

Application of the Time Study Method to Analyze Discrepancies in Production Planning and Realization at PT XYZ

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ABSTRACT

This study aims to analyze the incompatibility between the planning and realization of aluminum production at PT Indoaluminium Intikarsa Industri, especially in Time Between Coil (TBC) activities that have the potential to cause production delays. The research uses a quantitative approach with a case study method through observation, time study, interviews, and documentation of production data. The data was analyzed using cycle time calculations, normal time, and standard time. The results showed that TB downtime was the dominant factor causing production delays, with a compatibility rate between the standard time and the actual time of 90%–100%. These findings can be used as a basis for evaluation to improve production process efficiency and control of working time. Thus, the time study method has proven to be effective in identifying the sources of inefficiencies and supporting increased compatibility between planning and production realization.

Keywords :

Time Study, Production
Planning, Production
Realization, TBC Downtime,
Production Efficiency, Standard
Time, Aluminum Industry

1. Introduction

In an increasingly competitive manufacturing industry, the company's ability to maintain a smooth production process is an important factor in maintaining operational stability and competitiveness [1]. An effective production process depends not only on the availability of raw materials and machine capacity, but also on the quality of the planning and production control implemented by the company [2]. One of the departments that has a strategic role in this matter is Production Planning and Inventory Control (PPIC) [3]. The PPIC department is responsible for coordinating various important activities such as production planning, material needs management, production scheduling, and inventory control so that the entire production process can run as planned [4]. Good planning from PPIC can minimize various operational risks such as production delays, excess inventory, and shortage of raw materials that can hinder the smooth production process [5]. Thus, an effective production planning and control system is key to maintaining operational continuity and improving the efficiency of the company's resource use.

A number of previous studies have discussed the importance of the role of PPIC in supporting the smooth production process in the manufacturing industry. Research by other researchers shows that good coordination in production planning and inventory control can improve the stability of the production process and support the achievement of the company's operational targets [6]. In addition, other research emphasizes that effective communication between PPIC departments and other departments, particularly warehouse management, plays an important role in ensuring smooth material flow and production processes [7]. Meanwhile, another study explained that in the development of modern industry, the PPIC function has also begun to be integrated with various approaches to improve production performance such as Total Productive Maintenance (TPM), which aims to increase machine reliability and

minimize production downtime [8]. However, these studies generally examine PPIC from the perspective of planning coordination, inventory management, communication, or production system integration. The analysis of production discrepancies has also tended to focus on identifying downtime or measuring individual work activities separately. Consequently, there is still a research gap concerning an integrated analysis that connects production downtime with detailed working-time measurement to explain the difference between production plans prepared by PPIC and actual production realization in the field [9]. This gap is important because information on downtime alone can indicate where production losses occur but does not necessarily explain how the actual duration of specific production activities contributes to the discrepancy between planned and realized production time.

In practice, the difference between the production plan prepared by PPIC and the realization of production in the field often still occurs. This condition can be caused by various factors such as inaccurate process time estimates, changes in production materials, and unplanned additional activities in the production process [10]. These non-conformities can cause delays in order completion, reduce operational efficiency, and potentially interfere with the achievement of the company's production targets [11]. Therefore, an analytical approach is needed that can identify not only the dominant sources of production downtime but also the actual duration of activities contributing to the discrepancy between planned and realized production time. The integration of downtime analysis and time study provides a more comprehensive approach by first identifying the dominant sources of production time loss and subsequently measuring the actual working time of relevant production activities. This approach enables the discrepancy between production planning and actual production realization to be examined based on both the occurrence of downtime and the duration of operational activities.

One of the methods that can be used to analyze the efficiency of working time in the production process is the time study method. This method is used to measure the actual working time in each production activity so that standard times and activities that have the potential to cause time waste can be known. Through this approach, companies can obtain a more objective picture of the actual conditions of the production process and identify the factors that contribute to inconsistencies between planning and production realization. In this study, time study is not applied as an isolated measurement method, but is integrated with the analysis of production downtime to trace the operational causes of the discrepancy identified between planned and actual production time. This integration constitutes the specific contribution of the study, as it links production-level downtime information with activity-level working-time measurements to provide empirical evidence of where and how the production realization deviates from the planned production process.

Based on these problems, this study aims to analyze the incompatibility between production planning and production realization at PT Indoaluminium Intikarsa Industri, especially in the aspect of production implementation time. The analysis integrates production downtime analysis and the time study method to identify the dominant sources of time loss, measure the actual duration of production activities, determine standard times, and examine their contribution to the discrepancy between production planning and actual production realization. The novelty of this study lies in this integration, which connects the identification of dominant downtime with detailed measurement of production activities rather than examining the two aspects separately. Based on these findings, the study formulates improvement proposals to improve the compatibility between production planning and production realization. The results are expected to provide a practical contribution to the company by supporting more accurate production-time estimation, improving

production process efficiency, and supporting the optimization of PPIC performance in planning and controlling production activities.

2. Research Methods

This study uses a quantitative approach with a case study method conducted at PT XYZ to analyze the incompatibility between production planning and production realization through the integration of downtime analysis and time study [12]. The study focused on operator activities during the Time Between Coil (TBC) process on the Vonroll and Pitts Burgh machines. Downtime data were obtained for the January–March 2025 period, while direct time observations were conducted for 30 cycles for each work element. Nine work elements were observed on the Vonroll machine and six on the Pitts Burgh machine [13]. Primary data were collected through direct observation, time measurement, and interviews with operators and relevant production personnel, while secondary data were obtained from production planning records, production realization records, Daily Production Reports, and downtime records [14]. Documentation was used to support the analysis and verify the production conditions [15].

The observed activities consisted of lifting material using a crane, shifting material for sampling, sampling for QC inspection, moving the crane to the coil car, material entering the coil car, moving the coil car to the cones, position adjustment, waiting for the QC report, and material entering rolls 1 and 4 on the Vonroll machine. On the Pitts Burgh machine, the observed activities included material transfer from the doubler using a crane, material entering the coil car, material entering the cones, position adjustment and cutting dirty material, waiting for the QC report, and material entry into the roll. The working time of each activity was measured directly using a time measurement tool [confirm the actual instrument used]. Each activity was observed for 30 cycles using the same measurement procedure. The time recorded for each individual observation is referred to as observed time, while cycle time

represents the average observed time across the 30 cycles.

The data analysis consisted of normality, uniformity, and adequacy tests, followed by the calculation of cycle time, normal time, and standard time. Normality was tested using the Shapiro–Wilk test at $\alpha = 0.05$, with data considered normally distributed when the p-value was greater than 0.05. Uniformity was evaluated using the coefficient of variation (CV), with values below 10% considered sufficiently uniform. Data adequacy was evaluated using Minitab based on statistical power, with 80% used as the minimum acceptable criterion. The results showed that the observation data met the normality and uniformity requirements, while the adequacy analysis indicated that the observations were sufficient for further time-study calculations.

Cycle time was calculated by dividing the total observed time by the number of observation cycles. Normal time was then calculated by multiplying cycle time by the performance rating factor obtained using the Shumard method. The operator performance was classified as “Good” with a rating of 70, while 60 represented normal performance; therefore, the performance rating factor was $70/60 = 1.17$. The rating of 70 was applied consistently to the observed activities based on the performance classification used in the study. Standard time was subsequently calculated by incorporating allowances into normal time. The Vonroll machine used a total allowance of 57%, obtained from the sum of the individual allowance components totaling 56.5%, while the Pitts Burgh machine used 55%, obtained from individual components totaling 54.5%. Thus, the calculation was performed as Normal Time =

Cycle Time $\times$ 1.17 and Standard Time = Normal Time $\times$ (1 + Allowance).

