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Assessment of Conveyor Machine Maintenance Performance in the Filling Area Using MTTR, MTBF, and Availability Analysis

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Abstract

Efficient machinery maintenance is paramount to ensuring continuous production flows and minimizing unexpected asset disruptions in automated manufacturing environments. This study evaluates the operational reliability and maintenance performance of a critical belt-type conveyor machine within the Lithos filling line at PT. Pertamina Lubricants. Utilizing historical breakdown data extracted from the facility's Computerized Maintenance Management System (CMMS), empirical time-centric metrics were calculated across a representative 18-day continuous production period. Within this temporal window, a total of 60 unscheduled mechanical and electrical failure sequences were documented and analysed. Quantitative processing reveals that the conveyor system exhibited an empirical Mean Time to Repair (MTTR) of 26.28 minutes and a Mean Time Between Failures (MTBF) of 225.72 minutes. These structural parameters yield a cumulative operational availability rate of 89.57%. Although the availability index indicates a reasonable baseline of functional readiness, the high breakdown frequency highlights critical system vulnerabilities that cause downstream bottlenecks and degrade overall plant efficiency. To optimize asset lifecycle performance and mitigate micro-stoppages, implementing a structured Cleaning, Lubrication, and Inspection (CLI) schedule within an autonomous maintenance framework is highly recommended. Empowering shop-floor operators to execute initial inspections will systematically enhance conveyor availability and production throughput.

Keywords: asset readiness; breakdown frequency; bottleneck prevention; CMMS; operational reliability.

1. Introduction

In the contemporary industrial manufacturing landscape, strategic machine maintenance plays a vital role in ensuring production continuity, minimizing unscheduled asset downtime, and optimizing lifecycle operational costs [1]. Broadly conceptualized, the overarching objective of an industrial maintenance framework extends beyond the reactive remediation of failed components. It serves as an integrated operational strategy designed to preserve asset readiness, prolong the economic utility of machinery, and guarantee strict compliance with occupational safety standards within the shop floor environment [2]. Within standard industrial engineering practices, maintenance paradigms are universally classified into two primary vectors: planned maintenance which encompasses proactive, preventive and predictive routines. Another vector is unplanned maintenance, which governs emergency interventions during sudden, catastrophic equipment breakdowns, formally designated as corrective or breakdown maintenance [3]. On average, the company carries out machine maintenance after every 720 operating hours [4].

Within the specialized domain of the lubricant manufacturing industry, maintaining high equipment reliability performance indicators introduces severe operational constraints. This sensitivity is primarily attributed to the production environment, which relies heavily on highly continuous, automated, and tightly synchronized packaging lines [5]. In this specific operational context, the belt-type conveyor architecture functions as a critical mechanical backbone system. It structurally links sequential manufacturing stages from the automated fluid filling stations to downstream labelling and final secondary packaging units. Consequently, any unpredicted functional

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failure or transient downtime event localized on these conveyor systems immediately triggers a compounding domino effect across the integrated line. These disruptions manifest as severe material distribution bottlenecks at the front end and forced idling of downstream packaging equipment. It ultimately leads to significant degradation of overall plant throughput and a substantial reduction in systemic productivity [6].

To systematically evaluate and regulate asset performance at optimal thresholds, modern maintenance engineering frameworks depend fundamentally on empirical quantitative metrics. Three globally standardized indicators utilized to benchmark asset capability are mean time between failures (MTBF), Mean Time to Repair (MTTR), and operational availability. MTBF quantifies the mathematical mean of the operational duration an asset runs reliably before encountering a subsequent failure sequence, thereby functioning as the primary benchmark for equipment reliability [7]. Conversely, MTTR denotes the average time required by the technical crew to execute diagnostics, troubleshooting, and physical component restoration post failure, effectively reflecting the maintenance team's responsiveness and technical efficiency [4]. Mathematically compounding these two metrics yields the availability index, which isolates the net percentage of time an asset remains in a fully capable state to execute its designated manufacturing functions relative to the scheduled production time [8].

