



Time Control Analysis on the Warehousing Construction Package and Supporting Facilities of Juwata Airport Using the Earned Value Method

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Abstract

The construction of warehouses and supporting facilities at *Juwata Airport* encountered multiple constraints that resulted in project delays. To mitigate these issues, a project control methodology was implemented using the Earned Value Method (EVM), which integrates cost and schedule performance analysis. Key performance indicators—including Cost Variance (CV), Schedule Variance (SV), Schedule Performance Index (SPI), and Cost Performance Index (CPI)—were utilized to assess progress, forecast final expenditures, and estimate completion timelines. Analysis indicated that during Weeks 20–26, negative CV values reflected cost overruns against the budget. Concurrently, negative SV values in Weeks 24–26 confirmed schedule slippage. While CPI remained >1 throughout Weeks 20–26 (indicating cost efficiency), SPI fell below 1 in Weeks 24–26, validating delays. The Estimate at Completion (EAC) projected a final cost of IDR 15,019,062,678.43, and the Time Estimate (TE) at Week 26 was 239 calendar days—a 28-day deviation from the baseline schedule. To recover schedule slippage, an acceleration strategy requiring an additional IDR 68,970,000 investment was proposed. This study underscores EVM's efficacy in monitoring construction project performance, enabling data-driven interventions to ensure on-time delivery.

Keywords: Earned Value, Cost and Time Performance, Job Acceleration

INTRODUCTION

Construction projects comprise a series of interrelated and complex activities that utilize specific resources to achieve safe and comfortable buildings within the constraints of time, cost, and quality. In the execution of construction work, *construction management* has the primary objectives of managing implementation, specifically focusing on schedule adherence, construction costs, and the quality of the finished work. A construction project is considered successfully managed if it delivers a finished product of quality in accordance with agreed-upon specifications, on time, and within the allocated budget.

The interdependence and complexity of construction activities can lead to various challenges, such as unskilled labor, delayed completion, and excessive or inefficient material usage, all of which result in unplanned costs. The success of construction project execution is crucial for supporting regional development; therefore, careful consideration of cost efficiency is essential, as it impacts both the complexity of operations and material usage. This underscores the need for the development of robust work management

systems, including precise engineering planning, effective scheduling, and efficient cost control and management.

During project execution, several supporting factors require attention. A project is fundamentally an activity conducted within a defined timeframe, utilizing allocated resources to produce an output with clear and predetermined quality standards. As projects grow in scale and complexity, the involvement of materials, labor, and advanced technology becomes increasingly significant. Consequently, every project must have a defined deadline, meaning that all activities should be completed on or before the agreed-upon date. Effective time management is critical to minimize delays caused by unforeseen factors such as adverse weather, equipment failures, or material delivery issues. Therefore, comprehensive management is required throughout the project lifecycle, from initiation to completion.

Construction management plays a pivotal role in the planning and execution phases of a project. Successful project delivery demands meticulous planning, involving competent personnel or service providers such as planning consultants, contractors, and supervisory consultants. Developing a work plan is one of the initial planning steps, aimed at maximizing the effectiveness and efficiency of resources—including manpower, machinery, methods, materials, and money—throughout project execution. Job classifications should be organized according to qualifications, and proper scheduling with optimal resource allocation is essential for project success. Additionally, management must address delays through project controls, including schedule acceleration strategies such as *crashing*. *Crashing* involves analyzing cost variables to determine the most economical means of reducing project duration, focusing on activities along the *critical path*, which is typically identified using specialized software. The results of *crashing* directly impact the project's completion timeline.

In the case of the *Warehousing Development Work and Supporting Facilities at Juwata Airport*, several obstacles related to cost and schedule were encountered during construction. Progress delays led to increased costs, and failure to complete work on time could result in the imposition of late penalties. To address these issues, the author employs the *Earned Value Method* (EVM) to evaluate both cost and schedule performance. The analysis utilizes three key indicators: *Actual Cost of Work Performed* (ACWP), *Budgeted Cost of Work Performed* (BCWP), and *Budgeted Cost of Work Scheduled* (BCWS). These indicators enable calculation of performance metrics such as Cost Variance (CV), Schedule Variance (SV), Schedule Performance Index (SPI), and Cost Performance Index (CPI), as well as forecasts for project cost and completion time. Thus, the *Earned Value Method* is a valuable tool for project control and management, helping to prevent and optimize the resolution of delays so that completion aligns with the planned schedule.

The purpose of this study is to analyze the performance of the warehousing construction project and supporting facilities at *Juwata Airport* by measuring Cost Variance (CV), Schedule Variance (SV), Schedule Performance Index (SPI), and Cost Performance Index (CPI). The findings of

this research are expected to contribute valuable insights to all stakeholders involved in construction project management.

RESEARCH METHODS

This study uses a quantitative approach based on secondary data obtained from CV project documents. Fajar Karya as the implementing contractor. The research was carried out for 12 weeks, starting from the colloquium stage to the completion of the thesis report in the first week of January 2025. The data collected consists of several types, namely: Cost Budget Plan (RAB) of the contract, which contains the analysis of unit prices, wage lists, and material prices that have been agreed upon in the work contract between the project owner and the implementing contractor; time schedule (S Curve), which includes the implementation schedule of the plan (Master Schedule) as well as the realization schedule that is updated weekly based on the progress of the work; and weekly and monthly reports, which contain information on the volume and weight of work progress in a period.

The data analysis technique is carried out through several stages. First, analyze the factors that affect the progress of the work, including interviews with the implementing contractors and evaluation of weekly reports to find out the percentage of work that has been completed. Second, analyzing project performance using the Earned Value Management (EVM) method by calculating basic indicators such as BCWS (Budgeted Cost of Work Scheduled), BCWP (Budgeted Cost of Work Performed), and ACWP (Actual Cost of Work Performed). This analysis includes performance evaluation based on cost aspects (Cost Variance/CV and Cost Performance Index/CPI) as well as time aspects (Schedule Variance/SV and Schedule Performance Index/SPI). In addition, cost and time estimates for future work are also calculated, including Estimate to Complete (ETC), Estimate at Completion (EAC), and Time Estimate (TE).

