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Analysis of Challenge and Barrier Factors in Implementing the ESG Concept in Indonesia's Construction Sector

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Abstract: *The growing urgency of sustainability issues, including environmental degradation, social inequality, and governance weaknesses, has intensified global pressure on industries to adopt Environmental, Social, and Governance (ESG) principles. The construction sector, as one of Indonesia's major economic contributors and a significant source of global carbon emissions, faces increasing demand to align its practices with sustainability goals. Despite this urgency, ESG implementation in the Indonesian construction industry remains limited due to low awareness, inconsistent frameworks, and regulatory challenges. This study aims to identify key challenges and barriers to ESG implementation within Indonesia's construction sector and to formulate strategic recommendations for improvement. A descriptive quantitative method was applied using a survey distributed to construction experts and practitioners across Jakarta, Surabaya, and Bandung. Data were analyzed using the Relative Importance Index (RII) to determine the relative weight of each factor influencing ESG implementation. The results indicate that the main challenges include a lack of ESG socialization and education, short-term profit orientation, and limited stakeholder engagement, with RII values ranging from 0.44 to 1.00. Meanwhile, the main barriers are limited financial capacity, the absence of standardized reporting frameworks, and weak regulatory support, with RII values between 0.60 and 0.96. These findings suggest that ESG implementation in Indonesia's construction sector remains in its early stages, hindered by institutional and governance constraints. Strengthening ESG literacy, policy frameworks, and financial mechanisms is essential to accelerate sustainable construction practices and support national development goals.*

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INTRODUCTION

The rapid pace of industrialization has brought undeniable economic progress, but it has also led to serious environmental and social consequences. Increasing levels of pollution, rising carbon emissions, social inequality, poor labor conditions, and the decline in community well-being have become pressing global concerns (1). These challenges have prompted growing pressure from governments, investors, and the public for companies to move beyond profit-oriented goals and embrace broader responsibilities toward society and the environment (2). In response, the United Nations introduced the Principles for Responsible Investment (PRI) in 2006, encouraging organizations to integrate Environmental, Social, and Governance (ESG) factors into their investment and management decisions. ESG serves as a key framework for assessing a company's

performance not only in financial terms but also in how it contributes to sustainability and ethical governance (3). Its implementation has been proven to enhance corporate value, reduce risks, attract long-term investors, and strengthen sustainability and stakeholder satisfaction.

The social aspect of ESG, through Corporate Social Responsibility (CSR), plays a vital role in improving corporate reputation and performance, particularly in the construction sector. Studies show that CSR and ESG disclosure positively influence firm value, with competitive advantage acting as a reinforcing factor in the relationship between ESG and corporate performance (4).

Global awareness of ESG has grown rapidly since 2018, as reflected by the surge in academic publications and sustainable investments in Indonesia (5). The Financial Services Authority (OJK) has recorded growth in ESG-based mutual fund products, while the government has integrated ESG principles into infrastructure projects such as the Makassar–Parepare Public–Private Partnership (PPP), supported by UNDP and the Ministry of Finance through a sustainable financing framework (6).

The construction sector contributes significantly to Indonesia's economy (around 9.82% of GDP) but is also a major contributor to global carbon emissions (37%) (7). Within this context, Environmental, Social, and Governance (ESG) principles function as an important mitigation instrument by integrating sustainability considerations into corporate decision-making and public policy frameworks. The environmental dimension of ESG promotes emission reduction through energy efficiency, the adoption of low-carbon materials, and sustainable construction practices. The social dimension strengthens community engagement, labor protection, and occupational safety, while the governance dimension enhances transparency, accountability, and compliance with environmental regulations. Several Indonesian construction companies, such as PT Wijaya Karya (WIKA) and PT Hutama Karya, have adopted ESG principles and received international recognition. For example, WIKA earned a score of 53/100 from S&P Global (2024) and became a national pioneer in ESG implementation in the construction sector.

Despite growing recognition of ESG importance, several implementation challenges remain. Major issues include inconsistencies in ESG scores among major rating agencies (8), the need for a consistent evaluation framework (Singhania & Saini, 2023), low CSR adoption among small and medium enterprises (9), and limited ESG research in developing countries, including Indonesia (10).

