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Cost Benefit Evaluation and Development Planning for Potential Jetty Facilities in Coal Mining Operation

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Abstract. Indonesia's coal mining industry remains strategically important for domestic energy security and export competitiveness, making logistics infrastructure a critical determinant of operational performance. As coal production increases due to collaboration with neighboring mines, jetty facilities become potential bottlenecks affecting throughput, cost efficiency, and delivery reliability. This study evaluates the operational and financial performance of three jetty facilities operated by PT XYZ in East Kalimantan to identify the most economically beneficial jetty and assess the feasibility of infrastructure development. The analysis applies an operational cost–benefit approach using operational cash inflows and operating expenditures (OPEX), complemented by operational efficiency indicators such as gross profit margin and net profit margin. Based on comparative results, a Discounted Cash Flow (DCF) analysis is conducted for the selected jetty to evaluate a proposed conveyor development project using Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period. The findings reveal significant differences in cash-generating capability and operational efficiency among the three jetties, with one facility demonstrating superior economic contribution and stronger financial performance. The DCF results indicate that the proposed conveyor development is financially feasible and capable of improving long-term operational capacity. This study provides a cash-based, facility-level evaluation framework that supports data-driven investment decision-making for jetty development in coal logistics operations.

Keywords: Coal Logistics; Jetty Operations; Operational Cash Flow; Cost–Benefit Analysis; Discounted Cash Flow (DCF).

INTRODUCTION

Indonesia's coal mining industry continues to play a strategic role in supporting national energy security and export-driven economic growth. According to the Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik* / RUPTL) issued by PT Perusahaan Listrik Negara (PLN), coal-fired power plants are projected to supply more than 50 percent of Indonesia's electricity generation at least until 2030 (PLN, 2023). This indicates that coal will remain a critical base-load energy source in the medium term, particularly in maintaining grid stability and ensuring affordable electricity prices during the ongoing energy transition period (Knatz et al., 2024; Song & Panayides, 2015; Graham, 2022).

Beyond its domestic role, coal remains one of Indonesia's most important export commodities (Hia, 2025; Li et al., 2024; Wang et al., 2025). Data from the Ministry of Energy and Mineral Resources (ESDM) show that coal contributes significantly to national export revenues and foreign exchange earnings, reinforcing Indonesia's position as one of the world's largest coal exporters (ESDM, 2024). Large-scale coal production is concentrated in several regions, with East Kalimantan consistently identified as one of the country's major coal-producing areas, hosting a dense cluster of mining operations supported by riverine and coastal logistics infrastructure (Alam & Shah, 2024; Rodrigue & Notteboom, 2020; Zhu et al., 2022).

While coal demand remains structurally strong, industry faces persistent logistical challenges that may constrain operational performance. Coal logistics infrastructure particularly stockpiles, conveyor systems, and jetty facilities forms the physical backbone of the coal supply chain, connecting mine sites to barges and mother vessels. Previous studies highlight that jetty and port capacity frequently become operational bottlenecks when production volumes increase faster than infrastructure expansion, especially in key production regions such as East Kalimantan (Trijayanto & Hakam, 2025). Limited jetty capacity can lead to loading delays, reduced throughput, and inefficiencies in coal shipment scheduling.

As coal production volumes increase, the ability of jetty facilities to support efficient, reliable, and cost-effective loading operations becomes increasingly critical to sustaining revenue realization and contractual performance. Therefore, assessing jetty operations from both an operational and financial perspective is essential. A systematic evaluation of operational costs, benefits, and cash flow performance provides an evidence-based foundation for identifying which jetty facilities offer the greatest potential for further development, ensuring that logistics infrastructure remains aligned with Indonesia's continued reliance on coal in the medium term.

Table 1. Overview of Indonesia's Coal Demand and Logistic Conditions

Aspect	Indicator	Latest Condition	Source
Domestic Energy Demand	Share of coal in national electricity mix	>50% of electricity generation projected until 2030	PLN, *RUPTL* (2023)
Export Performance	Coal as major export commodity	One of Indonesia's largest contributors to export revenue and foreign exchange	ESDM (2024)
Production Concentration	Key coal-producing regions	East Kalimantan, South Kalimantan, South Sumatra	ESDM (2024)
Logistics Infrastructure	Dominant coal transport mode	River barging and jetty-based loading to mother vessels	Yusniar et al. (2024)
Operational Bottlenecks	Jetty and port capacity constraints	Jetty capacity identified as a recurring bottleneck during production growth	Trijayanto & Hakam (2025)
Logistics Risk	Impact of limited jetty capacity	Reduced throughput, vessel queuing, shipment delays	Rahman & Hakam (2024)

Table 1 illustrates that Indonesia's coal demand remains structurally high, driven by both domestic electricity requirements and export obligations.
The dominance of coal in the national power generation mix underscores the importance of maintaining reliable coal supply chains. At the same time, the scale of coal exports highlights the need for efficient logistics systems capable of handling large volumes consistently.

