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Optimizing Sustainable Coal Hauling Under Uncertainty: A Multi-Stage Decision Tree Approach for a Palembang-Based Subcontractor

Imelda Kurniawan Santoso[1*], Utomo Sarjono Putro[2]
[1]Institut Teknologi Bandung, Jawa Barat, Indonesia, 29324387@mahasiswa.itb.ac.id
[2]Institut Teknologi Bandung, Jawa Barat, Indonesia, utomo@itb.ac.id

*Corresponding Author: 29324387@mahasiswa.itb.ac.id[1]

Abstract: This study develops a multi-stage decision tree model to optimize coal hauling operations for PT Baseline Business Control (PT BBC), a Palembang-based subcontractor facing weather uncertainty, strict ESG requirements, and thin profit margins. The model sequences four key decisions: route selection, fleet composition, driver productivity targets, and weather conditions, with a calibrated 30% probability of rain-induced full operational stoppages. Using data from management workshops and anonymized company records, six operational scenarios were evaluated on a 10-truck scale. The analysis combined Expected Monetary Value (EMV) through backward induction, Net Present Value (NPV) at a 5% discount rate, and Break-Even Point (BEP). Scenario 1, which uses the BSE–EPI PORT route, a 75% new / 25% old fleet mix, and an incentivized 17 trips per month target, emerged as the best option. It delivers the highest EMV of IDR 3.366 billion, a break-even period of 2.68 years, and an 18% reduction in CO_2 emissions intensity while achieving full ESG compliance. Sensitivity analysis using tornado and spider diagrams confirms that this strategy remains robust even under ±20% changes in coal price or rain probability. The findings show that selective fleet renewal combined with productivity incentives can effectively balance profitability, capital efficiency, and sustainability. This practical decision framework can be adapted by other coal hauling subcontractors across Indonesia and similar emerging markets.

Keywords: Decision tree analysis, coal logistics, ESG compliance, fleet optimization, climate uncertainty, Indonesia, Expected Monetary Value, sustainability.

INTRODUCTION

Indonesia is one of the world's largest coal exporters. In South Sumatra, the Palembang region serves as an important logistics hub that connects major mining areas such as Lahat, Muara Enim, and Penukal Abab Lematang Ilir (PALI) with export terminals along the Musi River and the southern coast. Hauling subcontractors play a vital role in this supply chain by moving coal from the mines to the ports. PT Baseline Business Control (PT BBC), the company examined in this study, is one of these typical subcontractors that now faces growing operational challenges.

These challenges have become much more difficult since 2025. For a fleet of 10 trucks, annual operating costs normally range from IDR 2 billion to IDR 5 billion. Capacity utilization stays relatively low, between 60 and 75 percent. On average, drivers complete only 11 trips per month, which is far below the industry target of 15 to 20 trips. Profit margins have also become very thin, dropping to around 5 to 7 percent, mainly because of fluctuating coal prices. In early 2026, the Newcastle benchmark price was approximately USD 115 per tonne.

The situation grew even more challenging after the public road ban for coal trucks took effect in January 2026. This regulation requires all operators to use dedicated hauling roads, especially the 113-to-118-kilometer Servo Lintas Raya (SLR) toll-free corridor. Although this change helps avoid toll costs and reduces damage to public roads, it has created new decisions around route selection and daily operation.

Adding to these difficulties is the tropical monsoon climate in South Sumatra. Heavy rainfall does not simply slow down operations. In many cases, it forces a complete stoppage because of safety concerns, unstable road conditions, and temporary closures at mining sites. This study treats such events as a binary risk, with a calibrated 30 percent probability of full zero-output days. Most conventional logistics models do not handle this type of disruption well.

At the same time, ESG requirements have become a strict contractual condition rather than an optional practice. Major clients now include penalty clauses of 15 to 20 percent of contract value if operators fail to meet emissions or dust control standards. For a subcontractor working with narrow margins, a single penalty can erase an entire year's profit. This makes it necessary to consider sustainability as part of core operational decisions instead of treating it as a separate reporting task.