Bezerra et al. (2024) validated ESG implementation challenges in Brazil's construction sector and recommended three future research directions: expanding studies to other developing nations, developing concrete mitigation strategies, and analyzing ESG's impact on corporate performance and sustainability. Liou et al. (2023) identified barriers such as financial constraints, lack of managerial support, and regulatory complexity, suggesting broader cross-sector exploration. Chopra et al. (2024) highlighted the importance of examining government incentives and the reporting challenges faced by SMEs.

Khamisu et al. (2024) emphasized that ESG implementation challenges are highly context-dependent—varying by geography and industry—indicating the need for empirical studies in Indonesia's construction sector to test the generalizability of global findings. Similarly, Zhang et al. (2022) stressed the need to develop standardized ESG assessment models in developing countries to evaluate ESG's financial and reputational impacts.

Based on the background explanation, this study focuses on addressing two main issues: identifying the key challenges and barriers in implementing the principles of Environmental, Social, and Governance (ESG) within companies in Indonesia's construction sector, and formulating appropriate mitigation strategies to overcome these issues. The research emphasizes identifying factors that hinder ESG implementation, both from internal corporate aspects and external elements such as regulations and government policies. The scope of this study is limited to construction companies operating in Indonesia, with a focus on mapping the challenges and obstacles to ESG implementation as an initial step in understanding the current state of sustainability practices in the national construction industry.

LITERATURE REVIEW

A. Environment, Social, and Governance (ESG)

Sustainable development is defined as a process of meeting present needs without compromising the ability of future generations to meet their own (11). The three main dimensions of sustainability—environmental, social, and economic—must be implemented in an integrated manner, often referred to as the *three pillars of sustainability* (12). The implementation of sustainability depends on collaboration among the government, businesses, and educational institutions (the Triple Helix model) to ensure that regulation, education, and business practices align toward sustainable development goals.

ESG is an evaluative framework used to measure a company's non-financial performance across three dimensions: environmental, social, and governance. It serves as a key indicator of sustainability and corporate social responsibility, guiding modern investment decisions. The *Principles for Responsible Investment (PRI)*, introduced in 2006 and supported by the United Nations, promote six main principles encouraging the integration of ESG into investment analysis and ownership practices (3).

- Environmental: concerns energy use, climate change, and pollution.
- Social: includes employee welfare, occupational health and safety, and community engagement.
- Governance: covers business ethics, board structure, and corporate accountability.

In Indonesia, the Ministry of Finance introduced the ESG Framework for Infrastructure Financing in 2022—later updated in 2024—to ensure that public infrastructure projects not only address environmental and social impacts but also uphold stronger governance standards (13). Implementing ESG in construction companies enhances transparency, operational efficiency, and business reputation. ESG integration has become a necessity rather than an option. Zakaria (2025) emphasized that companies proactively adopting ESG gain competitive advantages and long-term sustainability. Hazaea et al. (2025) found that audit quality strengthens the impact of ESG on reducing the cost of capital, proving ESG's financial relevance.

In Indonesia, the construction sector has shown significant progress, with major companies like PT PP, PT WIKA, and PT Hutama Karya earning national and international recognition for ESG excellence. For example, PT PP (Persero) Tbk received the *"Pioneer Most Excellence in ESG Green Construction Practices"* award at the CNBC Indonesia Awards 2024, recognizing its leadership in sustainable construction. Similarly, PT Wijaya Karya (WIKA) achieved a score of 53 out of 100 from S&P Global in 2024, making it the first Indonesian construction company to reach this milestone. Meanwhile,

PT Hutama Karya earned the Bronze Winner title at the 3rd Indonesia DEI & ESG Awards (IDEAS) 2024 for its success in integrating social communication strategies into major infrastructure projects. The development of the Nusantara Capital City (IKN) project further illustrates this progress, where the establishment of an independent ESG Committee has been introduced as a model for sustainable urban governance in Indonesia (14). Similarly, the *Makassar–Parepare Railway Project* was highlighted in the BRICS 2025 forum as a showcase of ESG framework implementation in government-supported infrastructure projects.