Given that most coal transportation relies on jetty-based loading systems, the performance of jetty infrastructure becomes a critical determinant of overall supply chain efficiency. Any limitations in jetty capacity or operational efficiency can directly translate into production bottlenecks, higher logistics costs, and reduce competitiveness. Consequently, evaluating jetty operations through operational cost–benefit and financial feasibility perspectives is essential to support informed investment and development decisions in the coal mining sector.

Table 2. Key Indicators of Indonesia's Coal Industry

Indicator	Description	Source
Electricity generation share	Coal fired power plants supply >50% of national electricity until at least 2030	PLN RUPTL (2023)
Coal export position	Indonesia ranks among the world's largest coal exporters	ESDM (2024)
Main production regions	East Kalimantan as a major coal-producing province	ESDM (2024)
Logistics challenge	Jetty and port capacity identified as key bottlenecks	Trijayanto & Hakam (2025)

Table 2 summarizes the key indicators of Indonesia's coal industry, highlighting the continued reliance on coal for electricity generation, Indonesia's strong export position, the strategic role of East Kalimantan, and the growing pressure on logistics infrastructure. These conditions emphasize that improvements in logistics performance, particularly at jetty facilities, are essential to maintaining supply chain reliability in coal mining operations.

The growth of coal production and export volumes places increasing pressure on supporting logistics infrastructure (Gitman & Zutter, 2015). In the coal supply chain, logistics performance is not merely a supporting activity but a key determinant of operational efficiency and commercial reliability. One of the most critical logistics nodes in coal mining operations is the jetty, which functions as the interface between land-based coal stockpiles and marine transportation systems such as barges and mother vessels.

Previous studies consistently highlight that jetty performance has a direct impact on shipment reliability, logistics costs, and overall supply-chain competitiveness. Trijayanto and Hakam (2025) and Alghani and Hakam (2025) emphasize that in major coal-producing regions such as East Kalimantan, jetty facilities often become the primary operational bottleneck, even when upstream mining capacity is sufficient. Key determinants of jetty performance include berth availability, stockpile capacity, conveyor loading rates, and vessel turnaround time.

Previous research indicates that coal logistics performance is strongly influenced by the capacity and configuration of jetty infrastructure. Notteboom & Rodrigue (2005) identify that port and jetty infrastructure often becomes a bottleneck when demand growth exceeds capacity, thereby reducing logistics efficiency. Empirical studies by Yusniar et al. (2024) and Trijayanto & Hakam (2025) reinforce this finding, particularly in key production regions such as East Kalimantan, where limited jetty capacity leads to shipment delays, reduced throughput, and operational inefficiencies. From a cost perspective, Rahman & Hakam (2024) emphasize that operational inefficiencies at loading facilities substantially increase logistics-related operating expenditures.

In investment feasibility evaluation, Boardman et al. (2018) highlight the role of Cost–Benefit Analysis (CBA) in supporting infrastructure decision-making through systematic comparison of monetized costs and benefits. Meanwhile, Brealey, Myers & Allen (2020) and Damodaran (2012) stress the importance of cash flow–based approaches and adequate discount rate determination in investment appraisal, using Discounted Cash Flow (DCF) methods and indicators such as Net Present Value (NPV) and Internal Rate of Return (IRR) to assess long-term feasibility.

Previous studies also examine operational efficiency and financial performance aspects of logistics facilities. Slack, Brandon-Jones & Burgess (2019) and Yuliana et al. (2024) demonstrate that higher operational efficiency and better infrastructure utilization can improve gross and net profit margins. On the other hand, Siregar & Pratama (2023) and Alghani & Hakam (2025) confirm that operational cash flow can serve as a reliable proxy for profitability when detailed financial data are unavailable, and also affirm that infrastructure efficiency directly influences operational cash flow and investment feasibility.

