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# Time and Cost Control Using the Earned Value Method in the Construction of the Minut District Government Library Building

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ABSTRACT

Controlling project time and cost is a critical aspect of project management to ensure that a project is completed on time and within budget. The objective of this research is to determine the costs of three earned value indicators: BCWS, BCWP, and ACWP, and to estimate the required costs and time needed to complete the project. The method used in this research is the earned value method, which integrates cost, time, and physical work performance. In this study, the calculation of the budget plan (RAB) and the creation of the S-Curve are crucial initial steps. The RAB calculation and S-Curve creation resulted in a value of IDR 9,474,695,098 for a duration of 32 weeks. However, based on the EVM observations, the predicted total cost of project completion is IDR 8,098,723,371.01. The difference between the two calculations is IDR 1,375,971,726.49. Additionally, the weight and duration calculations on the S-Curve indicate a project duration of 32 weeks, which aligns with the EVM results showing a project completion time of 32 weeks, consistent with the planned schedule

## INTRODUCTION

Construction projects rarely proceed exactly as planned. In practice, many projects experience deviations in time, cost, and work volume during implementation. These deviations may cause delays, cost overruns, reduced productivity, and changes in project performance. However, some projects may also be completed earlier than the original schedule when project control is conducted effectively. Therefore, systematic project performance evaluation is needed to determine whether the project is still aligned with the planned schedule and budget.

One method that can be used to evaluate project performance is the Earned Value Method (EVM). Earned Value Method is a project management approach that integrates cost and schedule control in a single performance measurement system. This method provides important indicators such as Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), and Schedule Performance Index (SPI). These indicators can be used to assess whether a project is experiencing cost overrun, cost underrun, schedule delay, or schedule acceleration. In addition, EVM can also be used to forecast future project performance, including estimated completion cost and estimated completion time.

Although the Earned Value Method has been widely used in construction project control, several previous studies still tend to focus only on general cost and schedule deviations without providing a detailed interpretation of project performance trends during implementation. Many studies also discuss project delays descriptively, while fewer studies apply EVM as an early warning tool to evaluate the relationship between actual progress, planned progress, and actual cost in a specific public building construction project. This creates a research gap in the application of EVM for evaluating project performance in local government building projects, particularly in identifying whether the project is still financially and temporally controllable during the implementation stage.

The novelty of this study lies in the application of the Earned Value Method to evaluate the cost and time performance of the North Minahasa Regency Library Construction Project as a case study of a public building project. This study does not only calculate cost and schedule deviations but also interprets project performance through CPI and SPI values to provide a clearer assessment of project efficiency. The results are expected to provide practical information for project managers, contractors, and project owners in making corrective decisions before delays or cost overruns become more severe.

Therefore, this study aims to calculate and evaluate the cost and time performance of the North Minahasa Regency Library Construction Project using the Earned Value Method. The results of this study are expected to provide a useful reference for improving project control practices, especially in monitoring construction progress, controlling project costs, and supporting better decision-making during project implementation.

## METHODS

The method used in this study is Earned Value Management. This method will be implemented and carried out in accordance with observations and analyses, using references related to the topic under discussion.

The types of data and data collection methods in this study involve the use of supporting data related to the project, such as:

1. Primary data

   field observations regarding the work execution methods in the construction of the Minut Regency Government library building.

2. Secondary data

   documents used in the preparation of this thesis.

The required data include Project Drawings, AHSP PUPR CK 2023, and AHSP CK PERMEN MINUT 2022.

The data collection methods used in this study are:

1. Observation

   Observation is a research process involving the examination of the research situation; information obtained from observations includes location, participants, activities, and time.

2. Literature review and document analysis.

The author sought various relevant data in accordance with the topic of discussion. The sources consulted included scientific articles, books, and other sources. As for document analysis, the author relied on project drawings and other supporting documents.

3. Earned Value Management (EVM) Indicators and Data Analysis

The performance of the North Minahasa Regency Government Library Construction Project was evaluated using the Earned Value Management (EVM) method. EVM integrates cost performance and schedule performance into a single project control system, enabling project managers to monitor actual project conditions and forecast future project performance.

The analysis was carried out using three fundamental Earned Value parameters:

1. Planned Value (PV); Planned Value represents the budgeted cost of scheduled work up to a specific reporting period.
2. Earned Value (EV); Earned Value represents the budgeted cost of work actually completed during the reporting period.
3. Actual Cost (AC); Actual Cost represents the actual expenditure incurred for the completed work during the reporting period.

