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The Effect of EMA and CSR Costs on BOPO Mediated by GRI 11-Based CSR Disclosure: Pertamina Group 2020–2025

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Abstract: This study investigates the impact of Environmental Management Accounting (EMA) and CSR Cost Allocation on BOPO Efficiency, with GRI 11 Disclosure acting as a mediating variable, at the Pertamina Group during the 2020–2025 period. The analysis method employed is Structural Equation Modeling–Partial Least Squares (SEM-PLS). The findings from the empirical investigation indicate that the integration of EMA and CSR Cost Allocation is accountable for 63.8% of the variation in GRI 11 Disclosure, as indicated by $R^2 = 0.638$. This integration exhibited positive and statistically significant direct effects, $\beta = 0.521$ ($p = 0.000$) and $\beta = 0.348$ ($p = 0.000$), respectively. In contrast, the direct impact of CSR Cost Allocation on the BOPO ratio was found to be relatively robust ($\beta = -0.214$, $p = 0.023$). The findings of the mediation test demonstrated that GRI 11 Disclosure functions as a complete mediator in the association between EMA and BOPO, with an indirect effect coefficient of $\beta = -0.303$ ($p = 0.000$). Meanwhile, in the relationship between CSR Cost Allocation and BOPO, GRI 11 Disclosure acts as a partial mediator, with an indirect effect coefficient of $\beta = -0.202$ ($p = 0.000$). These findings serve to reinforce the theoretical integration between the Resource-Based View and Legitimation Theory, affirming that transparency in sector-based reporting has the capacity to transform internal capabilities and social expenditures into key drivers of long-term operational efficiency.

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INTRODUCTION

The global energy sector, and more specifically the oil and natural gas (O&G) extractive industry, is currently at a critical strategic juncture. The oil and gas (O&G) industry is of paramount importance in ensuring national energy security and promoting economic growth. Conversely, the sector is confronted with an increasing array of regulations that are designed to reduce carbon emissions, demands from stakeholders for greater environmental transparency, and the 2060 Net Zero Emissions (NZE) target. The present study explores the impact of global commodity price volatility and the precedent set by the energy transition on the operational paradigms of oil and gas corporations. The analysis demonstrates how these corporations are compelled to reorient their operational paradigms from merely maximising short-term profitability towards a balanced alignment between financial performance and Environmental, Social, and Governance (ESG) responsibilities. Recent scientific research confirms that the extractive industry still faces deviations and structural challenges in simultaneously reconciling corporate climate accountability targets with financial efficiency (Dietz et al., 2021).

Consequently, the investigation of sustainability-based operational efficiency has become an imperative issue in the discourse on financial accounting and management accounting within the energy sector. This challenge of strategic reorientation is clearly reflected in PT Pertamina (Persero).

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Following a restructuring process that resulted in the formation of a holding company and sub-holding entities, Pertamina now operates an integrated energy value chain. This encompasses upstream activities, refinery processing, marketing and logistics, and the implementation of New and Renewable Energy (EBT) projects. In implementing a dual-track strategy—namely, maintaining the reliability of fossil fuel energy supply while executing an energy transition portfolio—management's capability to control the structure of operating costs becomes a key determinant of financial resilience (Dietz et al., 2021). The measurement of this level of operational efficiency is facilitated the calculation of the Operating Expenses to Operating Revenue (BOPO) ratio.

Nevertheless, in conventional managerial discourse, environmental investments and Corporate Social Responsibility (CSR) programs are still often dichotomously categorized as additional cost centers. Capital expenditures for low-carbon technologies, energy efficiency, decarbonization, and waste treatment inherently increase operational costs during the early incubation phase. Without a precise framework for identifying, measuring, and allocating costs, sustainability expenditures risk causing budgetary inefficiencies if they do not demonstrate a positive impact on operational efficiency (Gyane et al., 2021). The empirical dynamics reflecting the relationship between the escalation of business activities, sustainability investment expenditures, and fluctuations in operational efficiency at the Pertamina Group in Figure 1 regarding Business Growth Trends, Sustainability Investments, and BOPO Dynamics of the Pertamina Group for the 2020–2025 Period.