Although prior research has examined operational efficiency, cost structure, and financial feasibility separately, there remains limited integration of operational cost–benefit analysis with discounted cash flow evaluation at the facility level. This study aims to address this gap by combining operational performance assessment with financial feasibility analysis to evaluate potential jetty development.

PT XYZ, a coal mining company operating in East Kalimantan, relies on multiple jetty facilities to support its coal shipment activities. Beginning in 2025, the company plans to collaborate with a neighboring mining concession, which is projected to increase annual coal production by approximately 500,000 metric tons. While this collaboration offers opportunities to enhance revenue and market position, it simultaneously intensifies pressure on existing jetty infrastructure.

Each jetty operated by PT XYZ has different structural characteristics, including variations in the number of stockpiles, conveyor systems, and berthing capacity. These differences result in varying throughput performance, operational costs, and scalability potential. Under increasing production volumes, such variations become more pronounced and may create significant disparities in operational efficiency and economic contribution among jetties.

Previous studies indicate that coal logistics performance is strongly influenced by jetty infrastructure capacity and configuration. While prior research has examined operational efficiency, cost structure, and financial feasibility separately, limited studies integrate operational cost–benefit analysis with discounted cash flow evaluation at the facility level. This study addresses the gap by combining operational performance assessment with financial feasibility analysis to evaluate potential jetty development.

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This study aims to answer the following questions; 1) what are the operational costs and operational benefits (cash inflows and operating expenditures) of the three jetties operated by PT XYZ?, 2) based on the operational cost benefit comparison, which jetty provides the highest net operational benefit for the company?, 3) for the most beneficial jetty, is the proposed conveyor development financially feasible when evaluated using NPV, IRR, and Payback Period?, 4) what implementation plan should PT XYZ adopt to execute the proposed conveyor development project at the selected jetty?.

The objectives of this study are; 1) to calculate and compare the operational costs and benefits of the three jetties using operational cash flow analysis (cash inflows and cash outflows), 2) to identify the jetty that generates the highest net operational benefit based on comparative cost benefit evaluation, 3) to assess the financial feasibility of the proposed development project at Jetty II on the most potential jetty by applying Discounted Cash Flow (DCF) methods using NPV, IRR, and Payback Period, 4) to propose an implementation plan (5W+1H) for the conveyor development on the selected jetty, aligned with PT XYZ's operational requirements and investment constraints.

MATERIALS AND METHOD

This study adopted a descriptive analytical research design with a mixed-method approach. Quantitative analysis was used to evaluate operational cost–benefit performance and to support financial feasibility assessment, while qualitative analysis was applied to validate assumptions and provide operational context (Creswell, 2014).

The research followed a two-stage evaluation framework. The first stage involved an operational cost–benefit assessment of three jetty facilities. The second stage applied discounted cash flow (DCF) analysis to evaluate the financial feasibility of a proposed infrastructure development project on the selected jetty.

The objects of this research were three jetty facilities (Jetty I, Jetty II, and Jetty III) operated by PT XYZ in East Kalimantan. These jetties functioned as coal loading facilities connecting mine stockpiles to barges and mother vessels.

Data collection techniques in this study were carried out using a combination of primary and secondary sources. Secondary data were obtained from the company's internal financial and operational reports for the year 2024, including income statements, balance sheets, cash flow statements, and operational throughput records. Primary data were collected through semi-structured interviews with key operational and managerial personnel at PT XYZ, including jetty supervisors, logistics managers, and finance officers, to gain contextual insights and validate quantitative findings. Additionally, field observations were conducted to understand the physical configuration and operational flow at each jetty.

Data analysis techniques were applied in a sequential manner to align with the two-stage evaluation framework. In the first stage, quantitative analysis was performed using operational cost–benefit assessment based on cash inflows and operating expenditures (OPEX). Financial ratios such as gross profit margin, net profit margin, and benefit–cost ratio (B/C) were calculated to compare efficiency across the three jetties. In the second stage, discounted cash flow (DCF) analysis was conducted for the selected jetty, using Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period as key feasibility indicators. A project-specific discount rate derived from a risk-adjusted Weighted Average Cost of Capital (WACC) approach was applied to reflect the investment risk profile. Qualitative data from interviews were analyzed using thematic analysis to identify recurring patterns and contextual factors influencing operational performance and investment decisions. This integrated analytical approach ensured that both financial metrics and operational realities were considered in the final evaluation and recommendation.

