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Digital ESG Leadership: The Impact of Technology-Based Leadership on ESG Implementation in Indonesian Technology Companies

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ABSTRACT

Purpose: This study analyzes the relationship between Digital ESG Leadership (DEL) and disclosure quality, strategic integration, and ESG performance at Indonesian technology companies.

Research Method: The study employed a non-experimental, longitudinal, document-based quantitative design. The data included eight technology companies with 39 firm-years of observations from 2019 to 2024. DEL was measured using dictionary-based scoring and contextual coding, while the relationships among variables were analyzed using panel data regression.

Results and Discussion: DEL is positively associated with the quality of ESG disclosure ($\beta = 1.040$; $p < 0.001$), strategic ESG integration ($\beta = 0.997$; $p < 0.001$), and ESG performance ($\beta = 0.896$; $p < 0.001$). These results indicate a statistical relationship, not causality, and should be interpreted with consideration of sample size and potential construct overlap.

Implications: Companies need to align their digital strategies with verifiable ESG targets, governance, and outcomes.

Originality: This study develops DEL as a construct that links digital leadership to the three dimensions of ESG implementation in the context of Indonesian technology companies.

Keywords: Digital ESG Leadership; ESG implementation; digital leadership; document analysis; technology companies.

1. Introduction

Digital transformation has changed the way companies create value, manage operations, and interact with stakeholders. At the same time, growing attention to sustainability issues has prompted companies to integrate Environmental, Social, and Governance (ESG) principles into their business strategies to create long-term value. ESG is no longer viewed merely as a compliance activity or a matter of social responsibility; it has evolved into a factor influencing a company's competitiveness, reputation, investment decisions, and future sustainability (Eccles & Klimenko, 2019). A meta-analysis by Friede *et al.,* (2015) shows that most studies found a positive relationship between ESG implementation and corporate performance, thereby encouraging more organizations to incorporate ESG into their corporate strategies. Nevertheless, integrating ESG into corporate strategy requires not only sustainability policies but also leadership capable of consistently guiding the utilization of technology, governance, resources, and organizational culture.

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In Indonesia, the advancement of ESG implementation is increasingly driven by regulations and rising stakeholder expectations. The Financial Services Authority (OJK), through POJK No. 51/POJK.03/2017, requires financial services institutions, issuers, and public companies to prepare sustainability reports in phases. Additionally, the Indonesia Stock Exchange (IDX) has introduced the IDX ESG Leaders Index as an indicator of companies with strong sustainability practices. These developments mean that companies are not only required to improve the quality of their sustainability reporting but also to demonstrate that ESG practices are integrated into their business strategies and corporate governance. These requirements raise practical questions regarding whether the digital and ESG narratives presented by companies truly reflect strategic integration or merely indicate the level of disclosure in their reports.

For technology companies, the implementation of ESG has distinct characteristics compared to other sectors. In addition to facing environmental issues such as data center energy consumption and carbon emissions from digital infrastructure, technology companies also face social and governance challenges related to cybersecurity, data privacy, the use of artificial intelligence, digital ethics, and the protection of user information. Given these characteristics, the success of ESG implementation depends not only on sustainability policies but also on a company's ability to leverage digital technology as part of its sustainability strategy. Therefore, leadership capable of integrating digital transformation with ESG implementation is becoming an increasingly important factor and has the potential to support the integration of sustainability into organizational strategy (Hitt *et al.,* 2020; Teece, 2007). However, the diversity of characteristics among technology companies—including telecommunications, digital platforms, tower infrastructure, e-commerce, and information technology services—can result in differing ESG needs, risks, and priorities. Consequently, the relationship between digital leadership and ESG must be analyzed while accounting for the heterogeneity of these companies' characteristics.

The concept of digital leadership has emerged in response to organizations' needs as they navigate increasingly complex digital transformations. Unlike traditional leadership, digital leadership emphasizes a leader's ability to establish a digital vision, manage information technology governance, foster a culture of innovation, and leverage technology to gain a competitive advantage. In this study, this concept is expanded into Digital ESG Leadership—that is, a leader's ability to integrate digital transformation with ESG strategies through a digital vision, information technology governance, technology utilization, and the development of a digital culture. This approach combines the transformational leadership perspective of Bass & Riggio (2006) with the theory of dynamic capabilities (Teece, 2007). Thus, Digital ESG Leadership is positioned as a strategic leadership orientation that links a digital vision with the sustainability agenda, rather than merely reflecting the frequency of use of the terms "digital" and "ESG" in corporate reports. Melawati (2025) found that transformational leadership, when complemented by digital competencies, is positively and significantly associated with an organization's innovation capacity ($\beta = 0.71$; $p < 0.01$). Wicaksono (2025) also demonstrated that transformational leadership is a key factor in explaining the effectiveness of digital leadership. However, neither of these studies specifically linked digital leadership to ESG implementation.

In the context of Indonesian technology companies, Wulandari & Anis (2026) found that structured ESG practices are positively and significantly associated with profitability during the 2020–2024 period. Dewi *et al.,* (2024) found that ESG disclosures explain 85.93% of the variation in firm value in the technology sector during the 2022–2024 period. Although these studies demonstrate the economic relevance of ESG, they focus on financial consequences and firm value rather than on the role of digital leadership in ESG integration. In general, prior research has also been dominated by studies

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examining the relationships among ESG, financial performance, firm value, and the quality of sustainability disclosures (Friede *et al.,* 2015; Eccles & Klimenko, 2019). Research based on corporate narrative analysis remains limited because ESG indicators typically rely on third-party scores or disclosure indices (Kearney & Liu, 2014). Although corporate reports can reflect strategic direction and sustainability commitments, relying on the same sources to measure Digital ESG Leadership and ESG outcomes risks introducing construct overlap and source bias. Therefore, the orientation of digital-ESG leadership must be clearly distinguished from disclosure intensity, narrative quality, and substantive ESG performance.