The industrial application of MTTR, MTBF, and availability metrics has demonstrated extensive empirical validity across diverse manufacturing sectors, spanning high precision automotive assembly lines, heavy cement processing facilities, and continuous food and beverage packaging plants. Although alternative comprehensive frameworks exist within the literature such as Reliability Centered Maintenance (RCM) or Total Productive Maintenance (TPM) [9] the MTTR and MTBF methodology is specifically isolated for this investigation due to distinct pragmatic advantages. First, both metrics maintain a strict, time centric focus on operational efficiency, yielding transparent data structures that are readily actionable for both floor-level technicians and executive management [10]. Second, this diagnostic approach exhibits high fidelity in manufacturing environments possessing rigorous breakdown logs but constrained baseline historical data. Its primary utility lies in providing an immediate, empirical overview of asset readiness without requiring overly convoluted, high dimensional statistical baselines, thereby significantly accelerating critical maintenance decision making cycles.

However, despite the ubiquitous deployment of MTTR and MTBF metrics across general manufacturing paradigms, rigorous empirical research addressing the specific implementation of these reliability parameters on belt-type conveyor machinery within the lubricant filling sector remains notably scarce. This critical literature gap requires empirical addressing because the automated lubricant filling process possesses distinct operational friction variables including high velocity fluid handling, continuous chemical mist exposure, and unique belt grip dynamics which fundamentally alter component wear and tear degradation mechanics compared to dry bulk material handling industries [8]. To resolve this omission, this study develops a systematic performance evaluation of the belt-type conveyor systems operating within the Lithos filling area at PT. Pertamina Lubricants utilizing localized MTTR, MTBF, and availability metrics. The empirical outputs derived from this analysis are intended to provide a transparent, mathematically rigorous diagnostic of current maintenance efficiency while serving as a baseline reference for the strategic optimization of future predictive maintenance frameworks.

2. Experimental Method

The object of this research is the belt-type conveyor machine operated in the Lithos filling area at PT. Pertamina Lubricants. This machine functions as a critical backbone component in supporting the continuous oil-filling process; therefore, maintaining its high availability level is highly important to avoid production bottlenecks. The research data were gathered from historical machine breakdown records documented in the factory's computerized maintenance management system (CMMS) as presented in Table 1 [11] .

The observation period covers 18 working days, which is highly representative of the plant's peak operational cycle [12]. During this timeframe, the factory operated continuously under a full three-shift configuration (24 hours per day), capturing the maximum workload fluctuations and mechanical stress experienced by the conveyor system [13]. A total of 60 failure events were recorded during this period. To ensure logical consistency in the repair time analysis, these 60 failures were categorized based on their severity and technical nature, as the average repair time naturally varies depending on whether the fault is minor or complex [14]. The breakdown

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data consists of light mechanical issues (e.g., belt misalignments or structural jams) [15], moderate electrical faults (e.g., sensor calibration errors or faulty wiring) [16], and severe component failures (e.g., drive motor overheating or gearbox wear) [17].

The scheduled time for production, derived by subtracting any officially planned nonproductive periods (such as scheduled operator breaks, shift handovers, or routine preventive maintenance) from the gross shift duration [2].

$$\text{Total Planned Time}=\text{Total Shift Time}\ \ \text{Planned Downtime} \quad (1)$$

The accumulated duration of time during which a machine is completely non-operational due to unscheduled breakdowns or unexpected failures [1].

$$\text{Total Downtime}=\sum(\text{Time Breakdown Ended}\ \ \text{Time Breakdown Started}) \quad (2)$$

The actual net time of the machinery is running and actively producing goods [18]. It is determined by subtracting the total unscheduled downtime from the total planned production time.

$$\text{Total Operating Time}=\text{Total Planned Production Time}\ \ \text{Total Downtime} \quad (3)$$

The quantitative analysis was conducted by calculating three primary performance parameters: MTTR, MTBF, and availability. To maintain document structural clarity, all formulas used in this study are numbered sequentially. MTTR, which measures the average time required by the maintenance crew to troubleshoot and repair a machine after a failure occurs [6], is calculated using the following formula.

$$\text{MTTR} = \text{Total Downtime}/\text{Total Number of Failures} \quad (4)$$

MTBF represents the average operating time of the equipment between consecutive breakdowns, serving as a key baseline for machine reliability [8]. It is calculated using the following formula.

$$\text{MTTR} = \text{Total Operating Time}/\text{Total Number of Failures} \quad (5)$$

