

Performance Analysis on the Flats Project in Maluku I with the Earned Value Method

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Abstract— Flats Construction Project in Maluku I at Nania Village, Ambon City is a construction project that built to answer the needs of the community. Flats Construction Project in Maluku I at Nania Village, Ambon City was carried out on May 20, 2018 and was scheduled to be completed on November 20, 2018. However, in the implementation until November 30, 2018 the progress of the work had only reached 69.79%, so that the adenddum was extended by 50 days until with 30 December 2018. The purpose of this research is to find out the schedule performance and cost performance in Flats Construction project in Maluku I at Nania Village, Ambon City using the Earned Value concept. The method used in this study is the yield value method. The yield value method can be used as a performance measurement tool that integrates cost aspects and time aspects. The data collection techniques used in this study are the interview method, observation method and literature method. The variables contained in this study are two types of variables namely the independent variable namely time and the dependent variable namely cost. The data analysis technique uses the earned value method. From the results of the analysis at 9th week, 14th and 21st schedule performance index (SPI) <1 which means that project performance is slower than the planned schedule so that the project has a time lapse with a weight of 21.30% of the 180 workday planning schedule and cost performance index (CPI) <1 which means the actual cost (ACWP) incurred is greater than the value of the work obtained (BCWP) so that the project experiences a fee deviation of Rp.159,787,216.18 from the RAB of Rp.16,796,733,000.00 (Contract Value).

Keywords— Earned Value, Schedule Performance Index, Cost Performance Index.

I. INTRODUCTION

Flats Construction Project in Maluku I at Nania Village, Ambon City is a construction project created to answer the needs of the community. This project has a building area of 61.25 m x 12.75 m (780.94 m²) consisting of 4 floors and 1 basement. The number of units contained in the Flats Construction Project in Maluku I at Nania Village was 58 Unit Type 36 (52 General Units, 6 Disability Units) with a budget value of Rp. 16,796,733,000.

Flats Construction Project in Maluku I at Nania Village, Ambon City was carried out on May 20, 2018 and was scheduled to be completed on November 20, 2018. However, in the implementation until November 30, 2018 the progress of the work had only reached 69.79%, so that the adenddum was extended by 50 days until with 30 December 2018.

This delay certainly has an impact on the planned costs and time. One of the costs and time control so that the project is still implemented and completed well is using the earned value method.

II. LITERATURE REVIEW

2.1 Earned Value Method

Earned Value Method is the concept of calculating the amount of costs according to the budget in accordance with the work that has been carried out or completed (budgeted cost of work performed). When viewed from the amount of work completed this concept means to measure the amount of work units that have been completed at a time when judged based on the amount of budget provided for the work. With this calculation, it is known that the relationship between what has actually been achieved physically and the amount of budget spent (Iman Suharto, 1995).

$$\text{Earned Value} = (\% \text{ completion}) \times (\text{budget}) \quad (\text{eq.1})$$

Notes :

- 1.% of completion achieved at the time of reporting.
2. The budget in question is the real cost of project.

2.2 Cost Varians(CV) And Schedule Varians (SV)

Cost Variance is the difference between the value obtained after completing work packages with the actual costs incurred during project implementation.

$$\text{Cost Variance (CV)} = \text{EV} - \text{AC} \text{ or}$$

$$\text{CV} = \text{BCWP} - \text{ACWP} \quad (\text{eq.2})$$

If the CV:

1. Negative (-) = Cost Overrun
2. Zero (0) = according to cost
3. Positive (+) = Cost Underrun

Schedule variance is used to calculate deviations between BCWS and BCWP.

Schedule Variance (SV) = EV - PV or

$$SV = BCWP - BCWS \quad (\text{eq.3})$$

If the SV:

1. Negative (-) = late from schedule
2. Zero (0) = on time
3. Positive (+) = ahead of schedule

The criteria of the two indicators above both SV (Schedule Variance) and CV (Cost Variance) are tabulated by ImanSoeharto as follows:

Table.1: Integrated Variance Analysis

SV	CV	Information
Positive	Positive	Work is ahead of schedule and costs are less than the budget
Zero	Positive	Work on schedule and costs less than the budget
Positive	Zero	Works faster and cost according to budget
Zero	Zero	Work according to schedule and budget
Negative	Negative	Work is completed late and costs are higher than the budget
Zero	Negative	Work is carried out according to schedule and costs are higher than the budget
Negative	Zero	Work is completed late and costs are within budget
Positive	Negative	Work is completed faster with costs above the budget