B. Challenges and Barriers to ESG Implementation

According to the Indonesian dictionary (KBBI), a *challenge* refers to something that motivates individuals to strengthen their determination and capability in facing difficulties, while a *barrier* is an obstacle that hinders progress. In the construction sector, environmental challenges include high carbon emissions, poor waste management, limited use of sustainable resources, and weak environmental policies. Social challenges involve low industry awareness of ESG, market uncertainty, inadequate attention to occupational safety, and weak community engagement.

Governance-related barriers include limited funding, lack of anti-corruption enforcement, absence of standardized ESG reporting, and insufficient government incentives. Environmental issues also encompass excessive construction waste generation and non-compliance with waste disposal regulations (15). Sustainable construction practices—such as recycling, innovative building methods, and green financing—are essential to minimize lifecycle impacts (16).

Bezerra et al. (2024) highlighted that addressing environmental issues alone is insufficient since environmental, social, and governance dimensions are interconnected. Social participation, community engagement, and ESG education play crucial roles. From the governance perspective, the lack of transparency, reliability, and auditability of non-financial indicators remains a key challenge (17). These challenges highlight how crucial sustainability reporting is for ensuring accountability and building stakeholder trust (18). At the organizational level, however, companies continue to struggle with four major reporting obstacles: behavioral, data credibility, methodological, and contextual (19). Based on Yu et al. (2020), implementing ESG merely as an administrative or reporting formality, without corresponding improvements in actual environmental, social, and governance performance, creates a high risk of greenwashing through organizational decoupling. The authors define greenwashing as a condition in which firms appear highly transparent by disclosing large volumes of ESG information, while simultaneously exhibiting poor ESG performance. This reflects a decoupling between symbolic disclosure and substantive operational practices, where ESG reporting is used to manage stakeholder perceptions rather than to drive real change (20).

C. Relative Importance Index (RII)

The Relative Importance Index (RII) is a quantitative method used to determine the ranking or priority of various factors based on respondents' perceptions of the importance or influence level of a given variable. It serves as a quantitative tool to assess and prioritize key factors in a project according to respondents' evaluations of their significance. The RII is calculated by dividing the total weighted score of a factor by the product of the total

number of respondents and the maximum value on the scale, producing a result between 0 and 1.

$$RII = \frac{\sum w}{A \times N}$$

Where:

W = weighted score from each respondent (e.g., 1 = no influence, 5 = very high influence)

A = highest value on the Likert scale (e.g., 5)

N = total number of respondents

RESEARCH METHODOLOGY

This study adopts a descriptive quantitative approach using a survey design to identify the main challenges and barriers in implementing Environmental, Social, and Governance (ESG) principles within Indonesia's construction sector. The research was conducted for 4 months targeting experts and construction practitioners with experience in ESG-related policies or initiatives. Implementing ESG principles in the construction industry presents unique difficulties shaped by the sector's inherent characteristics and external conditions. In this context, challenges are seen as demanding situations that can also open opportunities for growth, while barriers represent obstacles that restrict progress and must be addressed or eliminated.

Primary data were collected through a semi-structured questionnaire using a 1–5 Likert scale, distributed to selected respondents through purposive sampling, while secondary data were obtained from relevant literature reviews. The research instrument consisted of a list of validated challenge and barrier variables, confirmed through a preliminary survey. Data analysis was carried out using the Relative Importance Index (RII) method to determine the relative importance of each factor and to identify the most influential factors affecting ESG implementation in Indonesia's construction sector.

The respondents in this study consist of five practitioners from major Indonesian state-owned construction companies—PT Wijaya Karya Tbk (60%), PT PP (Persero) Tbk (20%), and PT Adhi Karya (Persero) Tbk (20%). All respondents hold a bachelor's degree (S1/D4) and occupy professional positions as Assistant Manager (20%), Manager (40%), and Senior Staff (40%), indicating their direct involvement in managerial and operational decision-making. Most respondents (80%) have 2–5 years of experience in ESG-related construction practices, while 20% have less than two years of experience, highlighting that ESG implementation in Indonesia's construction sector is relatively new and still in an early adoption phase.

Based on the literature review, the researcher summarized a list of potential variables that represent the challenges and barriers in implementing ESG. The challenge variables in the implementation of ESG are presented in Table 1, while the variables representing the barriers to ESG implementation in the construction sector discussed in this study are shown in Table 2.