Figure 1. Business Growth Trends, Sustainability Investments, and BOPO Dynamics of the Pertamina Group for the 2020–2025 Period

Figure 1 illustrates the empirical phenomenon that the expansion of the Pertamina Group's business scale and the increase in its sustainability budget during the 2020–2025 period do not necessarily translate linearly into a decrease in the BOPO ratio. The prominence of this phenomenon highlights the existence of a time-lag effect and underscores the urgency of establishing an internal accounting system capable of internalizing environmental externalities into corporate strategic decisions.

To address these distortions in the allocation of environmental costs, Environmental Management Accounting (EMA) serves as a strategic management accounting tool. EMA provides an integrated framework that presents monetary and physical information regarding energy consumption, material use, waste generation, and the identification of accumulated environmental costs (Gunarathne et al., 2021). Through EMA, material inefficiencies and emissions are identified as non-product output costs that can be eliminated. However, implementing EMA requires initial adaptation costs and complex coordination among business units, so its impact on reducing operational costs is not always immediate (Gunarathne et al., 2021). On the other hand, strategically articulated CSR cost allocation serves to mitigate social risks and secure a social license to operate (Gyane et al., 2021). To ensure that the effectiveness of EMA and CSR cost allocation provides a guarantee of external legitimacy, corporations require a standardized reporting mechanism based on the Global Reporting Initiative (GRI) Standards (Adams et al., 2022). Specifically, the use of GRI 11 (Oil and Gas Sector 2021) (GRI, 2021) serves as a precise validation tool for articulating the disclosure of material issues in the oil and gas sector to stakeholders (Aji & Wahyudin, 2025).

Theoretically, the dynamics between corporate management and stakeholders are firmly rooted in Agency Theory (Meckling & Jensen, 1976) and Legitimacy Theory (Suchman, 1995). Theory of agency posits that the relationship between shareholders or the government (the principal) and the management of state-owned enterprises (the agent) is prone to information asymmetry and opportunistic behaviour. Eisenhardt (1989) posits that mechanisms of accountability and internal oversight serve to mitigate information gaps of this nature. In this context, the implementation of EMA and the measurable allocation of CSR costs act as internal control mechanisms to minimise moral hazard. In addition, GRI 11-based sustainability disclosures provide external transparency that strengthens corporate legitimacy in the eyes of the public (Suchman, 1995).

A review of reputable empirical literature from the past five years (2021–2026) reveals an empirical gap and inconclusive findings. The study by Dietz et al. (2021) confirms that the burden of the energy transition on the oil and gas sector tends to reduce efficiency ratios in the short term. In the context of EMA implementation, Gunarathne et al. (2021) found that EMA facilitates the implementation of environmental management strategies and improves organizational performance, although its implementation requires adaptation costs and cross-unit coordination, so its impact on reducing operational costs is not always immediate. Regarding CSR allocation, Gyane et al. (2021) demonstrate that CSR investments are positively associated with the financial sustainability of multinational oil and gas companies; however, Adams et al. (2022) assert that CSR expenditures without standardized external disclosure will be viewed by the market as a waste of capital. Furthermore, Aji & Wahyudin (2025) demonstrate that GRI-standard-based sustainability disclosure acts as a mediating mechanism that bridges internal environmental practices with operational efficiency, as mapped in the Conceptual Framework of the Research Mediation Model in Figure 2.