The next stage is a cost need analysis to ensure project completion on schedule using the crashing method. Finally, conclusions are drawn from the results of the analysis carried out, accompanied by relevant recommendations for future project management improvements. This approach is expected to be able to provide a comprehensive overview of project performance as well as strategic solutions for optimizing the implementation of construction work.

RESULTS AND DISCUSSION

Analysis and Interpretation of Results

The analysis is carried out from the secondary data that has been obtained, namely the cost budget plan (RAB), *Time Schedule* (Plan and actual/realization), weekly work and financial reports for the implementation of work. And in this study, the review began to be carried out in the 20th to 26th week.

Analysis of Earned Value Indicators

The *earned value indicators* that are considered are *Planned Value* (PV) or BCWS (*Budget Cost of Work Schedule*), *Earned Value* (EV) or BCWP

(*Budget Cost of Work Performance*) and *Actual Cost (AC)* or *ACWP (Actual Cost of Work Performance)*.

Planned Value (PV) or Budget Cost Of Work Schedule (BCWS)

The *Planned Value (PV)* or *BCWS (Budget Cost of Work Schedule)* in this project is the cost budget allocated for the implementation of work based on the work plan for a certain time, where the value of the 1st amendment contract (Addendum 1) excluding VAT is Rp. 12,469,058,523.00 then calculated PV or BCWS with the percentage of plan progress data contained in the *time schedule* and project implementation costs listed in the cost budget plan (RAB). The calculation with the following formula:

The calculation of PV or BCWS in the 20th week of the period 2 – 8 September 2024 is as follows:

PV or BCWS = % plan progress x total project budget

PV or BCWS = 5.79% x Rp. 12,469,058,523

PV or BCWS = Rp. 721,958,488.48

For the calculation of the next week, it is carried out in the same way as the calculation above.

From the calculation results, PV or BCWS is obtained in the 26th week of the period 14 – 20 October 2024 as follows:

PV or BCWS = % plan progress x total project budget

PV or BCWS = 73.43% x Rp. 12,469,058,523

PV or BCWS = Rp. 9,156,029,673.44

The graph of PV or BCWS calculation results for weeks 20 to 26 can be seen in the following figure 4.2:

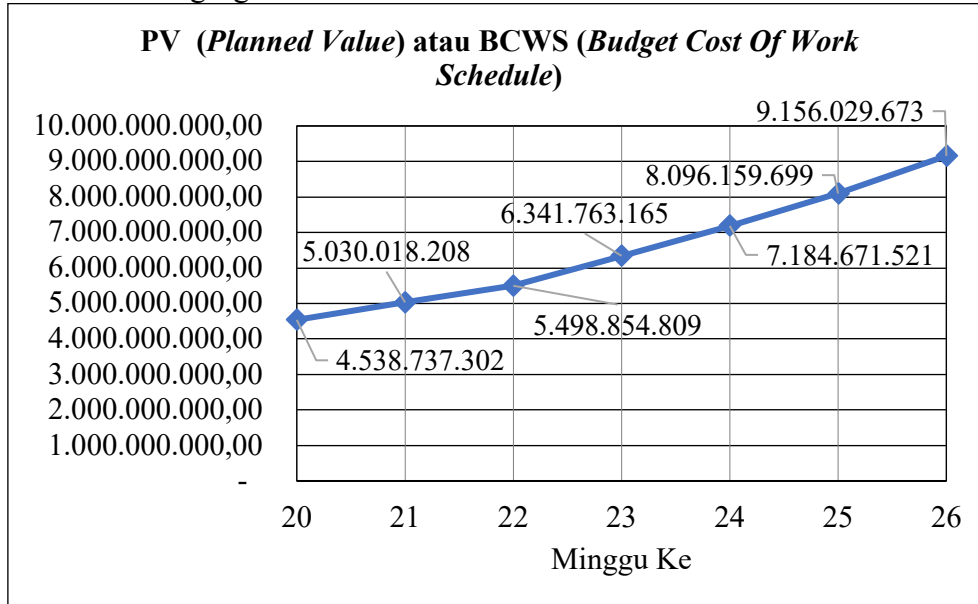


Figure 1. PV Graphics (*Planned Value*) or BCWS (*Budget Cost of Work Schedule*) 20th to 26th Week

Source: Author's analysis results 2024

Earned Value (EV) or Budget Cost Of Work Performance (BCWP)

Earned Value (EV) or BCWP (Budget Cost of Work Performance) in this project is the cost budget allocated for the work that has been completed. Where EV or BCWP is obtained by multiplying the percentage of progress that has been implemented by the total project budget, where the total project budget value for the 1st amendment contract excluding VAT is Rp. 12,469,058,523.00. The calculation with the following formula:

EV or BCWP = (% realization/actual progress) x (total project budget)

The calculation of EV or BCWP in the 20th week of the period 2 – 8 September 2024 is as follows:

EV or BCWP = % realization/actual progress x total project budget

EV or BCWP = 3.8% x Rp. 12,469,058,523

EV or BCWP = Rp. 473,824,223.87

For the calculation of the next week, it is carried out in the same way as the calculation above. And the results of the calculation for the next week.

From the results of the calculation above, EV or BCWP is obtained in the 26th week of the period 14 – 20 October 2024 as follows:

EV or BCWP = % plan progress x total project budget

EV or BCWP = 64.48% x Rp. 12,469,058,523

EV or BCWP = Rp. 8,040,048,935.63

The graph of the results of the calculation of EV or BCWP for weeks 20 to 26 can be seen in the following figure 2:

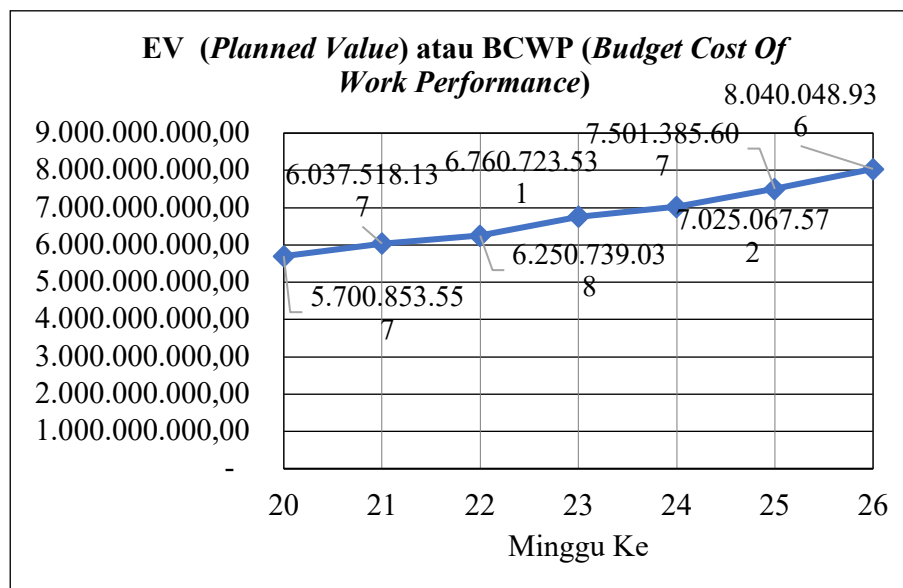


Figure 2. EV Graph (*Earned Value*) or BCWP (*Budget Cost of Work Performance*) 20th to 26th Week

Source: Author's analysis results 2024

Actual Cost (AC) or Actual Cost of Work Performance (ACWP)

The *Actual Cost (AC)* or *ACWP (Actual Cost of Work Performance)* in this project is the direct and indirect costs incurred to complete the work during a certain period. *Actual Cost (AC)* used as follows:

a. Direct Costs

The direct cost for the implementation of the Juwata Airport Warehousing and Supporting Facilities project is material costs, labor costs and equipment costs.

b. Indirect Costs

Indirect costs for the implementation of the Juwata Airport Warehousing and Supporting Facilities Development project are office overhead and field overhead, where details can be seen in the appendix.

The calculation with the following formula:

AC or ACWP = direct costs + indirect costs

The calculation of AC or ACWP in the 20th week of the period 2 – 8 September 2024 is as follows:

AC or ACWP = direct costs + indirect costs

AC or ACWP = Rp. 473,824,223.87 + Rp. 29,673,000.00

AC or ACWP = Rp. 503,497,224

For the calculation of the next week, it is carried out in the same way as the calculation above.

From the results of the calculation above, AC or ACWP is obtained in the 26th week of the period 14-20 October 2024 as follows:

AC or ACWP = direct costs + indirect costs

AC or ACWP = Rp. 665,847,725.13 + Rp. 21,245,664.00

AC or ACWP = Rp. 1,079,868,733.60

The graph of the results of the AC or ACWP calculation for weeks 20 to 26 can be seen in the following figure 3:

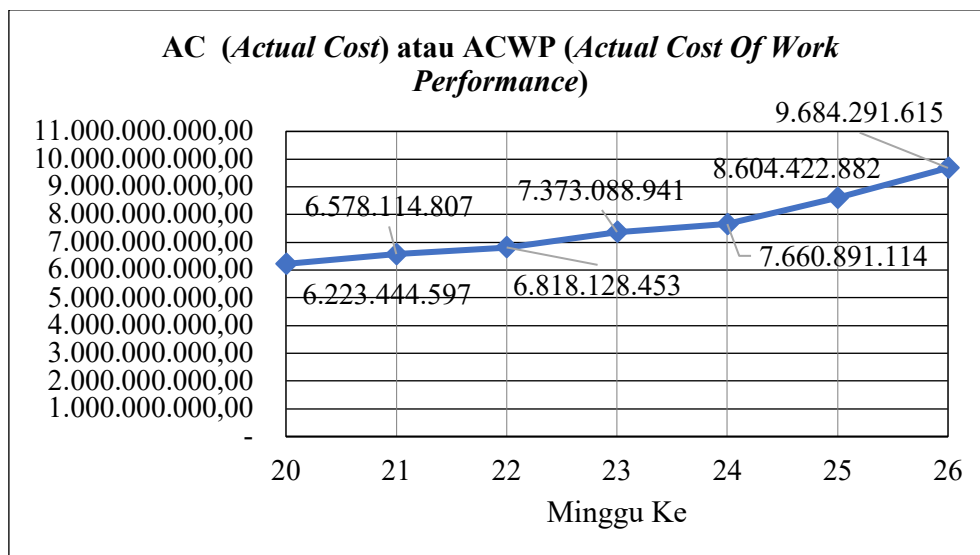


Figure 3. EV Graph (*Earned Value*) or BCWP (*Budget Cost of Work Performance*) 20th to 26th Week

Source: Author's analysis results 2024

Cost and Time Variance Analysis

The analysis calculation was carried out to obtain the value of the cost variance (*Cost Variance* / CV) and the value of the time variance (*Schedule Variance* / SV).

Cost Variance (CV)

Cost *Variance* (CV) is calculated in the 20th week of the period 2 – 8 September 2024 as follows:

$$CV = BCWP - ACWP$$

$$CV = 5,700,853,556.72 - 6,223,444,597.27$$

$$CV = - 522,591,040.56$$

The results of the CV calculation are negative, which means that the costs that have been incurred are greater than planned. For the calculation of the next week, it is carried out in the same way as the calculation above. And the results of the calculation for the next week can be seen in the following table 4.9:

Table 1. Cost Variance Value Results (CV)				
Sunday Period	BCWP (Rs.)	ACWP (Rs)	CV (Rs.)	Information
The – 20	5.700.853.556,72	6.223.444.597,27	- 522.591.040,56	Larger
The – 21	6.037.518.136,84	6.578.114.807,39	- 540.596.670,56	Larger
The – 22	6.250.739.037,58	6.818.128.452,99	-567.389.415,41	Larger
The – 23	6.760.723.531,17	7.373.088.940,73	-612.365.409,56	Larger
The – 24	7.025.067.571,86	7.660.891.114,42	-635.823.542,56	Larger
The – 25	7.501.385.607,44	8.604.422.882,45	- 1.103.037.275,01	Larger
The – 26	8.040.048.935,63	9.684.291.615,05	- 1.644.242.679,42	Larger

Source: Author's analysis results 2024

From the results of the calculation above, the CV was obtained in week 20 to week 26 with negative results (-) showing that the project costs that had been incurred for the implementation of the work were greater than planned.