Traditional analytical tools commonly used in Indonesian coal logistics, such as static Net Present Value analysis and linear programming, are not well suited to this environment. Static NPV usually simplifies uncertainty into a single discount rate, while linear programming cannot capture the sequential nature of real managerial choices. For example, the financial impact of selecting a certain fleet mix depends on the route chosen earlier, which then affects how badly weather disruptions will hurt revenue.

To the author's knowledge, no prior study in Indonesian coal logistics has modelled monsoon-related stoppages as a clear binary zero-output event inside a multi-stage decision framework. This research tries to fill that gap by building a multi-stage decision tree. The model includes four sequential decisions: route selection between BSE–EPI PORT and MIP–PORT, fleet composition (100 percent new trucks, 75 percent new and 25 percent old, or 100 percent old), driver productivity target (11 trips or an incentivized 17 trips per month), and weather outcome (70 percent chance of dry conditions with full operation versus 30 percent chance of rain with zero output).

The analysis evaluates these scenarios using three main measures: Expected Monetary Value (EMV) calculated through backward induction, Net Present Value (NPV) over a six-year period at a 5 percent weighted average cost of capital, and Break-Even Point (BEP) adjusted for the effective capacity under weather uncertainty.

This study has three main objectives. First, it aims to develop realistic operational scenario alternatives from the available decision options. Second, it seeks to identify the scenario that produces the highest EMV. Third, it tries to ensure the recommended solution delivers strong financial performance while also meeting ESG compliance requirements. In the end, the research hopes to offer PT BBC a practical decision-making tool and provide a useful framework that other coal hauling subcontractors in Indonesia and similar emerging markets can apply.

Coal Hauling Subcontracting in Indonesia

Coal hauling in Indonesia is a capital-intensive business marked by high fixed costs, thin profit margins, and heavy exposure to external risks such as weather, regulations, and price volatility.

Hardian (2010) highlighted how subcontractors bear most of the operational risks while facing limited ability to pass costs on to principals due to typical principal-agent problems. Pradono et al. (2019) focused on South Sumatra and found that many haulers hesitate to invest in new trucks because short-term contracts make it difficult to recover the high capital cost, a classic moral hazard situation. This pattern is clearly visible in PT BBC's current operations.

The January 2026 public road ban has changed the operating environment. Previously, public roads functioned as a shared resource that suffered from overuse. As Elinor Ostrom (1992) predicted in her work on the tragedy of the commons, unregulated heavy truck traffic led to rapid road damage, congestion, and high maintenance costs borne by the government (Kementerian PUPR, 2023). The shift to the dedicated SLR toll-free corridor helps internalize these costs and provides a more stable environment for route planning and daily operations.

ESG Compliance as a Contractual Constraint

ESG requirements have become a strict contractual condition rather than an optional practice. Major clients now impose penalty clauses of 15–20% of contract value for failing to meet emissions or dust control standards. The International Energy Agency (2023) noted that Scope 3 emissions from logistics are increasingly included in coal supply contracts, especially for buyers facing international carbon regulations. Ding et al. (2025) showed that newer trucks can reduce fuel consumption and emissions intensity by 18–22%, helping subcontractors meet these thresholds.

For small operators like PT BBC, ESG compliance acts as a binary filter: the fleet either meets the client's standard, or it triggers penalties. This reality makes partial fleet renewal a critical strategic decision rather than a simple cost-benefit calculation.

Decision Tree Analysis for Sequential Decisions Under Uncertainty

Decision tree analysis is well suited for evaluating sequential choices under uncertainty. Clemen and Reilly (2001) showed that backward induction can identify the strategy that maximizes Expected Monetary Value (EMV) while preserving the full range of possible outcomes, something that static NPV models often overlook. Kamiński et al. (2018) demonstrated its usefulness in energy and infrastructure decisions where timing and flexibility matter.

In logistics operations affected by climate risk, sensitivity tools such as tornado and spider diagrams help identify which variables have the greatest impact on outcomes (Saltelli et al., 2019). This study extends previous work by treating monsoon-induced stoppages as binary zero-output events rather than gradual delays, integrating ESG compliance directly into the payoff calculations, and validating the model with real company data from PT BBC.

