positive and significant association between AI and governance score (G_Score) at $p < 0.05$ (H4). Hence, H4 is accepted. AI will help enhance and foster transparency, better risk management, and regulatory compliance.

Further, in terms of the control variables, results show a positive relationship between the size of the board and the use of AI. A large board size brings diverse perspectives, expertise, and oversight in various business activities and strategic policy formulation. This would enhance effective decision-making, foster ethical use of resources, and encourage innovation. Also, the number of meetings strongly influences the adoption of AI technology. This is because more meetings provide more opportunities for discussion and strategic planning. Additionally, it encourages aligning values and organizational goals by addressing concerns and implementing AI technology effectively within an organization. It builds a facilitative organizational culture to adapt to the changing times with AI and ESG toward sustainable development. Regarding the impact of the board of directors' independence on adopting AI, results show a positive association between the two because more independent directors can improve oversight and ethical adoption of AI in reporting and business activities.

Furthermore, the results show that the firm's age positively influences the AI score. This suggests that companies have started adopting and using AI within their operations and have become informed about its benefits, applications, and implications. Lastly, the results indicate a positive influence of net income margin on AI adoption, which implies that the higher profitability of the firms encourages companies to invest in AI-based technologies to automate the process and enhance transparency and accuracy of information.

Conclusion

With the advent of AI, there has been a paradigm shift in operating activities, consequently reshaping the ESG reports by enhancing automation in data collection processes, enhancing analysis of ESG data, improving transparency and accuracy of insights, and enabling real-time reporting of information of business entities. This study investigated the influence of AI on ESG reporting by companies in India from 2016 to 2023. The content analysis was employed on the annual reports of 253 selected companies listed in India's National Stock Exchange (NSE). The results indicate that companies have become more aware of AI's adoption, benefits, and implications

within the business and their ESG reporting over recent years. Based on the usage and application of AI, the low AI scores suggest that some companies are still in the early stages of the adoption of AI and are yet to get the benefits of AI applications. Based on the findings of this study, it is suggested that the timely adoption and application of AI in ESG reporting allows harnessing its benefits in multiple ways.

The results indicate that artificial intelligence (AI) positively influences the ESG reporting of these companies under this study. AI is being explored as a transformative tool to enhance the accuracy, efficiency, transparency, and scalability of ESG reporting. The increasing relevance of AI adoption encourages companies to automate the business process and provide real-time information to their stakeholders to help them make more informed decisions. The results also show that AI positively influences the environmental and governance score but negatively influences the social score. This low social score is because of the rising concerns about the unethical use of AI and job displacement issues. Furthermore, this study extends the existing literature and broadens the scope of stakeholders' theory. By addressing stakeholder concerns, companies can enhance trust, reputation, and long-term viability, ultimately reducing the likelihood and impact of adverse events.

In addition, the results of this study have indicated a positive and significant relationship between AI and the company's board of director's characteristics, such as the board's size, frequency of meetings, and board independence. The increasing awareness about AI and its benefits in automation and ensuring transparency in a company's overall business operations are building an enabling work culture, equipping employees for sustainable development thought processes, and helping them embrace sustainability as a way of life across the business enterprise. In other words, AI can help provide meaningful insights to the board or leadership team to increase the sustainability of the business as a whole and contribute to the ecosystem of sustainable development.

Implications

Integrating AI with ESG reporting represents transformative opportunities and risk management strategies for managers and business leaders, changing their philosophy and approach to corporate social responsibility (CSR). An important implication for managers and business leaders is the requirement to integrate AI techniques with ESG reporting frameworks. AI can help automate complex and time-consuming data collection and analysis, enabling companies to generate ESG reports with greater efficiency and accuracy of information contained therein. It can help provide real-time, updated, more accurate, and comprehensive information on the sustainability practices adopted by various organizations.

AI can also equip and enable policymakers to help frame standardized policies for all sectors or regions to avoid unethical use of AI techniques and transparent reporting of information. The AI's ability to predict the future (i.e., predictive analysis) is also valuable for taking proactive actions and framing policies to respond to emerging ESG risks. Furthermore, AI is also potentially beneficial for regulators as it captures details, such as accuracy, timelines, and scope of ESG disclosures. AI is also supportive of providing real-time insights into ESG practices, allowing regulators to identify emerging opportunities and risks to ensure that companies meet regulatory requirements. Additionally, AI can help audit and offer assurance of ESG reports, thereby bringing more transparency and accuracy to the information in ESG reports and making the entities accountable for their actions and taking remedial measures.

Limitations of the Study and Scope for Further Research

Like most research, this study has some limitations. Firstly, this study examines the data sample of companies listed in a developing nation, viz., India, for 2016–23. Second, the annual reports available in English are considered, and there could be some annual reports in regional Indian languages. In addition, the sample does not include annual reports that were not downloadable or unavailable on the companies' websites.

Considering these perspectives, further studies and in-depth research in the near future can be undertaken to

investigate the role of AI in enhancing ESG reporting by increasing the sample size from various countries or continents/regions (like Asia, EU, USA & Canada, Asia Pacific, UAE Countries, Australia and New Zealand). A comparative analysis of developing countries versus developed nations can be conducted so that the findings will add value to the UN's macro-SDG mandate of 2030. In addition, studies could be done to analyze the impact of audit and assurance services through AI-driven tools to enhance the accuracy of ESG reporting.

Authors' Contribution

Dr. Amiya Kumar Mohapatra and Rahul Matta conceptualized and conceived the idea and developed the research framework. Further, Rahul Matta and Dr. Rashmi Soni substantially extracted the research papers from reputed publishers to find the research gaps. Dr. Amiya Kumar Mohapatra and Rahul Matta collected and analyzed the data by adopting a suitable methodology. Rahul Matta, Dr. Amiya Kumar Mohapatra, and Dr. Nandeesh V. Hiremath systematically analyzed the results and drafted a detailed manuscript. Dr. Rashmi Soni and Dr. Nandeesh V. Hiremath concluded the research outcomes along with the required implications.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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