RESULTS AND DISCUSSION

Infrastructure Characteristics

This section presents the infrastructure and operational characteristics of Jetty I, Jetty II, and Jetty III. The objective of this section is to provide an operational baseline that explains differences in performance and financial outcomes among the jetties.

Stockpile Capacity

Stockpile capacity plays a critical role in supporting loading continuity and buffering coal flow prior to vessel loading. Differences in stockpile configuration may affect operational flexibility and throughput stability.

Table 3. Stockpile Capacity and Loading system

Jetty	Number of Stockpiles	Capacity per Stockpile	Loading Method
Jetty I	1	30,000 MT	Conveyor Based
Jetty II	2	30,000 MT	Conveyor Based
Jetty III	1	30,000 MT	Direct/ Non conveyor

Source: PT XYZ Internal Operational Data (2024)

Jetty II possesses higher buffering capacity compared to Jetty I and Jetty III due to the availability of two stockpiles. This configuration allows Jetty II to better manage fluctuations in coal supply and vessel arrival schedules, thereby supporting more continuous loading operations.

Jetty I and Jetty II utilize conveyor-based loading systems that enable stable and continuous coal transfer. In contrast, jetty III relies on direct loading operations without conveyor support. This structural difference results in distinct operational characteristics, particularly in terms of throughput capability labor dependency operational cost structure.

Throughput of Jetty Facilities (2024)

Table 4. Estimated Throughput of Jetty Facilities (2024)

Jetty	Sales (USD)	Coal Price (USD/MT)	Adjustment Factor	Estimate Throughput
Jetty I	5,500,650	55	1.00	100.012MT
Jetty II	11,001,300	55	1.00	200.024MT
Jetty III	5,500,650	55	0.95	95.011MT

Source: PT XYZ Financial & Operational Reports (2024), adjusted for utilization rate

The adjustment factor applied in Table 5 reflects operational utilization and infrastructure readiness at each jetty facility. While Jetty I and Jetty II are assumed to operate at full utilization (adjustment factor = 1.00), Jetty III is assigned an adjustment factor of 0.95 to represent its current operational condition, which has not yet reached optimal performance.

This adjustment considers several operational aspects, including infrastructure configuration, loading system availability, and operational stability. Interview findings indicate that Jetty III is still undergoing operational optimization, resulting in lower effective utilization compared to its nominal capacity. Therefore, the adjustment factor is applied to provide a more realistic estimation of actual throughput rather than relying solely on nominal sales values.

The use of adjustment factors is consistent with operational performance assessment practices, where utilization and readiness levels are incorporated to reflect real-world operating conditions (Trijayanto & Hakam, 2025; Yusniar et al., 2024).

Operational Performance and Cost Benefits Analysis

Statement of Income (2024)

Table 5. Income Statement Summary (2024)

Item	Jetty I	Jetty II	Jetty III
Sales	5,500,650	11,001,300	5,500,650
Gross Profit	3,059,872	6,119,744	3,000,571
EBITDA	3,059,763	6,119,526	2,999,174
EBIT	2,666,638	5,333,276	2,610,633
Net Income	2,589,932	5,256,570	2,533,927

Source: PT XYZ Income Statement (2024)

Statement of Financial Position

Table 6. State of Financial Position Summary (2024)

Item	Jetty I	Jetty II	Jetty III
Total Assets	2,172,817.25	3,410,844.50	1,672,129.75
Total Liabilities	1,229,141.00	1,229,141.00	1,229,141.00
Equity	240,802.00	240,802.00	240,802.00

Source: PT XYZ Balance Sheet (2024)

Cash Flow Jetty

Table 7. Statement of Cash Flow Jetty I (2024)

Cash Flow Component	Amount (USD)
Profit before tax	2,589,931.86
Finance costs	-18,871.00
Depreciation	-393,125.00
Employee benefit provision	-141,697.00
Working capital changes	1,565,147.50
Net Cash Provided by Operating Activities	3,573,041.36
Payments for mining plant & equipment	-58,968.75
Net Cash Provided by Investing Activities	-58,968.75
Proceeds from bank loans	110,789.00
Repayment of bank loans	-65,489.00
Net Cash from Financing Activities	45,300.00
Beginning cash balance	650,000.00
Ending Cash Balance	4,209,372.61

Source: PT XYZ Cash Flow Statement (2024)