Based on these parameters, several project performance indicators were calculated as follows:

a. Schedule Variance (SV)

[SV = EV - PV]

Schedule Variance indicates whether the project is ahead of schedule or behind schedule. A positive value indicates that the project is ahead of schedule, while a negative value indicates delay.

b. Cost Variance (CV)

[CV = EV - AC]

Cost Variance measures the difference between earned value and actual expenditure. A positive value indicates cost savings, whereas a negative value indicates cost overrun.

c. Schedule Performance Index (SPI)

[SPI = \ frac {EV} {PV}]

SPI measures schedule efficiency. An SPI greater than 1 indicates better-than-planned schedule performance, while an SPI less than 1 indicates schedule slippage.

d. Cost Performance Index (CPI)

[CPI = \ frac {EV} {AC}]

CPI measures cost efficiency. A CPI greater than 1 indicates efficient cost performance, whereas a CPI less than 1 indicates cost inefficiency.

e. Estimate at Completion (EAC)

[EAC = \ frac {BAC} {CPI}]

where BAC is the Budget at Completion.

EAC is used to estimate the total project cost at completion based on current cost performance.

f. Estimate to Complete (ETC)

[ETC = EAC - AC]

ETC represents the estimated additional cost required to complete the remaining work.

g. Variance at Completion (VAC)

[VAC = BAC - EAC]

VAC indicates the difference between the planned project budget and the forecasted final project cost.

The EVM indicators were calculated for each reporting period based on project progress data obtained from the S-Curve, project schedule, and actual cost reports. The results were then analyzed to evaluate project performance, identify potential schedule delays and cost overruns, and forecast the expected project completion cost and completion time.

## RESULTS AND DISCUSSION

### General Project Information

The construction project that is the subject of this study is the construction of the North Minahasa Regency Library Building, located on the grounds of the North Minahasa Regency Regent's Office in Airmadidi Atas, Airmadidi District.

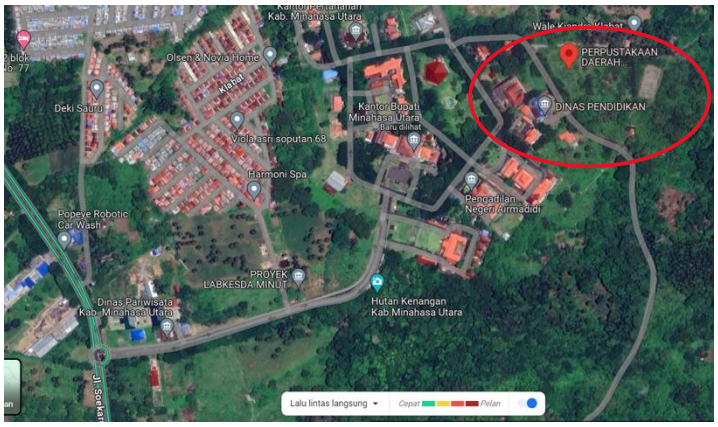



Figure 1. Project Location Layout

Data Analysis

• Cost Estimate Calculation

Cost estimate calculation for the Minut Regency government library building construction project. Table 1 below presents the results of the cost estimate calculation.

Table 1. Cost Estimate Calculation

| No. | WORK DESCRIPTION | QUANTITY PRICE |
|---|---|---|
| **1.** | INITIAL SITE | Rp. 127.590.690 |
| **2.** | SAND AND FOUNDATION SITE | Rp. 608.944.100 |
| **3.** | FLOOR 1ST STREET SITE | Rp. 562.974.370 |
| **4.** | FLOOR 2ND STREET SITE | Rp. 1.021.217.870 |
| **5.** | FLOOR 3RD STREET SITE | Rp. 808.994.706 |
| **6.** | OTHER CONCRETE SITE | Rp. 109.694.097 |
| **7.** | 3RD FLOOR DACK SITE | Rp. 310.448.568 |
| **8.** | PLASTERING AND PLASTERING SITE | Rp. 638.104.546 |
| **9.** | ROOF AND CEILING SITE | Rp. 1.218.815.594 |
| **10.** | FLOOR AND WALL COATING SITE | Rp. 817.176.227 |
| **11.** | FRAMES, DOORS, WINDOWS, AND FITTINGS | Rp. 176.349.218 |
| **12.** | INTERIOR SITE | Rp. 133.600.071 |
| **13.** | EXTERIOR SITE | Rp. 1.099.084.129 |
| **14.** | SANITARY/PLUMBING AND FIXTURES | Rp. 109.314.817 |
| **15.** | MECHANICAL/ELECTRICAL PACKAGE | Rp. 208.938.546 |
| **16.** | FINAL PACKAGE | Rp. 14.500.000 |
| **17.** | NEW ITEM PACKAGE | Rp. 360.878.167 |
| | TOTAL | Rp. 8.535.761.349 |
| | 11% TAX | Rp. 938.933.748 |
| | TOTAL + 11% TAX | Rp. 9.474.695.098 |

- 1. Data Analysis
- 2. • Cost Estimate Calculation
- 3. Cost estimate calculation for the Minut Regency Government library building construction project. Table 1 below presents the results of the cost estimate calculation.