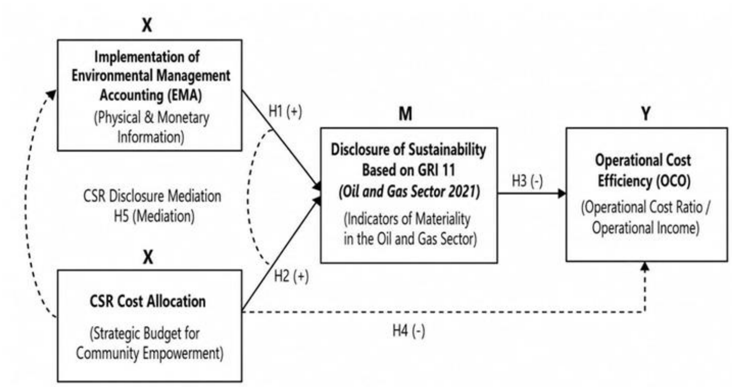

Figure 2. Conceptual Framework

Based on this comprehensive synthesis, the primary research gap in this study lies in the limited literature that comprehensively examines the combined effects of EMA and CSR cost allocation on operating cost efficiency (BOPO), while positioning GRI 11-based CSR disclosure (the oil and gas sector standard) as a mediating variable among integrated energy SOEs in developing countries. The novelty and scientific contribution of this study are based on the use of explicit panel data from the Pertamina Group (the Holding Company and all major Sub-holding Companies) covering the historical period of the energy transition from 2020 to 2025, as well as the application of Partial Least Squares - Structural Equation Modeling (PLS-SEM) with a longitudinal panel data approach (Roemer, 2016).

Based on the research question, theoretical framework, and synthesis of previous empirical findings, this study proposes five main hypotheses. This study hypothesizes that Environmental Management Accounting (EMA) has a positive and significant effect on GRI 11-based CSR disclosure at the Pertamina Group (H1), and that CSR cost allocation has a positive and significant effect on GRI 11-based CSR disclosure at the Pertamina Group (H2). Furthermore, this study hypothesizes that GRI 11-based CSR disclosure has a positive and significant effect on operating cost efficiency or a reduction in the BOPO ratio at the Pertamina Group (H3), and that the allocation of CSR costs has a direct and significant effect on operating cost efficiency or a reduction in the BOPO ratio at the Pertamina Group (H4). Finally, this study tests the hypothesis that GRI 11-based CSR disclosure significantly mediates the effects of EMA and CSR cost allocation on operational cost efficiency or a reduction in BOPO at the Pertamina Group (H5).

By testing these five hypotheses, this study aims to analyze and empirically demonstrate the mechanisms of direct and indirect influences among the research variables. Theoretically, this study reinforces the relevance of Agency Theory and Legitimacy Theory in explaining how financial governance instruments and the internal environment correlate with long-term performance efficiency. Practically, the results of this study are expected to make a tangible contribution to the management of state-owned energy enterprises in evaluating the effectiveness of sustainability cost allocation to optimize operational performance amid the dynamics of the national energy transition.

RESEARCH METHODOLOGY

The present study was conducted from October 2025 to February 2026, with the PT Pertamina (Persero) Group serving as the subject of observation. The units of analysis in this study comprise the Holding entity and five primary Sub-holding entities, namely the Upstream, Refining & Petrochemical, Commercial & Trading, Gas, and New & Renewable Energy Sub-holdings. An explanatory quantitative approach was applied using a balanced longitudinal panel data design over a six-year observation period, specifically from 2020 to 2025. The amalgamation of cross-sectional data from six entities and time-series data over a period of six years resulted in a total of 36 panel data observation units. The longitudinal design was selected to capture variations across business units while comprehensively mapping temporal trends in operational efficiency and the sustainability dynamics of state-owned energy enterprises (Sugiyono, 2023).

The data utilised in this study is secondary and repeated (panel data) derived from official corporate documents that have undergone audit. The data was collected through the use of a documentation study of the financial statements (annual reports), sustainability reports, and internal performance reports for the environment of PT Pertamina (Persero) Group from the 2020 to 2025 period. Operasionalisasinya mencakup empat konstruksi inti. Firstly, the Environmental Management Accounting (EMA) (X_1) is measured through the integration of physical and monetary indicators, encompassing the intensity of energy consumption, the cost of managing operational waste, the cost of decarbonisation or mitigation, and the allocation of environmental compliance costs. Secondly, the measurement of Corporate Social Responsibility (CSR) expenditure is based on the actual cash expenditure on social and environmental programmes (TJSL), which encompasses the empowerment of communities, the preservation of ecosystems, food security, and health. Thirdly, the disclosure of CSR in accordance with GRI 11 (Z) is measured by means of a content analysis method that employs a binary scoring system (where 1 = disclosure and 0 = non-disclosure) in accordance with the GRI 11 Oil and Gas Sector Standard 2021 indicators. The fourth issue pertains to the efficiency of operational expenses (Y), which is measured using the ratio of operational expenses to revenue (BOPO). It is evident that an increase in the BOPO ratio signifies an enhancement in the efficiency of operational expenses for a corporation.