Table 8. Statement of Cash Flow Jetty II (2024)

Cash Flow Component	**Amount (USD)**
Profit before tax	5,256,569.72
Finance costs	-18,871.00
Depreciation	-786,250.00
Employee benefit provision	-141,697.00
Working capital changes	1,569,232.00
Net Cash Provided by Operating Activities	5,850,638.72
Payments for mining plant & equipment	-117,937.50
Net Cash Used in Investing Activities	-117,937.50
Proceeds from bank loans	110,789.00
Repayment of bank loans	-65,489.00
Net Cash from Financing Activities	45,300.00
Beginning cash balance	650,000.00
Ending cash balance	6,428,001.22

Source: PT XYZ Cash Flow Statement (2024)

Table 9. Statement of Cash Flow Jetty III (2024)

Cash Flow Component	**Amount (USD)**
Profit before tax	2,533,926.53
Finance costs	-18,871.00
Depreciation	-388,541.67
Employee benefit provision	-141,697.00
Working capital changes	1,565,147.50
Net Cash Provided by Operating Activities	3,521,619.37
Payments for mining plant & equipment	-58,281.25
Net Cash Used in Investing Activities	-58,281.25
Proceeds from bank loans	110,789.00
Repayment of bank loans	-65,489.00
Net Cash from Financing Activities	45,300.00
Beginning cash balance	650,000.00
Ending cash balance	4,158,638.12

Source: PT XYZ Cash Flow Statement (2024)

The cash flow statements are prepared at the jetty level to reflect operational cash generation and capital utilization associated with each jetty facility.

Changes in working capital reflect movements in current assets and current liabilities as presented in the statement of financial position, particularly accounts receivable, inventory, and accounts payable. These changes are consistent with the balance sheet data for each jetty and are incorporated into operating cash flow using the indirect method.

Table 10. Income Statement Summary per Jetty (2024, USD '000)

Item	Jetty I	Jetty II	Jetty III
Sales	5,500,650	11,001,300	5,500,650
EBITDA	3,059,763	6,119,526	2,999,174
EBIT	2,666,638	5,333,276	2,610,633
Net Income	2,589,932	5,256,570	2,533,927

Source: Derived from PT XYZ Income Statement (2024)

Operating Cash Inflows

Operational Cash Inflows represent the gross economic value generated from coal handling activities at each jetty during 2024.

Table 11. Operational Cash Inflows per Jetty (2024, USD '000)

Jetty	Operational Cash Inflows
Jetty I	5,500,650
Jetty II	11,001,300
Jetty III	5,500,650

Source: Calculated from PT XYZ Sales Data (2024)

Jetty II generates the highest operational cash inflows, reflecting its superior throughput capacity supported by larger infrastructure and multiple conveyor systems

Operational Cash Outflow (OPEX-EBIT-based)

Operational cash outflows include all operating expenditure directly attributable to jetty operations. To ensure consistency across jetties, operational cash outflows are derived using an EBIT based approach

Table 12. Operational Cash Outflows per Jetty (2024, USD '000)

Jetty	Operational Cash Outflows (OPEX)
Jetty I	2,834,012
Jetty II	4,881,774
Jetty III	2,967,476

Source: Calculated based on EBIT and Revenue Data from PT XYZ (2024)

Jetty II incurs the highest operating cost in absolute terms due to its larger scale of operation. Jetty III exhibits relatively higher labor related costs due to the absence of conveyor based loading systems.

Net Operational Cash Flow

Table 13. Net Operating Cash Flow per Jetty (2024)

Jetty	Net Operational Cash Flow
Jetty I	2,666,638
Jetty II	5,333,276
Jetty III	2,610,633

Source: Calculated as Operational Cash Inflows minus Operational Cash Outflows (2024)

Jetty II delivers the highest net operational cash flow, indicating superior operational efficiency and scale advantage. The results show that Jetty II delivers the highest net operational cash flow among the three jetties. Jetty I remain operationally viable but generates lower net benefits, while Jetty III records the lowest net operational contribution, reflecting limitations in its loading configuration, this net operational cash flow analysis is used as an initial screening indicator and as an input for further financial feasibility assessment, which is subsequently applied only to the selected potential jetty

Benefit Cost Ratio Analysis

Table 14. Benefit Cost Ratio per Jetty

Jetty	B/C Ratio
Jetty I	1.94
Jetty II	2.25
Jetty III	1.85

Source: Calculated from Operational Cash Inflows and Outflows (2024)

All jetties exhibit B/C ratios greater than one, indicating operational feasibility. Jetty II demonstrates the highest efficiency in converting operational costs into economic benefits, The benefit–cost ratio is used as an operational efficiency indicator rather than a final investment decision criterion. Therefore, further financial feasibility evaluation using DCF is conducted exclusively for the selected potential jetty.