METHOD

Research Design and Data Collection

Primary data were collected through four semi-structured interviews and two workshops with PT BBC’s Operations Director, Fleet Manager, Finance Controller, and Driver Supervisors between October 2025 and January 2026. The 30% probability of rain-induced full stoppages was calibrated by combining BMKG historical rainfall data (2015–2025), GPS telemetry records of actual zero-output days, and management’s expert judgment.

Secondary data included anonymized GPS telemetry from the past 24 months, internal cost reports (presented in ranges to protect confidentiality), Newcastle coal price benchmarks

(2021–2026), and SLR route specifications. All sensitive financial figures were anonymized, and management confirmed that the relative proportions remained accurate.

Decision Tree Structure

The multi-stage decision tree sequences four nodes in a fixed logical order reflecting the operational timeline of investment and deployment decisions. Node 1 is a decision node representing route selection: the BSE–EPI PORT route versus the MIP–PORT route. These routes differ in distance, road quality, fuel consumption profiles, and access to loading infrastructure. Node 2 is a decision node representing fleet composition: 100% new trucks, 75% new / 25% old, or 100% old trucks. Fleet composition determines CAPEX requirements, fuel cost per trip, maintenance schedules, and ESG compliance status. Node 3 is a decision node representing the driver productivity target: the status-quo 11 trips per month versus an incentivized 17 trips per month target supported by GPS-based performance monitoring and financial incentive structures. Node 4 is a chance node representing weather outcome: a 70% probability of dry-season full operation and a 30% probability of rain-induced complete operational stoppage, yielding zero revenue for the affected period.

Eight terminal paths were initially generated from the combinatorial space of decision choices. Two paths, specifically those combining 11 trips per month with rain outcomes on the MIP–PORT route, were excluded from final analysis as non-viable following management confirmation that the revenue generated under those conditions would not cover fixed costs even in dry-season scenarios. The remaining six paths constitute the six scenarios reported in this study.

Figure 1 illustrates the full decision tree structure. Each path from left to right represents a sequential commitment: route selection locks in the cost and distance parameters that subsequently constrain fleet and productivity choices, with weather outcome as the terminal chance node determining realized revenue. The six viable terminal paths correspond to the six scenarios evaluated in this study.

Evaluation Metrics

Three complementary metrics were used to evaluate each scenario:

Net Present Value (NPV) was calculated over a six-year horizon at a 5% WACC, separately for dry-year (full operation) and rain-year (zero output during stoppage periods) conditions. The NPV formula applied was:

$$NPV = \Sigma\ [CFt / (1 + r)t] – C_0$$

where CFt represents the annual net cash flow in year t, r is the WACC (5%), and C_0 is the initial CAPEX for fleet acquisition.

Expected Monetary Value (EMV) was computed via backward induction through the decision tree, weighting scenario NPVs by their associated weather probabilities:

$$EMV = 0.7 \times NPV\_dry + 0.3 \times NPV\_rain$$

Break-Even Point (BEP) was calculated on an effective capacity basis, adjusting for the 70% dry-year utilization assumption to derive the realistic revenue stream against which fixed and variable costs are recovered.

Sensitivity Analysis

Sensitivity analysis was performed to test the robustness of Scenario 1. We varied five key inputs, namely coal price, rain probability, driver productivity, fuel cost, and incentive cost, by ±20% and examined their impact on EMV. Tornado diagrams ranked the variables by how much they affected the outcome, while spider diagrams showed how all six scenarios performed across the full range of changes. All calculations were done in Microsoft Excel and validated against 2024 operational data, with less than 6% deviation from actual results.

RESULTS AND DISCUSSION

Scenario EMV Comparison

Table 1 presents the EMV, BEP, and CO_2 reduction outcomes for all six scenarios evaluated on a 10-truck fleet scale. Scenario 1 (S1), which follows the BSE–EPI PORT route with 75% new/25% old fleet and an incentivized 17 trips/month productivity target, achieves the highest EMV of IDR 3.366 billion, a BEP of 2.68 years, and an 18% reduction in CO_2 emissions intensity relative to the all-old-fleet baseline.