(Source: ImanSoeharto, 2001: 23)

2.3 Cost Performance Index (CPI) And Schedule Performance Index (SPI)

Cost Performance Index (CPI) is a cost efficiency factor that has been incurred can be shown by comparing the value of physically completed work (EV) with costs that have been incurred in the same period (AC). This CPI value shows the weight of the value obtained (relative to the overall project value) against the costs incurred. A CPI of less than 1 indicates poor cost performance, because the costs incurred (AC) are greater than the value obtained (EV) or in other words waste occurs.

Schedule Performance Index (SPI), a factor of performance efficiency in completing work can be shown by the comparison between the value of work that has been physically completed (EV) with planned expenditure of

expenses based on the work plan (PV). The SPI value indicates how much work can be completed (relative to the whole project) to the unit of work planned. SPI value less than 1 indicates that job performance is not as expected because it is not able to achieve the planned work targets. Project managers often want to know the use of resources, which can be expressed as a productivity index or performance index. This performance index consists of Cost Performance Index (CPI) and Schedule Performance Index (SPI).

Cost performance index (CPI) = EV / AC or

$$CPI = BCWP / ACWP \quad (\text{eq.4})$$

Schedule performance index (SPI) = EV / PV or

$$SPI = BCWP / BCWS \quad (\text{eq.5})$$

Table.2: Analysis of Performance Index

Index	Value	Information
CPI	>1	Actual costs incurred are smaller than the value of the work obtained (BCWP)
	<1	Actual costs incurred are greater than the value of the work obtained (BCWP)
	=	Actual costs incurred are equal to the value of the work obtained (BCWP)
SPI	>1	Project performance is faster than planned schedule
	<1	Project performance is slower than the planned schedule
	=	Project performance is the same as the planned schedule

(Source: ImanSoeharto, 2001: 237)

2.4 Projected Cost Expenditures and Project Completion Period

Making cost estimates or project completion schedules based on indicators obtained during reporting will provide a hint of the Estimated At Completion (EAC) and Estimated At Schedule (EAS). Cost estimates or schedules are useful because they provide early warning about things that will happen in the future. If the remaining work is considered to have the same performance as at the time of reporting, the Estimate Temporary Cost (ETC) is:

$$ETC = (BAC - BCWP) / CPI \quad (\text{eq.6})$$

$$EAC = ACWP - ETC \quad (\text{eq.7})$$

Whereas Estimate Temporary Schedule (ETS) is:

$$ETS = (\text{remaining time}) / SPI \quad (\text{eq.8})$$

$$EAS = \text{end time} + ETS \quad (\text{eq.9})$$

Notes :

BAC (Budgeted At Completion)

SPI (Schedule Performance Index)

CPI (Cost Performance Index)

ETC (Estimate Temporary Cost)

EAC (Estimate At Completion)

ETS (Estimate Temporary Schedule)

EAS (Estimate At Schedule)

III. RESEARCH METHODOLOGY

3.1 Research Sites

This research is located in the Flats Construction Project in Maluku I at Nania Village, Ambon City.