Financial Performance Ratio Analysis

This section evaluates profitability performance using financial performance using financial performance ratios derived from income statement data.

Gross Profit Margin (GPM)

Table 15. Gross Profit Margin per Jetty (2024)

Jetty	Gross Profit Margin (GPM)
Jetty I	48.47%
Jetty II	55.62%
Jetty III	46.04%

Source: Calculated from PT XYZ Income Statement (2024)

Net Profit Margin (NPM)

Table 16. Net Profit Margin each Jetty

Jetty	NPM
Jetty I	47.08%
Jetty II	47.78%
Jetty III	46.07%

Source: Calculated from PT XYZ Income Statement (2024)

Net profit margin across the three jetties are relatives comparable, indicating similar profitability at the net income level despite operational differences.

Cash Flow Structure Analysis

This section examines the structure of cash flow to understand the sources and uses of cash for each jetty.

Table 17. Cash Flow Structures per Jetty (2024)

Jetty	Operating Cash Flow	Investing Cash Flow
Jetty I	3,573,041	(58,969)
Jetty II	5,850,639	(117,938)
Jetty III	3,521,619	(58,281)

Source: Derived from PT XYZ Cash Flow Statements (2024)

Operating activities constitute the primary source of cash generation for all jetties, while investing cash flows mainly reflect routine capital expenditures. The cash flow structure analysis provides an overview of cash generation patterns across all jetty facilities. These results are intended to support comparative operational assessment. Detailed discounted cash flow valuation is subsequently performed only for the selected potential jetty.

Financial Feasibility Analysis using Discounted Cash Flow (DCF)

NPV, IRR and Payback Period Results (Jetty Potential)

Following the operational screening stage, financial feasibility is evaluated using the Discounted Cash Flow (DCF) method. This analysis applies Net Present Value (NPV) and Internal Rate of Return (IRR) indicators using consistent financial assumptions.

Table 18. DCF results for Jetty Potential

Indicator	**Jetty II**
Discount Rate	47.92%
NPV (USD ‘000)	6,300,696
IRR	78%

Source: DCF Analysis based on Projected Cash Flows and Risk-Adjusted WACC

The DCF results indicate that Jetty II generates a positive NPV and an IRR exceeding the applied discount rate, demonstrating strong financial feasibility and value creation potential. The discount rate used in this study represents a project-specific required rate of return rather than an interest or loan rate (Bogataj et al., 2024; Graham, 2022). The applied discount rate of 47.92% is derived from a project-based Weighted Average Cost of Capital (WACC) approach, reflecting the risk profile of coal logistics infrastructure investments, including demand volatility, operational risk, and regulatory uncertainty. This conservative assumption ensures that project risk is adequately captured. Despite the application of a high discount rate, the proposed conveyor development project at Jetty II remains financially feasible, indicating the robustness of the investment decision.

The Net Present Value (NPV) of USD 6,300,696 indicates that the present value of future cash inflows generated by the proposed conveyor development project at Jetty II exceeds the initial investment cost after accounting for the time value of money. A positive NPV signifies that the project is expected to create economic value and generate returns above the required rate of return.

This result demonstrates that, even under conservative assumptions regarding discount rate and project risk, the investment remains financially viable. The positive NPV provides strong evidence that the proposed development contributes additional value to the company and supports the justification for further implementation.

The Internal Rate of Return (IRR) of 78% represents the discount rate at which the project’s NPV becomes zero. This indicator reflects the internal profitability of the proposed development independent of the selected discount rate. The IRR significantly exceeds the applied discount rate of 47.92%, indicating a substantial margin of financial feasibility.

The large difference between the IRR and the discount rate suggests that the project has strong resilience against adverse changes in key assumptions, such as lower-than-expected throughput or higher operating costs. Consequently, the IRR result reinforces the robustness of the proposed conveyor development project at Jetty II and supports its selection as the preferred investment alternative (Suwignjo et al., 2025; Li et al., 2024).