Table 1. EMV Comparison – Six Key Scenarios (IDR Billions, 10-Truck Scale)

Scenario	Route	Fleet Mix	Productivity	EMV (IDR B)	BEP (years)	CO_2 Δ
S1 (Optimal)	**BSE–EPI PORT**	**75% new / 25% old**	**17 trips/month**	**+3.366**	**2.68**	**–18%**
S2	BSE–EPI PORT	100% new	17 trips/month	+2.891	2.95	–20%
S3	BSE–EPI PORT	100% old	17 trips/month	+2.412	1.92	0%
S4	MIP–PORT	75% new / 25% old	17 trips/month	+2.81	2.78	–18%
S5 (Status Quo)	BSE–EPI PORT	75% new / 25% old	11 trips/month	–0.814	>4.5	n/a
S6	MIP–PORT	100% new	17 trips/month	+2.412	3.22	–20%

Source: Author calculations (2026). EMV = 0.7 × NPV_dry + 0.3 × NPV_rain.

S1 outperforms the 100% new fleet option (S2) because of what this study calls the Selective Renewal Advantage. Keeping 25% older trucks lowers upfront capital costs while still achieving the 17-trip target and full ESG compliance. The extra 2% CO_2 reduction from a fully new fleet does not justify the significantly higher investment at a 5% discount rate.

Although S3 (100% old fleet) offers the fastest break-even of 1.92 years, it fails ESG requirements. The resulting 15–20% revenue penalty would eliminate its apparent cost advantage, making it riskier than S1 in practice.

S4 and S5 both show negative EMVs, confirming that the MIP–PORT route and the current 11 trips/month productivity level are not viable under present conditions.

Sensitivity and Robustness Analysis

Tornado diagram analysis ranks the five tested variables by their contribution to EMV variance under ±20% perturbation. Coal price produces the widest EMV swing, with the range spanning from approximately IDR +9.0 billion (at +20% coal price) to IDR –3.3 billion (at –20% coal price), reflecting the direct pass-through of revenue exposure in a volume-based hauling contract. The total coal-price-driven range of IDR 12.3 billion represents the single largest financial risk faced by PT BBC and lies outside management's direct control, underscoring the importance of contractual price escalation clauses.

Rain probability emerges as the most significant controllable operational risk, producing an EMV range of approximately IDR 7.8 billion across the ±20% perturbation range. Unlike coal price, rain probability can be partially managed through operational responses: BMKG early-warning integration, pre-season maintenance scheduling to maximize truck availability during dry windows, and contractual force majeure documentation for verified weather stoppages. Fuel cost and incentive cost produce narrower sensitivity ranges, confirming that the business case for S1 is not sensitive to reasonable fluctuations in these input parameters.