Lastly, the operational availability percentage, which represents the machine's capability to support continuous production and readiness [9], is obtained using the following equation.

$$\text{Availability} = (\text{MTBF}/\text{MTBF}+\text{MTTR})\times 100\% \quad (6)$$

To guarantee mathematical precision, prevent calculation errors, and provide basic descriptive statistics for the time accumulations, all collected data and equations were computationally processed using Microsoft Excel and SPSS software [18]. These software integrations assist in managing data density and eliminating human errors during multivariable calculations [19]. These steps aim to quantitatively evaluate the performance of the conveyor machine, where MTTR indicates the average time needed for repairs. Meanwhile, MTBF describes the average time between failures, and availability represents the machine's capability to support continuous production.

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Table 1. Data recapitulation for the period July 2024, 1 – 24

No	Machine name	Problem description	Asset description	Data is input	Start date	Completion date
1	Filling Machine	Nozzle filler machine number 9 is not filling stably	FL2	03/07/2024 13:22	03/07/2024 08:20	03/07/2024 09:00
2	Filling Machine	The filler machine has a leaking air hose	FL6	03/07/2024 13:25	03/07/2024 10:00	03/07/2024 10:10
3	Filling Machine	Filler Holder machine number 10 does not fit	FL3	03/07/2024 13:59	03/07/2024 14:00	03/07/2024 14:20
4	Palletizer	Palletezer Error	FL2	03/07/2024 15:04	03/07/2024 14:54	03/07/2024 15:30
5	Carton Erector	Cardboard pusher bearing is damaged/broken	FL6	03/07/2024 20:27	03/07/2024 20:20	03/07/2024 21:00
6	Bottle Labeling	The bottle labeling machine is not shooting stably	FL4	03/07/2024 20:28	03/07/2024 17:10	03/07/2024 17:20
7	Bottle Labeling	Bottle label machine error	FL5	03/07/2024 20:31	03/07/2024 19:20	03/07/2024 19:30
8	Filling Machine	There is a leak in the air hose of the filler machine	FL5	03/07/2024 20:32	03/07/2024 19:10	03/07/2024 19:20
9	Filling Machine	Lasan pagar timbangan botol patah	FL3	03/07/2024 21:39	03/07/2024 21:15	03/07/2024 21:30
10	Filling Machine	Nozzle 10 filling is often slow	FL2	04/07/2024 20:24	04/07/2024 08:30	04/07/2024 09:00
11	Filling Machine	Bottles hit the bottle weigher	FL3	04/07/2024 20:26	04/07/2024 07:30	04/07/2024 08:15
12	Pick and Place	Robotic error	FL6	04/07/2024 20:27	04/07/2024 19:17	04/07/2024 19:40
13	Carton Labeling	The box label machine often fails to fire.	FL4	04/07/2024 20:28	04/07/2024 19:07	04/07/2024 19:20
14	Bottle Labeling	The rear label sensor is faulty and will not fire.	FL3	05/07/2024 22:09	05/07/2024 19:33	05/07/2024 20:00
15	Carton Labeling	The box label machine does not fire consistently.	FL4	05/07/2024 22:11	05/07/2024 19:04	05/07/2024 19:20
16	Unscrambler	The unscrambler is slow to start after stopping.	FL2	05/07/2024 22:18	05/07/2024 22:19	05/07/2024 22:40
17	Filling Machine	The filler machine frequently has a short screw drive fault.	FL4	05/07/2024 22:19	05/07/2024 22:20	05/07/2024 22:40
18	Carton Sealer	The thread on the glue nozzle on the carton sealer machine is loose.	FL2	08/07/2024 16:03	08/07/2024 16:00	08/07/2024 16:45
19	Palletizer	The long fan belt on the palletizer machine is not properly positioned, causing the boxes to be stacked in a mess.	FL4	08/07/2024 17:26	08/07/2024 17:00	08/07/2024 18:00
20	Carton Sealer	The glue nozzle on the carton sealer is clogged.	FL3	08/07/2024 19:27	08/07/2024 19:19	08/07/2024 19:30
21	Filling Machine	The filler machine is a nozzle hose leaking.	FL6	09/07/2024 10:30	09/07/2024 10:20	09/07/2024 10:30
22	Carton Erector	Carton erector glue is not firing.	FL1	09/07/2024 10:37	09/07/2024 09:30	09/07/2024 10:00
23	Carton Erector	Carton erector will not start.	FL4	09/07/2024 10:38	09/07/2024 07:45	09/07/2024 08:00

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Table 1. Data recapitulation for the period July 2024, 1 – 24 (cont.)