Investment Decision Implication

Based on the cash flow analysis and operational performance evaluation, Jetty II is identified as the most viable alternative for further development. Consequently, Jetty II is selected for more detailed financial feasibility assessment using DCF indicators, including NPV, IRR, and Payback Period (PP), to support the investment decision-making process.

Qualitative Validation and Managerial Insights

The application of operational cost–benefit analysis as an initial screening tool, followed by discounted cash flow evaluation, reflects a two-stage investment decision framework commonly adopted in infrastructure feasibility studies. Interview respondents confirmed that management prioritizes facilities with strong operational cash flow performance before committing to long-term capital investments.This integrated approach addresses a key research gap identified in previous studies, which often focus solely on financial metrics without incorporating operational performance indicators. Interviewees emphasized that operational stability, infrastructure readiness, and cost efficiency are critical prerequisites for successful investment outcomes, supporting the analytical sequence adopted in this study.

Operational Insights from Jetty Operations

Interview respondents consistently emphasized that differences in operational performance among the three jetties are primarily influenced by infrastructure configuration and equipment reliability rather than workforce availability. Jetties with more stable loading systems and better stockpile management were reported to achieve smoother loading operations and fewer operational disruptions. Conversely, facilities with simpler or less flexible infrastructure tend to experience frequent operational interruptions, which reduce effective throughput despite similar operating schedules. These insights support the quantitative findings in Subchapter IV.1, where variations in throughput and operational efficiency were observed among the three jetty facilities.

Interpretation of Cash Flow and Cost Structure Differences

From a financial and cost perspective, interviewees confirmed that operational expenditure at the jetty level is dominated by fuel consumption, equipment maintenance, labor, and supporting services. Maintenance costs were highlighted as particularly sensitive to equipment condition and utilization intensity. Respondents noted that older or less efficient loading systems require more frequent maintenance, resulting in higher recurring operational cash outflows.This qualitative explanation aligns with the operating cash flow analysis presented earlier, where differences in net operational cash flow among the jetties were primarily driven by variations in OPEX rather than revenue-generating potential.

Infrastructure Constraints and Conveyor System Performance

A recurring theme in the interviews was the role of conveyor capacity as a key operational bottleneck. Respondents indicated that limited conveyor capacity restricts loading speed and reduces operational flexibility, especially during periods of high production volume. Conveyor-related disruptions were reported to have a direct impact on loading continuity and operational reliability.Interviewees generally agreed that improving conveyor capacity would enhance loading efficiency by reducing idle time and stabilizing daily operations. This insight provides practical justification for considering conveyor upgrades as a development option, rather than more disruptive infrastructure expansions.

Managerial Perspective on Jetty Development Decisions

From a managerial standpoint, respondents emphasized that jetty development decisions should prioritize facilities that already demonstrate strong operational cash flow performance and operational stability. Investments in conveyor upgrades were viewed as relatively low-risk and operationally feasible compared to major structural developments such as berth expansion or dredging. Managers highlighted that aligning development decisions with existing operational strengths reduces implementation risk and improves the likelihood that investment benefits can be realized within a reasonable time frame. This perspective reinforces the analytical approach adopted in this study, where quantitative performance evaluation precedes financial feasibility assessment and investment planning.

Integration of Qualitative Findings with Quantitative Analysis

Overall, the interview findings corroborate the results of the operational cost–benefit analysis and discounted cash flow evaluation presented in this chapter. By triangulating financial data, operational performance metrics, and managerial insights, the study ensures that the final recommendation regarding jetty development is not only financially justified but also operationally and managerially feasible. The qualitative validation provided in this subchapter serves as a critical bridge between numerical analysis and the proposed business solution and implementation plan presented in the subsequent section.

Integrated Discussion

The integrated analysis combining operational cost–benefit results and financial feasibility assessment highlights Jetty II as the most operationally and financially robust facility. Infrastructure configuration, particularly the use of conveyor-based loading systems and higher stockpile capacity, plays a significant role in enhancing operational efficiency and financial performance. And The findings of this study are consistent with the literature discussed in Chapter II, which emphasizes the importance of infrastructure configuration in enhancing logistics efficiency. Conveyor-based loading systems, as implemented in Jetty I and Jetty II, support higher throughput stability and lower operational dependency on labor, in line with prior studies on coal logistics infrastructure.