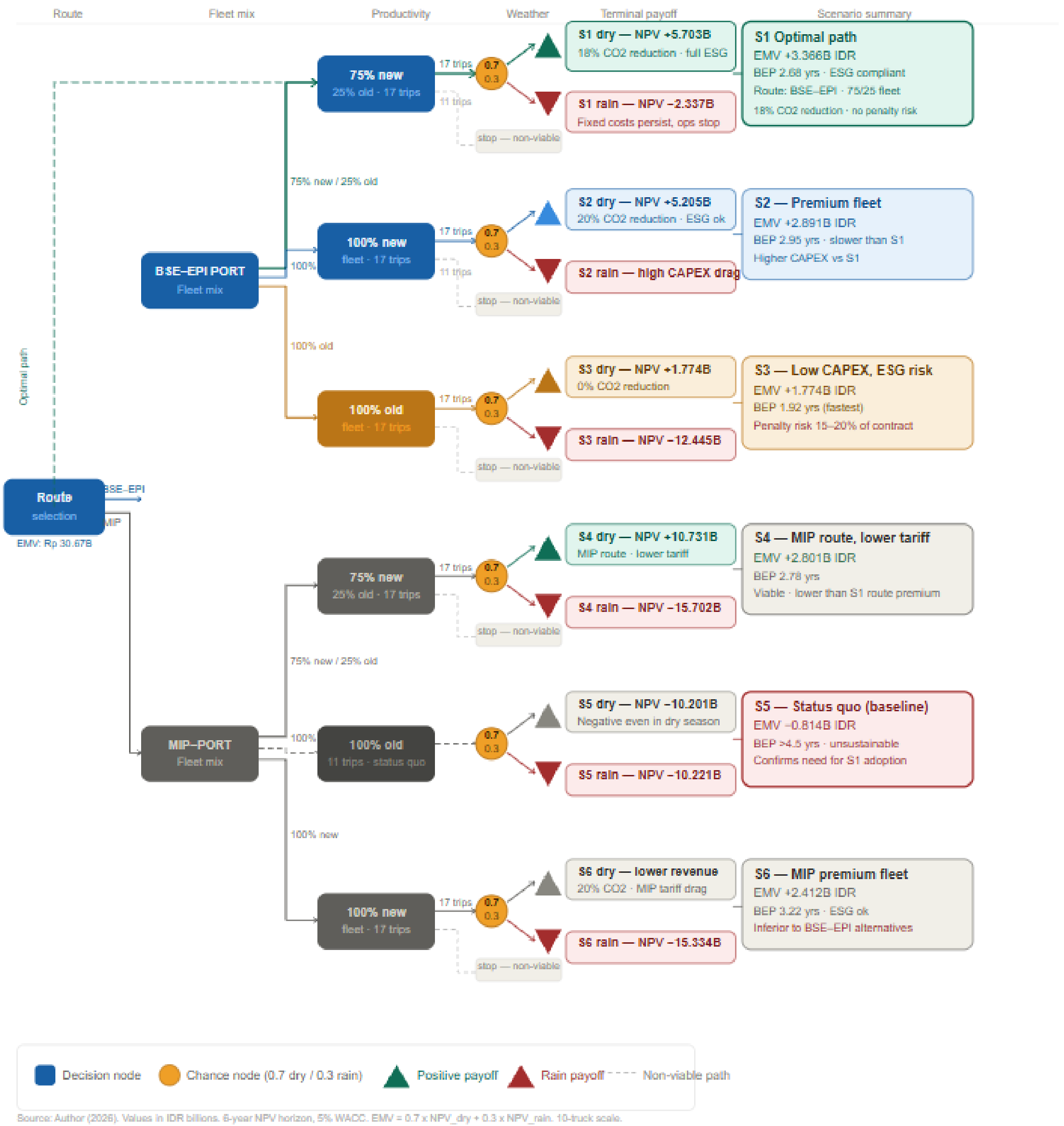

Figure 1. Multi-Stage Decision Tree – Operational Scenario Alternatives for PT BBC Coal Hauling
(Source: Author, 2026)

Figure 2 presents the tornado diagram for Scenario 1. The horizontal bars represent the EMV swing produced by a ±20% perturbation of each input variable, ranked from largest to smallest variance contribution. Coal price dominates the sensitivity profile, followed by rain probability. The former reflects external market exposure, while the latter represents the primary operational risk amenable to management intervention.

