Research Paper

Towards Resilient Sustainability: An Adaptive Model of Risk Management Integration in Sustainability Accounting for High-Risk Industries

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Abstract

High-risk industries in Indonesia, particularly in the energy, mining, and manufacturing sectors, face significant pressures in maintaining sustainability performance due to high exposure to environmental, social, and governance (ESG) risks. This study aims to develop an adaptive model that integrates risk management and sustainability accounting to strengthen corporate resilience. Panel data consists of 30 companies with 150 firm-year observations during the 2020–2024 period. The variables include Risk Disclosure Score as a proxy for risk management, ESG Score as a representation of sustainability accounting, and both financial (ROA) and non-financial performance (NF Index). Descriptive results show ROA ranging from 2.5% to 15.2%, ESG Scores between 57–73, Risk Disclosure Scores between 60–76, and NF Index between 55–71. These findings indicate a positive trend in risk and sustainability disclosure over the past five years. Preliminary analysis supports the hypothesis that risk disclosure is positively related to sustainability accounting practices, which in turn improves financial and non-financial performance. The study contributes theoretically by reinforcing the integration of COSO ERM and global ESG standards (GRI, SASB, IFRS S1 & S2), and practically by offering an adaptive framework that companies and regulators can use to enhance transparency, accountability, and competitiveness in high-risk industries.

Keywords: *Risk Management, Sustainability Accounting, ESG, Adaptive Model, High-Risk Industries*

INTRODUCTION

High-risk industries such as energy, mining, and manufacturing play a crucial role in national economic development, but are also highly vulnerable to environmental, social, and governance (ESG) risks. Sustainability challenges are becoming increasingly complex as global pressure intensifies on issues such as climate change, natural resource exploitation, and corporate social responsibility. This requires adaptive strategies that integrate risk management practices into sustainability accounting, enabling companies to remain resilient and competitive (Eccles & Serafeim, 2020; Michelon et al., 2021). Previous studies have shown that comprehensive risk management disclosure positively correlates with sustainability transparency and long-term performance (Bhimani, 2022; Zhang & Li, 2023). For example, research published in the Journal of Business Ethics (Q1) found that integrating the COSO ERM framework with sustainability reporting standards reduces capital costs and enhances stakeholder trust (Kaspereit & Lopatta, 2019). Likewise, studies in the Sustainability Accounting, Management and Policy Journal (Q1) emphasize sustainability accounting as a key mediator between risk management practices and corporate sustainability outcomes.

In Indonesia, sustainability reporting is reinforced by the Financial Services Authority (OJK) through POJK No.51/2017 on Sustainable Finance Implementation for Financial Service Institutions, Issuers, and Public Companies, which mandates listed companies to prepare sustainability reports. However, other studies (Rahmawati & Haryanto, 2020; Lestari, 2021) reveal

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that compliance and disclosure quality still vary across sectors, indicating a practice gap that may hinder efforts to achieve resilient sustainability.

The separation between risk management and sustainability reporting practices remains an issue in many high-risk companies. Poorly managed risks can lead to reputational crises, financial losses, and even going concern threats (Hanafi, 2016; Spikin, 2013). Therefore, integration is not only academically relevant but also practically essential for strengthening corporate resilience in the face of global dynamics.

This study aims to develop an adaptive model that integrates risk management and sustainability accounting to enhance both financial and non-financial sustainability in high-risk sectors. Using panel data from 30 companies listed on the IDX between 2020–2024, this study seeks to:

1. Analyze the direct relationship between risk management and sustainability accounting.
2. Test the mediating role of sustainability accounting in improving corporate performance.
3. Provide theoretical contributions to the literature on risk management and sustainability accounting.
4. Offer practical contributions in the form of integrative strategies for regulators and companies.

Theoretically, this research enriches the literature by combining the COSO ERM framework and global ESG reporting standards (GRI, SASB, IFRS S1 & S2). Practically, it develops an adaptive model that serves as a reference for companies and regulators in enhancing transparency, accountability, and competitiveness in Indonesia's high-risk sectors. Building on these issues, the next section reviews prior literature to establish the theoretical foundation of this study.

LITERATURE REVIEW

In the past decade, corporate sustainability has gained increasing attention, particularly in high-risk industries such as energy, mining, and manufacturing. These sectors play a significant role in economic growth but face considerable ESG risks. Consequently, risk management should no longer be seen merely as a defensive activity but must be integrated into corporate sustainability strategies. According to COSO ERM, organizational success depends on its ability to identify, assess, and respond to risks comprehensively (Michelon et al., 2021; Bhimani, 2022).