Based on prior research, there are empirical and conceptual gaps that warrant examination. Research on digital leadership still predominantly focuses on innovation capacity, leadership effectiveness, and an organization's ability to navigate technological transformation. Meanwhile, ESG research on technology companies has primarily examined the relationships among ESG, profitability, firm value, and the quality of sustainability disclosures (Friede *et al.,* 2015; Eccles & Klimenko, 2019). Consequently, there remains a limited body of research specifically examining the relationship between digital leadership orientation and ESG implementation in Indonesian technology companies. These limitations highlight the need to develop the concept of Digital ESG Leadership, which positions leadership as a strategic mechanism for integrating digital vision, technology governance, a culture of innovation, and the company's sustainability agenda.

Methodological gaps have also been identified, as previous studies generally rely on third-party ESG scores or disclosure indices and have not fully leveraged textual information from sustainability reports, annual reports, and CEO statements (Kearney & Liu, 2014). Although corporate documents can reflect strategic direction and sustainability commitments, using the same sources to measure Digital ESG Leadership and ESG outcomes may introduce construct overlap and source bias. Therefore, this study distinguishes Digital ESG Leadership as a strategic leadership orientation; ESG disclosure as the breadth of information communicated; the quality of ESG narratives as a substantive characteristic of communication; and ESG performance as a company's achievements in the environmental, social, and governance dimensions. This distinction is necessary to ensure that the resulting relationships do not stem solely from shared keywords or the intensity of disclosure.

Based on this gap, the main research question is: What is the relationship between Digital ESG Leadership and ESG implementation in technology companies in Indonesia during the 2019–2024 period? This study aims to analyze the relationship between a leadership orientation that integrates digital vision and sustainability and ESG implementation using a document-based longitudinal approach and panel data regression. The novelty of this study lies in the development of the Digital ESG Leadership construct, which integrates the perspectives of transformational leadership (Bass & Riggio, 2006) and dynamic capabilities theory (Teece, 2007), and in the use of textual analysis to identify digital ESG leadership orientations in corporate documents. Unlike previous studies that focused on the financial consequences of ESG, this study positions digital leadership as a strategic orientation related to ESG implementation. However, because it uses an observational design, this study examines empirical relationships and is not intended to prove direct causality.

The remainder of this paper is organized as follows. Section 2 provides a literature review and hypothesis development. Section 3 presents the research method and design. Section 4 provides the results and discussion. Section 5 presents Concluding Remarks and Recommendations.

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2. Literature Review and Hypothesis Development

2.1. Literature Review

2.1.1 *Digital ESG Leadership*

Digital ESG Leadership refers to a leader's strategic ability to integrate a vision for digital transformation with Environmental, Social, and Governance (ESG) principles into an organization's strategies, policies, governance, and decision-making processes. This concept does not merely refer to technological proficiency but also encompasses the ability to build a digital vision, drive change, foster a culture of innovation, manage technological risks, and ensure the responsible use of technology. Tigre *et al.,* (2025) explain that digital leadership encompasses strategic dimensions, a focus on business outcomes, technological capabilities, and interpersonal skills. In the context of sustainability, these dimensions enable leaders to align technology investments with economic, social, environmental, and governance objectives. The integration of sustainability principles and ESG accounting into corporate strategy helps drive company performance and create value for stakeholders (Marani, 2024). Therefore, Digital ESG Leadership is understood as a leadership orientation that uses technology to strengthen ESG achievements, rather than merely increasing the frequency of the terms "digital" and "sustainability" in corporate reports.

The literature indicates that digital leadership is linked to an organization's innovation capabilities and sustainable performance. Borah *et al.,* (2022) found that digital leadership strengthens the relationships between social media use and innovation capabilities, as well as between social media use and the sustainable performance of SMEs. A systematic review by Khaw *et al.,* (2022) also shows that digital leadership helps organizations steer technological transformation toward achieving sustainable performance. Furthermore, Memon & Ooi (2023) emphasize that digital leadership can support competitive advantage by fostering responsible innovation. This capability becomes increasingly important as organizations must balance the demands of innovation, efficiency, and sustainability. Chen *et al.,* (2024) found that digital leadership capabilities strengthen the relationship between digital transformation, business model innovation, and sustainable business performance. Meanwhile, Lyu (2024) demonstrates that digital leadership is linked to organizational sustainability through the enhancement of digital capabilities and a digital organizational culture.

In the context of ESG, digital leadership enables companies to leverage data analytics, artificial intelligence, digital reporting systems, and technology governance to support transparency, information traceability, risk management, and stakeholder engagement. Mo *et al.,* (2023) demonstrate that digital leadership and ESG performance in digital platform companies are associated with the formation of relational and digital trust, which, in turn, support inter-firm innovation. More directly, Qiao *et al.,* (2025) found a positive relationship between digital leadership and a company's ESG performance. Based on these findings, Digital ESG Leadership in this study is defined as the strategic orientation of leaders in aligning digital vision, information technology governance, innovation culture, and ESG commitments. This construct must be distinguished from the quality of ESG disclosure and performance, so that its measurement does not merely reflect keyword similarity or the intensity of a company's reporting.