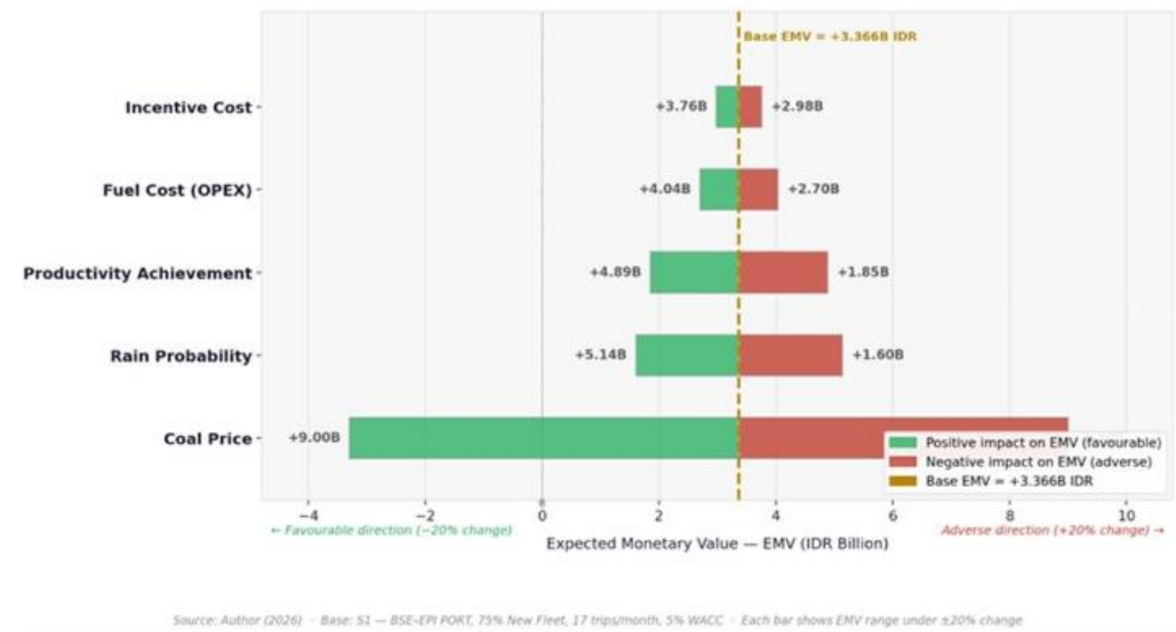

Figure 2. Tornado Diagram – Sensitivity of S1 EMV to Key Variables (Source: Author, 2026)

Figure 3 presents the spider diagram mapping EMV across all six scenarios under the same ±20% parameter range. S1 remains above the EMV = 0 threshold across all perturbations, confirming strategic robustness. The status-quo scenario (S5) crosses into negative EMV territory under virtually any adverse shift, while S4, despite achieving ESG compliance, is consistently dominated by S1 due to the MIP–PORT route's inferior cost structure.

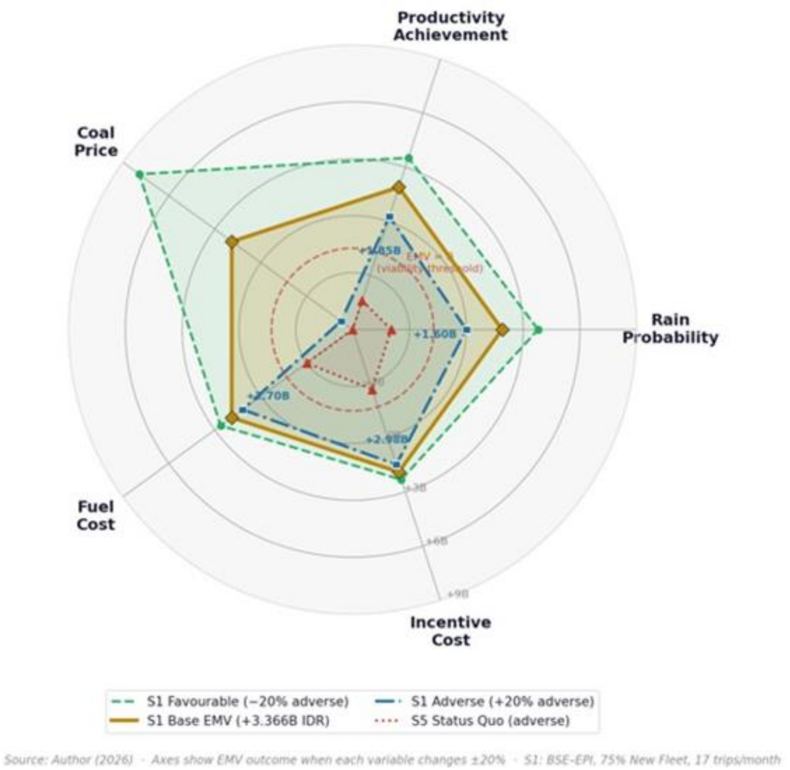

Figure 3. Spider Diagram – Robustness of S1 Across ±20% Variations (Source: Author, 2026)

Spider diagram analysis confirms that S1 maintains a positive EMV across all tested adverse scenarios, and is the only scenario to do so consistently. The status-quo scenario (S5) collapses below EMV = 0 under virtually any adverse parameter perturbation, confirming that continuing current operations without intervention is not a viable long-run strategy regardless of whether external conditions improve or deteriorate. S2 also maintains positive EMV under most perturbations but falls below S1 in all cases, reinforcing the dominance of the mixed-fleet strategy.