The development of a conceptual model and the formulation of a causal relationship between variables is grounded in the Resource-Based View (RBV) (Barney, 1991) and the Legitimacy Theory (Suchman, 1995). The two theoretical frameworks under consideration suggest that the management of environmental resources through the use of EMA and the strategic allocation of CSR can enhance corporate legitimacy through transparency in the disclosure of sustainability. This, in turn, can have a positive effect on the efficiency of the company's operations. The structural relationship between the variables is expressed in the following system of equations: In the context of the model, Z is defined as $\gamma_1X_1 + \gamma_2X_2 + \gamma_1Z$, Y as $\beta_1X_2 + \beta_2Z + \gamma_2$, and X_1 representing Environmental Management Accounting (EMA), X_2 representing Alocated CSR, Z representing CSR Disclosure Index based on GRI 11, Y representing BOPO Efficiency, and γ and β representing the coefficients of the path. Meanwhile, γ_1, γ_2, β_1, β_2 represent the coefficients of the error term or residual model. The empirical investigation into the mediating effect of variable Z employed the Specific Indirect Effects procedure in order to ascertain the role of sustainability disclosure as a moderating variable in the relationship between internal accounting factors and CSR allocation on the BOPO ratio.

The analysis of the data was conducted using a structural equation modelling (SEM) approach, with a particular focus on the implementation of partial least squares (PLS) in the context of statistical analysis. This approach was facilitated by the utilisation of the software program, SmartPLS, in its fourth iteration. The selection of PLS-SEM was informed by the methodological guidance set out in the works of Hair et al. (2022) and Roemer (2016). It is asserted that PLS-SEM is highly effective in the examination of complex structural models with mediating effects. It functions optimally when analysing restricted samples and longitudinal panel data structures, and is non-parametric in nature, thus eliminating the stringent assumptions of multivariate normality. The evaluation of the analytical model is conducted in two stages, as outlined in the standards set out by Hair et al. (2022). Firstly, the evaluation of the outer model is conducted, and secondly, the evaluation of the inner model. The outer model evaluation was conducted with the objective of assessing the validity of convergence (outer loading ≥ 0.70 and Average Variance Extracted/AVE ≥ 0.50), validity of discrimination (Heterotrait-Monotrait ratio/HTMT < 0.85) (Henseler et al., 2015), and reliability of the construct (Composite Reliability ≥ 0.70 and Cronbach's Alpha ≥ 0.70) (Ghozali & Latan, 2015).

The purpose of the evaluation of the structural model (inner model) is to ascertain the predictive strength and the interrelationships between the latent variables. The inner model testing was conducted in accordance with the criteria established by Hair et al. (2022). The aforementioned criteria encompass the evaluation of the coefficient of determination (R^2), which serves as a metric for the extent to which exogenous variables can explain the behaviour of endogenous variables. Furthermore, the effect size (f^2) was analysed in order to ascertain the relative contributions of each pathway. Furthermore, the predictive relevance (Q^2), as determined through the blindfolding procedure, was utilised to assess the predictive capability of the model. The hypothesis of direct and indirect influence (mediation) is evaluated through a non-parametric bootstrapping procedure, utilising 5,000 samples (resampling) at a significance level of $\alpha = 5\%$. It is generally accepted that a research hypothesis is statistically significant at the 0.05 level if the p-value is less than 0.05, the t-statistic is greater than 1.96, and the coefficient of direction is consistent with the research hypothesis (Hair et al., 2022).

RESULT AND DISCUSSION

This section presents the results of data analysis using the Structural Equation Modeling Partial Least Squares (SEM-PLS) approach applied to panel data from the Pertamina Group (holding and sub-holding units) for the 2020–2025 period. The analysis was conducted in stages, including an evaluation of the measurement model (outer model), an evaluation of the structural model (inner model), hypothesis testing via the bootstrapping procedure, and a discussion of the results and their implications.