- 4. Table 1. Cost Estimate Calculations
- Budgeted Cost Work Schedule (BCWS)
- The Budgeted Cost of Work to Date (BCWS) can be calculated by multiplying the cumulative planned percentage for the week in question by the project budget or contract value in the Bill of Quantities (BoQ). Example calculation for Week 5:
- BCWS = Cumulative Planned Percentage (%) × Project Budget
- BCWS = 4.55% = 0.0455 × Rp 9,474,695,098
- BCWS = Rp. 431,309,073.28
- The BCWS calculation for week 5 yields a value of Rp. 152,030,876.89. A summary of subsequent BCWS calculations for weeks 1–32 can be seen in Table 2 below:

Table 2. BCWS Calculation Results

| WEEK | BAC | PLAN WEIGHT (%) | CUMULATIVE PLAN WEIGHT (%) | BCWS | |
|---|---|---|---|---|---|
| | | | | PER WEEK (RP) | CUMULATIVE (RP) |
| **1** | 9.474.695.098 | 0.50 | 0.50 | 47.208.555,27 | 47.208.555,27 |
| **2** | 9.474.695.098 | 0.50 | 1.00 | 47.208.555,27 | 94.417.110,54 |
| **3** | 9.474.695.098 | 1.52 | 2.51 | 143.769.691,09 | 238.186.801,64 |
| **4** | 9.474.695.098 | 1.02 | 3.53 | 96.561.135,82 | 334.747.937,46 |
| **5** | 9.474.695.098 | 1.02 | 4.55 | 96.561.135,82 | 431.309.073,28 |
| **6** | 9.474.695.098 | 1.02 | 5.57 | 96.561.135,82 | 527.870.209,10 |
| **7** | 9.474.695.098 | 1.02 | 6.59 | 96.561.135,82 | 624.431.344,92 |
| **8** | 9.474.695.098 | 1.02 | 7.61 | 96.561.135,82 | 720.992.480,74 |
| **9** | 9.474.695.098 | 2.67 | 10.28 | 252.786.523,46 | 973.779.004,20 |
| **10** | 9.474.695.098 | 1.65 | 11.93 | 156.225.387,64 | 1.130.004.391,84 |
| **11** | 9.474.695.098 | 1.65 | 13.58 | 156.225.387,64 | 1.286.229.779,48 |
| **12** | 9.474.695.098 | 4.36 | 17.94 | 413.375.866,68 | 1.699.605.646,15 |
| **13** | 9.474.695.098 | 3.32 | 21.26 | 314.583.464,17 | 2.014.189.110,32 |
| **14** | 9.474.695.098 | 3.32 | 24.58 | 314.583.464,17 | 2.328.772.574,49 |
| **15** | 9.474.695.098 | 3.32 | 27.90 | 314.583.464,17 | 2.643.356.038,66 |
| **16** | 9.474.695.098 | 4.76 | 32.66 | 451.206.398,26 | 3.094.562.436,91 |
| **17** | 9.474.695.098 | 3.86 | 36.53 | 366.155.240,33 | 3.460.717.677,24 |
| **18** | 9.474.695.098 | 6.33 | 42.86 | 599.871.052,39 | 4.060.588.729,64 |
| **19** | 9.474.695.098 | 6.94 | 49.79 | 657.304.037,52 | 4.717.892.767,16 |
| **20** | 9.474.695.098 | 5.38 | 55.18 | 510.115.268,69 | 5.228.008.035,85 |
| **21** | 9.474.695.098 | 4.96 | 60.14 | 469.668.786,49 | 5.697.676.822,33 |
| **22** | 9.474.695.098 | 2.86 | 62.99 | 270.576.592,04 | 5.968.253.414,38 |
| **23** | 9.474.695.098 | 5.23 | 68.22 | 495.624.533,81 | 6.463.877.948,19 |
| **24** | 9.474.695.098 | 5.23 | 73.45 | 495.624.533,81 | 6.959.502.482,00 |
| **25** | 9.474.695.098 | 5.29 | 78.74 | 501.129.336,38 | 7.460.631.818,38 |