Resolving the Maintenance Moral Hazard

S1's optimality resolves what this study identifies as the Maintenance Moral Hazard endemic to Indonesian coal hauling subcontracting. Under the moral hazard framework, short-term contract structures create rational incentives for operators to defer maintenance on older trucks and avoid fleet renewal investment, since the payback horizon on new trucks typically exceeds the visible contract period. The result is an industry-wide pattern of aging, poorly maintained fleets running at low trip frequencies, exactly the status quo captured by S5.

S1 breaks this equilibrium through two mechanisms operating simultaneously. The productivity incentive structure, which links GPS telemetry-based bonuses to achieving 17 trips per month, directly increases output per truck without proportional cost increases, improving OPEX efficiency. The 75%/25% mixed fleet strategy avoids the full CAPEX burden of complete renewal while securing ESG compliance through the fleet-average emissions profile, which satisfies principal thresholds even with 25% older units in the mix. Together, these mechanisms produce a 55% increase in trip volume (from 11 to 17 trips/month) while preserving an attractive return on the incremental capital deployed.

The ESG-Profitability Integration

A central theoretical contribution of this study is demonstrating that ESG compliance and financial optimization are not in tension at the operational level for a subcontractor in PT BBC's position. The conventional framing in sustainability management literature treats ESG investment as a cost that reduces short-term profitability in exchange for long-term risk reduction or reputational benefits (Eccles et al., 2014). The results here present a different dynamic: under binding ESG contractual constraints with penalty rates of 15–20% of contract value, the relevant comparison is not between ESG investment and no investment, but between compliant and non-compliant fleet strategies whose financial consequences are asymmetric.

The 18% CO_2 emissions intensity reduction in S1 is not an incidental sustainability co-benefit but a direct consequence of fuel efficiency improvements in newer trucks. At a fleet-average level, each percentage point reduction in fuel consumption per trip reduces OPEX while simultaneously reducing emissions intensity. The ESG compliance achieved by S1 eliminates the penalty exposure that makes S3 financially inferior despite its faster BEP, illustrating that sustainability compliance is both commercially rational and achievable without sacrificing capital efficiency.

The Binary Weather Constraint: A Methodological Contribution

The decision to model monsoon-induced stoppages as binary zero-output events rather than proportional delays represents the most significant methodological departure from prior coal logistics literature. Validation against PT BBC's 2024 operational data, which yielded less than 6% deviation from recorded financial outcomes, confirms that this modelling choice better captures operational reality than continuous probabilistic delay distributions.

The practical implications of this choice are significant. Under a proportional delay model, rain probability affects all scenarios roughly symmetrically, slightly reducing NPV across the board. Under the binary zero-output model, scenarios with lower margins per trip (such as S3, despite its faster BEP, and all MIP–PORT scenarios) are disproportionately penalized because their rain-year NPV turns sharply negative while their dry-year surplus is insufficient to compensate. This asymmetric effect explains why the MIP–PORT scenarios (S4, S6) produce unexpected results: their route-level economics appear competitive in dry conditions but collapse in rain-year scenarios because the longer cycle time amplifies the revenue loss per zero-output day.

Generalizability and Limitations

The decision tree framework developed in this study can be easily adapted to other coal hauling operations across Indonesia. Only three key parameters need local calibration: the probability of rain-induced stoppages (which can be calculated from BMKG historical data for the specific region), route-specific cost differences (based on actual road conditions, fuel consumption, and loading facilities), and the ESG penalty rates stated in client contracts. Once these inputs are adjusted, the overall tree structure, backward induction method, and sensitivity analysis can be directly applied to operations in Kalimantan, East Sumatra, or other coal-producing areas.

Several limitations should be noted. Because this is a single case study focused on the Palembang region, the findings are most relevant to similar operations in South Sumatra. Financial figures were anonymized to protect confidentiality, which means absolute numbers are approximate, although the relative ranking of scenarios remains reliable. In addition, the base case assumes a constant coal price; while the ±20% sensitivity analysis covers most realistic price swings, it does not fully reflect futures market volatility. Future research could strengthen the model by incorporating real-options analysis for more flexible fleet investment decisions or by using machine-learning techniques to improve rain forecasting and move beyond a simple binary stoppage probability.