Evaluation of the Measurement Model (Outer Model)

The external model evaluation in this study was conducted to test the accuracy and consistency of the research instruments, using panel reports from all business units within Pertamina as the data source for the period from 2020 to 2025. In the process, the researcher applied a series of tests, ranging from convergent validity (through outer loadings and AVE), discriminant validity (using the HTMT approach), to construct reliability (using Cronbach's Alpha and Composite Reliability). As the primary criteria, an indicator was accepted if it had an outer loading above 0.70 and an AVE value exceeding 0.50, while a construct was considered reliable if both its Cronbach's Alpha and Composite Reliability values were above 0.70. Thus, every variable used underwent rigorous screening to ensure that the research results accurately reflect real-world conditions in the field.

Tabel 1. Loading Factor Result

Latent Construct	Indicator	Outer Loading	Status
Environmental Management Accounting (X1)	EMA_Monetary (Waste Treatment & Emissions Costs)	0,884	Valid
	EMA_Physical (Energy & Material Consumption)	0,841	Valid
	EMA_Capital (Green Technology Investment)	0,858	Valid
CSR Cost Allocation (X2)	CSR_Social (Community Development)	0,892	Valid
	CSR_Eco (Environmental & Biodiversity Conservation)	0,875	Valid
GRI 11 Disclosure (Z)	GRI_Emissions (GRI 11.1 – GHG Emissions)	0,865	Valid
	GRI_Transition (GRI 11.2 – Energy Transition)	0,832	Valid
	GRI_Biodiversity (GRI 11.4 – Biodiversity)	0,819	Valid
	GRI_Community (GRI 11.14 – Local Communities)	0,873	Valid
BOPO Efficiency (Y)	BOPO_Holding (Holding Expense-to-Revenue Ratio)	0,912	Valid
	B BOPO_Subholding (Average Subholding Ratio)	0,915	Valid

All indicators had outer loadings in the range of 0.819–0.915, which is above the minimum threshold of 0.70; thus, each indicator was deemed adequate in reflecting its latent construct. The AVE values for all constructs range from 0.718 to 0.835 (above 0.50), meaning that each construct is able to explain more than half of the variance in its constituent indicators. Thus, the constructs of EMA, CSR Cost Allocation, GRI 11 Disclosure, and BOPO Efficiency have met the criteria for convergent validity.

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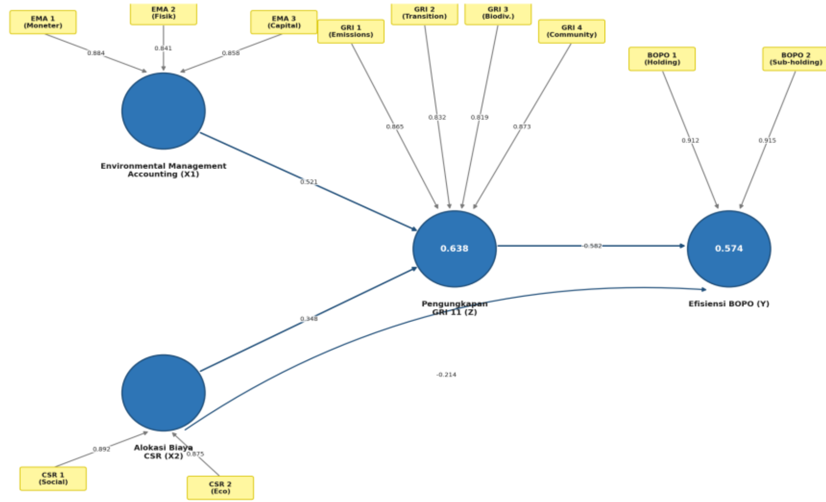

Figure 3. Outer Model and Path Coefficients

Table 2. Discriminant Validity Test Results (Heterotrait-Monotrait Ratio / HTMT)

Variable	EMA (X1)	CSR Allocation (X2)	GRI 11 (Z)	BOPO Efficiency (Y)
EMA (X1)	–			
CSR Allocation (X2)	0,642	–		
GRI 11 Disclosure (Z)	0,758	0,681	–	
BOPO Efficiency (Y)	0,512	0,589	0,724	–

All HTMT values were below the 0.85 threshold, with the highest value—0.758—observed in the relationship between EMA and GRI Disclosure 11. These results confirm that each construct is conceptually and empirically distinct from the others, thereby satisfying the criterion for discriminant validity.