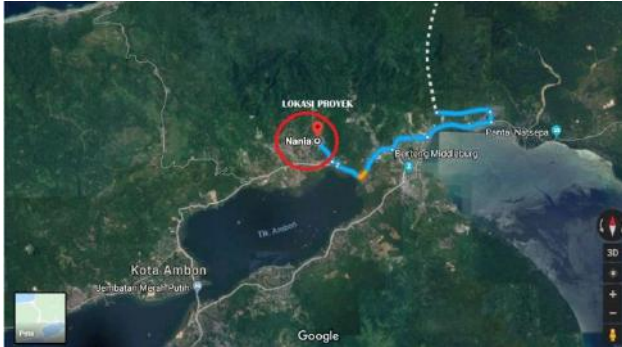


Fig.1: Research Location Map

3.2 Flowchart of Research

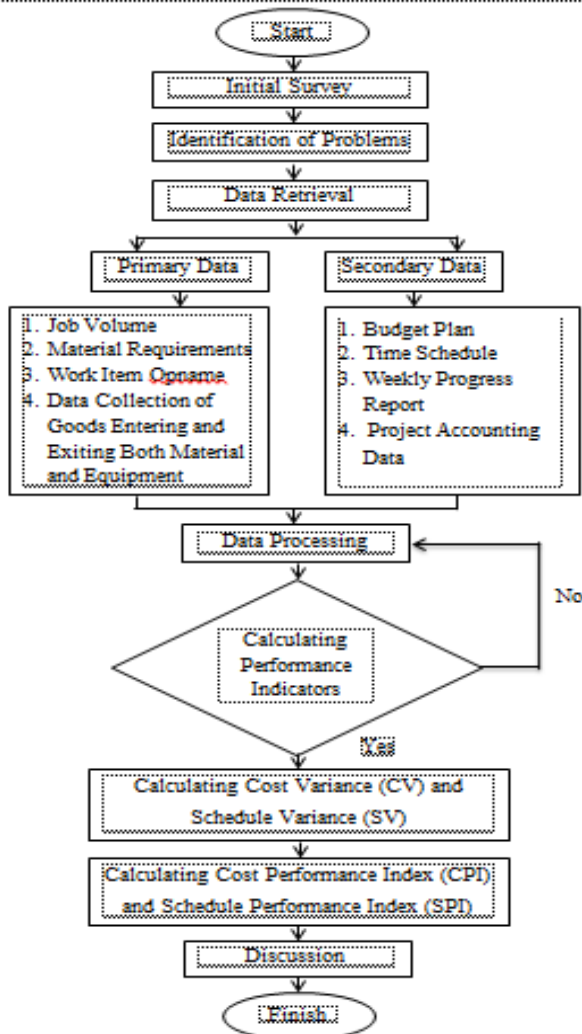


Fig.2: Research Flow Chart

IV. RESULTS AND DISCUSSION

4.1 Calculations of Actual Cost Of Work Performed (ACWP)

ACWP value at the time of reporting:

1) In the 21st week reporting Rp.9.656.660.054,38

Table.3: Actual Costs on Week

NO	Work Item	Total Cost (Rp)
1	Preliminary work	
	The cost of the preliminary work	191.776.375,00
	The cost of mobilization / demobilization work	30.900.000,00
2	Standard structural work	
	Cost of elevation basement floor structure work -3.5	210.318.056,23
	Cost of first floor work / ground floor elevation 0.00	1.277.874.351,88
	The cost of the second floor elevation work is +3.35	1.032.839.132,71
	The cost of the third floor elevation work is +6.55	935.908.245,18
	The cost of the fourth floor elevation work is +9.75	965.856.567,80
3	The cost of the work of the roof floor elevation is +12.95	511.448.159,86
	Non standard work	
	Lower non structure work costs	1.418.783.172,09
4	IPAL septictank work	276.800.710,80
	Standard architectural work (pair work and wall plastering)	
	First floor / ground floor work costs	406.234.595,28
	The cost of the second floor work	350.075.568,50
	Third floor work costs	317.602.568,50
	Fourth floor work costs	115.770.968,50
5	Costs for roofing and roofing tanks	5.075.512,81
	Ceiling work	
	First floor / ground floor fee	66.390.181,44
	Second floor fee	84.903.260,34
	Third floor fee	84.903.260,34
6	Fourth floor fee	84.903.260,34
	Floor job	
	First floor / ground floor fee	98.620.049,32
	Second floor fee	93.625.548,14
	Third floor fee	93.625.548,14
7	Fourth floor fee	93.625.548,14
	Utility work	
	First floor / ground floor fee	22.977.250,00
	Second floor fee	51.039.400,00
	Third floor fee	52.039.400,00
	Fourth floor fee	46.139.400,00

8	Entrance work	
	Spouse's work and painting costs	18.098.208,82
	Mechanical work	
	Cost of dirty water installation	178.140.489,00
	Firefighting work costs	134.057.827,50
9	Electrical work	
	Cost of electricity supply work	69.772.000,00

(Source: Project Data)

