



ET/BT Performance in Nickel Ore Handling Operations at PT. Tiran Indonesia, Southeast Sulawesi

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Abstract. This study aims to analyze the performance of Effective Time and Berthing Time (ET/BT) in the handling process of cargo ore nickel at PT. Tiran Indonesia, Southeast Sulawesi. The main focus of the research is to determine the effectiveness level of loading and unloading activities based on the ET/BT ratio and to identify the factors hindering performance improvement. The research applies both qualitative and quantitative approaches, with data collected through observation, interviews, and documentation. The study involved a total of 50 respondents who were employees of PT Tiran Indonesia. Data analysis is conducted using the Fishbone Diagram method to identify root causes affecting loading and unloading performance. The research results indicate that the ET/BT ratio is 62% in September 2026 and 86% in Oktober 2026. The fishbone analysis results show that there are three main issues at PT Tiran: excessive working hours, rainfall, and limited generator capacity.

Keywords: *ET/BT, Nickle Port, Productivity, Root ratio, Fishbone*

1. INTRODUCTION

One of the persistent issues in Indonesian port management concerns operational performance and service quality [1]. Ports play a strategic role in supporting local economic growth, stimulating regional development, and facilitating interregional commodity distribution. Given their critical function within Indonesia's maritime logistics system, port operations must be supported by efficient and reliable logistics performance, particularly as reflected in their operational indicators [2]. Improving port efficiency and service quality is therefore closely aligned with efforts to strengthen the competitiveness of Indonesia's maritime sector [3]. Higher user satisfaction with port services may also generate positive implications for corporate performance and business sustainability [4]. In this context, dry bulk cargo handling constitutes a crucial component of the global supply chain, as it involves the transfer of commodities such as grain, fertilizer, coal, and other bulk materials from vessels to shore facilities. Conducted mainly at specialized port terminals, dry bulk cargo operations involve multiple stakeholders and contribute significantly to food security, industrial activity, and international trade [5].

Indonesia occupies a prominent position in the global nickel industry, as it holds approximately 52% of the world's nickel reserves [6]. Global demand for nickel continues to increase annually due to its extensive use in ferronickel, stainless steel, and battery production [7]. To achieve optimal production targets, nickel ore loading and shipping activities must be conducted in accordance with company production plans [8]. However, several operational problems remain in ferronickel shipment activities. Insufficient attention to the relationship between vessel fleet capacity and the volume of mining output, particularly ferronickel, may lead to irregular and economically inefficient transportation costs [9]. In this regard, improving vessel service performance represents one of the key indicators of successful port service enhancement, as better port performance can increase user satisfaction [10].

Ship loading and unloading performance has a substantial influence on the overall operational performance of a port. An analysis of loading and unloading activities, particularly for vessels experiencing extended berthing periods, is essential to identify the factors affecting cargo handling operations, evaluate the level of berthing service, and assess the productivity of ship loading and unloading processes [11]. Effective Time to Berthing Time (ET/BT) is a service performance indicator that measures the ratio between the actual productive working time and the total time a vessel spends at berth. When the ET/BT achievement exceeds the minimum standard, the operational service performance is generally considered satisfactory [12].

Several ports in Indonesia have shown declining operational performance. For example, PT Terminal Kaltim Kariangau recorded an ET/BT performance of 70.70% in 2022, representing a slight decrease compared with 72.48% in 2021 [13]. Similarly, the Mirah Terminal at Tanjung Perak Port showed that the Effective Time to Berthing Time ratio in both 2023 and 2024 remained consistently below the required minimum standard [14]. In 2019, Padangbai Port also indicated a decline in operational performance, as reflected by long queues of vehicles waiting to cross [15].

PT Tiran Indonesia is a mining company engaged in the extraction of nickel ore deposits [16]. In its vessel loading and unloading activities, operational constraints frequently occur and may extend the cargo handling process beyond the predetermined schedule. Preliminary interviews indicated that several vessels had to remain at anchorage while waiting for berth availability at the jetty. Based on this condition, the present study aims to evaluate the effectiveness of nickel ore cargo loading and unloading activities at PT Tiran Indonesia, Southeast Sulawesi, using the ET/BT performance indicator. In addition, this study seeks to identify the factors influencing productivity in nickel ore cargo handling operations. The findings are expected to support PT Tiran Indonesia in improving operational efficiency, reducing logistics costs, and enhancing its competitiveness in the global market. Furthermore, this research is expected to contribute meaningfully to the advancement of scientific knowledge and operational practice in the nickel mining industry.