Table 3. Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE)

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Environmental Management Accounting (X1)	0,825	0,896	0,742
CSR Expense Allocation (X2)	0,720	0,877	0,781
PGRI 11 Disclosure (Z)	0,869	0,910	0,718
BOPO Efficiency (Y)	0,802	0,910	0,835

All Cronbach's Alpha values (0.720–0.869) and Composite Reliability values (0.877–0.910) exceeded the 0.70 threshold, demonstrating the instrument's very high internal consistency and making it suitable for structural analysis. All Cronbach's Alpha values (0.720–0.869) and Composite Reliability values (0.877–0.910) exceeded the 0.70 threshold, demonstrating the instrument's very high internal consistency and making it suitable for structural analysis.

Structural Model Evaluation (Inner Model)

Structural model evaluation is conducted to assess the model's ability to explain the relationships among latent variables as well as its predictive power, including the coefficient of determination (R^2), predictive relevance (Q^2), and effect size (f^2).

Table 4. Results for R-Square, Adjusted R-Square, and Predictive Relevance (Q^2)

Endogenous Variable	R Square	Adjusted R-Square	Q^2	Category
GRI 11 Disclosure (Z)	0,638	0,621	0,445	Strong
BOPO Efficiency (Y)	0,574	0,552	0,461	Moderate-Strong

The R^2 value of 0.638 for the GRI 11 Disclosure construct indicates that EMA and CSR Cost Allocation together explain 63.8% of the variation in GRI 11 Disclosure, while the remaining 36.2% is explained by other factors outside the model. For the BOPO Efficiency construct, an R^2 value of 0.574 indicates that CSR Cost Allocation and GRI 11 Disclosure account for 57.4% of its variance. The adjusted R^2 values (0.621 and 0.552) confirm that the model's explanatory power remains adequate after accounting for the number of predictors. The positive and relatively high Q^2 values (0.445 and 0.461) indicate that the model has good predictive relevance for both endogenous constructs.

Table 5. F-Square Test Results (Effect Size)

	GRI Disclosure 11 (Z)	OPO Efficiency (Y)
Environmental Management Accounting (X1)	0,382	–
CSR Cost Allocation (X2)	0,215	0,089
GRI Disclosure 11 (Z)	–	0,341

EMA makes the most significant contribution to GRI Disclosure 11, while GRI Disclosure 11 also makes a major contribution to BOPO Efficiency. In contrast, the direct effect of CSR Allocation on BOPO Efficiency is relatively small.

Hypothesis Testing and Discussion

To assess the significance of the findings, we employed the bootstrap method with 5,000 resamples at a significance level of $\alpha = 0.05$. The hypothesis is considered to be supported if the t-statistic is greater than 1.96 and the p-value is less than 0.05.

Table 6. Path Coefficient Test Results (Direct Effect and Indirect Effect)

Direct Effect Hypothesis Test			
	Original sample (O)	T-statistics	P-values
EMA (X1) → GRI 11 (Z) → BOPO Efficiency	0,521	6,679	0,000
CSR Allocation (X2) → GRI 11 Disclosure (Z)	0,348	4,243	0,000
GRI 11 Disclosure (Z) → BOPO Efficiency (Y)	-0,582	6,847	0,000
CSR Allocation (X2) → BOPO Efficiency (Y)	-0,214	2,276	0,023
Indirect Effect Hypothesis Test			
EMA (X1) → GRI 11 (Z) → BOPO Efficiency	-0,303	5,224	0,000
CSR Allocation (X2) → GRI 11 (Z) → BOPO Efficiency (Y)	-0,202	3,741	0,000

Note: A negative coefficient for the BOPO Efficiency (Y) variable indicates an increase in efficiency, that is, a decrease in the ratio of expenses to operating revenue.