No	Machine name	Problem description	Asset description	Data is input	Start date	Completion date
24	Bottle Divider	Divider track error.	FL3	09/07/2024 10:42	09/07/2024 08:00	09/07/2024 08:20
25	Palletizer	Palletizer scratch spring is loose.	FL4	09/07/2024 14:25	09/07/2024 14:30	09/07/2024 16:00
26	Carton Erector	Noisy noise occurs when the bottom vacuum of the carton erector moves backward.	FL6	09/07/2024 14:26	09/07/2024 14:03	09/07/2024 14:10
27	Pick and Place	Robot machine suddenly shuts down and will not start.	FL2	09/07/2024 14:27	09/07/2024 13:43	09/07/2024 14:00
28	Bottle Labeling	Label machine error.	FL5	09/07/2024 14:28	09/07/2024 11:26	09/07/2024 11:40
29	Palletizer	Palletizer spring is loose.	FL4	09/07/2024 16:17	09/07/2024 15:30	09/07/2024 16:15
30	Palletizer	Palletizer machine error.	FL5	09/07/2024 21:39	09/07/2024 20:40	09/07/2024 21:00
31	Carton Sealer	Conveyor is making a harsh noise.	FL6	12/07/2024 16:08	12/07/2024 15:45	12/07/2024 16:00
32	Palletizer	Error, product will not come out.	FL5	12/07/2024 16:38	12/07/2024 16:40	12/07/2024 17:20
33	Palletizer	Error again, the product will not come out.	FL5	12/07/2024 20:58	12/07/2024 20:30	12/07/2024 23:00
34	Filling Machine	Filler machine error.	FL5	15/07/2024 12:23	15/07/2024 07:25	15/07/2024 08:10
35	Carton Labeling	Batch box shadowed.	FL2	15/07/2024 12:26	15/07/2024 08:30	15/07/2024 08:55
36	Bottle Labeling	Error, constant alarm.	FL2	15/07/2024 12:28	15/07/2024 09:45	15/07/2024 10:10
37	Carton Erector	The vacuum will not suck.	FL5	15/07/2024 12:29	15/07/2024 10:50	15/07/2024 11:10
38	Bottle Labeling	Error again, constant alarm.	FL2	15/07/2024 13:46	15/07/2024 13:20	15/07/2024 13:35
39	Bottle Labeling	Labeling machine alarm keeps sounding.	FL2	15/07/2024 19:07	15/07/2024 13:35	15/07/2024 16:00
40	Bottle Labeling	Labeling machine alarm keeps sounding.	FL2	15/07/2024 19:08	15/07/2024 17:35	15/07/2024 18:00
41	Filling Machine	Filler machine AC and fan are dead.	FL1	15/07/2024 19:10	15/07/2024 19:05	15/07/2024 19:10
42	Bottle Labeling	Labeling machine bolts are dead, causing continuous shooting.	FL4	15/07/2024 19:11	15/07/2024 19:06	15/07/2024 19:15
43	Carton Erector	Carton sealer glue nozzle keeps dripping.	FL1	15/07/2024 21:04	15/07/2024 16:15	15/07/2024 16:45
44	Palletizer	Palletizer machine long fan belt is torn.	FL1	15/07/2024 22:53	15/07/2024 21:30	15/07/2024 22:00
45	Bottle Divider	The reset button is not responding.	FL4	17/07/2024 11:11	17/07/2024 07:30	17/07/2024 07:50
46	Bottle Labeling	Continuous alarm	FL2	17/07/2024 11:12	17/07/2024 10:00	17/07/2024 10:30
47	Carton Erector	Glue gun 1	FL5	17/07/2024 11:13	17/07/2024 10:20	17/07/2024 10:35

Table 1. Data recapitulation for the period July 2024, 1 – 24 (cont.)