2. METHODOLOGY

Timeliness in ship loading and unloading operations is a critical determinant of service performance in the maritime industry, particularly because delays may disrupt vessel turnaround time, cargo distribution, and overall port efficiency [14]. In this study, data analysis was conducted by compiling empirical data obtained from field

surveys. The survey results were then examined and compared with the operational service performance standards stipulated in the Regulation of the Director General of Sea Transportation No. HK 103/2/18/DJPL-2016 concerning Port Operational Service Performance Standards. The performance of nickel ore cargo handling at PT Tiran Indonesia was assessed by calculating the Effective Time to Berthing Time ratio (ET/BT). This calculation refers to the Regulation of the Director General of Sea Transportation No. HK 103/2/2/DJPL-17 concerning guidelines for measuring port operational service performance.

Berthing Time (BT) refers to the total number of hours a vessel remains at berth, starting from the moment the first line is secured to the quay until the last line is released before departure. In operational terms, Berthing Time can be formulated as follows:

$$BT = BWT + NOT \quad (1)$$

Berth Working Time (BWT) denotes the total amount of working time planned and available for loading and unloading activities while the vessel is alongside the berth. Meanwhile, Not Operation Time (NOT) refers to the planned period during which no cargo handling activities are carried out while the vessel remains berthed. This includes rest periods and preparation time prior to vessel departure. The components of NOT generally include rest breaks; preparation for cargo handling activities, such as opening and closing hatch covers, installing or removing pipes, and positioning conveyors; departure preparation, including the release of mooring lines; and other planned non-working periods, such as religious holidays or non-24-hour work patterns.

Idle Time (IT) is defined as the number of unused working hours during cargo handling operations at berth, excluding official rest periods. Idle Time may occur due to several operational constraints, including adverse weather conditions, truck unavailability, delays in cargo readiness, malfunctioning loading and unloading equipment, occupational accidents, delays in labor availability, and other cargo handling disruptions. Effective Time (ET), on the other hand, refers to the actual number of hours effectively used to perform loading and unloading activities. Effective Time can be calculated using the following formula:

$$ET = BWT - IT \quad (2)$$

The Effective Time to Berthing Time ratio (ET/BT) represents the proportion of productive working time relative to the total time a vessel spends at berth. A higher ET/BT ratio indicates better operational efficiency because it reflects a lower proportion of unproductive time while the vessel is docked, thereby reducing idle periods and improving the effectiveness of port services [14]. The ET/BT ratio is calculated as follows:

$$ET/BT = \frac{BWT - IT}{BWT + NOT} \times 100\% \quad (3)$$

To identify the operational problems that may affect performance improvement at PT Tiran Indonesia, this study employed a fishbone analysis approach. Interviews were conducted with respondents based on six fishbone categories, namely tools, policy,

material, people, environment, and machine. The interview findings were then used as the basis for identifying the root causes of problems in nickel ore cargo handling operations. This analytical approach enables the study to systematically map the factors that hinder loading and unloading productivity and to provide a more structured understanding of performance constraints at the operational level.

3. DISCUSSION

The level of operational effectiveness needs to be assessed to determine the extent to which nickel ore loading and unloading activities at Tiran Jetty are performed efficiently and effectively. The analysis of Effective Time (ET) and Berthing Time (BT) provides a measurable basis for evaluating the efficiency of cargo handling services at the berth. Ports with higher levels of effectiveness are generally more preferred by service users because they offer better time efficiency, lower operational costs, and more reliable cargo handling performance.