To maintain consistency, this study distinguishes observed time, cycle time, normal time, and standard time. Observed time is the directly measured duration of an individual observation; cycle time is the average observed duration across 30 cycles; normal time is cycle time adjusted using the Shumard performance rating; and standard time is normal time adjusted by the applicable allowance. All time values were standardized into seconds before comparison with the standard time. The resulting standard times were then compared with production planning, production realization, and downtime data to identify the activities contributing to discrepancies between planned and actual production time. This procedure integrates downtime analysis with time study to identify both the dominant sources of production time loss and the specific work activities contributing to production-time discrepancies.

3. Results and Discussion

a. Vonroll and Pitts Burg Downtime

Data Collection

Based on downtime data during the period from January to March 2025, it is known that disruptions in the production process occurred frequently. This indicates that efforts to control and improve the production process are still needed to minimize downtime. The recapitulation of downtime categories on the Vonroll machine, including both the frequency of downtime events and the total downtime duration, is presented in Table 1.

Tabel 1. Downtime Frequency and Duration on the Vonroll Machine, January–March 2025

Downtime Category	Total Downtime (min)	Number of Downtime Events
TBC (Time Between Coil)	11,360	586
Quality	8,230	453
PST	4,740	248
Schedule	4,550	72
Change Roll	5,465	110
Mechanic	1,610	31
Cleaning Filter	2,795	36
Roll Shop	1,410	30

Downtime Category	Total Downtime (min)	Number of Downtime Events
Electric	670	17
Power House Utility/PLN	135	3
Others	45	1
PPC	55	2

Based on Table 1, the Vonroll machine recorded a total downtime of 41,065 minutes across 1,589 downtime events during January to March 2025. When assessed based on frequency, TBC (Time Between Coil) was the most frequent downtime category, with 586 events, followed by quality-related downtime with 453 events. In terms of duration, TBC also recorded the longest total downtime at 11,360 minutes, followed by quality-related downtime at 8,230 minutes. Other categories, including PST, change roll, and schedule, also contributed to the overall downtime duration.

These findings indicate that the identification of dominant downtime should consider both the number of occurrences and the accumulated duration, because a category with a high frequency does not necessarily have the longest duration. In this case, TBC was dominant in both frequency and total duration, indicating that it represents a significant source of production disruption requiring further evaluation.

Furthermore, a recapitulation of Pitts Burgh engine downtime during the same period is presented in Table 2.

Table 2. Pitts Burgh Downtime Data Recapitulation (January-March)

Downtime Category	Total Downtime (min)	Number of Downtime events
schedule	36.285	141
tbc	5.195	316
quality	3.120	228
mechanic	3.085	26
change roll	2.970	47
cleaning filter	2.155	28
electric	2.905	32
preventif maintenance	1.350	5
roll shop	610	9
pst	205	10
power house utility /pln	70	2

Based on the table, the Total Downtime reached 57,950 minutes with 846 incidents. The largest downtime category came from the schedule with a duration of 36,285 minutes from 141 events, which indicated inefficiencies in production planning. In addition, the TB category had the highest frequency of occurrences, namely 316 times with a duration of 5,195 minutes, followed by quality of 3,120 minutes from 228 incidents. Several other categories such as mechanic, change roll, and electric also contribute to Downtime. In general, these results show that Downtime is influenced by mechanical technical factors as well as aspects of planning and management of production processes that need to be evaluated to improve operational efficiency.

b. Application of Time study on Vonroll Machine

1) Data Normality Test

The normality test was conducted to determine whether the observed working-time data followed a normal distribution before further time-study analysis. The test was performed using the Shapiro–Wilk method on 30 observation cycles for each work element of the Vonroll machine. The null hypothesis (H_0) states that the observation data are normally distributed, while the alternative hypothesis (H_1) states that the data are not normally distributed. The significance level was set at $\alpha = 0.05$. The data were considered normally distributed when the p-value was greater than 0.05. The Shapiro–Wilk test results for each work element are presented in Table 4.

Table 3. Description of Time Activity Between Coils of Vonroll Machine

Split	kegiatan								
	1	2	3	4	5	6	7	8	9
	lifting material using crane	Shifting the material for sampling	Sample Taking to Be Checked by QC	Crane shifts to place material to coil cark	Material Goes Into Coil Cark	coil cark Shifting to cones	Position adjustment	Waiting for a report from QC	material goes into rolls 1 and 4 (as there is no trimming)
1	0,16	0,14	0,10	1,10	0,52	2,19	0,59	1,50	3,10
2	0,17	0,14	0,11	1,10	0,52	2,20	0,57	1,48	3,06
3	0,16	0,15	0,10	1,12	0,53	2,19	0,58	1,49	3,07
4	0,18	0,16	0,12	1,11	0,54	2,21	0,59	1,50	3,08
5	0,17	0,14	0,11	1,13	0,52	2,20	0,57	1,48	3,09
6	0,16	0,15	0,10	1,10	0,53	2,19	0,58	1,49	3,10
7	0,17	0,15	0,12	1,12	0,54	2,21	0,59	1,50	3,06
8	0,18	0,16	0,11	1,11	0,52	2,20	0,57	1,48	3,07
9	0,16	0,14	0,10	1,13	0,53	2,19	0,58	1,49	3,08
10	0,17	0,15	0,11	1,10	0,54	2,21	0,59	1,50	3,09
11	0,18	0,16	0,12	1,12	0,52	2,20	0,57	1,48	3,10
12	0,16	0,14	0,10	1,11	0,53	2,19	0,58	1,49	3,06
13	0,17	0,15	0,11	1,13	0,54	2,21	0,59	1,50	3,07
14	0,18	0,16	0,12	1,10	0,53	2,20	0,57	1,48	3,08
15	0,16	0,15	0,11	1,11	0,52	2,19	0,58	1,49	3,09
16	0,17	0,14	0,10	1,12	0,54	2,21	0,59	1,50	3,10
17	0,17	0,16	0,12	1,13	0,53	2,20	0,57	1,48	3,06
18	0,18	0,14	0,11	1,11	0,52	2,19	0,58	1,49	3,07
19	0,16	0,15	0,10	1,10	0,54	2,21	0,59	1,50	3,08
20	0,17	0,16	0,11	1,12	0,53	2,20	0,57	1,48	3,09
21	0,18	0,15	0,12	1,13	0,52	2,19	0,58	1,49	3,10
22	0,16	0,14	0,10	1,11	0,54	2,21	0,59	1,50	3,06
23	0,17	0,16	0,11	1,10	0,53	2,20	0,57	1,48	3,07
24	0,18	0,15	0,12	1,13	0,52	2,19	0,58	1,49	3,08
25	0,17	0,14	0,10	1,12	0,54	2,21	0,59	1,50	3,09
26	0,16	0,16	0,11	1,11	0,53	2,20	0,57	1,48	3,10
27	0,18	0,15	0,12	1,10	0,52	2,19	0,58	1,49	3,06
28	0,17	0,14	0,10	1,13	0,54	2,21	0,59	1,50	3,07
29	0,16	0,15	0,11	1,12	0,53	2,20	0,57	1,48	3,08
30	0,18	0,16	0,12	1,11	0,52	2,19	0,58	1,49	3,09

Table 3. Shapiro–Wilk Normality Test Results for Vonroll Machine Observation Data

Activity	N	W (Illustrative)	p-value (Illustrative)	α	Decision
Lifting Materials Using a Crane	30	0.967	0.438	0.05	Normal
Shifting the Material for Sampling	30	0.958	0.271	0.05	Normal
Sample Taking to Be Checked by QC	30	0.972	0.571	0.05	Normal
Crane Shifts to Place Material to Coil Car	30	0.981	0.842	0.05	Normal
Material Goes into Coil Car	30	0.965	0.391	0.05	Normal
Coil Car Shifting to Cones	30	0.974	0.623	0.05	Normal
Position Adjustment	30	0.969	0.476	0.05	Normal
Waiting for a Report from QC	30	0.979	0.801	0.05	Normal
Material Goes into Rolls 1 and 4	30	0.963	0.347	0.05	Normal

Based on the Shapiro–Wilk test results, all work elements obtained p-values greater than the significance level of 0.05. Therefore, the null hypothesis (H_0) was not rejected, indicating that the observed working-time data for all Vonroll machine activities were

normally distributed. The normality results indicate that the 30 observations collected for each activity satisfied the normality assumption required for the subsequent time-study analysis.