Table.4: ACWP Values

Week	%Cumulative	ACWP Value (Rp)
1	0.22	36.400.000,00
2	0.74	123.481.375,00
3	1.30	218.176.375,00
4	1.93	324.183.366,30
5	3.10	521.053.681,90
6	4.67	783.993.827,03
7	6.32	1.061.271.933,09
8	10.12	1.699.959.547,09
9	11.40	1.914.777.603,32
10	13.78	2.315.160.139,41
11	17.20	2.888.327.463,45
12	18.11	3.042.459.513,54
13	22.94	3.852.713.445,71
14	26.46	4.443.811.075,04
15	33.30	5.592.871.090,98
16	35.65	5.987.337.183,30
17	37.44	6.287.964.703,63
18	48.64	8.169.506.998,73
19	52.08	8.747.891.434,24
20	55.74	9.362.448.989,23
21	57.49	9.656.660.054,38
PPN		965.666.005,44
JUMLAH		10.622.326.059,82
DIBULATKAN		10.622.326.000,00

(Source: Project Data)

4.2 Calculation of Budget Cost of Work Schedule (BCWS)

BCWS values at the time of reporting:

1) In the 21st week reporting

BCWS = % Plan Progress / 100 x Contract Value

BCWS = 77.84 / 100 x 16.796.733.000,00

BCWS = Rp. 13.075.394.589,87

For the calculation of the following week can be done in the same way as above, here are the results of the BCWS calculation from week 1 to week 21.

Table.5: BCWS Calculations

Week	% Cumulative Plan	BCWS Value (Rp)
1	0.26	43.935.085,06
2	0.62	104.427.568,87
3	0.98	164.920.052,69
4	1.24	208.855.137,75
5	3.00	503.455.859,80
6	4.75	798.056.581,85
7	6.60	1.109.214.702,65
8	10.50	1.762.914.519,55
9	12.91	2.168.154.422,67
10	17.32	2.909.440.535,21
11	19.75	3.316.717.521,43
12	26.86	4.512.139.347,02
13	31.98	5.371.514.963,18
14	36.97	6.210.550.341,83
15	41.95	7.045.785.077,77
16	46.65	7.834.879.005,44
17	53.47	8.981.593.490,96
18	59.48	9.991.187.753,16
19	65.00	10.918.413.595,99
20	71.01	11.928.007.858,18
21	77.84	13.075.394.589,87

(Source: Analysis Results)

4.3 Calculation of Budget Cost of Work Performed (BCWP)

BCWP values at the time of reporting:

1) In the 21st week reporting

BCWP = % Actual Progress / 100 x Contract Value

BCWP = 56.54 / 100 x 16.796.733.000,00

BCWP = Rp.9.496.872.838,20

For the calculation of the following week can be done in the same way as above, here are the results of the BCWP calculation from week 1 to week 21.

Table.6: BCWP Calculations

Week	% Cumulative Actual	BCWP Value (Rp)
1	0.22	36.952.812,60
2	0.72	120.936.477,60
3	1.24	208.279.489,20
4	1.94	325.856.620,20
5	3.22	540.854.802,60
6	4.37	734.017.232,10
7	6.00	1.007.803.980,00
8	9.43	1.583.931.921,90
9	10.69	1.795.570.757,70
10	13.12	2.203.731.369,60
11	16.53	2.776.499.964,90
12	17.60	2.956.225.008,00
13	22.35	3.754.069.825,50

14	25.84	4.340.275.807,20
15	32.16	5.401.829.332,80
16	34.63	5.816.708.637,90
17	36.01	6.048.503.553,30
18	46.01	7.728.176.853,30
19	50.01	8.400.046.173,30
20	54.20	9.103.829.286,00
21	56.54	9.496.872.838,20

(Source: Analysis Results)

4.4 Calculation of Cost Variance (CV)

CV values at the time of reporting:

1) In the 21st week reporting

$CV = BCWP - ACWP$

$CV = \text{Rp.}9.496.872.838,20 - \text{Rp.}9.656.660.054,38$

$CV = \text{Rp.} 159.787.216,18$

For the calculation of the following week can be done in the same way as above, here are the results of the CV calculation from week 1 to week 21.

