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 adendum 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 adendum 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 Variance (CV) And Schedule Variance (SV)

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

\[
\text{Cost Variance (CV)} = \text{EV-AC or CV} = \text{BCWP-ACWP} \quad (\text{eq.2})
\]
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
(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:

| 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
(eq.4)

Schedule performance index (SPI) = EV / PV or
SPI = BCWP / BCWS
(eq.5)

| 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
(eq.6)

EAC = ACWP - ETC
(eq.7)

Whereas Estimate Temporary Schedule (ETS) is:

ETS = (remaining time) / SPI
(eq.8)

EAS = end time + ETS
(eq.9)

Notes:
BAC (Budgeted At Completion)
SPI (Schedule Performance Index)
CPI (Cost Performance Index)
ETC (Estimate Temporary Cost)
III. RESEARCH METHODOLOGY

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

![Research Location Map](image1)

Fig. 1: Research Location Map

3.2 Flowchart of Research

![Research Flow Chart](image2)

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

| NO | Work Item | Total Cost (Rp) |
|----|-----------|----------------|
| 1  | Preliminary work | 191,776,375,00 |
|    | The cost of the preliminary work | 191,776,375,00 |
|    | The cost of mobilization / demobilization work | 30,900,000,00 |
| 2  | Standard structural work | 210,318,056,23 |
|    | 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 |
| 3  | The cost of the third floor elevation work is +6.55 | 935,908,245,18 |
| 4  | The cost of the fourth floor elevation work is +9.75 | 965,856,567,80 |
| 5  | The cost of the work of the roof floor elevation is +12.95 | 511,448,159,86 |
| 6  | Lower non structure work costs | 1,418,783,172,09 |
| 7  | Non standard work | 276,800,710,80 |
| 8  | Standard architectural work (pair work and wall plastering) | 406,234,595,28 |
| 9  | Fourth floor work costs | 115,770,968,50 |
| 10 | Costs for roofing and roofing tanks | 5,075,512,81 |
| 11 | Ceiling work | 66,390,181,44 |
| 12 | Second floor fee | 84,903,260,34 |
| 13 | Third floor fee | 84,903,260,34 |
| 14 | Fourth floor fee | 84,903,260,34 |
| 15 | Floor job | 98,620,049,32 |
| 16 | Second floor fee | 93,625,548,14 |
| 17 | Third floor fee | 93,625,548,14 |
| 18 | Fourth floor fee | 93,625,548,14 |
| 19 | Utility work | 22,977,250,00 |
| 20 | First floor / ground floor fee | 22,977,250,00 |
| 21 | Second floor fee | 51,039,400,00 |
| 22 | Third floor fee | 52,039,400,00 |
| 23 | Fourth floor fee | 46,139,400,00 |

Table 3: Actual Costs on Week
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)

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)

4.2 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 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|
4.4 Calculation of Cost Variance (CV)

CV values at the time of reporting:

1) In the 21st week reporting
\[ \text{CV} = \text{BCWP} - \text{ACWP} \]
\[ \text{CV} = \Rp 9,496,872,838,20 - \Rp 9,656,660,054,38 \]
\[ \text{CV} = \Rp 159,787,216,18 \]

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    | 734.017.232,10  | 783.993.827,03  | -49.976.594,93          |
| 6    | 1.007.803.980,00| 1.061.271.933,09| -53.467.953,09          |
| 7    | 1.583.931.921,90| 1.699.184.587,09| -116.027.625,19         |
| 8    | 5.401.829.332,80| 5.592.781.090,98| -191.041.758,18         |
| 9    | 2.403.731.369,60| 2.315.160.139,41| -111.428.769,81         |
| 10   | 1.243.499.964,90| 2.888.327.463,45| -111.827.498,55         |
| 11   | 6.048.503.533,30| 3.042.545.135,54| -86.234.505,54          |
| 12   | 3.754.069.825,50| 3.852.713.445,71| -98.643.620,21          |
| 13   | 4.340.275.807,20| 4.443.811.075,04| -103.535.267,84         |
| 14   | 5.401.829.332,80| 5.592.871.090,98| -191.041.758,18         |
| 15   | 2.243.731.369,60| 2.315.160.139,41| -111.428.769,81         |
| 16   | 6.048.503.533,30| 3.042.545.135,54| -86.234.505,54          |
| 17   | 3.754.069.825,50| 3.852.713.445,71| -98.643.620,21          |
| 18   | 4.340.275.807,20| 4.443.811.075,04| -103.535.267,84         |
| 19   | 5.401.829.332,80| 5.592.871.090,98| -191.041.758,18         |
| 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
\[ \text{SV} = \text{BCWP} - \text{BCWS} \]
\[ \text{SV} = 56.54\% - 77.84\% \]
\[ \text{SV} = -21.30\% \]

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 |
4.6 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:

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 = 56.54 / 77.84
CPI = 0.73 <1 means that project performance is slower than the planned schedule.

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                          |

Table 9: CPI Calculations

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The schedule performance index (SPI) can be seen in Table 2: Performance Index Analysis (Iman Soeharto, 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.

| 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

\[
\text{ETC} = \frac{\text{BAC} - \text{BCWP}}{\text{SPI}}
\]

\[
\text{ETC} = \frac{16,796,733.000,00 - 5.401.829,332,80}{0.98}
\]

ETC = Rp.11,586,625,717,89

\[
\text{EAC} = \text{ACWP} + \text{ETC}
\]

EAC = 9,656,660,054,38 + 11,586,625,717,89

EAC = Rp.21,243,285,772,27

While the estimated time of completion of all work:

\[
\text{ETS} = \frac{\text{Remaining time}}{\text{SPI}}
\]

ETS = \frac{83}{0.73}

ETS = 114 Days

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

EAS = 147,00 + 114

\[
\text{EAS} = 261 \text{ Days}
\]

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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