2) Data Uniformity Test

Following the normality assessment, a data uniformity test was conducted to evaluate the consistency of the observed processing times for each work element. The analysis was based on the mean, standard deviation, and coefficient of variation (CV). The coefficient of variation was calculated as the ratio of the standard deviation to the mean, expressed as a percentage, as follows:

$$CV (\%) = (SD / \bar{x}) \times 100\% \quad (1)$$

where SD is the standard deviation and $\bar{x}$ is the mean observation time. The resulting coefficient of variation values are presented in Table 5.

Table 4. Vonroll Machine Data Uniformity Test Results

Activities	Mean	Std. Deviation	Coefficient of Variation
Lifting Materials using a Crane	0,17	0,0081	4,8
Shifting Materials to Sample	0,15	0,0081	5,4
Sample Taking to be checked by QC	0,11	0,0081	7,4
The crane shifts to place the material onto the coil cark	1,11	0,0114	1,0
Material goes into the coil cark	0,53	0,0083	1,6
Coil cark digeser ke Cones	2,20	0,0083	0,4
Position Adjustment	0,58	0,0083	1,4
Waiting for the QC report	1,49	0,0083	0,6
Material goes into rolls 1 and 4 (as there is no trimming)	3,08	0,0144	0,5

The coefficient of variation values ranged from 0.4% to 7.4%. The lowest variation was observed in the coil-car movement to the cones activity at 0.4%, while the highest variation occurred in the QC sampling activity at 7.4%. These results

indicate that the observed processing times showed varying degrees of dispersion across the work elements. The coefficient of variation values were subsequently used to assess the consistency of the observations before calculating cycle time, normal time, and standard time.

3) Data Uniformity Test

The data adequacy test is carried out using Minitab software to ensure that the amount of observation data is adequate. Based on the power curve graph in Figure 1, the power value increases as the average difference tested increases and is close to 100% at a difference of about ± 0.1 . These results show that the data used has been sufficient to detect significant differences in the test.

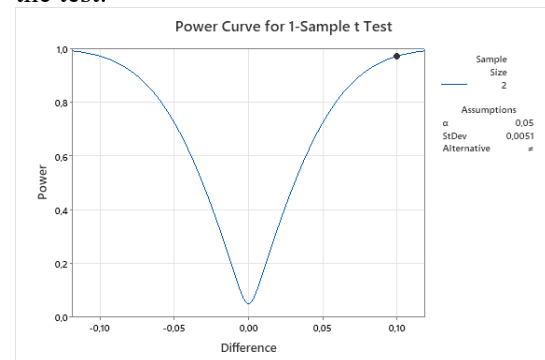


Figure 1. Graph of Vonroll Machine Data Adequacy Test Results

4) Calculation of Cycle Time, Normal Time and Standard Time

a) Cycle Time

Cycle time calculation is carried out to find out the average time on each element of activity by dividing the total observation time by the number of cycles. The results of the calculation of the cycle time of the Vonroll machine are shown in Table 5 and are the basis for determining the normal time and standard time of the production process.

Table 5. Vonroll Machine Cycle Time

Activities	Cycle Time (sec)
Lifting Materials using a Crane	17
Shifting Materials to Sample	15
Sample Taking to be checked by QC	11
The crane shifts to place the material onto the coil cark	71
Material goes into the coil cark	53
Coil cark digeser ke Cones	140

Activities	Cycle Time (sec)
Position Adjustment	58
Waiting for the QC report	109
Material goes into rolls 1 and 4 (as there is no trimming)	188

b) Normal Time

Normal time is calculated by multiplying the observed cycle time by the performance rating factor. In this study, the performance rating was determined using the Shumard method. The operator's performance was classified as "Good," corresponding to a Shumard rating of 70, while the reference value for normal performance is 60. Therefore, the performance rating factor was calculated as $70/60 = 1.17$. This adjustment factor was applied consistently to the average cycle time of each work element to obtain the corresponding normal time. The Shumard rating scale and the resulting normal time calculations are presented in Table 6 and Table 7, respectively.

Table 6. Normal Time Adjustment Value Table

Class	Value
Superfast	100
Fast +	95
Fast	90
Fast -	85
Excellent	80
Good +	75
Good	70
Good -	65
Normal	60
Fair +	55
Fair	50
Fair -	45
Poor	40

Table 7. Normal Time Vonroll Machin

Activity	Cycle Time (sec)	Normal Time
Lifting Materials using a Crane	17	19.83
Shifting Materials to Sample	15	17.5

Activity	Cycle Time (sec)	Normal Time
Sample Taking to be checked by QC	11	12.83
Crane shifts to place material onto the coil car	71	82.83
Material goes into the coil car	53	61.83
Coil car moved to Cones	140	163.33
Position Adjustment	58	67.67
Waiting for the QC report	109	127.17
Material goes into rolls 1 and 4	188	219.33

c) Normal Time

Standard time is determined by incorporating an allowance factor into the normal time to account for unavoidable variations in working conditions, including energy expenditure, work posture, work movement, eye fatigue, workplace temperature, atmospheric conditions, environmental conditions, and personal needs. In this study, the allowance components were assessed based on the observed working conditions and summarized in Table 8. The total allowance obtained for the Vonroll machine was 57%. The allowance was then incorporated into the normal time to determine the standard time for each work element. The calculation procedure is expressed as follows:

$$W_b = W_n(1 + L) \quad (2)$$

where W_b is the standard time, W_n the normal time, and L is the total allowance expressed as a decimal.

Factor	Examples of Work	Load Equivalent	Percent of Impairment (%)	
			Men	Women
A. Weight of Load Handled				
1. Very light	Working at a table, sitting	No load	0.0–6.0	0.0–6.0
2. Very light	Working at a table, standing	0.00–2.25 kg	6.0–7.5	6.0–7.5
3. Light	Light work, standing	2.25–9.00 kg	7.5–12.0	7.5–16.0
4. Moderate	Pushing and pulling	9.00–18.00 kg	12.0–19.0	16.0–30.0
5. Heavy	Handling heavy tools	18.00–27.00 kg	19.0–30.0	
6. Very heavy	Handling heavy objects	27.00–50.00 kg	30.0–50.0	
7. Extremely heavy	Handling loads over 50 kg	More than 50 kg		
B. Working Posture				
1. Sitting	Sitting, light work		0.00–1.0	
2. Standing on both feet	Upright body, supported on both feet		1.0–2.5	
3. Standing on one foot	Standing on one foot while operating equipment		2.5–4.0	
4. Stooping	Body bent forward, backward, or to the side		2.5–4.0	
5. Kneeling	Resting on both knees		4.0–10.0	
C. Movement				
1. Normal	Free movement of arms		0	
2. Limited	Arm movement limited		0–5	
3. Difficult	Carrying heavy load with one hand		0–5	
4. Very limited (body members)	Working with hands above the head		5–10	
5. Extremely limited (body members)	Working in a narrow space		10–15	
D. Eye Fatigue *)			Good Lighting	Poor Lighting
1. Constant eye movement	Using measuring instruments		0.0–6.0	0.0–6.0
2. Constant eye movement with hamper	Detailed tasks		6.0–7.5	6.0–7.5
3. Constant eye movement with high focus			7.5–12.0	7.5–16.0
4. Constant eye movement with high focus with changes	Very detailed inspection		12.0–19.0	16.0–30.0
5. Constant eye movement with very high focus	Inspecting defects in fabric		19.0–30.0	
6. Constant eye movement with very high focus with changes			30.0–50.0	
E. Thermal Conditions at the Workplace **)		Temperature (°C)	Normal Allowance	Allowable Deviation
1. Very hot		Above 0	Above 10	Above 12
2. Low		0–13	10–0	12–5
3. Moderate		13–22	5–0	8–0
4. Normal		22–28	0–5	0–8
Factor	Examples of Work	Load Equivalent	Percent of Impairment (%)	
			Men	Women
5. High		28–38	5–40	8–100
6. Very high		More than 38	More than 40	More than 100
F. Atmospheric Conditions ***)				
1. Good	Well-ventilated room, fresh air		0	
2. Adequate	Ventilation is inadequate, there is some odor (not hazardous)		0–5	
3. Poor	Presence of dust, fumes, or gases that are not hazardous but in high concentration		5–10	
4. Very poor	Presence of hazardous fumes or gases that require the use of respiratory protection equipment		10–20	
G. Good Environmental Conditions				
1. Clean, healthy, bright with low noise level			0	
2. Work cycle repeated every 5–10 seconds			0–1	
3. Work cycle repeated every 0–5 seconds			1–3	
4. Very noisy			0–5	
5. If factors that affect conditions can reduce quality			0–5	
6. Feeling vibration on the floor			5–10	
7. Environment conditions outside the normal range (dust, cleanliness, etc.)			5–15	
*) Contrast between colors that need to be considered				
**) Requirements for good ventilation				
***) Also influenced by the height of the workplace above sea level and climate conditions				
Note: Allowance for personal needs: Men = 0–2.5%				
Women = 2–5%				