Table 1. Challenge variables in the implementation of ESG in the construction sector

Code	Variabel	Definition	References
Enviromental Dimension			
ET1	High carbon emission intensity from construction activities	Refers to the large amount of greenhouse gas emissions (such as CO_2) produced during the construction process, including the use of heavy machinery, material transportation, and building operations.	(17), (1), (21), (22), (23), (24), (25), (26), (27)
ET2	Suboptimal construction waste management	Inefficiencies in separating, storing, recycling, or disposing of construction waste, which negatively impact the environment.	(17), (1), (21), (23), (28), (26)
ET3	Limited utilization of sustainable resources	Lack of use of environmentally friendly and renewable materials and energy in construction activities.	(17), (1), (23), (24), (26), (27)
ET4	High energy consumption in construction projects, especially from fossil sources	Dependence on fossil energy in construction activities increases operational costs and carbon emissions.	(17), (23), (26)
Social Dimension			
ST1	Market pressures and business uncertainty hindering ESG commitment	Economic fluctuations, business competition, and market uncertainty hinder companies from investing in ESG initiatives.	(17), (1), (19), (28), (29), (25)
ST2	Low consumer awareness of corporate social and environmental responsibility	Consumer indifference toward the environmental and social impacts of construction companies' products or services.	(17), (1), (19), (28), (24), (25)

Code	Variabel	Definition	References
ST3	Limited social contribution and weak community relations around project sites	Weak corporate involvement in social programs or community development near construction project areas.	(17), (1), (22), (23), (24), (29)
ST4	Lack of ESG socialization and education in the construction sector	Limited dissemination of information and capacity building related to ESG, resulting in low awareness and implementation in the field.	(21), (28), (30), (26), (29)
Governance Dimension			
GT1	Company orientation focused on short-term profits without sustainability strategy	Companies prioritize short-term profits over long-term investments that support sustainability.	(17), (22), (28), (30), (24), (29), (27)
GT2	Low stakeholder pressure and involvement in ESG implementation	Lack of encouragement, oversight, or participation from investors, clients, government, and the public in implementing ESG principles.	(17), (1), (21), (22), (19), (23), (30), (29)

Table 2. Challenge variables in the implementation of ESG in the construction sector

Code	Variabel	Definition	References
Enviromental Dimension			
EH1	Absence or weakness of environmental policies in construction companies	Lack of internal regulations or clear strategic guidelines regarding environmental protection within company operations.	(17), (31), (29), (24), (26), (27)
EH2	Limited access to green financing or sustainable investment	Difficulty obtaining funding from financial institutions that support environmentally and	(17), (31), (21), (22), (23), (28), (29), (26)

Code	Variabel	Definition	References
		socially responsible projects.	
Social Dimension			
SH1	Low knowledge and awareness of construction practitioners regarding ESG concepts	Limited understanding and attention among construction industry players about the importance of environmental, social, and governance aspects.	(21), (22), (19), (23), (29), (32)
SH2	Poor labor management regarding fairness and welfare principles	Failure to fulfill workers' rights such as fair wages, humane working hours, and opportunities for self-development.	(17), (1), (21), (22), (23), (28), (24)
SH3	Lack of attention to safety and decent working conditions on-site	Low implementation of occupational health and safety (OHS) standards, increasing the risk of workplace accidents and health issues.	(17), (21), (23), (28), (24), (27)
Governance Dimension			
GH1	Limited financial capacity to adopt ESG policies	Inability of companies to allocate sufficient funds or investments required for ESG programs.	(1), (31), (21), (28), (29), (25)
GH2	Absence of standardized ESG reporting models or weak standardization	Lack of consistent, measurable, and widely recognized ESG reporting guidelines or systems.	(17), (31), (22), (19), (29), (32), (27)
GH3	Insufficient government support and incentives for ESG implementation	Limited policies, regulations, or subsidies from the government to encourage ESG practices in the construction sector.	(1), (31), (22), (19), (28), (20), (25)
GH4	Low corporate transparency in ESG reporting	Inadequate disclosure of ESG-related information to the public or stakeholders, including incomplete or non-comprehensive reports.	(17), (1), (21), (22), (30), (24), (29)
GH5	Ineffective implementation	Weak enforcement of monitoring and	(17), (21), (22), (20), (24), (30)