TABLE 1. ET/BT SEPTEMBER 2026

Ship Name	Cargo (MT)	Duration (Hours)				ET:BT
		BT	BWT	IT	ET	
TB. Delta Cakra 1	4.157.787	234.58	183.83	1.83	182	78%
TB. Delta Cakra 17	8.504.681	275.83	175.17	1.83	173.34	63%
TB. Marina 2205	8.005.013	171.00	133.58	0.00	103.83	61%
TB. Marina 2435	10.505.343	216.33	204.58	1.83	155.9	72%
TB. Nabila Bay	10.530.509	164.05	134.75	1.83	103.17	63%
TB. Kasih Power 2000-1	8.602.797	310.75	163.83	7.33	119.3	38%
TB. Leo Power 2201	10.502.255	137.58	123.50	1.83	94.42	69%
TB. Marina 2205	7.505.223	197.67	156.25	3.33	117.72	60%
TB. Delta Cakra 1	8.503.186	160.83	153.92	3.33	116.63	73%
TB. Indah Megah 10	7.507.678	162.75	127.17	3.33	95.33	59%
TB. Vier Navigator	11.023.093	189.67	154.92	3.33	116.38	61%
TB. Ananta Sesa 1	14.506.334	277.08	254.67	15.83	181.83	66%
TB. Li Chen-Chen	8.507.689	144.00	96.25	3.33	71.12	49%
TB. Sinar Putra III	5.505.680	201.17	190.33	8.83	137.6	68%
TB. Intan Megah 10	7.508.051	151.58	105.50	12.50	69.95	46%
TB. Pegasus 178	12.601.592	213.17	209.33	22.67	138.57	65%
TB. Leo Power 2201	8.508.167	122.58	118.08	5.50	85.03	69%
TB. Bina Marine 99	7.505.691	143.58	132.17	12.50	89.17	62%
TB. Rimau 1609	8.602.796	237.50	203.83	18.75	138.23	58%
TB. Delta Cakra 3	7.026.846	152.50	134.17	8.17	95.50	63%
TB. Satria Laksana 248	7.513.303	223.67	83.00	18.75	45.40	20%
TB. Delta Cakra 17	3.805.043	213.67	151.33	18.75	98.63	46%
TB. Marina 2205	7.251.011	187.33	133.83	18.75	85.33	46%
TB. Marina 2435	10.501.507	147.75	132.00	13.25	89.00	60%
BG. Marina 2205	8.505.428	95.92	86.58	5.92	61.07	64%

TB. Bumi 2403	10.507.753	195.17	169.33	13.25	117.93	60%
TB. Theodore III	5.201.572	362.92	355.08	24.42	249.87	69%
TB. patria 37	9.855.295	142.33	122.50	9.00	86.25	61%
TB. Delta Cakra 5	7.005.803	177.00	151.00	9.00	108.05	61%
TB. Bumi 2203	10.506.633	112.42	97.17	9.00	66.37	59%
TB. Intan Megah 10	7.579.774	139.25	108.25	9.00	74.20	53%
TB. Bumi 2204	10.504.895	188.17	168.00	14.50	115.35	61%
TB. Kelly 01	9.651.501	93.67	87.50	3.08	64.32	69%
TB. Maju Daya 29	8.037.511	132.92	135.42	11.25	93.67	70%
TB. Rimau 1602	8.500.697	118.50	116.00	8.17	81.53	69%
TB. Satria Laksana 248	7.504.391	97.17	86.33	8.17	59.32	61%
TB. Sinar Putra III	5.508.419	79.42	79.50	8.17	53.73	68%
TB. Marina 2435	8.511.280	86.33	78.08	8.17	52.32	61%
TB. Nabila Bay	10.500.110	79.50	79.33	8.17	53.57	67%
TB. Intan Megah 10	7.051.815	172.25	102.67	8.17	71.45	41%
TB. BUCP II	5.814.595	172.25	162.17	8.17	116.80	68%
TB. Intan Megah 10	7.502.149	241.75	196.50	8.17	143.48	59%
TB. Delta Cakra 5	3.803.101	200.00	169.75	0.00	131.60	66%
TB. Delta Cakra 3	7.005.056	99.58	94.00	0.00	71.90	72%
TB. Intan Megah 10	7.502.149	116.83	77.50	0.00	59.90	51%
TB. Pegasus 178	12.603.298	144.50	127.00	0.00	98.50	68%
TB. Slu Merlin T7	10.502.056	110.75	101.92	0.00	78.87	71%
TB. Satria Laksana 248	7.565.958	175.05	140.83	0.00	109.08	62%
TB. Rimau 1625	8.605.287	94.17	92.08	0.00	71.23	76%
TB. Leo Power 2201	10.501.607	142.42	118.75	0.00	91.20	64%
TB. Intan Megah 10	7.804.322	136.58	92.75	0.00	71.90	53%
TB. Beaver 2	8.572.790	102.92	81.25	0.00	62.40	61%
TB. Marina 2435	10.501.002	130.25	121.17	0.00	93.92	72%
TB. Sinar Putra III	5.503.812	56.42	50.17	0.00	39.27	70%
TB. PM 242	10.517.443	146.75	144.92	0.00	112.22	76%
TB. Delta Cakra 5	7.000.822	166.25	130.17	0.00	101.67	61%
TB. Trisakti Langgeng	5.504.659	54.00	46.58	0.00	36.63	68%
TB. Niko Maru	7.505.775	71.58	69.17	0.00	52.52	73%
TB. Intan Megah 10	7.502.149	101.50	90.50	0.00	70.40	69%
TB. Rimau 1607	8.605.217	121.00	109.25	0.00	84.95	70%
TB. Intan Megah 13	7.508.959	86.17	75.67	0.00	59.32	69%
Average						62%