This linkage has become even more important as global reporting standards such as GRI, SASB, and IFRS S1 & S2 gain traction. These standards emphasize the comparability and transparency of non-financial information. Eccles and Serafeim (2020) found that consistent ESG reporting not only strengthens corporate legitimacy but also influences investment decisions. However, challenges arise in emerging markets like Indonesia, where disclosure quality remains inconsistent. Rahmawati and Haryanto (2020) and Lestari (2021) found that while sustainability disclosure tends to increase firm value, there are significant sectoral differences. Similar findings from Soraya and Nurrochmah (2024), Maharani and Akbar (2025), and Odang and Sinambela (2025) highlight the role of green accounting and environmental management accounting in promoting transparency.

At the international level, growing evidence supports the integration of risk management and sustainability accounting. Kaspereit and Lopatta (2019) showed that firms with strong ESG performance enjoy lower capital costs. Michelon et al. (2021) confirmed that mature ERM practices correlate with better sustainability performance. More recent studies in the Journal of Management Control (Edirisinghe et al., 2025) show that management control systems integrating sustainability dimensions push organizations to proactively manage risks. In Malaysia, Khalid et al. (2025) emphasized the role of strategic management accounting in strengthening sustainability practices in the construction sector, while Soares et al. (2024) underlined the importance of accountants'

behavioral engagement in sustainability reporting.

Technological advances add another dimension. Tariq and Rahim (2024) explained how artificial intelligence (AI) can improve the quality of sustainability reporting by providing more timely and accurate information. Akano et al. (2024) proposed a framework integrating sustainability with workplace safety in high-risk industries, showing that ESG issues cannot be separated from daily operational needs. A meta-synthesis study by Sundarasen et al. (2024) further confirmed the role of environmental accounting in promoting sustainability practices, though heterogeneity in measurement across firms and sectors remains.

From this literature, the relationship between risk management, sustainability accounting, and corporate performance has been extensively examined both globally and nationally. However, several gaps remain. First, most research focuses on the direct relationship between ERM or ESG and performance without explicitly testing the mediating role of sustainability accounting. Second, studies in emerging markets, especially Indonesia, are still limited, even though OJK regulations (POJK No. 51/2017) and IFRS adoption create a natural laboratory for ERM–ESG integration. Third, non-financial performance indicators, such as social and environmental indices, are often overlooked, despite their relevance to high-risk sectors.

This study addresses these gaps by building an adaptive ERM-sustainability accounting integration model in Indonesia's high-risk industries. Specifically, it will: (1) test the mediating role of sustainability accounting in the relationship between risk disclosure and corporate performance, (2) combine financial (ROA) and non-financial performance (NF Index) in a single framework, (3) focus on the 2020–2024 period when Indonesian firms adjusted to IFRS S1 & S2 and OJK regulations, and (4) account for technology and workplace safety as material risks. This approach bridges the literature gap and contributes to both theory and practice in building resilient sustainability. Based on these identified gaps, the following section outlines the methodology adopted to empirically test the proposed model.

RESEARCH METHOD

This study applies a quantitative approach with an explanatory research design, focusing on testing causal relationships among variables. The main objective is to explain how risk management practices (risk disclosure) influence financial and non-financial performance through the mediating role of sustainability accounting. Thus, the study examines both direct and mediated pathways that strengthen corporate resilience in high-risk sectors.

The research population includes all energy, mining, and manufacturing companies listed on the IDX between 2020–2024. After selection, only companies with annual and sustainability reports, complete data, and consistent reporting were included.

Table 1. Population and Sample

Selection Stage	Number of Companies	Notes
Initial population	240	Energy, mining, manufacturing
Published annual & sustainability reports	130	Consistent reporting 2020–2024
Complete data	30	Eligible for further analysis

The sample was chosen using purposive sampling with strict inclusion-exclusion criteria, ensuring representativeness and data completeness. Data sources include:

1. Annual and Sustainability Reports (IDX & company websites),
2. Commercial databases such as Bloomberg, Refinitiv, and S&P Global for ESG and risk disclosure scores,

3. Manual content analysis for unavailable variables.
   Key variables:
4. Risk Management (X): Risk Disclosure Score (0–100), covering strategic, operational, social, and environmental risk disclosure.
5. Sustainability Accounting (Z): ESG Score (0–100), based on GRI, SASB, IFRS S1 & S2 standards.
6. Financial Performance (Y1): Return on Assets (ROA).
7. Non-Financial Performance (Y2): NF Index (0–100), constructed from GRI/SASB indicators such as emissions, workplace safety, and community engagement.
   Data were analyzed using Structural Equation Modeling – Partial Least Squares (SEM-PLS), chosen for its suitability in mediation models, ability to handle small sample sizes, and robustness against non-normal distributions. Key stages include:
8. Control variables: firm size, leverage, listing age, sector dummy.
9. Reliability and validity tests (Cronbach's Alpha, Composite Reliability, AVE),
10. Structural model testing (path coefficient significance, R^2, Q^2, f^2),
11. Mediation testing (5,000 bootstrap replications for indirect effects),
12. Robustness analysis (sector/size heterogeneity, leverage × ESG moderation).