Figure 2. Relaxation Adjustment Table

Each allowance component was determined according to the observed physical and environmental conditions during the work process, including the level of energy expenditure, work attitude, movement, visual demand, workplace temperature, atmospheric conditions, environmental conditions, and personal needs. The individual allowance components are presented in Table 8, with a total allowance of 57%.

Table 8. Vonroll Machine Adjustment Results

No	Factor	Relaxation
1	Energy Expended	6%
2	Work Attitude	2%
3	Work Movement	0%
4	Eye Fatigue	7,5%
5	Workplace Temperature Conditions	30%
6	Atmospheric Conditions	4%
7	Good Environmental Conditions	5%
8	Personal Needs	2%
Total		57%

The individual allowance components sum to 56.5%, which is rounded to 57% for the standard-time calculation.

Table 9. Standard Time Results of the Vonroll Machine

Activities	Standard Time (sec)
Lifting Materials Using a Crane	19
Shifting Materials for Sampling	16
Sampling for QC Inspection	12
Crane Moving Material onto Coil Car	122
Material Entering the Coil Car	58
Coil Car Moving to Cones	242
Position Adjustment	64
Waiting for QC Report	164
Material Entering Rolls 1 and 4 (No Trimming)	338
Total Standard Time	1,035

The standard time for each activity was determined by considering the normal time and the total allowance of 57%. Based on the calculation results, the standard times for the nine activities were 19, 16, 12, 122, 58, 242, 64, 164, and 338 seconds, respectively. The total standard time for the complete Vonroll

activity sequence was 1,035 seconds, equivalent to approximately 17.25 minutes. The longest standard time was found in the material entry process into rolls 1 and 4, with 338 seconds, while the shortest standard time was found in the sampling activity for QC inspection, with 12 seconds.

Table 10. Final Results of the Vonroll Machine Time Study

Activities	Cycle Time (sec)	Normal Time (sec)	Standard Time (sec)
Lifting Materials Using a Crane	17	11.9	19
Shifting Materials for Sampling	15	10.5	16
Sampling for QC Inspection	11	7.7	12
Crane Moving Material onto Coil Car	71	78	122
Material Entering the Coil Car	53	37.1	58
Coil Car Moving to Cones	140	154	242
Position Adjustment	58	40.6	64
Waiting for QC Report	109	104.3	164
Material Entering Rolls 1 and 4 (No Trimming)	188	215.6	338
Total	662	660	1,035

The final results of the Vonroll machine time study show that the observed activities have different cycle times, normal times, and standard times. The total cycle time of the nine activities was 662 seconds, while the total standard time was 1,035 seconds. The material entry process into rolls 1 and 4 had the longest standard time, at 338 seconds, followed by the coil car movement to the cones at 242 seconds. Meanwhile, the sampling activity for QC inspection had the shortest standard time, at 12 seconds. These results provide a basis for evaluating the duration of each activity and identifying activities that require further attention in efforts to improve production process efficiency.

c. Application of Time study on Vonroll Machine

1) Analysis of Cycle Time Between Coil Pittsburg Machines

Based on Table 11 Description of Time Between Coil Activities of Pittsburg Machine, it is known that the Time Between Coil process consists of six stages of activity, namely the removal of materials from the doubler machine using a crane, the material entering the coil car, the material entering the cones, position adjustment as well as cutting of dirty materials, waiting for QC reports, and process of material entry to rolls. The results of observations of 30 cycles showed that the time required for each activity was relatively stable with very little variation. The activity with the largest time is found in the process of

entering the material into the roll with an average of about 2.28–2.30 minutes, while the fastest time is found in the process of material entering the coil car with an average of about 0.11–0.13 minutes. This shows that the final

stage of the process has the greatest time contribution in the Time Between Coil cycle, so it has the potential to be the main focus in efforts to improve the efficiency of the production process.

Table 11. Description Of Activity Time Between Coil Pitts Burgh Engines

Cycle	Activities					
	1	2	3	4	5	6
	Material is removed from the Doubler using a Crane	Material into the coil cark	Material entry into cones	Position adjustment and cut dirty material	Waiting for QC repor	Process of material entry to roll
1	1,06	0,12	1,20	1,38	0,27	2,30
2	1.05	0.11	1.18	1.38	0.26	2.28
3	1.06	0.12	1.19	1.39	0.27	2.29
4	1.07	0.13	1.20	1.40	0.28	2.30
5	1.06	0.12	1.19	1.39	0.27	2.29
6	1.05	0.11	1.18	1.38	0.26	2.28
7	1.07	0.13	1.20	1.40	0.28	2.30
8	1.06	0.12	1.19	1.39	0.27	2.29
9	1.06	0.12	1.19	1.39	0.27	2.29
10	1.07	0.13	1.20	1.40	0.28	2.30
11	1.05	0.11	1.18	1.38	0.26	2.28
12	1.06	0.12	1.19	1.39	0.27	2.29
13	1.07	0.13	1.20	1.40	0.28	2.30
14	1.06	0.12	1.19	1.39	0.27	2.29
15	1.05	0.11	1.18	1.38	0.26	2.28
16	1.06	0.12	1.19	1.39	0.27	2.29
17	1.06	0.12	1.19	1.39	0.27	2.29
18	1.07	0.13	1.20	1.40	0.28	2.30
19	1.05	0.11	1.18	1.38	0.26	2.28
20	1.06	0.12	1.19	1.39	0.27	2.29
21	1.07	0.13	1.20	1.40	0.28	2.30
22	1.06	0.12	1.19	1.39	0.27	2.29
23	1.06	0.12	1.19	1.39	0.27	2.29
24	1.07	0.13	1.20	1.40	0.28	2.30
25	1.05	0.11	1.18	1.38	0.26	2.28
26	1.07	0.13	1.20	1.40	0.28	2.30
27	1.06	0.12	1.19	1.39	0.27	2.29
28	1.06	0.12	1.19	1.39	0.27	2.29
29	1.05	0.11	1.18	1.38	0.26	2.28
30	1.07	0.13	1.20	1.40	0.28	2.30

2) Data Uniformity Test

After the data is declared normal, a data uniformity test is carried out to determine the consistency of the data pattern through the mean value, standard deviation, and coefficient of variation. The results of the calculation are presented in Table 12 Based on the table, the entire value of the variation coefficient is below 10%, so that the time data on each Pitts Burgh machine activity can be said to be uniform and stable and suitable for future working time analysis.