Source: Researcher's data processing results (2025)

Table 1 shows that the average ET/BT ratio was 62%, based on a total of 61 vessels berthing during September. Among these vessels, TB. Delta Cakra 1 recorded the highest ET/BT ratio at 78%. TB Satria Laksana 248 demonstrated the lowest ET/BT ratio, with only 20% effective time. The average ET/BT ratio recorded in September

indicates that port performance had not yet reached an optimal level, suggesting that operational activities during the month were not carried out at standard performance.⁸⁶

TABLE 2. ET/BT OKTOBER 2026

Ship Name	Cargo (MT)	Duration (Hours)				ET:BT
		BT	BWT	IT	ET	
TB. Satria Laksana 248	7.531.152	175.83	132.00	16.00	116	66%
TB. Intan Megah 10	7.508.496	251.75	102.08	12.67	89.41	36%
TB. Bumi 2403	10.505.663	170.75	168.33	18.67	149.41	88%
TB. Bumi 2204	8.518.999	157.25	134.50	18.00	116.5	74%
TB. Delta Cakra 3	6.804.218	234.33	218.83	31.17	187.66	80%
TB. Sinar Putra III	5.504.435	101.00	97.83	6.00	91.83	91%
TB. Kelly 01	9.655.099	168.50	164.75	18.67	146.08	87%
TB. Rimau 1625	8.605.287	185.50	173.42	27.42	146	79%
TB. Theodore III	5.203.863	112.33	105.00	18.67	86.33	77%
TB. Marina 2435	10.529.140	230.08	242.00	37.17	204.83	89%
TB. Intan Megah 13	8.603.295	175.75	132.83	14.75	118.08	67%
TB. Pegasus 178	11.704.844	236.25	228.92	31.17	197.75	84%
TB. Delta Cakra 3	3.800.212	180.50	169.50	16.17	153.33	85%
TB. Trisakti Langgeng	5.500.371	217.00	207.75	31.25	176.67	81%
TB. Patria 37	9.859.841	218.33	215.83	26.25	189.58	87%
TB. Marina 2205	7.524.857	151.08	141.17	13.50	127.67	85%
TB. Beaver 2	8.502.565	261.67	255.08	29.62	225.46	86%
TB. Slu Merlin T7	10.508.132	150.42	165.50	28.58	136.92	91%
TB. Rimau 1609	8.613.131	260.83	235.17	27.53	207.64	80%
TB. Intan Megah 10	7.553.440	165.17	141.00	20.87	120.13	73%
TB. Leo Power 2201	10.507.753	207.75	200.75	27.53	173.22	83%
TB. Max 03	9.508.212	259.83	240.67	20.87	219.8	85%
TB. Delta Cakra 5	6.800.607	224.00	204.67	11.12	193.55	86%
TB. Rimau 1607	8.605.217	346.25	280.08	11.12	268.96	78%
TB. Marina 2205	7.005.156	237.92	186.75	11.12	175.63	74%
TB. Marina 2435	10.517.379	145.50	144.58	11.12	133.46	92%
TB. Sinar Putra III	5.503.812	237.08	197.42	1.03	196.39	83%
TB. Theodore III	5.213.375	141.83	140.00	1.03	138.97	98%
TB. Bumi 2403	10.504.895	179.08	150.67	1.03	149.64	84%
TB. Samudera Perkasa 11	7.500.614	136.42	120.00	0.00	120	88%
TB. Marina 2205	7.805.350	158.92	136.58	0.00	136.58	86%
TB. Maitreya 6	9.008.956	267.08	242.75	0.00	242.75	91%
TB. Intan Megah 13	8.507.296	235.08	175.42	0.00	175.42	75%
TB. Intan Megah 10	7.816.349	141.17	120.33	0.00	120.33	85%
TB. Nabila Bay	10.506.511	121.42	116.50	0.00	116.5	96%
TB. Bumi 2204	8.503.186	218.00	216.00	0.00	216	99%
TB. Delta Cakra 5	8.505.677	141.00	136.58	0.00	136.58	97%