H1 - EMA on GRI 11 Disclosure

EMA has a positive and significant effect on GRI 11 Disclosure (β = 0.521; t = 6.679; p = 0.000), so H1 is accepted. The positive coefficient indicates that increased implementation of EMA tends to be followed by an improvement in the quality of GRI 11 Disclosure. Physical environmental information (energy and material consumption, emissions, waste) and monetary information (environmental protection costs, green technology investments) generated by the EMA system provide a more structured database for the process of identifying, measuring, and disclosing material information. Theoretically, these findings are explained through the Resource-Based View (RBV) perspective: EMA represents a company's internal capability to manage environmental information that supports decision-making while also providing information for external reporting. These findings align with Gunarathne et al. (2021), who demonstrated that EMA facilitates the translation of environmental management strategies into improved organizational performance.

H2 - CSR Expenditure Allocation on GRI 11 Disclosure

CSR expenditure allocation has a positive and significant effect on GRI 11 disclosure (β = 0.348; t = 4.243; p = 0.000), thus H2 is accepted. The implementation of the CSR budget results in social and environmental activities (community development, environmental conservation, ecosystem restoration, biodiversity) that can be documented and communicated as material information in GRI 11. These findings are explained by Legitimacy Theory: companies in sectors with high environmental and social risks allocate resources to social and environmental activities accompanied by adequate disclosure as a mechanism to maintain legitimacy in the eyes of stakeholders. These results are consistent with Adams et al. (2022), who emphasize the importance of materiality and standardized disclosure for the legitimacy of CSR activities in the eyes of stakeholders, as well as with Gyane et al. (2021), who found a correlation between CSR practices and the sustainable performance of multinational oil and gas companies.

H3 -GRI 11 Disclosures on BOPO Efficiency

GRI 11 disclosures have a significant negative effect on BOPO (β = -0.582; t = 6.847; p = 0.000), so H3 is accepted. Since BOPO represents the ratio of expenses to operating revenue, a decrease in this ratio is interpreted as an improvement in operational efficiency. The magnitude of the coefficient indicates that more comprehensive sustainability disclosures encourage companies to improve the quality of their collection, monitoring, and evaluation of environmental information, thereby strengthening oversight of energy consumption, material use, emissions, and resource efficiency. However, this relationship should be understood as an empirical one and does not necessarily prove that disclosure is the sole cause of the decline in BOPO, as efficiency can also result from managerial processes accompanying increased transparency and internal controls. These findings are consistent with Suchman's (1995) argument regarding the role of the strategic legitimacy of disclosure for a company's operational sustainability, as well as with Cardoni et al. (2019), who found that more comprehensive sustainability reporting by oil and gas companies is associated with better operational governance.

H4 -The Effect of CSR Expenditures on BOPO Efficiency

CSR cost allocation has a significant negative effect on BOPO (β = -0.214; t = 2.276; p = 0.023), so H4 is accepted, albeit with a small effect size (f^2 = 0.089) --- its direct contribution to BOPO efficiency is relatively limited compared to GRI 11 Disclosure. Substantively, targeted CSR allocation can serve as a mechanism for managing social risk: community empowerment and local economic development programs have the potential to stabilize social relations in the areas surrounding operational sites, thereby supporting operational smoothness. However, CSR expenditures do not in and of themselves constitute a major source of efficiency—their effectiveness depends on the planning, direction, and evaluation of the programs. This finding is consistent with

Gyane et al. (2021), who showed that CSR investments by multinational oil and gas companies are associated with sustainable financial performance, although the magnitud