Table 12. Pitts Burgh Engine Data Uniformity Test Results

Activities	Mean	Std. Deviation	Coefficient of Variation (%)
Material removed from the Doubler using the Crane	1,06	0,0074	0,7

Activities	Mean	Std. Deviation	Coefficient of Variation (%)
Material into the coil cark	0,12	0,0074	6,1
Material entry into cones	1,19	0,0076	0,6
Position adjustment and cut dirty material	1,39	0,0076	0,6
Waiting for QC repor	0,27	0,0074	2,7
Process of material entry to roll	2,29	0,0076	0,3

3) Data Sufficiency Test

The data adequacy test was carried out using Minitab software with the Power and Sample Size for 1-Sample method t. The test results shown in Figure 4.25 show that the actual power value is 99.83%, which means that it has exceeded the minimum limit of

80%. Thus, the amount of data used is declared sufficient and can be used for further analysis.

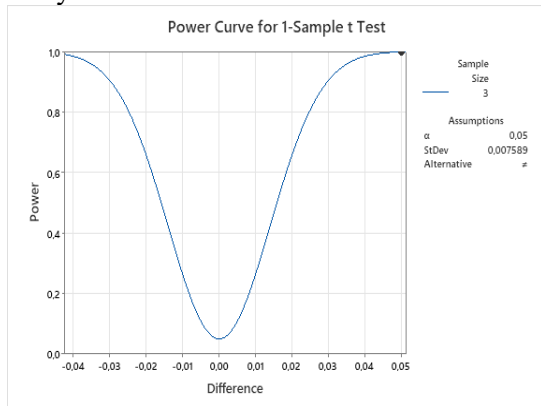


Figure 3. Pitts Burgh Engine Data Adequacy Test Results

4) Calculation of Cycle Time, Normal Time and Standard Time

a) Cycle Time

The results of the cycle time calculation for each activity on the Pitts Burgh machine are shown in Table 13, and these values are further used as the basis for determining normal time.

Table 13. Pitts Burgh Engine Cycle Time Results

Activities	Cycle Time (seconds)
Material Transferred from Doubler Using Crane	66
Material Entering the Coil Car	12
Material Entering the Cones	79
Position Adjustment and Cutting Dirty Material	99
Waiting for QC Report	27
Material Entry Process into the Roll	149

b) Normal Time

Normal time is calculated based on cycle time taking into account adjustment factors using the Shurmark method. The results of the normal time calculation for each activity are shown in Table 14, where the activity with the largest time is the process of material entry into the roll, while the material activity enters the coil car has the shortest time. This shows that there is a difference in duration between activities that can be considered in an effort to improve the efficiency of the work process.

Table 14. Normal Time Results of Pitts Burgh Machines

Activities	Normal Time (seconds)
Material Transferred from Doubler Using Crane	74.2
Material Entering the Coil Car	8.4
Material Entering the Cones	83.4
Position Adjustment and Cutting Dirty Material	97.3
Waiting for QC Report	18.9
Material Entry Process into the Roll	160.4

c) Standard Time

Standard time for the Pitts Burgh machine is determined by incorporating an allowance factor into the calculated normal time. The allowance accounts for variations associated with energy expenditure, work attitude, work movement, eye fatigue, workplace temperature, atmospheric conditions, environmental conditions, and personal needs. These components were evaluated based on the observed working conditions and are summarized in Table 15. The total allowance obtained for the Pitts Burgh machine was 55%. The standard time was subsequently calculated by applying this allowance to the normal time using the following equation:

$$W_b = W_n(1 + L) \quad (3)$$

where W_b represents standard time, W_n represents normal time, and L represents the total allowance expressed as a decimal. The 55% allowance therefore represents the cumulative value of the individual allowance components listed in Table 15 and was not assigned as a single arbitrary adjustment.

Table 15. Pitts Burgh Engine Adjustment Results

No	Factor	Kelonggaran
1	Energy Expended	7%
2	Work Attitude	1,9%
3	Work Movement	0%
4	Eye Fatigue	6,8%
5	Workplace Temperature Conditions	28%
6	Atmospheric Conditions	3,9%
7	Good Environmental Conditions	4,9%
8	Personal Needs	2%
Total		55%

The individual allowance components sum to 54.5%, which is rounded to 55% for the standard-time calculation.

Tabel 16. Pitts Burgh Machine Raw Time Results

Activities	Standard Time (sec)
Material is removed from the Doubler using a Crane	115
Material into the coil cark	13

Activities	Standard Time (sec)
Material entry into cones	129
Position adjustment and cut dirty material	151
Waiting for QC repor	29
Process of material entry to roll	249

Table 17. Final Results of Pitts Burgh Machinery Time study

Cycle	Activities					
	1	2	3	4	5	6
	Material is removed from the Doubler using a Crane	Material into the coil cark	Material entry into cones	Position adjustment and cut dirty material	Waiting for QC repor	Process of material entry to roll
1	1,06	0,12	1,20	1,38	0,27	2,30
2	1,05	0,11	1,18	1,38	0,26	2,28
3	1,06	0,12	1,19	1,39	0,27	2,29
4	1,07	0,13	1,2	1,4	0,28	2,3
5	1,06	0,12	1,19	1,39	0,27	2,29
6	1,05	0,11	1,18	1,38	0,26	2,28
7	1,07	0,13	1,2	1,4	0,28	2,3
8	1,06	0,12	1,19	1,39	0,27	2,29
9	1,06	0,12	1,19	1,39	0,27	2,29
10	1,07	0,13	1,2	1,4	0,28	2,3
11	1,05	0,11	1,18	1,38	0,26	2,28
12	1,06	0,12	1,19	1,39	0,27	2,29
13	1,07	0,13	1,2	1,4	0,28	2,3
14	1,06	0,12	1,19	1,39	0,27	2,29
15	1,05	0,11	1,18	1,38	0,26	2,28
16	1,06	0,12	1,19	1,39	0,27	2,29
17	1,06	0,12	1,19	1,39	0,27	2,29
18	1,07	0,13	1,2	1,4	0,28	2,3
19	1,05	0,11	1,18	1,38	0,26	2,28
20	1,06	0,12	1,19	1,39	0,27	2,29
21	1,07	0,13	1,2	1,4	0,28	2,3
22	1,06	0,12	1,19	1,39	0,27	2,29
23	1,06	0,12	1,19	1,39	0,27	2,29
24	1,07	0,13	1,2	1,4	0,28	2,3
25	1,05	0,11	1,18	1,38	0,26	2,28
26	1,07	0,13	1,2	1,4	0,28	2,3
27	1,06	0,12	1,19	1,39	0,27	2,29
28	1,06	0,12	1,19	1,39	0,27	2,29
29	1,05	0,11	1,18	1,38	0,26	2,28
30	1,07	0,13	1,2	1,4	0,28	2,3
Cycle Time	1,06	0,12	1,19	1,39	0,27	2,29
Normal Time	74,2	8,4	83,4	97,3	18,9	160,4
Standard Time	115	13	129	151	29	249

d. Analysis

Based on the results of data processing, it is known that the category of Downtime with the highest frequency is TBC (Time Between Coil). This condition shows that the process of changing coils before the next production is one of the main causes of delays in the production pipeline. Therefore, analysis of the TB category is important to identify the cause and find solutions to improve the process.

This is reinforced by the data shown in Figure 4 and Figure 5, which shows a graph of the intensity of Downtime on the Vonroll and Pitts Burgh engines for the January-March 2025 period. From the graph, it can be seen that the TB category has the highest frequency of occurrence compared to other Downtime categories, so it can be concluded that TB is the main factor that causes disruptions in the production process.