Schedule Variance (SV)

Time Variance / *Schedule Variance* (SV) is calculated in the 20th week of the period 2 – 8 September 2024 as follows:

$$SV = BCWP - BCWS$$

$$SV = 5,700,853,556.72 - 4,538,737,302.37$$

$$SV = 1,162,116,254.34$$

The results of the SV calculation are positive, which means that the work is faster than planned. For the calculation of the next week, it is carried out in the same way as the calculation above. And the results of the calculation for the next week can be seen in the following table 2:

Table 2. Time Variance (SV) Value Results				
Sunday Period	BCWP (Rs.)	BCWS (Rs)	SV (Rs.)	Information
The – 20	5.700.853.556,72	4.538.737.302,37	1.162.116.254,34	Faster
The – 21	6.037.518.136,84	5.030.018.208,18	1.007.499.928,66	Faster

Table 3. Advanced Time Variant (SV) Value Results

Sunday Period	BCWP (Rs.)	BCWS (Rs.)	SV (Rs.)	Information
The – 22	6.250.739.037,58	5.498.854.808,64	751.884.228,94	Faster
The – 23	6.760.723.531,17	6.341.763.164,80	418.960.366,37	Faster
The – 24	7.025.067.571,86	7.184.671.520,95	-159.603.949,09	Late
The – 25	7.501.385.607,44	8.096.159.698,98	-594.774.091,55	Late
The – 26	8.040.048.935,63	9.156.029.673,44	-1.115.980.737,81	Late

Source: Author's analysis results 2024

From the results of the calculation above, the SV obtained in the 24th to 26th week of the period of September 30 – October 20, 2024 amounting to Rp. 1,115,980,737.81, which shows that the project is delayed from the planned schedule.

Cost and Time Performance Index Analysis

The analysis calculation was carried out to obtain the cost performance index (CPI) and the time performance value (*Schedule Performance Index* / SPI).

Cost Performance Index (CPI)

The *Cost Performance Index* (CPI) is calculated in the 20th week of the period 2 – 8 September 2024 as follows:

$$\text{CPI} = \text{BCWP} / \text{ACWP}$$

$$\text{CPI} = 5,700,853,556.72 - 6,223,444,597.27$$

$$\text{CPI} = 0.92$$

The result of the CPI calculation is > 0 which means that the costs that have been incurred are smaller than planned. For the calculation of the next week, it is carried out in the same way as the calculation above. And the results of the calculation for the next week can be seen in the following table 4.12:

Table 4. Cost Performance Index (CPI) Results

Sunday Period	BCWP (Rs.)	ACWP (Rs.)	CPI (Rs.)	Information
The – 20	5.700.853.556,72	6.223.444.597,27	0,92	Smaller
The – 21	6.037.518.136,84	6.578.114.807,39	0,92	Smaller
The – 22	6.250.739.037,58	6.818.128.452,99	0,92	Smaller
The – 23	6.760.723.531,17	7.373.088.940,73	0,92	Smaller
The – 24	7.025.067.571,86	7.660.891.114,42	0,92	Smaller
The – 25	7.501.385.607,44	8.604.422.882,45	0,87	Smaller
The – 26	8.040.048.935,63	9.684.291.615,05	0,83	Smaller

Source: Author's analysis results 2024

From the results of the calculation above, the CPI in week 20 to week 26 is greater than 0 ($\text{CPI} > 0$) shows that the costs incurred are smaller than planned.

Schedule Performance Index (SPI)

The *Schedule Performance Index* (SPI) is calculated in the 20th week of the period 2 – 8 September 2024 as follows:

$$\text{SPI} = \text{BCWP} / \text{BCWS}$$

$$SPI = 5,700,853,556.72 - 4,538,737,302.37$$

$$SPI = 1.26$$

The results of the calculation of $SPI > 1$ which means that the work was completed on time according to the planned schedule. For the calculation of the next week, it is carried out in the same way as the calculation above.

From the results of the calculation, the SPI in week 24 to week 26 was less than 1 ($SPI < 1$) showing that there was a delay in completing the work from the planned schedule.

Project Cost and Time Estimate

Calculation to get an estimate of the Residual Work Cost / *Eestimate to Complate* (ETC) and Project Completion Cost / Estimate at Complete (EAC) as well as the estimated length of time needed until the work is completed.

Estimate to Complete (ETC)

ETC is an estimate of the cost for the remaining work until the end of the project. The calculation of ETC for week 26 with a progress value of $> 50\%$ is as follows:

$$\begin{aligned} ETC &= (BAC - BCWP) / CPI \\ &= (Rp. 12,469,058,523.00 - Rp. 8,040,048,935.63) / 0.83 \\ &= Rp. 5,334,771,063.38 \end{aligned}$$

So the cost needed for the implementation of the work in the 27th to the 29th week is 5,334,771,063.38

Estimate at Complete (EAC)

EAC is an estimate of the total cost until the end of the project. The calculation of EAC in week 26 is as follows:

$$\begin{aligned} EAC &= ACWP + ETC \\ &= Rp. 9,684,291,615,0496 + Rp. 5,334,771,063.38 \\ &= Rp. 15,019,062,678.43 \end{aligned}$$

So the cost needed until the work is completed is Rp. 15,019,062,678.43. So the budget difference between the contract and the estimate is Rp. 15,019,062,678, 43 - Rp. 12,469,058,523.00 = Rp. 2,550,004,155.43

Time Estimate (TE)

TE is the estimated time of project completion, where the project is completed according to the planned schedule or more than the planned schedule. TE is calculated in week 26 as follows:

$$\begin{aligned} TE &= ATE + ((OD - (ATE \times SPI)) / SPI) \\ &= 182 + ((210 - (182 \times 0.88)) / 0.88) \\ &= 239 \text{ Calendar Days} \end{aligned}$$

In the same calculation method, the calculation of the next week is carried out in the same way as the calculation above. The time required to complete the work is 34 weeks or 238 calendar days, so there is an additional 28 calendar days of work duration from the schedule in the 210-calendar day contract.

Analysis of Project Completion Estimates as Planned

Identify work items that have increased the volume of work that cause critical paths to be analyzed to accelerate the work so that the project is completed according to the planned schedule.