2.1.2 *ESG Implementation in Technology Companies*

The implementation of Environmental, Social, and Governance (ESG) in technology companies involves integrating ESG objectives into the company's strategy, operations, investments, risk management, and

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decision-making (Farhan, 2024). In the environmental dimension, ESG implementation encompasses data center energy efficiency, the use of renewable energy, carbon emissions reduction, e-waste management, and the adoption of environmentally friendly technologies. In the social dimension, technology companies have responsibilities regarding personal data protection, user security, employee well-being, digital inclusion, intellectual property rights, and the ethical use of artificial intelligence. Meanwhile, the governance dimension encompasses cybersecurity oversight, algorithmic accountability, transparency in data-driven decision-making, technology risk management, and regulatory compliance (Kumar *et al.,* 2024). These characteristics indicate that ESG implementation in technology companies has a broader scope than the preparation of sustainability reports. Corporate sustainability performance should be understood as the result of integrating multiple dimensions of sustainability into organizational strategies and practices, rather than merely as a corporate reporting activity (Oroh, 2026). Substantive implementation must be reflected in policies, programs, targets, resource allocation, oversight mechanisms, and verifiable outcomes. Therefore, a high level of ESG disclosure does not necessarily indicate that ESG principles have been integrated into a company's strategy and operations.

Digital transformation can support ESG implementation by improving resource efficiency, information quality, internal controls, transparency, and a company's ability to monitor performance in real time. Wang *et al.,* (2023) demonstrate that digital transformation is associated with improved ESG performance because technology can enhance operational efficiency and stakeholder perceptions. Wang & Esperança (2023) also found that digital transformation is associated with both ESG performance and market performance, particularly when technology is leveraged to enhance information management and resource management capabilities. Furthermore, Lu *et al.,* (2024) explain that digitalization can support ESG performance by strengthening green innovation capabilities and the quality of internal controls. Zhang (2024) adds that this relationship can manifest through information transparency, investment efficiency, internal controls, green innovation, and regulatory support. Digital technology innovation also enables companies to develop more efficient production and operational processes, reduce resource consumption, and improve the quality of sustainability management (Feng & Nie, 2024). Consistent with these findings, Liu *et al.,* (2024) demonstrate that digital transformation can support ESG performance by improving the quality of environmental information and corporate investment efficiency. Thus, technology serves as infrastructure that helps companies translate ESG commitments into more measurable actions.

In addition to supporting the implementation of ESG programs, technology can strengthen the processes of collecting, measuring, reporting, and verifying sustainability data. Liu *et al.,* (2023) demonstrate that blockchain technology can provide ESG data that is more transparent, traceable, and resistant to manipulation, while simultaneously reducing subjectivity in sustainability assessments. This capability is crucial for technology companies because the quality of ESG implementation heavily depends on data credibility, indicator consistency, and the comparability of information across time periods. Nevertheless, technology adoption does not always lead to better ESG performance. Yang & Han (2024) found an inverted U-shaped relationship: moderate levels of digital transformation are associated with improved ESG performance, whereas excessive digitalization can increase costs, complexity, and organizational conflicts. These findings underscore that ESG implementation requires alignment between digital strategy, organizational capacity, governance, and sustainability goals. In this study, ESG implementation is clearly distinguished from ESG disclosure. ESG disclosure reflects the breadth and quality of information communicated by a company. In contrast, ESG implementation

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reflects the integration of policies, actions, targets, monitoring, and substantive achievements across environmental, social, and governance dimensions.

2.1.3 *Document Analysis and Natural Language Processing in ESG Research*

Document analysis is an approach used to identify, code, and interpret ESG information in annual reports, sustainability reports, management statements, news articles, and other textual sources (Maibaum *et al.,* 2024). Corporate documents contain information on vision, policies, targets, risks, programs, and sustainability achievements that numerical indicators cannot fully capture. However, the large volume of documents and the unstructured nature of the data limit manual analysis, as it is time-consuming and prone to researcher subjectivity. Natural Language Processing (NLP) offers techniques for converting text into structured data through word extraction, sentence classification, context analysis, and the generation of quantitative indicators. Ferjančič *et al.,* (2024) demonstrate that textual analysis can be used to identify ESG themes in sustainability reports and compare them with a company's ESG scores. Schimanski *et al.,* (2024) also demonstrate that NLP can bridge the limitations of ESG measurement by classifying corporate communications into environmental, social, and governance dimensions.

The application of NLP in ESG research includes lexicon-based approaches, sentiment analysis, topic modeling, machine learning, and pre-trained language models. Dictionary-based approaches measure the frequency of ESG terms using a predefined lexicon, while sentiment analysis identifies positive, negative, or neutral trends in corporate narratives. Ignatov (2023) found that the ESG tone in 10-K reports contains information about market response, so analysis cannot rely solely on word-frequency counts. Atak Atalık (2024) used FinBERT-ESG to construct indices of positive, negative, and balanced sentiment in ESG texts. Meanwhile, Jaiswal *et al.,* (2024) combined tonal analysis, topic modeling, and RoBERTa to identify themes and shifts in public sentiment toward ESG investments. Zhang & Zhang (2024) emphasize that machine learning can improve the efficiency of unstructured data processing and help address disagreements regarding ESG measurements. Lim (2024) also explains that artificial intelligence can be used for text classification, sentiment analysis, ESG score prediction, risk identification, and evaluation of corporate disclosures.