TB. Intan Megah 13	7.570.261	323.08	204.58	0.00	204.58	63%
TB. Maitreya 6	8.509.225	105.92	100.33	0.00	100.33	95%
TB. Nasya 01	9.852.927	115.67	105.92	0.00	105.92	92%
TB. Bina Marine 99	7.058.241	151.92	105.25	0.00	105.25	69%
TB. Intan Megah 13	7.502.543	90.50	85.75	0.00	85.75	95%
TB. Marina 2435	10.505.923	267.25	265.42	0.00	265.42	99%
BG. Delta Cakra 3	6.809.074	145.17	132.17	0.00	132.17	91%
TB. Pegasus 178	12.616.273	118.67	114.08	0.00	114.08	96%
TB. Satria Laksana 248	7.006.355	77.42	76.58	0.00	76.58	99%
TB. Theodore III	5.205.954	133.83	116.33	0.00	116.33	87%
TB. Putra Rupert 26	8.205.418	182.75	181.00	0.00	181	99%
TB. Intan Megah 13	7.810.009	96.67	92.08	0.00	92.08	95%
TB. Niko Maru	7.504.627	196.50	192.58	0.00	192.58	98%
TB. Rimau 1621	8.607.279	170.00	160.92	0.00	160.92	95%
TB. Leo Power 2201	10.529.075	87.58	73.00	0.00	73	83%
TB. Bumi 2204	10.545.535	71.17	66.58	0.00	66.58	94%
TB. Beaver 2	8.502.066	189.67	177.50	0.00	177.5	94%
TB. MP 09	10.563.030	122.08	117.58	0.00	117.58	96%
TB. Sinar Putra III	5.509.789	107.50	77.08	0.00	77.08	72%
TB. Delta Cakra 5	6.806.335	101.50	97.33	0.00	97.33	96%
TB. Intan Megah 13	8.513.770	49.58	47.50	0.00	47.5	96%
TB. BUCP II	5.809.117	62.92	46.08	0.00	46.08	73%
TB. Rimau 1607	8.603.610	125.42	120.42	0.00	120.42	96%
TB. Delta Cakra 5	8.515.513	158.08	148.58	0.00	148.58	94%
TB. Lintas Samudera 126	10.508.581	71.08	60.67	0.00	60.67	85%
TB. Marina 2205	7.508.671	91.33	85.08	0.00	85.08	93%
TB. DMP 01	10.509.633	58.33	46.75	0.00	46.75	80%
TB. Theodore III	5.205.257	71.67	68.75	0.00	68.75	96%
TB. Makindo 02	10.504.795	65.67	58.92	0.00	58.92	90%
TB. Delta Cakra 5	3.805.964	72.42	70.75	0.00	70.75	98%
TB. Satria Laksana 248	7.813.239	112.58	69.25	0.00	69.25	62%
Average						86%

Source: Researcher's data processing results (2025)

The results presented in Table 2 indicate the average ET/BT ratio recorded in October, which reached 86% across 68 berthed vessels. Among these vessels, TB. Bumi 2204 achieved the highest ET/BT value, with an effective operating time of 99%. Conversely, the lowest ET/BT performance was recorded by TB. Intan Megah 10, with an effective operating time of only 36%. Several vessels still exhibited ET/BT performance levels well below the minimum benchmark of 80%. Nevertheless, the overall average ET/BT ratio at the port in October exceeded the minimum performance threshold, reaching 86%. This result indicates that, at the aggregate level, port operational performance in October was satisfactory and had achieved the established

efficiency standard, although performance disparities remained among individual vessels.