Critical Path Analysis

Critical Path is one of the analysis methods for identifying critical path paths using Microsoft Project software or software. The steps taken are to input / enter project activities and duration into Microsoft Project then connect between activities according to the planned schedule to produce a work network diagram, where the network diagram describes activities or tasks to help organize and monitor the project from start to finish. The critical path is determined from the work network diagram,

The data that is entered / input into Microsoft Project is the work activity and the duration of the work time starting from April 22, 2024 to November 17, 2024 according to the time schedule for the implementation of the work. And for working hours is 8 hours starting from 08.00 – 17.00 and there are no holidays due to the work contract of 210 calendar days. The results of the critical path of the Microsoft Project can be seen in the following figure 4.6:

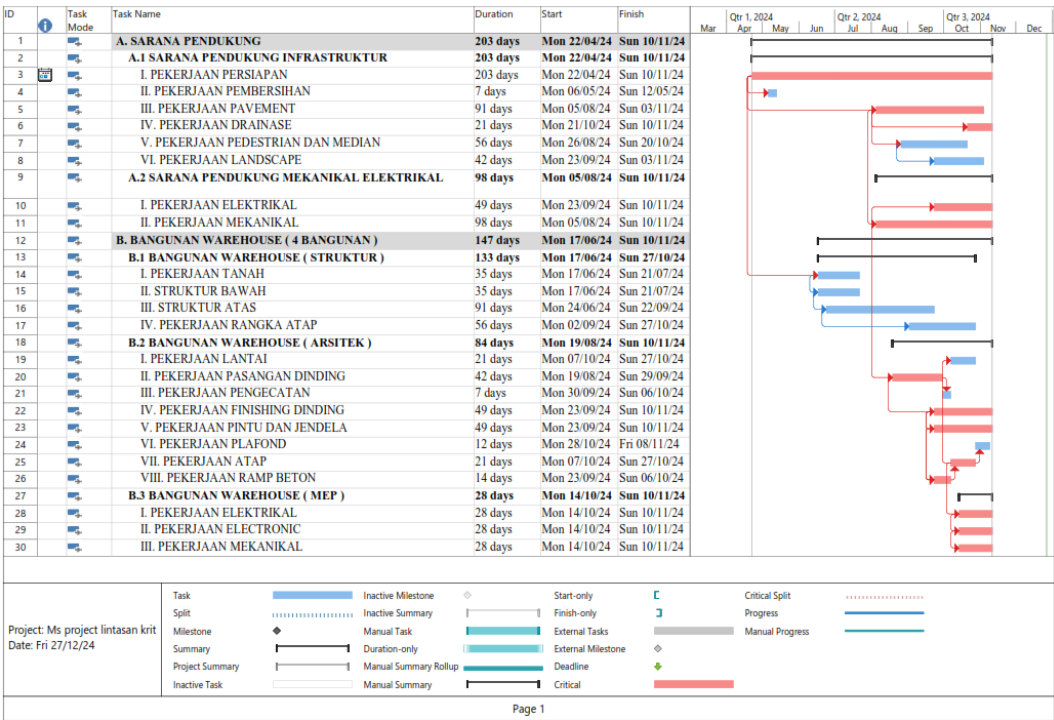


Figure 4. Results of employment relationships according to the time schedule addendum 1

Source: Author's processed results 2024

Based on the critical trajectory, the works that are on the critical trajectory are preparation work, pavement work, drainage work, electrical work, mechanical work, wall pairing work, painting work, wall finishing work, door and window work, roofing work, concrete ramp work, electrical work, electronic work and

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mechanical work. Of the several works on the critical track, the work that experienced the most delays was the wall finishing work of -5.61%.

Next, analyze the length of the delay duration according to the deviation and the percentage of the plan according to *Time schedule Addendum 1* for work included in the critical trajectory. The results of the analysis of the duration of work delays can be seen in the following table 5:

Table 5. Results of Delay Duration Analysis

Yes	Job Description	Deviation	Plan Progress (%)	Delays (Calendar Days)
1	PAVEMENT WORK	-0,55	1,58	1
2	DRAIN WORK	-0,75	0,06	13
3	ELECTRICAL WORK	-4,51	0,66	7
4	MECHANICAL WORK	-4,29	0,48	9
6	WALL FINISHING WORK	-5,61	0,8	8
7	DOOR AND WINDOW WORK	-4,28	0,73	6
9	ELECTRICAL WORK	-0,85	0,33	3
10	ELECTRONIC WORK	-3,29	0,9	4
11	MECHANICAL WORK	-0,89	0,35	3

Source: Author's analysis results 2024

Based on the table above, it is entered into the Microsoft Project Back to know the critical trajectory and the completion date of the work. The results of the *critical path* of the *Microsoft Project* can be seen in the following figure 5:

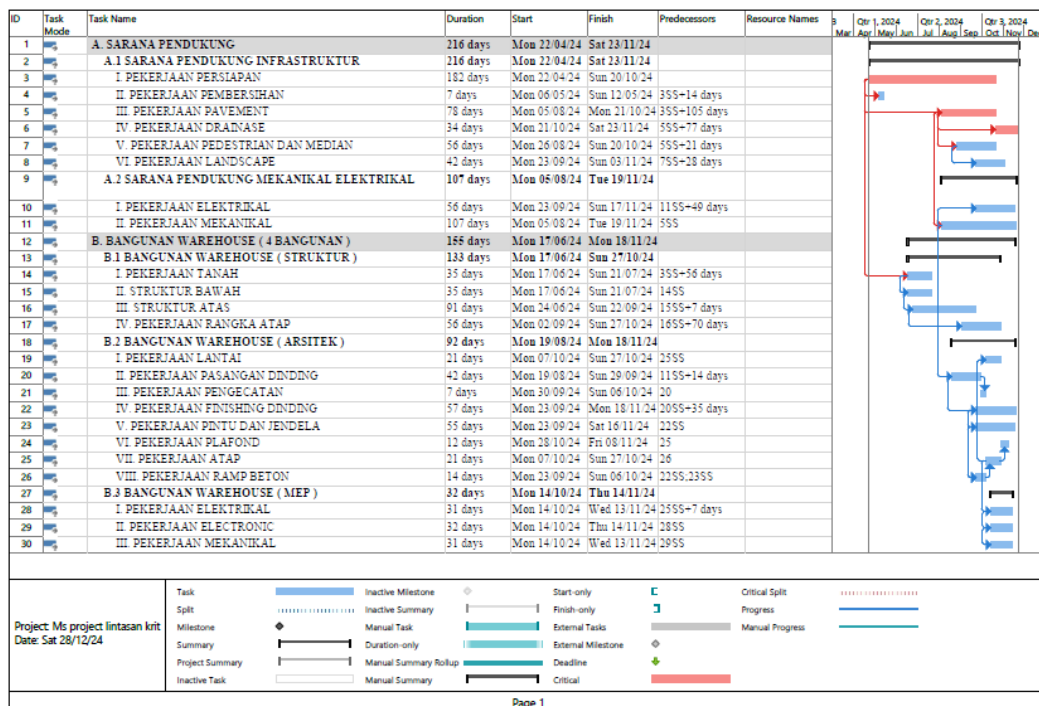


Figure 5. Results of the employment relationship according to the duration of the delay

Source: Author's processed results 2024

Based on the critical trajectory above, the work that is on the critical trajectory path is preparation work, pavement work and drainage work.