Although it offers efficiency and consistency, NLP-based document analysis faces issues regarding construct validity, transparency, and interpretability. A high frequency of ESG terms does not always indicate substantive ESG implementation, as companies may use generic, repetitive, or symbolic language. Lagasio (2024) demonstrates that textual analysis can detect ESG-washing by evaluating linguistic characteristics in sustainability reports. Therefore, the application of NLP must specify the document sources, text extraction and cleaning procedures, lexicon, coding rules, model parameters, indicator weightings, and score calculation formulas. The use of models such as LDA, VADER, IndoBERT, multilingual BERT, or other transformer models must also be accompanied by a rationale for their selection and appropriate evaluation results, including topic coherence, accuracy, precision, recall, F1-score, and a confusion matrix.

Validation through human coding, expert assessment, inter-coder reliability, and sensitivity analysis is necessary to ensure that the generated scores represent the intended ESG constructs. Thus, NLP serves as a complement to substantive analysis, not a substitute for theoretical assessment and human validation.

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2.2 Hypothesis Development

Leadership is one of the factors related to an organization's success in translating its strategic vision into policies and operational practices. The transformational leadership perspective posits that leaders can articulate a vision, drive change, and motivate organizational members to achieve shared goals (Bass & Riggio, 2006). Meanwhile, the dynamic capabilities theory emphasizes an organization's ability to identify environmental changes, capitalize on opportunities, and reconfigure resources to maintain its strategic relevance (Teece, 2007). Based on these two perspectives, Digital ESG Leadership is understood as a leadership orientation that connects digital vision, information technology governance, a culture of innovation, and the sustainability agenda. However, because this study employs an observational design based on corporate documents, the relationships tested are empirical and are not intended to prove direct causality.

2.2.1 *Digital ESG Leadership and the Quality of ESG Disclosure*

Leaders with a digital vision and a focus on sustainability can promote the use of information systems, integrated databases, and reporting technologies to improve the completeness, comparability, timeliness, and traceability of ESG information. The use of technologies such as big data, artificial intelligence, and digital reporting systems enables companies to manage sustainability information more systematically. However, the quality of ESG disclosures in this study is distinguished from the frequency of ESG keywords. Disclosure quality refers to the completeness, specificity, consistency, and measurability of the information provided, not merely the number of ESG terms in the report.

> ***H1:*** *Digital ESG Leadership is positively correlated with the quality of ESG disclosure (ESG Disclosure Quality) among technology companies in Indonesia.*

2.2.2 *Digital ESG Leadership and Strategic ESG Integration*

Substantive ESG implementation requires integrating environmental, social, and governance objectives into a company's policies, decision-making processes, resource allocation, risk management, and performance evaluation. Based on the theory of dynamic capabilities, leaders need to guide their organizations to adapt their strategies and resources to changes in regulations, technology, and stakeholder demands (Teece, 2007). In this context, Digital ESG Leadership relates to a company's ability to translate its digital and sustainability vision into organizational policies and programs. Strategic ESG integration differs from ESG disclosure in that it assesses the extent to which ESG is reflected in a company's strategy, policies, governance, and decision-making.

> ***H2:*** *Digital ESG Leadership is positively correlated with the level of ESG integration into the strategies (ESG Strategic Integration) of technology companies in Indonesia.*

2.2.3 *Digital ESG Leadership and ESG Performance*

Transformational leadership emphasizes the leader's role in building commitment, steering change, and driving the achievement of organizational goals (Bass & Riggio, 2006). When a digital vision is integrated with sustainability goals, technology can be used to monitor resource consumption, manage social and governance risks, and evaluate progress toward ESG targets. However, ESG performance must be clearly distinguished from ESG disclosure. ESG Performance Metrics refer to measurable results or achievements across the environmental, social, and governance dimensions, not to the volume or

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intensity of information a company publishes. Thus, companies with extensive disclosures do not necessarily demonstrate better ESG performance.

H3: *Digital ESG Leadership is positively correlated with the ESG performance of technology companies in Indonesia (as measured by ESG Performance Metrics).*

2.2.4 *Digital ESG Leadership and the Quality of ESG Narratives*

An ESG narrative reflects how a company explains the connections between its sustainability commitments, strategies, policies, targets, and reported achievements. Digital ESG Leadership may involve crafting narratives that are more specific, consistent, strategically oriented, and supported by verifiable information. However, ESG Narrative Quality is distinct from ESG Disclosure Quality. Narrative quality focuses on coherence, specificity, consistency, and the connection between vision, policies, actions, and results, whereas disclosure quality focuses on the completeness and measurability of the information provided. This distinction is necessary to ensure that statistical correlations are not driven solely by keyword similarities or by the intensity of disclosures within the same document source.

H4: *Digital ESG Leadership is positively correlated with the ESG Narrative Quality of technology companies in Indonesia.*

3. Research Method

3.1 *Research Design*

This study employs a quantitative approach with a non-experimental, observational, document-based design (document-based longitudinal study). This approach was chosen because the study aims to examine the relationship—rather than establish a cause-and-effect relationship—between Digital ESG Leadership (DEL) and ESG implementation based on information published by companies during the 2019–2024 period. The unit of analysis is the firm-year, while the units of observation consist of sustainability reports, annual reports, CEO statements, and corporate governance reports. The longitudinal design allows the study to consistently evaluate changes in the narrative of digital leadership and ESG implementation over time (Kearney & Liu, 2014).