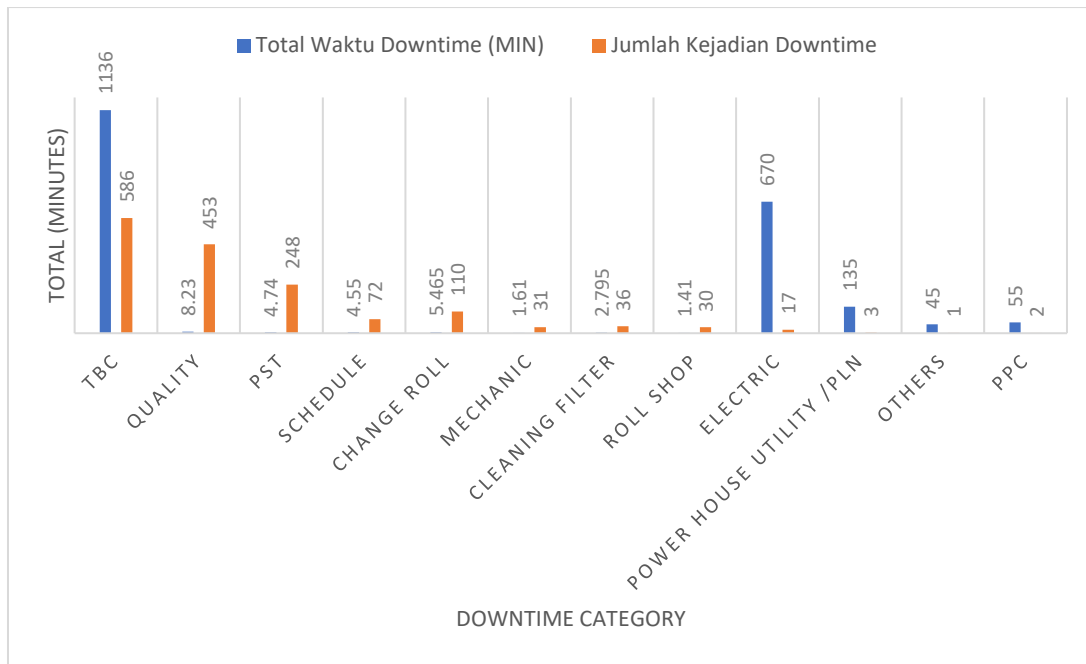


Figure 4. Vonroll Category Downtime Intensity Graph January-March 2025

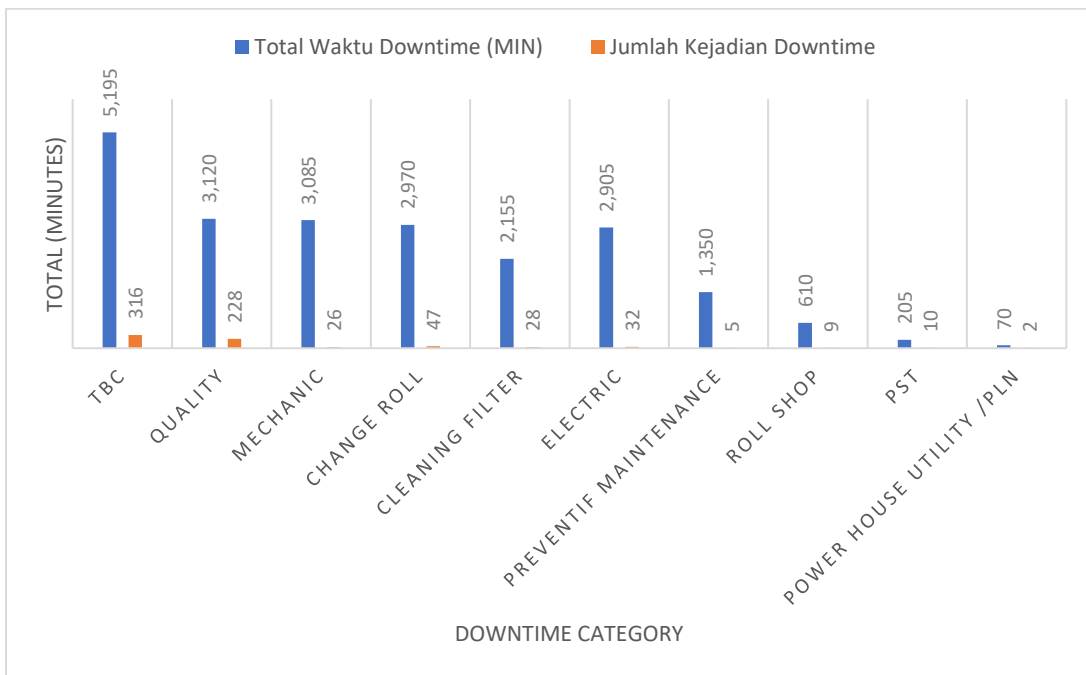


Figure 5. Pitts Burgh Category Downtime Intensity Graph January-March 2025

Based on the observation results, the discrepancy between planning and the realization of production time was caused by the implementation of work in the field that was not in accordance with the planned time. This is mainly influenced by the length of the material handling process as well as some other activities that exceed the standard time, causing delays in the production process.

The discrepancy can be seen in the Daily Production Report data of the Vonroll and Pitts Burgh machines shown in Figure 6. In the image, the Start Time and Finish Time columns show the production planning time of 05.06 to 06.53, while the Coil No column shows the coil produced, which is A-1217088-24F-D. Therefore, the time study method is used to measure the activity time directly during the Time Between Coil (TBC)

period so that it can identify the source of delay and improve the efficiency of the production process.

DATE : 08/01 – 08/01, 2025

No.	Process, Pass, shift	Planning			Speed	Speed	Handling time	Time Actual	Opr.	Customer	Coil No.
		Start Time	Finish Time	Total Time							
		08/Jan 6:05	08/Jan 6:05					08/Jan 6:05			PROSES MENURUT NOMOR COIL & SIZE PROGRAM
	PASS 9	08/Jan 6:05	08/Jan 6:05	147	300	330	15	08/Jan 6:05	162	F095	A-1226127-24F-B
		08/Jan 6:20	08/Jan 8:46					08/Jan 8:46			
1	Chg Wr 0.05	08/Jan 8:46	08/Jan 8:46	70				08/Jan 8:46	70		INJEKSI BACKUP + WORK ROLL
	Cr 40	08/Jan 9:56	08/Jan 13:45	229				08/Jan 13:45	229		
	PASS 9	08/Jan 14:00	08/Jan 18:40	280	300	330	15	08/Jan 18:40	295	F007	A-1213065-24F
	PASS 9	08/Jan 18:55	08/Jan 22:51	236	300	330	15	08/Jan 22:51	251	F007	A-1213066-24F-A
	PASS 9	08/Jan 23:06	09/Jan 1:47	160	300	330	15	09/Jan 1:47	175	F007	A-1217089-24F-A
	PASS 9	09/Jan 2:02	09/Jan 4:51	170	300	330	15	09/Jan 4:51	185	F007	A-1217089-24F-B
	PASS 9	09/Jan 5:06	09/Jan 6:53	107	300	330	15	09/Jan 6:53	122	F007	A-1217088-24F-D
		09/Jan 6:53	09/Jan 6:53					09/Jan 6:53			
2	Chg Wr 0.10	09/Jan 6:53	09/Jan 8:03	70				09/Jan 8:03	70		INJEKSI BACKUP + WORK ROLL
	Cr 40	09/Jan 8:03	09/Jan 8:03					09/Jan 8:03			
	PASS 6	09/Jan 8:18	09/Jan 11:54	216	150	165	15	09/Jan 11:54	231	F095	241130041-1
		09/Jan 11:54	09/Jan 11:54					09/Jan 11:54			
	PASS 7	09/Jan 12:29	09/Jan 15:46	197	150	165	35	09/Jan 15:46	232	F095	241130041-1
	PASS 7	09/Jan 16:21	09/Jan 19:37	196	150	165	35	09/Jan 19:37	231	F095	241130041-2
	PASS 7	09/Jan 20:12	09/Jan 23:25	193	150	165	35	09/Jan 23:25	228	F095	241130041-3
		09/Jan 23:25	09/Jan 23:25					09/Jan 23:25			

Figure 6. Daily Production Planning Vonroll (January)

The time study method is used to directly measure operator activity during the Time Between Coil (TBC) period so that the actual working time at each stage of the process can be known. The data in Figure 7 shows the difference between planning and

production realization. Production planning is scheduled from 05.06 to 06.53, but at its realization it is recorded from 06.30 to 08.30, which indicates a delay in the production process.