No	Machine name	Problem description	Asset description	Data is input	Start date	Completion date
48	Induction Sealer	Seal head element 2 is dead.	FL3	17/07/2024 11:14	18/07/2024 07:30	18/07/2024 07:50
49	Check Weigher	Conveyor is off track.	FL3	18/07/2024 12:01	18/07/2024 11:00	18/07/2024 11:30
50	Laser Code	The cooling unit is dead.	FL1	18/07/2024 13:10	18/07/2024 13:15	18/07/2024 13:30
51	Check Weigher	Conveyor derailed again.	FL3	18/07/2024 13:12	18/07/2024 13:15	18/07/2024 14:00
52	Carton Erector	The Carton Erector Machine's Punch Pulls Late, Resulting in Many Rejected Boxes.	FL1	20/07/2024 16:04	20/07/2024 16:00	20/07/2024 16:25
53	Filling Machine	Air Leaks at the Top of the Filler.	FL6	22/07/2024 08:47	22/07/2024 07:20	22/07/2024 07:35
54	Filling Machine	Air Leaks at the Top of the Filler.	FL5	22/07/2024 08:52	22/07/2024 07:20	22/07/2024 07:35
55	Carton Erector	Loose Encoder, Leading to Many Rejected Cartons.	FL1	22/07/2024 08:54	22/07/2024 08:20	22/07/2024 08:50
56	Laser Code	Thin Batch Laser Shots.	FL6	22/07/2024 15:15	22/07/2024 15:15	22/07/2024 15:30
57	Palletizer	Palletizer Scratches Off Track.	FL4	22/07/2024 15:16	22/07/2024 15:17	22/07/2024 15:45
58	Check Weigher	Carton Weigher Rejector Leaks Air.	FL1	22/07/2024 15:19	22/07/2024 14:00	22/07/2024 14:15
59	Carton Erector	Slow Fuser	FL1	22/07/2024 19:22	22/07/2024 17:40	22/07/2024 19:00
60	Capper	Holders do not Fit the Bottles	FL3	22/07/2024 19:52	22/07/2024 19:45	22/07/2024 20:05

3. Results and Discussion

This section presents the quantitative findings obtained from the evaluation of the belt-type conveyor machine at PT. Pertamina Lubricants, followed by a comprehensive analysis of its maintenance implications. The primary focus is to examine the calculated values of MTBF, MTTR, and operational availability based on the 60 recorded breakdown events over the 18-day observation period

3.1. Quantitative Evaluation of MTTR and MTBF Metrics

The data collected from the Lithos filling area over 18 working days (operating 14 hours daily) yielded specific baseline metrics for the conveyor system. The mathematical processing of the 60 recorded failure events resulted in an average MTTR of 26.28 minutes and an MTBF of 225.716 minutes, yielding a final machine availability of 89.57%. The granular operational and breakdown parameters compiled from each consecutive failure sequence are summarized in Table 2.

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Table 2. Calculation of 60 damage values in 18 working days

Sequence of failures	Total number of failures	Total downtime	Total machine uptime	MTTR (minutes)	MTBF (minutes)	Availability (%)
1	1	40	840	40	800	95.238
2	1	10	840	10	830	98.809
3	1	20	840	20	820	97.619
4	1	36	840	36	804	95.714
5	1	40	840	40	800	95.238
6	1	10	840	10	830	98.809
7	1	10	840	10	830	98.809
8	1	10	840	10	830	98.809
9	1	15	840	15	825	98.214
10	1	30	840	30	810	96.428
11	1	45	840	45	795	94.642
12	1	23	840	23	817	97.261
13	1	13	840	13	827	98.452
14	1	27	840	27	813	96.785
15	1	16	840	16	824	98.095
16	1	21	840	21	819	97.500
17	1	20	840	20	820	97.619
18	1	45	840	45	795	94.642
19	1	60	840	60	780	92.857
20	1	11	840	11	829	98.690
21	1	10	840	10	830	98.809
22	1	30	840	30	810	96.428
23	1	15	840	15	825	98.214
24	1	20	840	20	820	97.619
25	1	30	840	30	810	96.428
26	1	7	840	7	833	99.166
27	1	17	840	17	823	97.976
28	1	14	840	14	826	98.333
29	1	45	840	45	795	94.642
30	1	20	840	20	820	97.619
31	1	15	840	15	825	98.214
32	1	40	840	40	800	95.238
33	1	30	840	30	810	96.428
34	1	45	840	45	795	94.642
35	1	15	840	15	825	98.214
36	1	25	840	25	815	97.023
37	1	20	840	20	820	97.619

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Table 2. Calculation of 60 damage values in 18 working days (cont.)