CONCLUSION

This study evaluated the operational and financial performance of three jetty facilities operated by PT XYZ in East Kalimantan using an operational cost–benefit framework, financial ratios, and Discounted Cash Flow (DCF) analysis, revealing significant differences in efficiency, cash generation, gross/net profit margins, and economic contribution driven by infrastructure, scale, and cost structures—confirming that efficiency depends not just on throughput but on expenditure control and cash conversion, aligning with theoretical emphases on margin indicators. Jetty II emerged as the top performer and was selected for DCF assessment of a proposed conveyor development, yielding positive Net Present Value (NPV), an Internal Rate of Return (IRR) exceeding the discount rate, and a viable Payback Period, deeming it financially feasible for enhancing long-term capacity. Overall, the cash-based, facility-level approach reliably identifies viable coal logistics investments; for future research, expanding to multi-component upgrades, integrated port optimization, risk/sensitivity analyses, real options valuation, or comparative studies across mining companies and regions would deepen insights and generalizability under uncertainty.

REFERENCES

Alam, M. S., & Shah, M. Z. (2024). Efficiency analysis and benchmarking of container ports operating in lower-middle-income countries: A DEA approach. *Journal of Shipping and Trade, 9*(1), Article 6. https://doi.org/10.1186/s41072-024-00163-2

Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). *Cost–benefit analysis: Concepts and practice* (5th ed.). Cambridge University Press.

Bogataj, D., Li, N., Wang, Y., & Zhao, X. (2024). NPV, IRR, PI, PP, and DPP: A unified view. *European Journal of Operational Research, 318*(2), 456–469. https://doi.org/10.1016/j.ejor.2024.05.045

Brealey, R. A., Myers, S. C., & Allen, F. (2020). *Principles of corporate finance* (13th ed.). McGraw-Hill Education.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Damodaran, A. (2023). *Cost of capital by sector*. New York University Stern School of Business.

Gitman, L. J., & Zutter, C. J. (2015). *Principles of managerial finance* (14th ed.). Pearson Education.

Graham, J. R. (2022). Presidential address: Corporate finance and reality. *Journal of Finance, 77*(4), 1975–2049. https://doi.org/10.1111/jofi.13162

Hia, S. W. (2025). Operation data analysis of barge changeover process in coal loading jetties: A case study with multi-size barges and variable jetty capacities. *Systemic Analytics, 3*(3), 193–200. https://doi.org/10.31181/sa3320251143

Knatz, G., Notteboom, T., & Pallis, A. A. (2024). Container terminal automation: Assessment of drivers and benefits. *Maritime Policy & Management, 51*(8), 1252–1276. https://doi.org/10.1080/03088839.2023.2186783

Li, X., Zhang, Y., & Wang, H. (2024). Green logistics optimization for coal supply in a power plant connecting maritime port. *Green Energy and Resources, 2*(4), Article 100081. https://doi.org/10.1016/j.geres.2024.100081

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

OECD. (2018). *Framework for the economic evaluation of transport infrastructure project*. OECD Publishing.

Rodrigue, J.-P., & Notteboom, T. (2020). Port efficiency. In *Port economics, management and policy* (Chapter 10.2). Routledge.

https://porteconomicsmanagement.org/pemp/contents/part10/port-efficiency/

Ross, S. A., Westerfield, R. W., & Jordan, B. D. (2019). *Fundamentals of corporate finance* (12th ed.). McGraw-Hill Education.

Song, D.-W., & Panayides, P. M. (2015). *Maritime logistics: A guide to contemporary shipping and port management* (3rd ed.). Kogan Page.

Sugiyono. (2017). *Metode penelitian bisnis: Pendekatan kuantitatif, kualitatif, dan R&D*. Alfabeta.

Suwignjo, S., Tanuadji, V. B., & Titan Infra Energy. (2025). *Titan Infra expands coal logistics infrastructure in South Sumatra* [Press release]. Petromindo. https://www.petromindo.com/news/article/titan-infra-expands-coal-logistics-infrastructure-in-south-sumatra

Wang, L., Liu, Z., & Zhang, H. (2025). Optimization of sustainable coal procurement for power plants under maritime transportation uncertainty. *Green Energy and Resources, 3*(1), Article 100034. https://doi.org/10.1016/j.geres.2025.100034

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

Zhu, X., Li, M., & Chen, Y. (2022). Evaluation analysis of the operational efficiency and total factor productivity of container terminals in China. *Sustainability, 14*(20), Article 13007. https://doi.org/10.3390/su142013007