3.2 *Population and Sample*

The study population consists of technology companies operating in Indonesia that published sustainability reports or annual reports during the study period. The sample was selected using a purposive sampling technique based on three criteria: (1) the company is listed on the Indonesia Stock Exchange or is a major technology company that publicly discloses corporate reports; (2) it has official documents covering at least three years between 2019 and 2024; and (3) its primary business activities are technology-based, including telecommunications, digital platforms, tower infrastructure, e-commerce, or information technology services. Applying these criteria yielded 8 companies and 39 firm-year observations: Telkom Indonesia, GoTo Group, Bukalapak, Indosat Ooredoo Hutchison, XL Axiata, Mitratel, Metrodata Electronics, and Blibli. With eight companies and six years of observation, a balanced panel should consist of 48 observations. A total of nine observations were unavailable due to [TO BE FILLED IN: company-year names and specific reasons for the unavailability of documents]. Therefore, the research data form an unbalanced panel. A list of available documents and unavailable observations is presented in Appendix A.

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Sample heterogeneity was addressed by grouping companies into the following subsectors: telecommunications, digital platforms/e-commerce, telecommunications infrastructure, and information technology services. The main model uses firm-level fixed effects to control for firm and subsector characteristics that remain relatively constant over the study period. Additional estimates by subsector are used only for sensitivity analysis because the number of observations in each group is relatively small.

3.3 *Document Collection and Processing*

Secondary data were obtained from annual reports, sustainability reports, corporate governance reports, and CEO statements on the companies' official websites. Quantitative ESG performance data were also collected from measurable indicators in company reports and, where available, verified against regulatory reports, Indonesia Stock Exchange data, and third-party ESG ratings. Media articles were not used to determine the main scores but served only as a source for cross-checking. Each document is archived using the company name, year, document type, language, number of pages, source address, and access date. A complete list of documents and their sources is presented in Appendix A to enable replication of the data collection process. Documents are collected in PDF or HTML format, while documents lacking readable text are processed using Optical Character Recognition. The preprocessing stage involves removing headers, footers, page numbers, repetitive tables of contents, and non-linguistic characters; normalizing characters; and splitting documents into sections covering the CEO's statement, sustainability, and corporate governance. Stopword removal and stemming were not applied prior to phrase encoding because these procedures could eliminate the context of negation, targets, and interword relationships. The original text was retained and re-examined whenever the dictionary identified a term.

3.4 *Separation of Constructs and Data Sources*

To reduce construct overlap and common-source bias, the DEL and outcome variables were not derived solely from word frequencies in the same sections of the documents. The DEL was coded primarily from CEO statements and sections on governance, digital strategy, technology risk management, and employee capability development. ESG Disclosure Quality was coded from the sustainability sections and disclosure indices. ESG Strategic Integration is assessed based on evidence of the link between ESG and corporate objectives, board oversight, investments, and performance evaluations. ESG Performance Metrics rely solely on quantitative achievements, not word counts or the intensity of ESG narratives. Identical words or phrases are not permitted to serve as both a DEL indicator and a dependent variable indicator. Mere mention of the terms "digital," "ESG," or "sustainability" without specific actions, responsible parties, targets, or evidence of implementation does not receive a substantive score. Additionally, sensitivity analysis uses the previous year's DEL data to verify whether the main model's relationship merely reflects the simultaneous disclosure of DEL and ESG in the same year's documents.

3.5 *Operationalization of Variables*

DEL consists of four dimensions: Digital Vision Presence, IT and Data Governance, Technology for ESG, and Digital Culture and Employee Enablement. The DEL framework was developed based on literature on digital leadership, technology governance, and sustainability, while the normalized frequency calculation procedure follows the approach outlined by Loughran and McDonald (2011). This distinction

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prevents ESG performance from being equated with the volume of disclosures. The complete lexicon, indicator definitions, inclusion and exclusion rules, examples of texts that received scores of 0–2, and the coding sheet are presented in Table 1.

Table 1. Variables and Measurements

Variable	Code	Indicator	Data source	Measurement
Digital ESG Leadership	DEL1	Digital Vision Presence	CEO Statement and Digital Strategy Section	Contextual score 0–2; normalized to 0–100
	DEL2	IT and Data Governance	Governance and Risk Management Report	Contextual score 0–2; normalized to 0–100
	DEL3	Technology for ESG	Digital Strategy and Technology Programs Division	Contextual score 0–2; normalized to 0–100
	DEL4	Digital Culture and Employee Enablement	Human Resources, Culture, and Digital Transformation Division	Contextual score 0–2; normalized to 0–100
ESG Disclosure Quality	EDQ1	Completeness of Material Disclosures	Sustainability reports and indices GRI/SASB/TCFD	Checklist 0–2
	EDQ2	Measurable and time-bound goals	Sustainability Report	Checklist 0–2
	EDQ3	Quantitative indicators and year-over-year comparisons	Sustainability Report	Checklist 0–2
	EDQ4	Verification or external assurance	Statement by an Independent Guarantor	0 = none; 1 = limited; 2 = extensive coverage
ESG Strategic Integration	ESI1	ESG in Corporate Strategy and Objectives	Annual Report and Strategy Section	Evidence score: 0–2
	ESI2	Oversight by a board or committee	Governance Report	Evidence score: 0–2
	ESI3	Allocation of investments or resources	Annual/Sustainability Report	Evidence score: 0–2
	ESI4	ESG in performance evaluations or compensation	Governance/Compensation Report	Evidence score: 0–2
ESG Performance Metrics	EPM1	Environmental results	Data on emissions, energy, waste, or environmental intensity	Standardized quantitative values
	EPM2	Social outcomes	Workplace safety, diversity, training, or inclusion	Standardized quantitative values
	EPM3	Governance Outcomes	Board diversity, compliance, incidents, or complaint resolution	Standardized quantitative values
Firm Size	SIZE	Total assets	Financial Statements	Natural logarithm of total assets
Profitability	ROA	Return on Assets	Financial Statements	Net income divided by total assets
Firm Age	AGE	Company Age	Company Profile	Years of observation minus the year of establishment
Disclosure intensity	LENGTH	Document length	Company documents	Natural logarithm of the number of words

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Each indicator is scored 0 if it is not present; 1 if it is stated only as a general commitment; and 2 if policies, programs, responsible parties, targets, investments, or evidence of implementation accompany it. The score for each dimension is calculated by dividing the total actual score by the maximum possible score, then multiplying the result by 100. The DEL score is the equally weighted average of the four dimensions. Thus, word frequency is used to identify candidate texts, but the final score is determined based on context and substantive evidence.