Code	Variabel	Definition	References
	of anti-corruption policies in the construction sector	prevention mechanisms for corruption in procurement, contracting, and project management processes.	
GH6	Absence of uniform and clear ESG performance standards	Lack of standardized guidelines or indicators, making consistent evaluation of ESG implementation difficult.	(1), (21), (22) (19), (29)
GH7	Limited governmental policy and regulatory standards	Absence of clear, consistent, and standardized ESG regulations and guidelines in the construction sector.	(1), (31), (22), (19), (28), (20), (25)

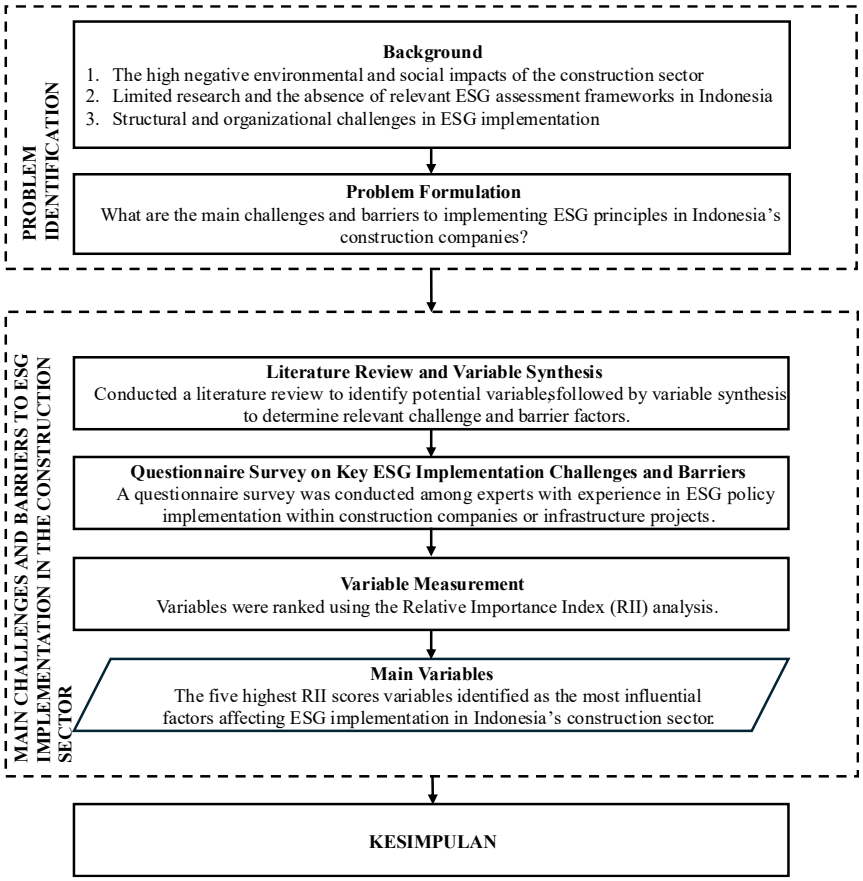

Figure 1. Research Flowchart

RESULTS AND DISCUSSION

The results of the study using the Relative Importance Index (RII) method show that, among the ten challenge variables in implementing Environmental, Social, and Governance (ESG) principles in Indonesia's construction sector, the RII values range from 0.44 to 1.00, as shown in Table 3. The five factors with the highest values, ST4 (1.00), GT1 (0.96), GT2 (0.88), ET1 (0.84), and ET4 (0.80), were identified as the main challenges most significantly affecting the success of ESG implementation. These results indicate that the lack of ESG socialization and education (ST4) is a fundamental obstacle that leads to low industry awareness, while companies' short-term profit orientation (GT1) and limited stakeholder pressure and involvement (GT2) weaken sustainability commitments. Additionally, high carbon emissions (ET1) and fossil energy consumption (ET4) reflect major environmental challenges that require green technology innovation as a long-term solution.