The factors constraining loading productivity at PT Tiran Indonesia were further examined using the fishbone analysis method. The fishbone analysis was conducted based on data collected from 50 respondents, all of whom were employees of PT Tiran Indonesia. The respondents' perspectives were used to identify and categorize the potential root causes associated with the operational problems examined in this study. The results of the interviews are presented in Table 3.

TABLE 3. CONSTRAINTS AFFECTING PT TIRAN'S EFFORTS TO ENHANCE LOADING AND UNLOADING PERFORMANCE

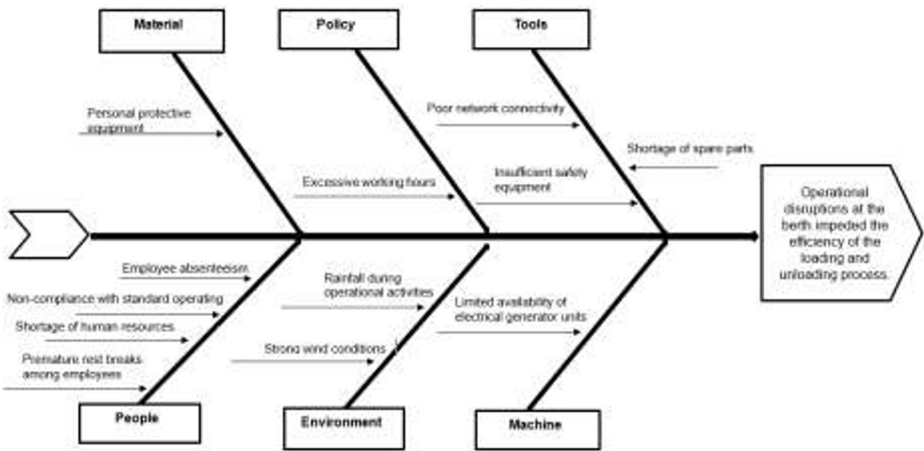
No.	Category	Constraints Identified from the Interviews	Number of Respondents
1	Tools	- Poor network connectivity - Shortage of spare parts - Insufficient safety equipment	15 20 15
2	Policy	- Excessive working hours	50
3	Material	- Personal protective equipment deteriorates quickly	25
4	People	- Employee absenteeism - Non-compliance with standard operating procedures - Shortage of human resources - Premature rest breaks among employees	13 7 17 13
5	Environment	- Rainfall during operational activities - Strong wind conditions	40 10
6	Machine	- Limited availability of electrical generator units	50

Source: Researcher's data processing results (2025).

Based on the number of respondents, three major operational issues were identified at PT Tiran Indonesia: excessive working hours, rainfall-related disruptions, and limited electricity generator capacity. Excessive working hours mainly occurred due to the insufficient number of human resources within the company, which increased the workload of employees and extended their working duration beyond normal operational limits.

Rainfall was also identified as a significant external constraint affecting mining and loading activities. When rain occurs, mining operations are temporarily suspended because wet and slippery road conditions may increase the risk of occupational accidents. In addition, rainfall may cause nickel ore to become excessively wet, thereby affecting material handling efficiency and potentially disrupting vessel stability during the loading process.

Another critical problem concerns the limited availability and reliability of electricity generators. When the generator malfunctions, the power supply is interrupted and internet connectivity is lost. This condition may hinder employee performance, particularly among administrative staff. The administrative unit is responsible for preparing hourly ritase reports to be submitted to the head office, as well as compiling operational reports from the time the vessel arrives and anchors in the waters near the jetty until the loading process is completed and the vessel departs for the unloading destination. Therefore, disruptions in electricity and internet access may delay reporting activities, weaken operational coordination, and reduce the overall effectiveness of nickel ore cargo handling at PT Tiran Indonesia.



Source: Researcher’s data processing results (2025).

Figure 1. Operational disruption observed during nickel ore handling activities at PT Tiran Indonesia.