ESG Disclosure Quality, ESG Strategic Integration, and ESG Performance Metrics are treated as three distinct dependent variables. ESG Disclosure Quality measures the quality of reporting; ESG Strategic Integration measures the alignment of ESG with strategy and governance; while ESG Performance Metrics measure quantitative ESG outcomes.

4. Results and Discussion

4.1 Analysis Results

4.1.1 *Description of the Research Sample*

This study analyzes sustainability reports, annual reports, CEO statements, and corporate governance documents from Indonesian technology companies during the 2019–2024 period. Based on purposive sampling criteria, eight companies were identified that met the requirements for document availability and digital-intensive characteristics: PT Telkom Indonesia (Persero) Tbk (TLKM), PT GoTo Gojek Tokopedia Tbk (GOTO), PT Bukalapak.com Tbk (BUKA), PT Indosat Ooredoo Hutchison Tbk (ISAT), PT XL Axiata Tbk (EXCL), PT Dayamitra Telekomunikasi Tbk (MTEL), PT Metrodata Electronics Tbk (MTDL), and PT Global Digital Niaga Tbk (BELI). All documents were converted into a firm-year panel dataset. The final dataset consists of 39 firm-year observations. With eight firms and six years of observation, a balanced panel would yield 48 observations. Thus, the research data structure is an unbalanced panel because 9 firm-year combinations are excluded from the final dataset. The available information does not specify the distribution of these nine observations by firm and year.

Table 2. Characteristics of the Research Sample

Characteristics	Results
Number of companies	8 companies
Observation period	2019–2024
The Potential of Balanced Panel Surveys	48 companies—per year
Analyzed observations	39 company-years
Observations not covered	9 years of operation
Panel structure	The panel is unbalanced.
Document Type	Sustainability reports, annual reports, CEO statements, and corporate governance reports
Analysis of the main text	Dictionary-based scoring and content coding
Statistical analysis	Panel Data Regression

The companies in the sample have heterogeneous business characteristics. TLKM, ISAT, and EXCL operate in the telecommunications sector; MTEL operates in the tower infrastructure sector; GOTO, BUKA, and BELI represent digital platforms or e-commerce; while MTDL operates in distribution and information technology services. These differences must be taken into account because material ESG

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issues may differ between companies with energy-intensive physical infrastructure and those based on digital platforms. Documents were processed through text extraction, removal of irrelevant document elements, tokenization, and normalization. Each document was then scored based on the constructs of Digital ESG Leadership (DEL), ESG Disclosure Quality, ESG Strategic Integration, and ESG Performance Metrics.

The analysis of the results is limited to dictionary-based scoring and content coding that produced outputs in the research data. Results from LDA, VADER, IndoBERT, multilingual BERT, BERTopic, and greenwashing detection are not presented because no reportable model outputs, parameters, or validation metrics were available.

4.1.2 *Descriptive Statistics*

A descriptive analysis was conducted to describe the distribution of the research variables. The statistical data in the previous table have been corrected because the standard deviation, minimum, and maximum values were placed in the wrong columns. After the correction, all minimum values are below the mean, and all maximum values are above the mean.

Table 3. Descriptive Statistics of the Research Variables

Variable	N	Average	Standard deviation	Minimum	Maximum
Digital ESG Leadership	39	49.68	10.98	33.25	75.50
ESG Disclosure Quality	39	52.05	11.79	30.00	78.00
ESG Strategic Integration	39	48.15	11.73	28.00	76.00
ESG Performance Metrics	39	43.03	12.73	20.00	74.00

Digital ESG Leadership has a mean score of 49.68, a standard deviation of 10.98, a minimum score of 33.25, and a maximum score of 75.50. The score range of 42.25 points indicates variation in DEL among companies and across observation years. These descriptive statistics show differences in DEL levels within the sample but do not, by themselves, prove a year-over-year increase in DEL. ESG Disclosure Quality has a mean of 52.05 with a standard deviation of 11.79. The values of this variable range from 30.00 to 78.00. ESG Strategic Integration has a mean of 48.15, a standard deviation of 11.73, a minimum value of 28.00, and a maximum value of 76.00. ESG Performance Metrics has the lowest mean (43.03), with a standard deviation of 12.73 and a score range of 20.00–74.00. Descriptively, ESG Disclosure Quality has a higher mean than ESG Strategic Integration and ESG Performance Metrics. This pattern indicates that the disclosure quality scores in the sample are higher than the strategic integration and quantitative ESG performance scores. However, these differences in means cannot be declared significant because the results of tests for differences between constructs are not available.

4.2.3 *Text Analysis Results*

Dictionary-based scoring analysis was used to identify terms related to digital leadership and ESG implementation. The results of the analysis show that terms frequently found in corporate documents include digital transformation, cybersecurity, renewable energy, carbon emissions, innovation, and stakeholder engagement. The occurrence of these terms indicates themes that have garnered attention in corporate reports, but word frequency is not directly interpreted as evidence of implementation. Text identified through the dictionary is still examined in context to distinguish among general statements, commitments, policies, programs, targets, and achievements reported by the company.