Table.7: CV Calculations

Week	BCWP Value (Rp)	ACWP Value (Rp)	Cost Variance (CV) (Rp)
1	36.952.812,60	36.400.000,00	552.812,60
2	120.936.477,60	123.481.375,00	-2.544.897,40
3	208.279.489,20	218.176.375,00	-9.896.885,80
4	325.856.620,20	324.183.366,30	1.673.253,90
5	540.854.802,60	521.053.681,90	19.801.120,70
6	734.017.232,10	783.993.827,03	-49.976.594,93
7	1.007.803.980,00	1.061.271.933,09	-53.467.953,09
8	1.583.931.921,90	1.699.959.547,09	-116.027.625,19
9	1.795.570.757,70	1.914.777.603,32	-119.206.845,62
10	2.203.731.369,60	2.315.160.139,41	-111.428.769,81
11	2.776.499.964,90	2.888.327.463,45	-111.827.498,55
12	2.956.225.008,00	3.042.459.513,54	-86.234.505,54
13	3.754.069.825,50	3.852.713.445,71	-98.643.620,21
14	4.340.275.807,20	4.443.811.075,04	-103.535.267,84
15	5.401.829.332,80	5.592.871.090,98	-191.041.758,18
16	5.816.708.637,90	5.987.337.183,30	-170.628.545,40
17	6.048.503.553,30	6.287.964.703,63	-236.101.803,73
18	7.728.176.853,30	8.169.506.998,73	-441.330.145,43
19	8.400.046.173,30	8.747.891.434,24	-347.845.260,94
20	9.103.829.286,00	9.362.448.989,23	-258.619.703,23
21	9.496.872.838,20	9.656.660.054,38	-159.787.216,18

(Source: Analysis Results)

4.5 Calculation of Schedule Variance (SV)

SV values at the time of reporting:

1) In the 21st week reporting

$SV = BCWP - BCWS$

$SV = 56.54\% - 77.84\%$

$SV = -21.30\%$

For the calculation of the following week can be done in the same way as above, here are the results of the SV calculation from week 1 to week 21.

Table.8: SV Calculations

Week	% BCWP	% BCWS	% SV
1	0.22	0.26	-0.04
2	0.72	0.62	0.10
3	1.24	0.98	0.26

4	1.94	1.24	0.70
5	3.22	3.00	0.22
6	4.37	4.75	-0.38
7	6.00	6.60	-0.60
8	9.43	10.50	-1.07
9	10.69	12.91	-2.22
10	13.12	17.32	-4.20
11	16.53	19.75	-3.22
12	17.60	26.86	-9.26
13	22.35	31.98	-9.63
14	25.84	36.97	-11.13
15	32.16	41.95	-9.79
16	34.63	46.65	-12.02
17	36.01	53.47	-17.44
18	46.01	59.48	-13.47

19	50.01	65.00	-14.99
20	54.20	71.01	-16.81
21	56.54	77.84	-21.30

(Source: Analysis Results)

4.6 Analysis of Earned Value Indicators, Cost Variance (CV) and Schedule Variance (SV)

Following are the results of the analysis of the results value indicators presented in graphical form as below :

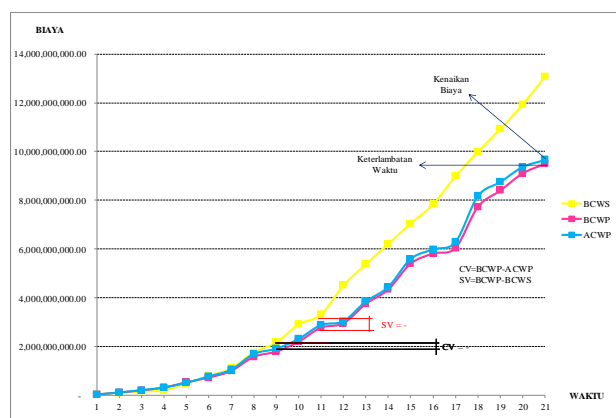


Fig.3: S Curve Graph of Earned Value

From the calculation of CV (cost variance) and SV (schedule variance) above, it can be analyzed as follows:

SV	CV	Information
Negative	Negative	Work is completed late and costs are higher than the budget

The analysis can be seen in *Table.1: Analysis of Integrated Variants* (ImanSoeharto, 2001: 23).

4.7 Calculation of Cost Performance Index (CPI)

CPI values at the time of reporting:

1) In the 21st week reporting

$$CPI = BCWP / ACWP$$

$$CPI = 9.496.872.838,20 / 9.656.660.054,38$$

$CPI = 0.98 < 1$ means the actual cost (ACWP) incurred is greater than the cost of real field plan work (BCWP).

For the determination of the cost performance index (CPI) can be seen in *Table.2: Analysis of Performance Index* (ImanSoeharto, 2001: 237).

For the calculation of the following week can be done in the same way as above, here are the results of the CPI calculation from week 1 to week 21.