Sequence of failures	**Total number of failures**	**Total downtime**	**Total machine uptime**	**MTTR (minutes)**	**MTBF (minutes)**	**Availability (%)**
38	1	15	840	15	825	98.214
39	1	145	840	145	695	82.738
40	1	25	840	25	815	97.023
41	1	5	840	5	835	99.404
42	1	9	840	9	831	98.928
43	1	30	840	30	810	96.428
44	1	30	840	30	810	96.428
45	1	20	840	20	820	97.619
46	1	30	840	30	810	96.428
47	1	15	840	15	825	98.214
48	1	20	840	20	820	97.619
49	1	30	840	30	810	96.428
50	1	15	840	15	825	98.214
51	1	45	840	45	795	94.642
52	1	25	840	25	815	97.023
53	1	15	840	15	825	98.214
54	1	15	840	15	825	98.214
55	1	30	840	30	810	96.428
56	1	15	840	15	825	98.214
57	1	28	840	28	812	96.666
58	1	15	840	15	825	98.214
59	1	80	840	80	760	90.476
60	1	20	840	20	820	97.619
Total	**60**	**1577**	**15120**	**26.28**	**225.716**	**89.57%**

Based on the aggregated values from Table 2, the specific parameter calculations are detailed through the equations below. First, the MTTR is calculated by dividing the total accumulated downtime by the total number of breakdown events.

$$\text{MTTR} = \frac{1577 \text{ Minutes}}{60 \text{ Breakdowns}} = 26.28 \text{ Minutes}$$

Second, the MTBF is determined by assessing the total available planned uptime minus the total downtime, divided across the cumulative failure occurrences.

$$\text{MTBF} = \frac{(18 \text{ days x } 14 \text{ hours x } 60 \text{ minutes}) \;\; 1577 \text{ minutes}}{60 \text{ Breakdowns}}$$

$$\text{MTBF} = \frac{(15120 \;\; 1577}{60} = 225.716 \text{ minutes}$$

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Finally, the overall operational reliability and asset readiness are evaluated using the Availability ratio formula.

$$\text{Availability} = \frac{225.716}{225.716 + 26.28} \text{x } 100\% = 89.57\%$$