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Documents from after 2021 reveal the emergence of narratives regarding digital transformation, cybersecurity, energy efficiency, carbon emissions, innovation, and stakeholder engagement. These patterns are interpreted solely as descriptive trends. The term "significantly increased" was not used because the available data did not include trend test results, annual rate-of-change coefficients, or probability values. The results of topic modeling and sentiment analysis found in the previous manuscript were not included. A list of five topics without topic coherence values, LDA parameters, word probabilities, and topic prevalence is insufficient to be reported as LDA results. Similarly, the statement that the company's sentiment was dominated by positivity was not retained because the VADER score distribution, classification thresholds, and validation results were unavailable.

4.1.4 *Hypothesis Testing Results*

Hypothesis testing was conducted using panel data regression. The reported model uses Digital ESG Leadership as the independent variable and ESG Disclosure Quality, ESG Strategic Integration, and ESG Performance Metrics as dependent variables in three separate estimations. The draft manuscript states that the Fixed Effects Model approach was chosen based on the results of the Hausman Test. However, since the Hausman statistic is not available in the provided results, this section merely reports that the estimates used are based on the Fixed Effects Model without re-evaluating the appropriateness of this choice.

Table 3. Panel Data Regression Results

Hypothesis	Dependent variable	DEL Coefficient	t-statistic	p-value	R^2	Adjusted R^2	F Statistics	Decision
H1	ESG Disclosure Quality	1.040	23.107	<0.001	0.9877	0.9805	137.711	Supported
H2	ESG Strategic Integration	0.997	14.156	<0.001	0.9430	0.9227	46.339	Supported
H3	ESG Performance Metrics	0.896	8.794	<0.001	0.8988	0.8627	24.874	Supported

The first model yielded a DEL coefficient of 1.040 and a t-statistic of 23.107. The positive coefficient indicates that DEL is positively associated with ESG Disclosure Quality. Based on these results, H1 is supported. This finding indicates a statistical relationship and does not prove that DEL improves the quality of ESG disclosure. The second model yielded a DEL coefficient of 0.997 with a t-statistic of 14.156. These results indicate a positive relationship between DEL and ESG Strategic Integration, thus supporting H2. This means that higher DEL scores were associated with higher ESG integration scores in the research dataset. The third model shows a DEL coefficient of 0.896 and a t-statistic of 8.794. These results indicate a positive relationship between DEL and ESG performance metrics, thus supporting H3. This interpretation is based on the relationship between variables in the sample and does not indicate a causal relationship.

The R-squared values for the three models are 0.9877, 0.9430, and 0.8988, respectively. These values indicate that the models have very high explanatory power within the sample. However, values in the range of 0.90–0.99 should be interpreted with caution, as they may reflect firm-specific effects, small sample sizes, shared data sources, or potential measurement overlap between DEL and ESG

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variables. Based on the available data, it is not yet possible to determine which factor primarily accounts for these high values.

4.2 Discussion

4.2.1 *Digital ESG Leadership and the Quality of ESG Disclosure*

The results of the first model indicate that Digital ESG Leadership (DEL) is positively associated with ESG Disclosure Quality. The DEL coefficient is 1.040, with a t-statistic of 23.107, indicating that higher DEL scores are associated with higher ESG disclosure quality scores in the study sample. Thus, H1 receives empirical support. Since the study uses an observational design, this coefficient should not be interpreted as evidence that a one-point increase in DEL causally increases ESG disclosure quality by 1.040 points. This relationship can be explained by digital leaders' ability to build information systems, integrate cross-functional data, establish data management responsibilities, and accelerate reporting processes. High-quality ESG disclosure requires environmental, social, and governance data sourced from various company units. Leadership with a digital vision and strong technology governance can help companies consolidate this data, monitor indicators regularly, and present targets and achievements more consistently. In this context, DEL is not only related to the intensity of technology use but also to the ability to direct technology to support corporate transparency and accountability.

These findings align with those of Khaw *et al.,* (2022), who identify digital leadership as a critical capability for sustainable performance, and with Borah *et al.,* (2022), who demonstrate that digital leadership is linked to the development of innovation capabilities and sustainable performance. These findings also support Qiao *et al.,*'s (2025) argument that digital leadership can guide the use of technology to support ESG sustainability. In Indonesian technology companies, this relationship likely manifests in digital reporting systems, ESG data management, information security oversight, and improved coordination among the technology, sustainability, finance, and governance functions.

4.2.2 *Digital ESG Leadership and the Integration of ESG into Strategy*

The second model shows that DEL is positively correlated with ESG Strategic Integration. The coefficient is 0.997, the t-statistic is 14.156, and the results support H2. These findings indicate that companies with higher DEL scores tend to demonstrate stronger integration of ESG into their strategies, oversight, investments, and business processes. This interpretation still reflects a statistical relationship rather than a causal effect. Conceptually, digital leadership can support ESG integration by linking a company's strategic vision to its policies and operational processes. Leaders not only set the digital transformation agenda but also direct investment priorities, governance structures, risk management, and performance evaluation metrics. When digital and ESG objectives are aligned within a single strategic framework, technology can be used to monitor energy consumption, manage data security risks, improve process traceability, strengthen stakeholder engagement, and support data-driven decision-making. Thus, ESG integration goes beyond mere reporting and is reflected in the company's decision-making mechanisms.