Table.9: CPI Calculations

Week	BCWP Value (Rp)	ACWP Value (Rp)	Cost Performance Index (CPI)
1	36.952.812,60	36.400.000,00	1.02
2	120.936.477,60	123.481.375,00	0.98
3	208.279.489,20	218.176.375,00	0.95
4	325.856.620,20	324.183.366,30	1.01
5	540.854.802,60	521.053.681,90	1.04
6	734.017.232,10	783.993.827,03	0.94
7	1.007.803.980,00	1.061.271.933,09	0.95
8	1.583.931.921,90	1.699.959.547,09	0.93
9	1.795.570.757,70	1.914.777.603,32	0.94
10	2.203.731.369,60	2.315.160.139,41	0.95
11	2.776.499.964,90	2.888.327.463,45	0.96
12	2.956.225.008,00	3.042.459.513,54	0.97
13	3.754.069.825,50	3.852.713.445,71	0.97
14	4.340.275.807,20	4.443.811.075,04	0.98
15	5.401.829.332,80	5.592.871.090,98	0.97
16	5.816.708.637,90	5.987.337.183,30	0.97
17	6.048.503.553,30	6.287.964.703,63	0.96
18	7.728.176.853,30	8.169.506.998,73	0.95
19	8.400.046.173,30	8.747.891.434,24	0.96
20	9.103.829.286,00	9.362.448.989,23	0.97
21	9.496.872.838,20	9.656.660.054,38	0.98

(Source: Analysis Results)

4.8 Calculation of Schedule Performance Index (SPI)

SPI values at the time of reporting:

1) In the 21st week reporting

$$SPI = BCWP / BCWS$$

$$SPI = 56.54 / 77.84$$

$SPI = 0.73 < 1$ means that project performance is slower than the planned schedule.

The schedule performance index (SPI) can be seen in Table.2: *Performance Index Analysis* (ImanSoeharto, 2001: 237).

For the calculation of the following week can be done in the same way as above, here are the results of the CPI calculation from week 1 to week 21.

Table.10: SPI Calculations

Week	% BCWP	% BCWS	% SPI
1	0.22	0.26	0.84
2	0.72	0.62	1.16
3	1.24	0.98	1.26
4	1.94	1.24	1.56
5	3.22	3.00	1.07
6	4.37	4.75	0.92
7	6.00	6.60	0.91
8	9.43	10.50	0.90
9	10.69	12.91	0.83
10	13.12	17.32	0.76
11	16.53	19.75	0.84
12	17.60	26.86	0.66
13	22.35	31.98	0.70
14	25.84	36.97	0.70
15	32.16	41.95	0.77
16	34.63	46.65	0.74
17	36.01	53.47	0.67
18	46.01	59.48	0.77
19	50.01	65.00	0.77
20	54.20	71.01	0.76
21	56.54	77.84	0.73

(Source: Analysis Results)

4.9 Cost Estimates and Final Project Schedule

Calculation of cost and time estimates according to the reporting week:

1) In the 21st week reporting

$$ETC = \frac{BAC - BCWP}{CPI}$$

$$ETC = \frac{16.796.733.000,00 - 5.401.829.332,80}{0.98}$$

$$ETC = \text{Rp.}11.586.625.717,89$$

$$EAC = ACWP + ETC$$

$$EAC = 9.656.660.054,38 + 11.586.625.717,89$$

$$EAC = \text{Rp.}21.243.285.772,27$$

While the estimated time of completion of all work:

$$ETS = \frac{\text{Remaining time}}{SPI}$$

$$ETS = \frac{83}{0.73}$$

$$ETS = 114 \text{ Days}$$

$$EAS = \text{Time's up} + ETS$$

$$EAS = 147,00 + 114$$

$$EAS = 261 \text{ Days}$$

V. CONCLUSION

Based on the analysis using the earned value method in the Flats Construction Project in Maluku I at Nania Village, Ambon City, the following results were obtained:

- 1) From the results of the analysis at 9th week, 14th and 21st schedule performance index (SPI) <1 which means that project performance is slower than the planned schedule so that the project has a time lapse with a weight of 21.30% of the 180 workday planning schedule.
- 2) From the results of the analysis at 9th week, 14th and 21st cost performance index (CPI) <1 which means the actual cost (ACWP) incurred is greater than the value of the work obtained (BCWP) so that the project experiences a fee deviation of Rp.159,787,216.18 from the RAB of Rp.16,796,733,000.00 (Contract Value).

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