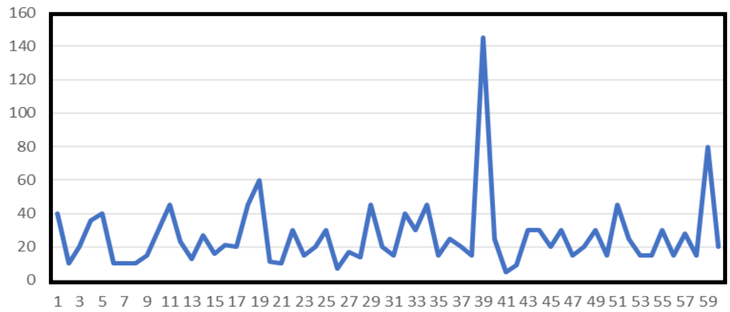

Figure 1. Trend graph of MTTR values during the observation period

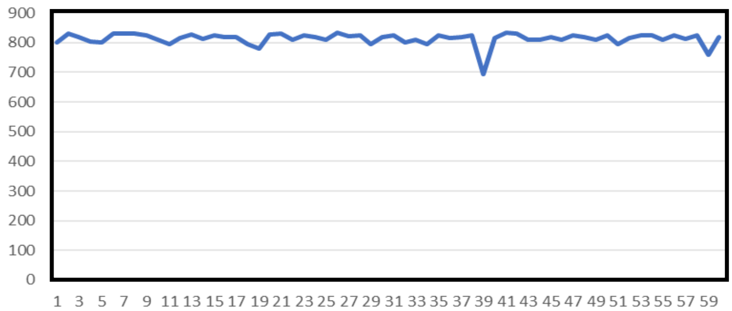

Figure 2. Trend graph of MTBF values during the observation period

As illustrated in Figures 1 and 2, the fluctuation of MTTR and MTBF values reveals critical insights into the machinery's reliability and the maintenance team's efficiency. In the initial phase of the study, the MTTR values exhibited a noticeable spike—most prominently observed during failure sequence 39, where downtime peaked heavily at 145 minutes. This trend indicates that complex troubleshooting or severe mechanical component failures required significantly more time due to delayed fault diagnosis or a temporary shortage of critical spare parts in the Lithos filling area. Conversely, as the production cycle advanced, a more stabilized and declining pattern in MTTR was observed. This shift demonstrates a positive learning curve, better operational readiness, and enhanced technical responsiveness from the repair crew to bring the conveyor back online well within the 26.28-minute historical average. Moreover, trend graph of operational availability rate, comparison of total failures and total downtime, and comparison of MTTR and MTBF is seen in Figures 3, 4, and 5, respectively.

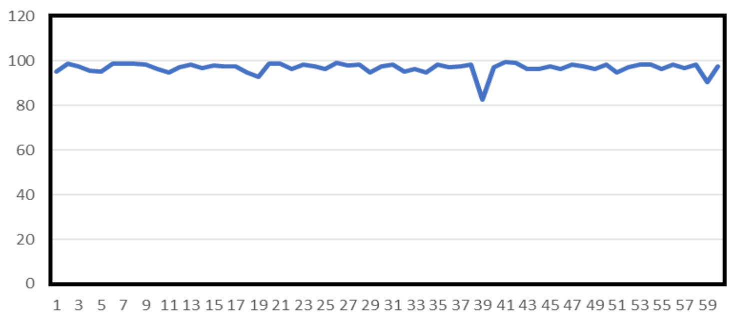

Figure 3. Trend graph of operational availability rate

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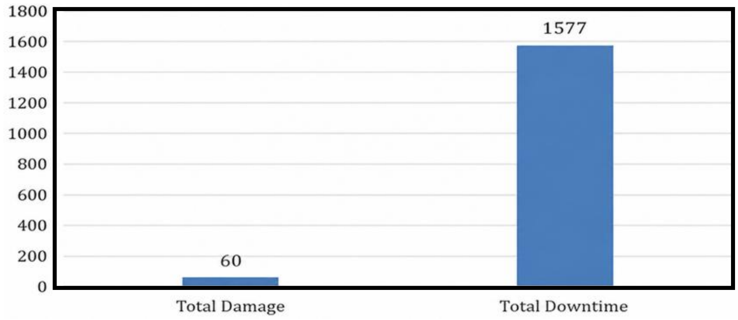

Figure 4. Comparison of total failures and total downtime

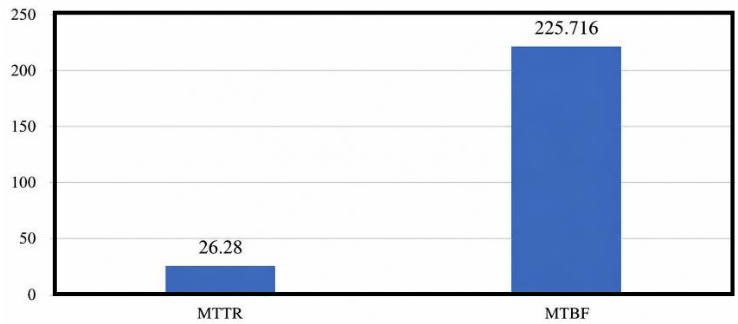

Figure 5. Comparison of MTTR and MTBF

3.2. Causal Relationship with Overall Equipment Effectiveness (OEE)

The analysis of these metrics must transcend basic numerical output. In industrial systems engineering, MTTR and MTBF metrics share a highly direct causal relationship with broader manufacturing frameworks, specifically OEE. The empirical processing compiled in Table 2 establishes that the belt-type conveyor achieved an operational availability rate of 89.57%. Within the standard OEE structure, Availability functions as one of the three foundational pillars alongside Performance rate and Quality output [14].