After the most dominant causal constraints contributing to the problem had been identified, the subsequent stage involved formulating corrective action plans to address the existing performance issues. These proposed countermeasures were designed to resolve the factors affecting the ET/BT performance in nickel ore cargo handling operations at PT Tiran Indonesia. The detailed action plan for improving ET/BT performance in nickel ore cargo handling is presented in Table 4.

TABLE 4. STRATEGIC ACTION PLAN FOR ADDRESSING OPERATIONAL CONSTRAINTS AT PT TIRAN INDONESIA

Observed Factor	Identified Problems	Proposed Mitigation Strategies
Tools	- Poor network connectivity - Shortage of spare parts - Insufficient safety equipment	- Network infrastructure should be strengthened by increasing the number of Wi-Fi access points to ensure more stable internet connectivity. - Spare parts procurement should be conducted proactively before stock

		depletion occurs. - The company should procure adequate safety equipment and implement a monitoring standard to ensure that all safety devices are available in sufficient quantity and maintained in proper working condition.
Policy	- Excessive working hours	Workload and task allocation should be managed more effectively by improving time management practices and ensuring adequate staffing. This strategy is expected to reduce excessive working hours and minimize the risk of fatigue among employees.
<i>Material</i>	- Personal protective equipment deteriorates quickly	A routine maintenance procedure for personal protective equipment should be developed and implemented. This procedure should include periodic inspection, cleaning, repair, and replacement to ensure that all protective equipment remains functional and safe for use.
<i>People</i>	- Employee absenteeism - Non-compliance with standard operating procedures - Shortage of human resources - Premature rest breaks among employees	Workload distribution should be adjusted according to employee capacity to maintain workers' health and performance. Warning signs should be installed at road points with a high accident risk. The company should also initiate recruitment for applicants who meet the required competency standards. Furthermore, work supervision should be strengthened to ensure that rest periods and employee activities remain consistent with operational procedures.
<i>Environment</i>	- Rainfall during operational activities - Strong wind conditions	Weather-related operational disruptions should be anticipated by referring to weather forecasts issued by the Indonesian Meteorology, Climatology, and Geophysics Agency. This approach enables the company to predict potential weather constraints and prepare preventive operational measures in advance.
<i>Machine</i>	- Limited availability of electrical generator units	The number of generator units should be increased to prevent excessive use of existing generators and to ensure more

		reliable electricity supply during loading and unloading operations.
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Source: Researcher’s data processing results (2025).

4. CONCLUSION

The ET/BT analysis demonstrates a substantial improvement in the operational performance of Tiran Jetty between September and October. In September, the average ET/BT ratio was only 62%, indicating that berth utilization and cargo-handling activities had not yet achieved the expected level of operational efficiency. In contrast, the average ET/BT ratio increased to 86% in October, exceeding the minimum performance benchmark of 80%. This improvement indicates that a greater proportion of vessel berthing time was effectively utilized for cargo-handling operations, reflecting enhanced operational efficiency at the jetty. However, considerable variations in ET/BT performance were still observed among individual vessels, with several vessels remaining below the established benchmark. Therefore, although the overall operational performance improved significantly in October, further efforts are required to minimize ineffective time, improve the consistency of cargo-handling operations, and ensure that the established performance standard is achieved across all vessel calls.

Jetty Tiran Indonesia still faces several operational constraints that reduce the effectiveness of nickel ore loading activities. These constraints include poor network connectivity, which delays the submission of ritase data and online reports; insufficient spare parts, which slows the repair of dump trucks and excavators; and inadequate safety equipment, which increases occupational health and safety risks. From the policy perspective, the 12-hour shift system may contribute to worker fatigue despite the availability of overtime compensation. Material-related issues are reflected in personal protective equipment that is easily damaged or no longer suitable for use. Human resource constraints also affect performance, including employee absenteeism due to fatigue, non-compliance with standard operating procedures, limited manpower, and premature rest breaks during working hours. Environmental factors such as rainfall and strong winds further disrupt loading operations by increasing the risk of road accidents and limiting dump truck access to vessels. In addition, the limited availability of electrical generators creates a critical vulnerability because generator failure may stop electricity supply, reduce night-time visibility, and interrupt nickel ore loading activities. Overall, these factors indicate that improvements in infrastructure, workforce management, safety compliance, weather-risk anticipation, equipment readiness, and power supply reliability are required to enhance loading productivity at Jetty Tiran Indonesia.

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