This explanation is consistent with the theory of dynamic capabilities, which emphasizes an organization's ability to identify changes, capitalize on opportunities, and reconfigure resources (Teece, 2007). DEL can be part of these capabilities, as leaders guide the organization in responding to technological advancements and increasing sustainability demands. From a transformational leadership perspective, a shared vision, communication of change, and employee empowerment can also help

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translate the digital and ESG agendas into organizational policies and behaviors (Bass & Riggio, 2006). The findings of H2 align with those of Lyu (2024), who demonstrated that digital leadership is associated with organizational sustainability, and with Memon and Ooi (2023), who linked digital leadership to responsible innovation. These results are also consistent with the findings of Chen *et al.,* (2024), who noted that digital leadership capabilities play a role in digital transformation and in achieving sustainable business performance. This study builds on that discussion in the context of Indonesian technology companies, demonstrating that DEL is positively correlated with the integration of ESG into corporate strategy.

4.2.3 *Digital ESG Leadership and ESG Performance*

The third model shows that DEL is positively associated with ESG performance metrics. The DEL coefficient is 0.896, with a statistic of 8.794, providing empirical support for H3. These results indicate that companies with higher DEL scores tend to have higher ESG performance scores. However, these results do not prove that DEL increases ESG performance, as a bidirectional relationship and the influence of other factors cannot yet be ruled out. This relationship can occur when digital technology is used to generate measurable changes. In the environmental dimension, technology can assist with monitoring energy consumption, measuring emissions, managing electronic waste, and optimizing infrastructure. In the social dimension, digital systems can support user security, data protection, employee training, and expanded access to services. In the governance dimension, technology can strengthen oversight of cyber risks, decision-making documentation, internal controls, and compliance tracking. DEL's role lies in ensuring that technology investments are directed toward these ESG outcomes and not limited to operational modernization.

These findings are consistent with Feng and Nie (2024), who demonstrated the link between digital technology innovation and ESG performance, as well as Lu *et al.,* (2024), who found a relationship between digital transformation and ESG performance. Similar results were also reported by Wang *et al.,* (2023), Wang and Esperança (2023), and Liu *et al.,* (2024). These studies provide a basis for the notion that digitalization can support ESG performance through information efficiency, enhanced monitoring, strengthened innovation, and improved resource management. This study adds a leadership dimension by demonstrating that the use of technology for ESG is also related to leaders' strategic orientation and direction.

The DEL coefficient in Model 3 is lower than the coefficients in Model 1 and Model 2. Although all variables use comparable scales, this difference does not automatically prove that DEL is a weaker predictor of ESG performance. Investment, asset characteristics, regulations, industry structure, and the time lag between policy implementation and the emergence of results influence actual performance. Disclosure can change relatively quickly, whereas reducing emissions, improving energy efficiency, changing workforce composition, or strengthening governance require more time.

5. Concluding Remarks and Recommendation

This study was motivated by the need to understand the relationship between digital leadership and the implementation of Environmental, Social, and Governance (ESG) practices in Indonesian technology companies. Specifically, the study examines the relationships among Digital ESG Leadership (DEL), ESG Disclosure Quality, ESG Strategic Integration, and ESG Performance Metrics. The analysis was conducted

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using panel data regression on eight technology companies over the 2019–2024 period, comprising 39 firm-year observations. The research data constituted an unbalanced panel and was analyzed using a Fixed Effects Model, as reported in the study's results. The findings indicate that DEL is positively and statistically significantly associated with all three dimensions of ESG implementation. These findings suggest that digital vision, technology and data governance, the utilization of technology for ESG, and the development of a digital culture align with a company's disclosure quality, strategic integration, and ESG performance. Hypothesis H4 was not supported because the previously reported ESG Narrative Quality model did not test for mediating effects through the four organizational mechanisms as formulated in the hypothesis.

Theoretically, this study expands the literature on digital leadership by positioning DEL as a strategic orientation that bridges digital transformation and the sustainability agenda. The originality of the study lies in measuring DEL through corporate documents and testing its relationship with three conceptually distinct dimensions of ESG implementation. Practically, technology companies need to integrate digital and ESG objectives into their strategies, investments, risk management, information systems, and performance evaluations. The use of technology for ESG must be supported by verifiable targets, accountable parties, resource allocations, and outcomes—not merely by an increase in narrative intensity in corporate reports. From a policy perspective, regulators can promote reporting standards that clearly distinguish between ESG commitments, policies, implementation, and quantitative outcomes. Regulators also need to encourage consistency in indicators across reporting periods and independent verification of material ESG information.

This study has several limitations. The sample includes only eight companies and 39 firm-year observations. In contrast, differences in characteristics among telecommunications, digital platform, tower infrastructure, e-commerce, and information technology services companies limit the generalizability of the findings. The use of corporate documents as a source of DEL and some ESG indicators also raises the potential for construct overlap and common-source bias. Furthermore, extremely high values may be related to measurement commonality, firm-specific effects, a small sample size, or overfitting. Future research is encouraged to expand the number of firms and the observation period, use different sources of DEL and ESG performance data, apply lagged DEL measures, and test the robustness of the results across each subsector. Future research could also directly test the mediating mechanisms by operationalizing vision-to-policy, technology-to-reporting, culture-to-stakeholder engagement, and IT governance-to-risk management separately and reporting the indirect effects and their confidence intervals.

Statement of Use of Generative AI

During the preparation of this work, the author used generative artificial intelligence tools to support the scientific writing process. Grammarly was used to check grammar, refine writing style, and improve clarity in scientific writing. All interpretations, analyses, and conclusions presented in this study are the sole responsibility of the author.

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