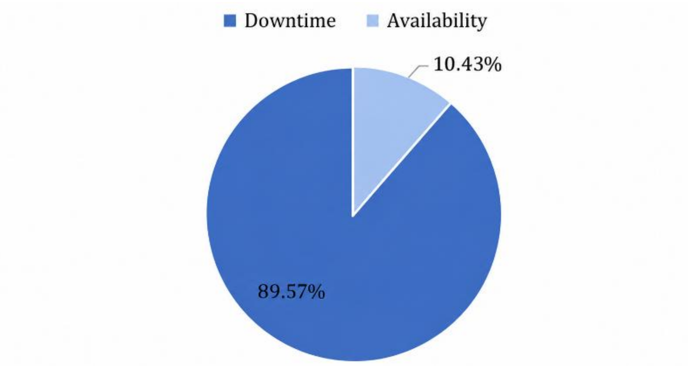

Figure 6. Comparison of system availability and downtime

A high frequency of mechanical breakdowns or extended individual repair times directly decreases the asset's net operational availability. Although an availability rate of 89.57% indicates a solid baseline of machine readiness, the remaining 10.43% of downtime represents completely unfulfilled production potential (see Figure 6). When a critical conveyor system stops unexpectedly within an integrated filling line even for minor halts that align with the 26.28-minute average it causes an immediate downstream operational bottleneck. Upstream filling operations must be stopped, and downstream labelling and packaging equipment idle without input material.

Consequently, these recurring small stops disrupt the sequential flow of the automated line, drastically reducing the volumetric output efficiency and lowering the plant's total OEE index.

3.3. Maintenance Strategy Optimization within TPM Framework

Within the strategic framework of TPM, experiencing 60 failure events within a limited span of 18 working days points to an urgent need for proactive operational restructuring. The high frequency of breakdowns, which are heavily concentrated around the conveyor's automated filling and labelling interface zones, strongly indicates that the Autonomous Maintenance pillar is not yet functioning efficiently on the production floor [9]. Under standard conditions, shopfloor operators should actively participate in early-stage machine upkeep.

Currently, line operators appear to lack the structured training or sensitivity required to detect early physical indicators of component wear, such as minor belt misalignments, excessive friction vibrations, or oil residue accumulation from continuous filling activities. When these trivial abnormalities are left unaddressed, they rapidly deteriorate into severe, unscheduled breakdown events that demand specialized technical intervention. Therefore, the concrete recommendation derived from this study is that PT. Pertamina Lubricants must optimize its maintenance strategy by enforcing strict, standardized cleaning, lubrication, and inspection (CLI) schedules. Implementing dedicated autonomous maintenance training will empower line operators to execute fundamental first line adjustments and minor problem solving independently, thereby substantially depressing both the high failure frequency and the cumulative MTTR.

4. Conclusion

This study successfully evaluated the maintenance performance and operational reliability of the belt-type conveyor machine within the Lithos filling area at PT. Pertamina Lubricants. Based on the empirical data collected over an 18day representative working period, the mathematical processing of 60 recorded failure events revealed an average MTTR of 26.28 minutes and a MTBF of 225.716 minutes. These metrics culminate in an operational availability rate of 89.57%. While this percentage indicates a solid baseline of asset readiness, the frequent mechanical disruptions highlight latent inefficiencies that directly impact the factory's production flow.

In the context of manufacturing optimization, the high frequency of breakdowns and individual repair times share a strong causal relationship with OEE. The 10.43% of lost operational time due to unexpected downtime creates significant bottlenecks in the automated line, forcing both upstream filling and downstream packaging equipment to idle, which ultimately lowers the total plant productivity. Furthermore, within the framework of TPM, the concentration of failures indicates that the Autonomous Maintenance pillar is not yet fully maximized on the shop floor. Line operators currently lack the structured training to identify early symptoms of equipment wear, such as belt misalignments or oil residue accumulation.

To mitigate these losses and optimize the current maintenance strategy, it is highly recommended that the company enforces a standardized CLI schedule. Additionally, implementing dedicated autonomous maintenance training will empower floor operators to execute basic adjustments and first line troubleshooting independently. This proactive restructuring will effectively reduce failure frequencies, minimize cumulative MTTR, and systematically elevate the conveyor's availability and the facility's overall OEE index.

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