Crashing Analysis

Acceleration of work (crashing) to analyze the acceleration work that experiences the most delay by means of adding resources, in this case is labor, especially workers. Based on the results of the critical path analysis, the largest deviation in the pavement work of the concrete slab work consists of concrete work K-300, steel wire mesh work, Ø25 mm dowel work, D-13 supporting ironing work, Ø8 wiremesh chicken leg installation work, concrete formwork and curing work. The following is the *crashing* calculation for pavement work on the work section Making 1 m³ of quality concrete f_c = 26.4 MPa (K 300):

a. *Crash Duration*

Duration of work	: 70 Days
Worker coefficients	: 1,6500
Builder coefficients	: 0,2750
Builder head coefficient	: 0,0280
Foreman coefficient	: 0,0830
Work units	: 1 m ³
Total volume of work	: 598.55 m ³
Work delays	: <i>Time estimate</i> – Total contract time : 239 calendar days – 210 calendar days : 29 calendar days
Number of employees of work	= (Vol. of work x Koef. of workers) / duration = (598.55 x 1.65) / 70 = 14.11 people ≈ 15 people
Number of builders of work	= (Vol. of work x Koef. of workers) / duration = (598.55 x 0.275) / 70 = 2.35 people ≈ 3 people
Number of handyman's heads	= (Vol. work x Koef. worker) / duration of pack. = (598.55 x 0.028) / 70 = 0.24 people ≈ 1 person
Number of foremen of work	= (Vol. of work x Koef. of workers) / duration = (598.55 x 0.083) / 70 = 0.71 people ≈ 1 person
Number of Employees <i>Crashing</i> Number of employees)	= Number of employees + (100% x = 15 + (100% x 15) = 30 people
Production capacity	= Worker / Worker Coefficient = 1 / 1.65 = 0.606

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$$\begin{aligned}\text{Duration Crashing} &= \text{Volume of work} / (\text{Production capacity} \times \text{number of workers Crashing}) \\ &= 598.55 \text{ m}^3 / (0.606 \times 30 \text{ people}) \\ &= 32.92 \text{ days} \approx 33 \text{ days}\end{aligned}$$

$$\begin{aligned}\text{Acceleration (Crashing)} &= \text{Duration of Work} - \text{Total Duration of Crashing} \\ &= 70 - 33 \\ &= 37 \text{ Days}\end{aligned}$$

b. *Crash Cost*

Worker : 15 people
Craftsman : 3 people
Head builder : 1 person
Foreman : 1 person

Normal duration work costs

$$\begin{aligned}\text{Worker} &= 15 \text{ people} \times 70 \text{ days} \times \text{Rp. } 120,000 = \text{Rp. } 126,000,000 \\ \text{craftsman} &= 3 \text{ people} \times 70 \text{ days} \times \text{Rp. } 120,000 = \text{Rp. } 30,450,000 \\ \text{Worker} &= 1 \text{ person} \times 70 \text{ days} \times \text{IDR } 120,000 = \text{IDR } 10,500,000 \\ \text{Worker} &= 1 \text{ person} \times 70 \text{ days} \times \text{IDR } 120,000 = \text{IDR } 11,200,000 \\ \text{Total labor costs with normal duration} &= \text{IDR } 178,150,000\end{aligned}$$

Number of manpower after the duration of *the crash*

$$\begin{aligned}\text{Number of employees of work} &= (\text{Vol. of work} \times \text{Koef. of workers}) / \text{duration of work} \\ &= (598.55 \times 1.65) / 33 \\ &= 29.93 \text{ people} \approx 30 \text{ people}\end{aligned}$$

$$\begin{aligned}\text{Number of builders of work} &= (\text{Vol. of work} \times \text{Koef. of workers}) / \text{duration of work} \\ &= (598.55 \times 0.275) / 33 \\ &= 4.99 \text{ people} \approx 5 \text{ people}\end{aligned}$$

$$\begin{aligned}\text{Number of handyman's heads pack.} &= (\text{Vol. work} \times \text{Koef. worker}) / \text{duration of pack.} \\ &= (598.55 \times 0.028) / 33 \\ &= 0.51 \text{ people} \approx 1 \text{ person}\end{aligned}$$

$$\begin{aligned}\text{Number of foremen} &= (\text{Vol. of work} \times \text{Koef. of workers}) / \text{duration of work} \\ &= (598.55 \times 0.083) / 33 \\ &= 1.51 \text{ people} \approx 1 \text{ person}\end{aligned}$$

So the amount of labor after the duration of *the crash*

$$\begin{aligned}\text{Worker} &= 30 \text{ people} - 15 \text{ people} = 15 \text{ people} \\ \text{Craftsman} &= 5 \text{ people} - 3 \text{ people} = 2 \text{ people} \\ \text{Head builder} &= 1 \text{ person} - 1 \text{ person} = 0 \text{ people} \\ \text{Foreman} &= 1 \text{ person} - 1 \text{ person} = 0 \text{ people}\end{aligned}$$

Cost of work with *crash duration*

$$\begin{aligned}\text{Worker} &= 15 \text{ people} \times 33 \text{ days} \times \text{Rp. } 120,000 = \text{Rp. } 118,800,000 \\ \text{craftsman} &= 2 \text{ people} \times 33 \text{ days} \times \text{Rp. } 120,000 = \text{Rp. } 14,355,000 \\ \text{Total labor cost with crash duration} &= \text{Rp. } 68,970,000\end{aligned}$$