CONCLUSION

This study used a multi-stage decision tree approach to find the best operational strategy for PT BBC, a coal hauling subcontractor in Palembang. The model considered four sequential decisions under weather uncertainty, ESG requirements, and tight cost pressures. After evaluating six scenarios, Scenario 1 emerged as the clear winner: using the BSE–EPI PORT route, adopting a 75% new and 25% old truck fleet mix, and setting an incentivized target of 17 trips per month.

Scenario 1 delivers the strongest results, with an Expected Monetary Value (EMV) of IDR 3.366 billion, a break-even period of 2.68 years, and an 18% reduction in CO_2 emissions intensity per trip. Importantly, it remains profitable even under adverse ±20% changes in key variables.

The study makes three main contributions. First, it shows that modeling rain as a binary zero-output event (complete stoppage) reflects monsoon risk in South Sumatra far better than traditional proportional delay models. Second, it proves that financial performance and ESG compliance can go hand in hand. The mixed fleet strategy achieves full ESG compliance without the high capital cost of replacing all trucks. Third, it offers a practical and replicable decision framework that other coal hauling subcontractors in Kalimantan, East Sumatra, and similar regions can easily adapt.

For implementation, this study offers targeted recommendations. PT BBC should immediately secure contracts based on the S1 route and productivity targets, roll out the GPS-based incentive program for drivers, begin gradually replacing trucks to reach the 75/25 fleet mix within two seasons, and incorporate BMKG weather alerts into daily dispatching. The SLR road operator could improve overall efficiency by giving priority access to high-productivity subcontractors. Coal principals would benefit from offering premium tariffs for low-emission fleets, while regulators could accelerate industry-wide renewal by providing subsidies or faster depreciation for cleaner trucks.

Overall, this framework gives logistics managers a useful tool to balance profitability and climate risk. As ESG standards become stricter and weather patterns grow more unpredictable, the ability to make clear, sequenced decisions under binary uncertainty will be increasingly important for coal logistics operators across Indonesia and other emerging markets.

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Declarations

Author contribution: Imelda Kurniawan Santoso led the research design, data collection, modelling, and writing of the manuscript. Utomo Sarjono Putro supervised the research, provided methodological guidance, and contributed to the critical revision of the manuscript. Both authors read and approved the final paper.

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REFERENCES

Clemen, R., & Reilly, T. (2001). Making Hard Decisions with DecisionTools. Duxbury Press.

Ding, X., Vukovic, D. B., Shams, R., & Vukovic, N. (2025). Does air pollution affect corporate shareholder responsibility performance?: Analysis of regression discontinuity design based on the "Qinling-Huaihe" line. Environment, Development and Sustainability, 27(2), 4083–4116. https://doi.org/10.1007/s10668-023-04063-6

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The Impact of Corporate Sustainability on Organizational Processes and Performance. Management Science, 60(11), 2835–2857.

Hardian, B. (2010). Transport Economics of Coal Resources in South Sumatra, Indonesia.

International Energy Agency. (2023). World Energy Outlook 2023. www.iea.org/terms

Kamiński, B., Jakubczyk, M., & Szufel, P. (2018). A framework for sensitivity analysis of decision trees. Central European Journal of Operations Research, 26(1), 135–159. https://doi.org/10.1007/s10100-017-0479-6

Kementerian PUPR. (2023). Laporan kondisi jalan nasional Sumatera Selatan 2022–2023 [Report on national road conditions in South Sumatra].

Newcastle and HBA Coal Price Historical Trends (2021–2026). (2026). https://tradingeconomics.com/commodity/coal

Ostrom, E. (1992). Governing the Commons. Cambridge University Press.

Pradono, P., Syabri, I., & Fathoni, M. (2019). Comparative Analysis on Integrated Coal Transport Models in South Sumatra. https://api.semanticscholar.org/CorpusID:244733189

Saltelli, A., Aleksankina, K., Becker, W., Fennell, P., Ferretti, F., Holst, N., Li, S., & Wu, Q. (2019). Why so many published sensitivity analyses are false: A systematic review of sensitivity analysis practices. Environmental Modelling and Software, 114, 29–39. https://doi.org/10.1016/j.envsoft.2019.01.012