On the barriers side, the RII results for twelve variables range between 0.60 and 0.96, as shown in Table 4, with the five highest factors being GH1 (0.96), GH2 (0.92), GH7 (0.88), GH3 (0.84), and GH6, EH1, and EH2 (all 0.80). These factors highlight structural governance, environmental, and policy constraints, such as limited financial capacity, the absence of standardized ESG reporting models, weak government support and regulation, and inadequate environmental management practices. This condition reflects that ESG implementation in the construction sector is still at an early stage, with insufficient institutional, financial, and policy readiness.

Furthermore, the finding that many companies still prioritize short-term profit orientation (GT1) supports Bezerra et al.'s observation that a disconnect between long-term corporate strategies and sustainability objectives often leads to gaps in ESG implementation. Similarly, the identification of limited financial capacity (GH1) as a major barrier echoes Bezerra et al.'s conclusion that the absence of adequate incentives and financial support mechanisms continues to hinder sustainability investments in emerging markets.

Construction firms in Indonesia often view ESG as a cost rather than a long-term investment due to a short-term, project-based business mindset reinforced by the national procurement system. The RII results show that short-term profit orientation (GT1) and low stakeholder pressure (GT2) are key challenges, indicating that ESG benefits are not yet embedded in strategic decision-making. Public and SOE procurement processes still prioritize lowest-cost bids and timely delivery, with limited weighting for ESG performance, making sustainability investments appear as added expenses that reduce tender competitiveness. This perception is strengthened by limited financial capacity (GH1), the absence of standardized ESG reporting (GH2, GH6), and weak regulatory incentives (GH7), which create uncertainty over the returns of ESG investments. As a result, ESG initiatives are seen as compliance costs rather than value-creating assets, highlighting the need to integrate ESG criteria into procurement policies and incentive mechanisms to shift firms toward a long-term sustainability perspective.

Pressure from the financial sector, particularly through instruments such as the OJK Green Taxonomy, has begun to influence ESG adoption in Indonesia's construction sector, mainly among large and state-owned contractors that rely on capital markets and formal financing. For these firms, ESG is increasingly linked to access to green financing, bonds, and sustainability-linked loans. However, the study's findings show that this pressure remains limited in reach, as many contractors—especially mid-sized and project-

based firms—still face high financial constraints and unclear ESG standards. Because ESG requirements are more visible at the financing level than in procurement and project execution, contractors often perceive ESG as an added compliance cost rather than a value-creating investment. Stronger alignment between financial-sector policies, government procurement rules, and clear ESG performance incentives is therefore needed to improve industry-wide readiness.

Table 3. RII calculation results for the main challenge factors in ESG implementation

No	Variabel	RII Score
1	ET1	0,84
2	ET2	0,76
3	ET3	0,76
4	ET4	0,80
5	ST1	0,76
6	ST2	0,44
7	ST3	0,76
8	ST4	1,00
9	GT1	0,96
10	GT2	0,88

Table 4. RII calculation results for the main barrier factors in ESG implementation

No	Variabel	RII Score
1	EH1	0,8
2	EH2	0,8
3	SH1	0,76
4	SH2	0,6
5	SH3	0,64
6	GH1	0,96
7	GH2	0,92
8	GH3	0,84
9	GH4	0,76
10	GH5	0,64
11	GH6	0,8
12	GH7	0,88

CONCLUSION

The implementation of Environmental, Social, and Governance (ESG) principles in Indonesia's construction sector continues to face structural, regulatory, and cultural challenges and barriers. Based on the analysis using the Relative Importance Index (RII) method, the main challenges include a lack of ESG socialization and education, companies' short-term profit orientation, and low stakeholder involvement. The primary barriers are limited financial capacity, the absence of standardized ESG reporting models, and weak government regulatory support.

These findings emphasize that the success of ESG implementation in the construction sector depends not only on internal corporate readiness but also on strong governance systems and national policy support. The novelty of this study lies in its mapping of priority barriers to ESG implementation using the RII method, which provides

an empirical foundation for formulating both national and corporate strategies to strengthen sustainability in the construction industry. The practical implications of this research highlight the need to enhance ESG literacy among industry players, develop integrated reporting standards, and reform policies that promote sustainable investment and green innovation within the construction sector.