With 150 firm-year observations, the study meets the 10-times rule (Hair et al., 2021), ensuring valid results. This methodology provides a strong foundation to test the adaptive model of ERM-sustainability accounting integration and addresses both theoretical gaps and practical needs in high-risk industries.

FINDINGS AND DISCUSSION

SEM-PLS analysis shows that risk disclosure significantly affects sustainability accounting ($\beta=0.62$; $p<0.001$). Furthermore, sustainability accounting positively influences financial performance (ROA) with a moderate effect ($\beta=0.28$; $p=0.002$), and more strongly influences non-financial performance (NF Index) ($\beta=0.55$; $p<0.001$). The direct effect of risk disclosure on ROA is not significant ($p\approx0.051$), while its direct effect on NF Index is significant ($\beta=0.18$; $p=0.009$). R^2 values demonstrate substantial explanatory power, especially for NF Index (52%). Q^2 values confirm predictive relevance.

These results highlight that strong risk management practices enhance the quality of sustainability accounting, which in turn improves corporate performance. The most substantial impact is observed in non-financial performance, indicating that the benefits of ERM–ESG integration are more evident in social and environmental aspects, such as emission reduction, workplace safety improvements, and community engagement, than in short-term profitability. Financial performance is positively affected, but the impact is weaker and requires long-term consistency. Thus, sustainability accounting serves as a crucial mediator linking risk management practices with holistic sustainability outcomes.

These findings are consistent with Michelon et al. (2021), who demonstrated that ERM maturity enhances sustainability performance, and Zhang and Li (2023), who confirmed the mediating role of sustainability accounting in high-risk industries. However, unlike prior studies, this research highlights a stronger influence on non-financial outcomes, particularly in emerging markets like Indonesia, where regulatory enforcement (POJK No.51/2017) and IFRS S1 & S2 adoption play significant roles. This novelty underlines that sustainability accounting is not merely complementary but serves as a vital mechanism for achieving resilient sustainability in high-risk sectors.

Table 2. Summary of SEM-PLS Path Results

Path	*Coefficient (β)*	*t-stat*	*p-value*
X → Z	0.62	9.41	<0.001
Z → Y1	0.28	3.07	0.002
Z → Y2	0.55	8.02	<0.001
X → Y1	0.12	1.95	0.051
X → Y2	0.18	2.64	0.009

Table 3. Summary of R^2 and Q^2

Construct	R^2	Q^2
Z (ESG)	0.39	0.26
Y1 (ROA)	0.31	0.18
Y2 (NF Index)	0.52	0.35

CONCLUSIONS

This study concludes that integrating risk management with sustainability accounting is a crucial strategy for high-risk sector companies to achieve resilient sustainability. Findings show that risk disclosure significantly affects the quality of sustainability accounting, which in turn mediates the impact on corporate performance. The strongest effects are seen in non-financial dimensions such as social and environmental performance, while financial profitability effects are weaker but still relevant over the long term. Thus, sustainability accounting acts as a vital bridge between risk governance and corporate sustainability achievement.

Despite these contributions, this study has several limitations. The sample is limited to 30 companies across the energy, mining, and manufacturing sectors, which restricts generalizability to other industries. The NF Index constructed here may not fully capture sector-specific indicators. Moreover, the reliance on secondary data introduces the risk of reporting bias due to variations in disclosure quality. Future studies should expand the sample, adopt longer observation periods, and integrate qualitative insights from managers or report preparers to provide deeper contextual understanding.

Theoretically, the research contributes by providing empirical evidence of the mediating role of sustainability accounting in the relationship between risk management and corporate performance, particularly in emerging markets. Practically, the adaptive model developed here serves as a reference for regulators, investors, and corporate management in improving transparency, accountability, and resilience in high-risk sectors.

LIMITATIONS & FURTHER RESEARCH

Future research is recommended to:

1. Expand the sample to include more firms and other relevant sectors.
2. Use longer longitudinal data to assess the long-term effects of ERM–ESG integration.
3. Incorporate more sector-specific non-financial indicators, such as carbon emissions in energy or workplace accidents in mining.
4. Combine quantitative and qualitative methods, such as interviews with risk managers or sustainability report preparers, for deeper contextual understanding.

By doing so, future studies can provide a more comprehensive picture of the integration of risk management and sustainability accounting in fostering resilient sustainability.

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