Date	Shift	COIL No.	COIL PART No.	Pass	Start	Stop	Runtime	Thick Entry	Thick Exit
2025-01-08	1	A-1218092-24F-C	A-1218092-24F	3	06:00	06:10	10	14,50	6,50
2025-01-08	1	A-1226127-24F-B	A-1226127-24F-A+A-1226127	3	06:20	08:20	120	16,50	8,80
2025-01-08	1	A-1213065-24F-B	A-1213065-24F	3	12:10	13:00	50	14,50	6,50
2025-01-08	1	A-1213066-24F-A-A	A-1213066-24F-A	3	13:20	13:40	20	14,50	6,50
2025-01-08	2	A-1213066-24F-A-B	A-1213066-24F-A	3	14:15	14:45	30	14,50	6,50
2025-01-08	2	A-1213065-24F-C	A-1213065-24F	3	15:00	16:40	100	14,50	6,50
2025-01-08	2	A-1213065-24F-D	A-1213065-24F	3	16:50	18:40	110	14,50	6,50
2025-01-08	2	A-1217089-24F-A	A-1217089-24F-A+A-1217089	3	19:00	21:20	140	14,50	6,50
2025-01-08	3	A-1213066-24F-A-C	A-1213066-24F-A	3	22:15	01:30	195	14,50	6,50
2025-01-08	3	A-1217089-24F-B	A-1217089-24F-A+A-1217089	3	01:55	04:50	175	14,50	6,50
2025-01-08	3	A-1218092-24F-C	A-1218092-24F	3	05:15	06:00	45	14,50	6,50
2025-01-09	1	A-1217088-24F-D	A-1217088-24F	3	06:30	08:30	120	14,50	6,50
2025-01-09	1	241130041-1-A	241130041-1	1	10:50	12:50	120	96,00	44,00
2025-01-09	1	241130041-1-B	241130041-1	1	12:40	14:20	100	96,00	44,00
2025-01-09	1	241130041-1-A	241130041-1	2	14:50	17:00	130	44,00	24,13
2025-01-09	2	241130041-1-B	241130041-1	2	17:15	18:00	45	44,00	24,13
2025-01-09	2	241130041-1-B	241130041-1	2	18:00	18:50	50	44,00	24,13
2025-01-09	2	241130042-2-A	241130042-2	2	19:20	20:45	85	44,00	24,13

Figure 7. Daily Production Report Vonroll (January)

1) Vonroll Machine Downtime Identification

Figure 8 shows a graph of Total Downtime on Vonroll machines by category. The results showed that the TBC (Time Between Coil) category had the greatest Downtime duration compared to other categories. This indicates that tuberculosis is the dominant factor that causes engine operational disruptions.

Furthermore, Figure 9 shows the details of the remarks in the TB category. The results of the analysis showed that the most frequent activity was "changing materials + spools in line", which is the process of replacing the aluminum arrangement on the machine. The high frequency of this activity shows that the process of changing materials is one of the main causes of delays in the production process.

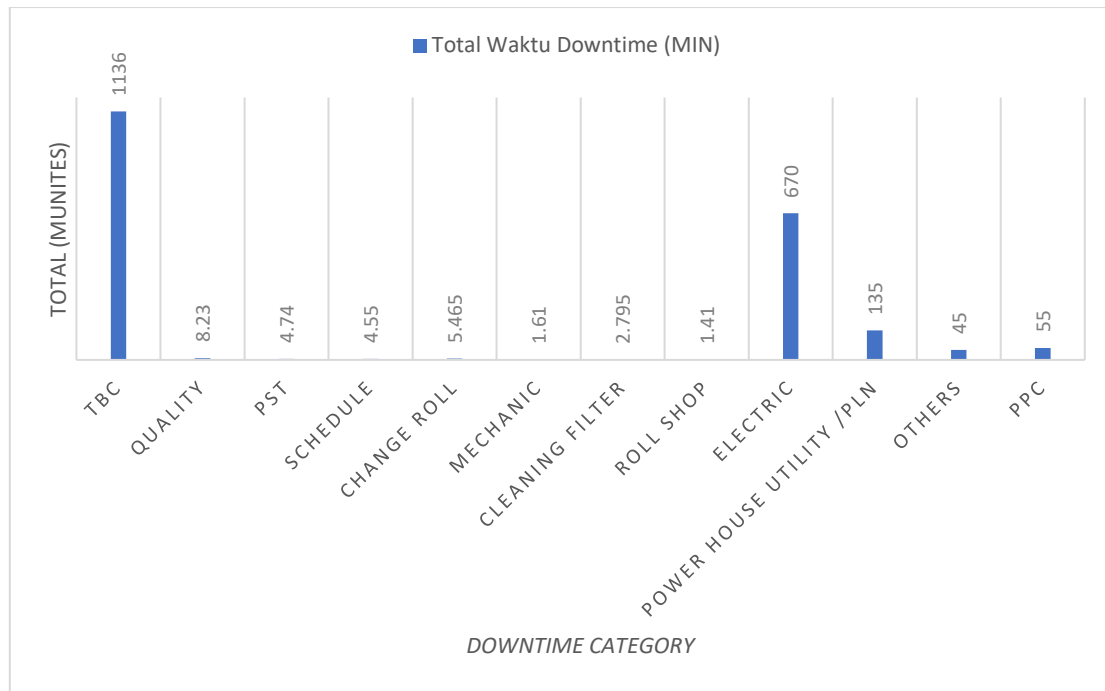


Figure 8. Vonroll Total Downtime Graph

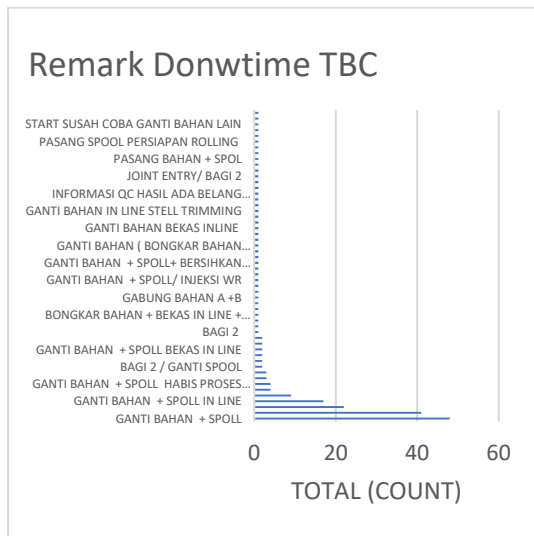


Figure 9. Vonroll TBC Remark Chart

2) Pitts Burgh Engine Downtime Identification

Figure 10 shows the total downtime of the Pitts Burgh engine by category. The results show that the TBC (Time Between Coil) category has the greatest Downtime duration compared to other categories, making it the dominant factor in engine operational disruption.

Furthermore, Figure 11 shows the details of the remarks in the TB category. The results of the analysis showed that the most frequent remark that appeared was "change the material

+ wait for the QC check", which is the process of replacing aluminum materials and the quality checking process by the QC team. The high frequency of this activity shows that the process of material replacement and QC inspection is one of the main causes of delays in the production process.