Based on the RII findings, strategic actions should prioritize the highest-ranked challenges and barriers. Improving ESG socialization and education (ST4) is essential through structured training and awareness programs for construction firms. To address short-term profit orientation and low stakeholder pressure (GT1 and GT2), ESG criteria should be integrated into government and SOE procurement systems, for example by providing preference points or tender advantages to companies with strong ESG performance. Limited financial capacity and weak regulatory support (GH1, GH3, GH7) can be mitigated through tax incentives, green financing schemes, and clearer ESG regulations. In addition, the absence of standardized ESG reporting (GH2 and GH6) underscores the need for a unified national ESG reporting framework for the construction sector to reduce uncertainty and encourage long-term ESG investment.

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DAFTAR REFERENSI

1. Liou JJH, Liu PYL, Huang SW. Exploring the key barriers to ESG adoption in enterprises. Syst Soft Comput. 2023;5(1).
2. Zumente I, Bistrova J. Esg importance for long-term shareholder value creation: Literature vs. practice. J Open Innov Technol Mark Complex. 2021;7(2).
3. UNPRI. What are the Principles for Responsible Investment? [Internet]. Principles for Responsible Investment. 2024 [cited 2025 May 13]. Available from: https://www.unpri.org/about-us/what-are-the-principles-for-responsible-investment
4. Zhang Q, Oo BL, Lim BTH. Linking corporate social responsibility (CSR) practices and organizational performance in the construction industry: A resource collaboration network. Resour Conserv Recycl. 2022;179(November 2021).
5. Senadheera SS, Gregory R, Rinklebe J, Farrukh M, Rhee JH, Ok YS. The development of research on environmental, social, and governance (ESG): A bibliometric analysis. Sustain Environ [Internet]. 2022;8(1). Available from: https://doi.org/10.1080/27658511.2022.2125869
6. Prathama S. ESG Aspek dalam Proyek Pembangunan Infrastruktur di Indonesia [Internet]. Kemenkeu.go.id. 2022 [cited 2025 May 13]. Available from:

https://kpbu.kemenkeu.go.id/read/1213-1743/umum/kajian-opini-publik/esg-aspek-dalam-proyek-pembangunan-infrastruktur-di-indonesia
7. United Nations Environment Programme. CO2 emissions from buildings and construction hit new high, leaving sector off track to decarbonize by 2050 - UN Report [Internet]. 2022 Global Status Report for Buildings and Construction. 2022 [cited 2025 Apr 8]. Available from: https://www.unep.org/news-and-stories/press-release/co2-emissions-buildings-and-construction-hit-new-high-leaving-sector
8. Ang G, Guo Z, Lim EP. On Predicting ESG Ratings Using Dynamic Company Networks. ACM Trans Manag Inf Syst. 2023;14(3):1–34.
9. Bernaciak A, Halaburda M, Bernaciak A. The construction industry as the subject of implementing corporate social responsibility (The case of Poland). Sustain. 2021;13(17):1–18.
10. Husted BW, Sousa-Filho JM de. Board structure and environmental, social, and governance disclosure in Latin America. J Bus Res. 2019;102(November 2016):220–7.
11. Samosir DKBMT. Sustainability: Green & Healthy Building, Mendukung Indonesia Menuju Net Zero Emission. Vol. 1. 2022. 1–159 p.
12. Purvis B, Mao Y, Robinson D. Three pillars of sustainability: in search of conceptual origins. Sustain Sci [Internet]. 2019 May 3;14(3):681–95. Available from: http://link.springer.com/10.1007/s11625-018-0627-5
13. Kemenkeu. Kerangka Kerja untuk Pembiayaan Infrastruktur pada Dukungan dan Fasilitas Pemerintah Lingkungan, Sosial, dan Tata Kelola (LST). Kerangka kerja. 2022;1–37.
14. IKN. Ibu Kota Nusantara Menjadi Kota Pertama yang Memiliki Komite ESG [Internet]. 2023. Available from: https://ikn.go.id/ibu-kota-nusantara-menjadi-kota-pertama-yang-memiliki-komite-esg
15. Sapuay SE. Construction Waste – Potentials and Constraints. Procedia Environ Sci. 2016;35:714–22.
16. Bui T, Domingo N, Le A. Factors Affecting the Selection of Sustainable Construction Materials: A Study in New Zealand. Buildings. 2025;15(5).
17. Muñoz-Torres MJ, Fernández-Izquierdo MÁ, Rivera-Lirio JM, Escrig-Olmedo E. Can environmental, social, and governance rating agencies favor business models that promote a more sustainable development? Corp Soc Responsib Environ Manag. 2019;26(2):439–52.
18. Appiah-Kubi E, Koranteng FO, Dura CC, Mihăilă AA, Drigă I, Preda A. Green financing and sustainability reporting among SMEs: The role of pro-environmental behavior and digitization. J Clean Prod. 2024;478(20).
19. Chopra SS, Senadheera SS, Dissanayake PD, Withana PA, Chib R, Rhee JH, et al. Navigating the Challenges of Environmental, Social, and Governance (ESG) Reporting: The Path to Broader Sustainable Development. Sustain. 2024;16(2).
20. Yu EP yi, Luu B Van, Chen CH. Greenwashing in environmental, social and governance disclosures. Res Int Bus Financ. 2019;52(September 2019).
21. Oh HJ, Lee B, Ma HH, Jang D, Park S. A preliminary study for developing perceived ESG scale to measure public perception toward organizations' ESG performance. Public Relat Rev. 2023;50(1).
22. Bezerra RRR, Martins VWB, Macedo AN. Validation of Challenges for Implementing ESG in the Construction Industry Considering the Context of an