So, the total cost needed for the acceleration of the work is Rp. 68,970,000

Result Analysis

From the analysis of the three indicators that have been taken into account, it can provide an overview of the achievement of cost and time cumulatively each week, here is a recapitulation of the three indicators (PV, EV and AC) which can be seen in the following table 6:

Table 6. Recapitulation of PV (BCWS), EV (BCWP) and AC (ACWP) values

Sunday Period	PV (BCWS) (Rs.)	EV (BCWP) (Rs.)	AC (ACWP) (Rs.)
The – 20	4.538.737.302,37	5.700.853.556,72	6.186.891.530,59
The – 21	5.030.018.208,18	6.037.518.136,84	6.049.731.886,84
The – 22	5.498.854.808,64	6.250.739.037,58	6.262.952.787,58
The – 23	6.341.763.164,80	6.760.723.531,17	6.772.937.281,17
The – 24	7.184.671.520,95	7.025.067.571,86	7.037.281.321,86
The – 25	8.096.159.698,98	7.501.385.607,44	7.513.599.357,44
The – 26	9.156.029.673,44	8.040.048.935,63	8.052.262.685,63

Source: Author's data processing 2024

And the graph of the relationship of the three indicators (PV, EV and AC) can be seen in the following figure 6:

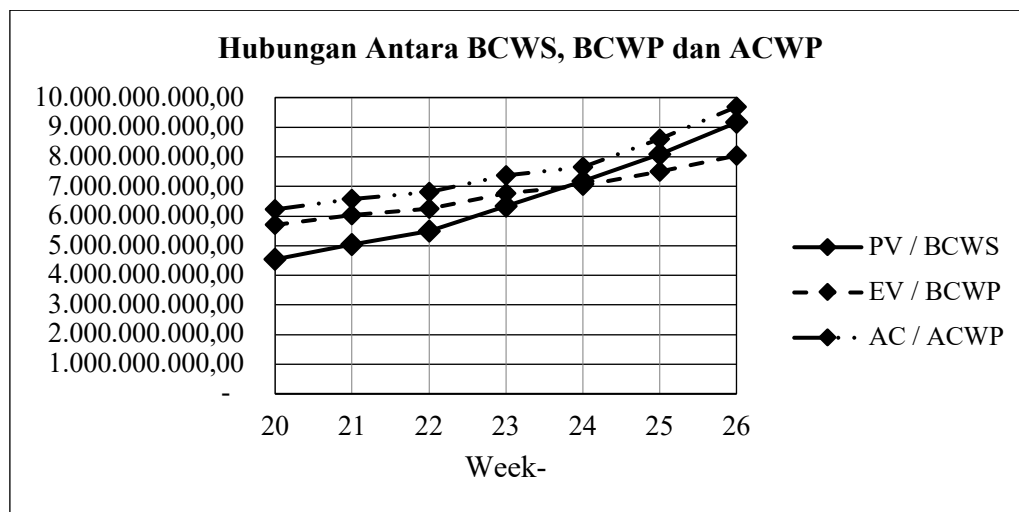


Figure 6. Graph of the Relationship Between PV/BCWS), EV (BCWP) and AC (ACWP)

Source: Author's Processed Results 2024

From the graph above, it can be seen that the BCWP curve for weeks 24 to 26 is located below the BCWS curve, which means that the work is done later than the planned schedule while the ACWP curve in weeks 20 to 26 is above the BCWS and BCWP curves, which means that the costs incurred are greater than planned.

The analysis of cost and time variants that have been calculated can provide an overview of the value of the results of cost and time variants

cumulatively each week, following a recapitulation of cost and time variants (CV and SV) which can be seen in the following table 7:

Table 7. Recapitulation of CV values (*Cost Variance*) and SV (*Schedule Variance*)

Sunday Period	CV (Rs.)	SV (Rs)
The – 20	522.591.040,56	1.162.116.254,34
The – 21	540.596.670,56	1.007.499.928,66
The – 22	567.389.415,41	751.884.228,94

Source: Author's data processing 2024

**Table 8. Recapitulation of CV values (*Cost Variance*) and SV (*Schedule Variance*)
Advanced**

Sunday Period	PV (BCWS) (Rs.)	EV (BCWP) (Rs)
The – 23	612.365.409,56	418.960.366,37
The – 24	7.184.671.520,95	7.025.067.571,86
The – 25	8.096.159.698,98	7.501.385.607,44
The – 26	9.156.029.673,44	8.040.048.935,63

Source: Author's data processing 2024

And the graph of the relationship between the value of the cost and time variance results (CV and SV) can be seen in the following figure 7:

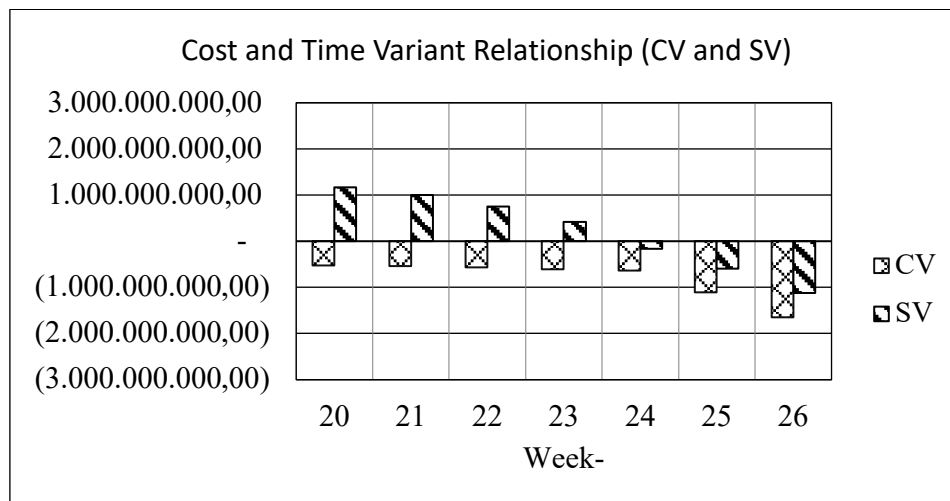


Figure 7. Cost and Time Variant Graph (CV and SV)

Source: Author's Processed Results 2024

From the graph above, it can be seen that the CV curve shows negative results, which can be interpreted as poor cost performance. The SV curve in weeks 24 to 26 shows that negative numbers can be interpreted as work time performance is delayed and in weeks 20 to 23 shows positive numbers can be interpreted as good time performance or completed according to the plan schedule but in terms of poor cost performance.