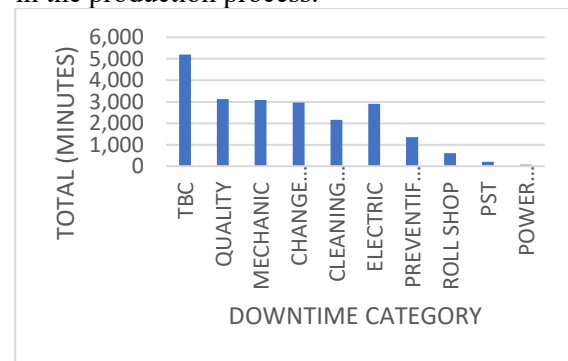


Figure 10. Pitts Burgh Engine Total Downtime Time Graph

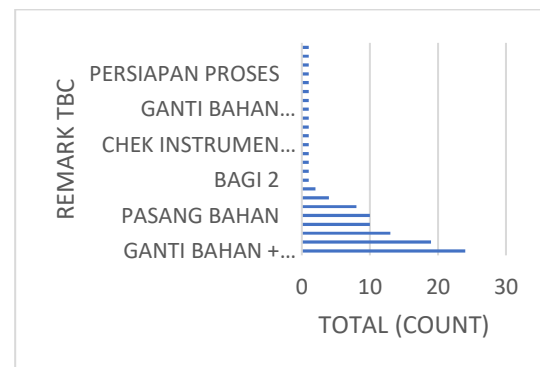


Figure 11. Pitts Burgh TBC Remark Chart

3) Implementation of Time Study Results

Based on the results of observations and calculations of time studies, a standard time estimate was obtained that represented the performance of the machine more accurately. A recapitulation of the standard time of activity on the Vonroll and Pitts Burgh machines is presented in Table 18.

Furthermore, the standard time was compared with the actual observed time to evaluate the conformity between the Furthermore, the standard time was compared with the actual observed time to evaluate the conformity between the established standard and the actual working conditions. Since the observed time was initially recorded in minutes, while the standard time was expressed in seconds, all observed time values were first converted into seconds by multiplying the recorded time in minutes by 60. The conformity level was then calculated using the ratio between the actual observed time and the corresponding standard time, as expressed in the following equation:

$$\text{Conformity Level (\%)} = \frac{\text{Actual Time (sec)}}{\text{Standard Time (Sec)}} \times 100\% \quad (4)$$

The recalculated conformity levels for the Vonroll and Pitts Burgh machines are presented in Table 19.

Table 18. Vonroll & Pitts Burgh Machine Raw Time Recapitulation

Mesin	Aktifitas	Waktu Baku
Vonroll	Mengangkat Material menggunakan Crane	19
	Menggeser Material untuk ambil Sampel	16
	Penggambilan Sampel untuk di cek oleh QC	12
	Crane bergeser untuk menempatkan material ke coil cark	122
	Material masuk ke Coil cark	58
	Coil cark digeser ke Cones	242
	Penyesuaian Posisi	64
	Menunggu report dari QC	164
	Material masuk ke roll 1 dan 4 (karena tidak ada trimming)	338
Pitts Burgh	Material dipindahkan dari Doubler menggunakan Crane	115
	Material masuk ke coil cark	13
	Material masuk ke cones	129
	Penyesuaian posisi dan potong material kotor	151
	Menunggu repor QC	29
	Proses entri material ke roll	249

Table 19. Comparison of Raw Time Before & After Vonroll and Pitts Burgh Machines

Machine	Activity	Actual Time (min)	Actual Time (sec)	Standard Time (sec)	Conformity Level (%)
Vonroll	Lifting Material Using Crane	0.18	10.8	19	56.8
	Shifting Material for Sampling	0.16	9.6	16	60
	Sampling for QC Inspection	0.12	7.2	12	60
	Crane Moving to Place Material onto Coil Car	1.11	66.6	122	54.6
	Material Entering the Coil Car	0.52	31.2	58	53.8
	Coil Car Moving to Cones	2.19	131.4	242	54.3
	Position Adjustment	0.58	34.8	64	54.4
	Waiting for QC Report	1.49	89.4	164	54.5
	Material Entering Rolls 1 and 4 (No Trimming)	3.09	185.4	338	54.9
Pitts Burgh	Material Transferred from Doubler Using Crane	1.07	64.2	115	55.8
	Material Entering the Coil Car	0.13	7.8	13	60
	Material Entering the Cones	1.2	72	129	55.8

	Position Adjustment and Cutting Dirty Material	1.4	84	151	55.6
	Waiting for QC Report	0.28	16.8	29	57.9
	Material Entry Process into the Roll	2.3	138	249	55.4

The conformity level was recalculated after standardizing all time measurements into seconds. The observed time values obtained from the measurement process were initially recorded in minutes, whereas the standard time values were expressed in seconds. Therefore, the observed time was first converted into seconds by multiplying the recorded value in minutes by 60. The conformity level was then calculated using the ratio between the actual observed time in seconds and the corresponding standard time in seconds, multiplied by 100%. The calculation formula is: Conformity Level (%) = (Actual Time (sec) / Standard Time (sec)) × 100%. Based on the recalculated results, the conformity levels for the Vonroll machine range from 53.8% to 60.0%, while those for the Pitts Burgh machine range from 55.4% to 60.0%. These results differ from the previously reported values because the previous calculation did not use consistent time units. The recalculated values provide a more consistent comparison between observed and standard time.

4) Implications for the Company

The findings provide several practical implications for improving production planning and realization at the company. The downtime analysis shows that TBC had the highest frequency on both Vonroll and Pitts Burgh machines, while Schedule recorded the longest total downtime on the Pitts Burgh machine. Therefore, improvement priorities should consider both the frequency of occurrence and the accumulated duration of downtime rather than relying on a single indicator. The time-study results further show that material handling, waiting for QC reports, and other activities during the TBC process contribute to differences between planned and actual production time. Based on these findings, the company can implement the following improvements:

- a) Production monitoring through CCTV. CCTV can be used to monitor critical production activities and verify deviations between planned and actual production

conditions, particularly during TBC activities and material changes. The monitoring system can support PPIC and production supervisors in identifying the timing and causes of deviations without relying solely on retrospective production reports. Its effectiveness can be evaluated through indicators such as the frequency and duration of TBC downtime, the number of deviations between planned and actual production time, and the response time to identified deviations.

- b) Improving material availability and production coordination. The high frequency of TBC downtime and the observed duration of material-handling activities indicate the need to ensure that materials and supporting resources are available before the next production cycle begins. Coordination between PPIC, warehouse, and production should therefore be strengthened to reduce waiting and material-change delays. Line balancing can also be considered to distribute workload more evenly between related activities. Improvement can be monitored through material-related downtime duration, waiting time before production, the frequency of material-change delays, and the gap between planned and actual production completion time.
- c) Improving QC inspection responsiveness. Waiting for QC reports is identified as one of the observed activities in the TBC process and can contribute to delays when inspection results are not available according to the planned production sequence. The QC inspection process should therefore be evaluated by establishing clearer response-time standards and coordination procedures between QC and production. The improvement can be measured through QC waiting time per production cycle, average inspection response time, frequency of production delays caused by QC waiting, and the proportion of production activities completed within the planned time.

Overall, these improvements should be evaluated using both downtime frequency and duration as well as the gap between planned and actual production time. This approach allows the company to determine whether corrective actions reduce recurring disruptions and shorten accumulated production losses, while also providing measurable evidence of improvements in production planning and realization.

4. Conclusions and Recommendations

Based on the results of the study on the application of the time study method in analyzing the incompatibility between planning and production realization at PT Indoaluminium Intikarsa Industri, it can be concluded that one of the main causes of production process delays is the high Downtime in the Time Between Coil (TBC) category which is influenced by material change activities, material handling processes, and quality inspection waiting times by the QC team. Through the application of the time study method, more accurate working time measurements were obtained so that cycle times, normal times, and standard times can be calculated on each element of production activities on Vonroll and Pitts Burgh machines. The results of the analysis show that the degree of conformity between the standard time and the actual time is in the range of 90% to 100%, which shows that the resulting raw time is representative enough to be used as a reference in the control of the production process time. However, some activities still have the potential to cause inefficiencies that can affect production delays. Therefore, companies are advised to improve production process control through a more systematic monitoring system, ensure the availability of materials before the production process begins, and evaluate work procedures in the process of material change and quality checks so that waiting times can be minimized so that the efficiency of the production process can be improved.

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