Emerging Economy Country. Appl Sci. 2024;14(14).
23. Dong R, Shao C, Xin S, Lu Z. A Sustainable Development Evaluation Framework for Chinese Electricity Enterprises Based on SDG and ESG Coupling. Sustain. 2023;15(11):1–26.
24. Sulaiman NN, Omar AJ, Pakir F, Mohamad M. Evaluating Environmental, Social and Governance (ESG) Practice Among Malaysian Public Listed Construction Companies Using FTSE Russell Rating Model. Int J Sustain Constr Eng Technol. 2024;15(1):25–40.
25. Huang YF, Chen APS, Do MH, Chung JC. Assessing the Barriers of Green Innovation Implementation: Evidence from the Vietnamese Manufacturing Sector. Sustain. 2022;14(8):1–14.
26. Mohammad WMW, Wasiuzzaman S. Environmental, Social and Governance (ESG) disclosure, competitive advantage and performance of firms in Malaysia. Clean Environ Syst [Internet]. 2021;2(February):100015. Available from: https://doi.org/10.1016/j.cesys.2021.100015
27. Atkins J, Doni F, Gasperini A, Artuso S, La Torre I, Sorrentino L. Exploring the Effectiveness of Sustainability Measurement: Which ESG Metrics Will Survive COVID-19? J Bus Ethics [Internet]. 2023;185(3):629–46. Available from: https://doi.org/10.1007/s10551-022-05183-1
28. Almalki Sultan Musaad O, Zhuo Z, Almalki Otaibi Musaad O, Siyal ZA, Hashmi H, Shah SAA. A fuzzy multi-criteria analysis of barriers and policy strategies for small and medium enterprises to adopt green innovation. Symmetry (Basel). 2020;12(1).
29. Khamisu MS, Paluri RA, Sonwaney V. Stakeholders' perspectives on critical success factors for environmental social and governance (ESG) implementation. J Environ Manage [Internet]. 2024;365(June):121583. Available from: https://doi.org/10.1016/j.jenvman.2024.121583
30. Khamisu MS, Paluri RA, Sonwaney V. Environmental social and governance (ESG) disclosure motives for environmentally sensitive industry: an emerging economy perspective. Cogent Bus Manag [Internet]. 2024;11(1). Available from: https://doi.org/10.1080/23311975.2024.2322027
31. Wang Z, He Q, Locatelli G, Wang G, Li Y. Exploring Environmental Collaboration and Greenwashing in Construction Projects: Integrative Governance Framework. J Constr Eng Manag. 2023;149(11).
32. Parameswar N, Hasan Z, Shri C, Saini N. Exploring the barriers to ESG adoption using modified TISM approach. Kybernetes. 2024;53(12):5775–800.