H5a & H5b - The Mediating Role of GRI 11 Disclosure

GRI 11 disclosure significantly mediates the relationship between EMA and BOPO efficiency (indirect β = -0.303; t = 5.224; p = 0.000; H5a accepted) as full mediation, and mediates the relationship between CSR allocation and BOPO efficiency (indirect β = -0.202; t = 3.741; p = 0.000; H5b accepted) as partial mediation because the direct effect of CSR on BOPO remains significant (β = -0.214), resulting in a total effect of -0.416. The findings of H5a indicate that environmental information from EMA gains broader managerial value when processed into structured sustainability disclosures; while H5b indicates that CSR Allocation is related to BOPO Efficiency both through direct mechanisms (social risk management) and indirect mechanisms (through GRI 11 Disclosure). GRI 11 disclosures thus serve as a bridge between a company's internal capabilities/activities and operational outcomes, consistent with the Resource-Based View (Barney, 1991) and Legitimacy Theory (Suchman, 1995), which assert that internal capabilities attain their full strategic value when transparently communicated to external stakeholders. Methodologically, the interpretation of full mediation in H5a must still be based on the finding that the direct path from EMA to BOPO is not significant when the mediator is included in the model.

Table 7. Summary of Hypothesis Testing Results

Hipotesis	Direction of Effect	Conclusion
H1	EMA → GRI 11 (+)	Significant, Accepted
H2	CSR Allocation → GRI 11 (+)	Significant, Accepted
H3	GRI 11 → BOPO Efficiency (−)	Significant, Accepted
H4	CSR Allocation → BOPO Efficiency (−)	Significant, Accepted
H5a	Mediation of EMA → GRI 11 → BOPO	Full Mediation, Accepted
H5b	Mediation of CSR → GRI 11 → BOPO	Partial Mediation, Accepted

In summary, all six research hypotheses are supported by the data. EMA and CSR Cost Allocation both promote GRI 11 Disclosure, which in turn serves as the primary pathway to improved BOPO Efficiency both directly and as a mediator of these two exogenous variables.

Research Implications Theoretical implications

First, this study integrates the Resource-Based View and Legitimacy Theory into a single analytical framework: EMA represents a company's internal capabilities in generating and managing environmental information, while GRI 11 Disclosure represents an external transparency mechanism that links the company's activities to stakeholder demands; these two perspectives complement each other in explaining the conversion of internal resources and capabilities into valuable information for stakeholders. Second, this study strengthens the understanding of the mediating role of sectoral standards: GRI 11 Disclosure, as a standard specific to the oil and gas sector, has been shown to function not only as the end result of the reporting process but also as a mechanism linking internal information management to operational consequences. Third, the use of 2020–2025 panel data on holding and sub-holding units provides a longitudinal perspective that captures variations across units and periods that cannot be fully observed through cross-sectional data.

Overall, the research findings indicate that the relationship between sustainability and operational efficiency is not solely determined by the amount of resources allocated. Information management mechanisms and transparency are key factors linking a company's internal activities to its operational outcomes; thus, the integration of internal capabilities, management of social and environmental activities, and sustainability disclosure provides a relevant framework for understanding efficiency creation in oil and gas companies.

CONCLUSION

This study demonstrates that the implementation of Environmental Management Accounting (EMA) and the allocation of Corporate Social Responsibility (CSR) costs contribute significantly to improving the operating cost efficiency ratio (BOPO) at the Pertamina Group for the 2020–2025 period, with GRI 11-based sustainability disclosure serving as the key mediating variable that validates the relevance of the Resource-Based View and Legitimacy Theory. Empirical findings confirm that EMA and CSR cost allocation positively drive improvements in the quality of GRI 11 disclosures, which in turn substantially reduce the BOPO ratio, with GRI 11 acting as a full mediator for EMA and a partial mediator for CSR cost allocation. Internal capabilities in managing environmental and social data, when transparently communicated through sectoral standards, have proven to transform into tangible operational advantages, where the efficiency of energy companies depends not only on resource allocation but also on standardized information management mechanisms. Furthermore, from the perspective of sustainability impact, this synergy underscores that corporate environmental accounting and social investment are no longer merely cost centers or a matter of administrative compliance, but rather strategic value drivers* that ensure long-term operational resilience, ecological accountability, and a sustainable energy transition in the extractive sector. In practical terms, management at state-owned energy companies is advised to integrate environmental accounting systems more deeply into strategic decision-making and strengthen compliance with GRI 11 reporting to optimize financial performance, while future research is encouraged to expand the scope of the study to other extractive industries or include external moderator variables to enrich the sustainability efficiency analysis model.

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