The analysis of the cost and time performance index that has been calculated can provide an overview of the value of cost and time performance results cumulatively each week, following the recapitulation of the cost and

time performance index (CPI and SPI) which can be seen in the following table 9:

Table 9. Recapitulation of CV values (*Cost Variance*) and SV (*Schedule Variance*)

Sunday Period	CPI	SPI
The – 20	0,92	1,26
The – 21	0,92	1,20
The – 22	0,92	1,14
The – 23	0,92	1,07
The – 24	0,92	0,98
The – 25	0,87	0,93
The – 26	0,83	0,88

Source: Author's data processing 2024

And the graph of the relationship between the value of the cost and time performance results (CPI and SPI) can be seen in the following figure 8.

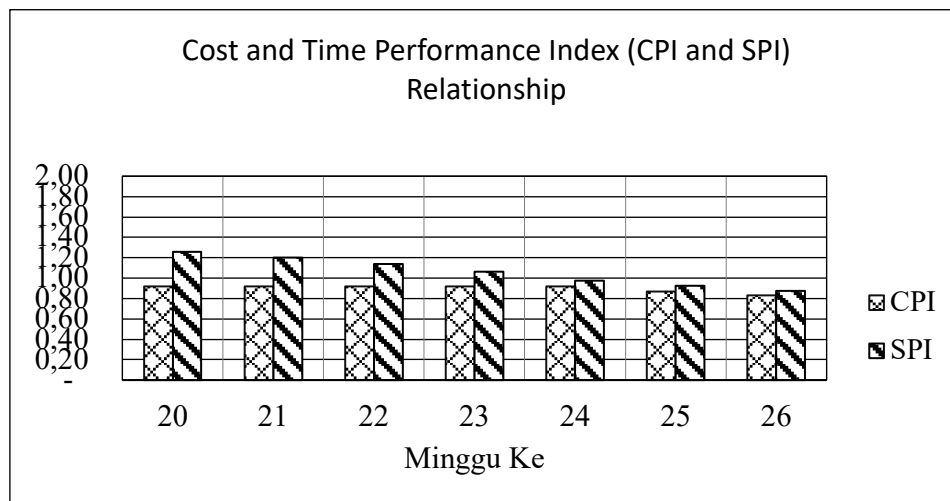


Figure 8. Cost and Time Performance Index (CPI and SPI) Chart

Source: Author's Processed Results 2024

From the graph above, it can be seen that the CPI curve shows that the CPI result > 0 can be interpreted as a smaller cost performance. The SV curve in weeks 24 to 26 shows that the results of $SPI < 1$ can be interpreted as the performance of work time is delayed and in weeks 20 to 23 shows the results of $SPI > 1$ can be interpreted as performance on time or completed on time.

Estimated Residual Work Costs / *Eestimate to Complate* (ETC) and Project Completion Costs / *Estimate at Complete* (EAC) as well as the estimated length of time needed until the work is completed can be seen in the following figure 9:

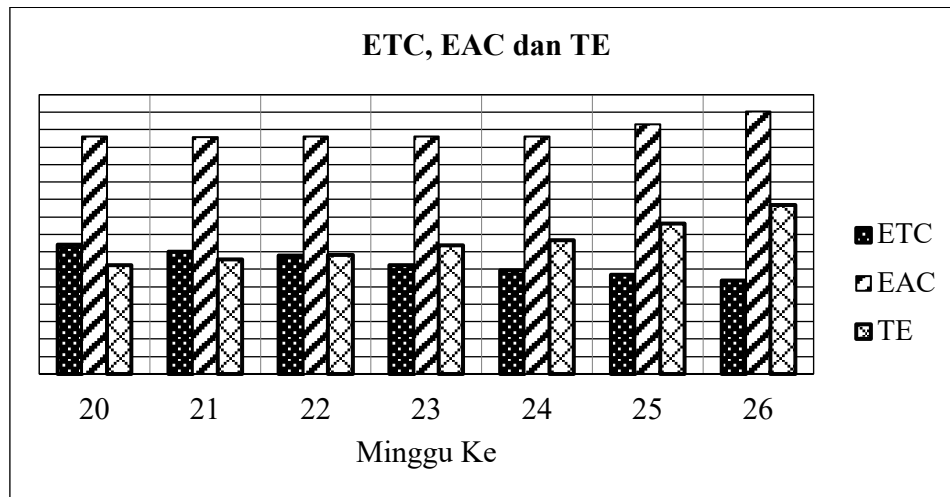


Figure 9. ETC, AEC and TE charts
Source: Author's Processed Results 2024

The required work completion time is 34 weeks or 238 calendar days from the schedule in the 210-calendar day contract, so the completion time has been increased by 28 calendar days

The delay was analyzed using work acceleration analysis (*Crashing*). The results of the analysis were obtained a critical path in pavement work, especially concrete slab work. Analysis of the acceleration of work (*Crashing*) was carried out on the work of Making 1 m3 of quality concrete $f'c = 26.4$ MPa (K 300) along with the overlay on the inside of the concrete slab work. The results of the analysis of work acceleration (*Crashing*) were obtained an additional workforce, namely 15 workers and required an additional cost of Rp. 68,970,000, -

CONCLUSION

Based on the analysis of the Juwata Airport Warehousing and Supporting Facilities project, the project's cost and time performance showed variations during implementation. The negative cost variance (CV) from week 20 to week 26 indicated that actual costs exceeded the planned budget, while the schedule variance (SV) and schedule performance index (SPI) reflected faster progress in weeks 20 to 23, but delays occurred in weeks 24 to 26. The cost performance index (CPI) consistently showed cost efficiency ($CPI > 1$) during this period. The estimated remaining cost of work until week 30 is Rp5,334,771,063.38, with a total project completion cost of Rp15,019,062,678.43 and an estimated completion time of 239 calendar days, which is 29 days behind the contract schedule. To ensure the project can be completed according to the targeted time and quality, an additional cost of Rp68,970,000 is required. For future research, it is recommended to further examine the causes of delays in the final phase of the project and the effectiveness of additional funding in accelerating project completion without compromising quality.

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