| | | | | | |
|---|---|---|---|---|---|
| **26** | 9.474.695.098 | 2.10 | 80.84 | 198.774.132,43 | 7.659.405.950,81 |
| **27** | 9.474.695.098 | 5.32 | 86.16 | 503.769.978,24 | 8.163.175.929,05 |
| **28** | 9.474.695.098 | 4.00 | 90.16 | 379.143.884,98 | 8.542.319.814,03 |
| **29** | 9.474.695.098 | 4.00 | 94.16 | 379.143.884,98 | 8.921.463.699,01 |
| **30** | 9.474.695.098 | 4.44 | 98.61 | 421.066.122,15 | 9.342.529.821,16 |
| **31** | 9.474.695.098 | 1.31 | 99.92 | 124.117.776,34 | 9.466.647.597,50 |
| **32** | 9.474.695.098 | 0.08 | 100.00 | 8.047.500,00 | 9.474.695.097,50 |

• Calculation of Budgeted Cost of Work Performed (BCWP)

BCWP can be calculated by multiplying the project's weekly cumulative percentage of completion by the project cost budget. An example of the BCWP calculation for Week 5 is as follows:

BCWP = Cumulative Percentage of Completion (%) × Project Cost Budget

BCWP = 1.60% = 0.016 × Rp. 9,474,695,098

BCWP = Rp. 152,030,876.89

From the BCWP calculation based on Equation 2 in Chapter II above, the BCWP value for Week 5 is Rp. 152,030,876.89. Furthermore, the summary of BCWP for Weeks 1–32 can be seen in Table 3 below:

Table 3. BCWP Calculation Results

| **WEEK** | **BAC** | **CUMULATIVE REALIZATION WEIGHT (%)** | **BCWP** CUMULATIVE (RP) |
|---|---|---|---|
| **1** | 9.474.695.098 | 0.003 | 272.458,85 |
| **2** | 9.474.695.098 | 0.14 | 12.904.524,36 |
| **3** | 9.474.695.098 | 0.29 | 27.804.672,70 |
| **4** | 9.474.695.098 | 0.57 | 54.265.298,82 |
| **5** | 9.474.695.098 | 1.60 | 152.030.876,89 |
| **6** | 9.474.695.098 | 3.92 | 371.730.646,05 |
| **7** | 9.474.695.098 | 4.69 | 444.063.222,13 |
| **8** | 9.474.695.098 | 6.54 | 619.486.901,78 |
| **9** | 9.474.695.098 | 8.57 | 812.429.116,32 |
| **10** | 9.474.695.098 | 10.60 | 1.004.447.309,79 |
| **11** | 9.474.695.098 | 12.49 | 1.183.029.024,78 |
| **12** | 9.474.695.098 | 18.64 | 1.765.818.855,13 |
| **13** | 9.474.695.098 | 25.37 | 2.403.640.016,58 |
| **14** | 9.474.695.098 | 30.25 | 2.866.230.029,82 |
| **15** | 9.474.695.098 | 32.16 | 3.047.074.750,64 |
| **16** | 9.474.695.098 | 35.22 | 3.336.895.040,28 |
| **17** | 9.474.695.098 | 42.00 | 3.979.318.688,44 |
| **18** | 9.474.695.098 | 42.87 | 4.062.143.647,63 |
| **19** | 9.474.695.098 | 43.63 | 4.133.895.194,34 |
| **20** | 9.474.695.098 | 44.42 | 4.208.735.881.12 |

| | | | |
|---|---|---|---|
| **21** | 9.474.695.098 | 45.67 | 4.327.413.379,54 |
| **22** | 9.474.695.098 | 47.12 | 4.464.277.645,20 |
| **23** | 9.474.695.098 | 52.18 | 4.944.234.834,26 |
| **24** | 9.474.695.098 | 55.70 | 5.277.164.912,46 |
| **25** | 9.474.695.098 | 57.60 | 5.457.701.000,38 |
| **26** | 9.474.695.098 | 61.45 | 5.822.178.448,12 |
| **27** | 9.474.695.098 | 68.69 | 6.508.414.452,66 |
| **28** | 9.474.695.098 | 75.95 | 7.195.946.831,91 |
| **29** | 9.474.695.098 | 81.01 | 7.675.066.311,39 |
| **30** | 9.474.695.098 | 88.09 | 8.345.814.455,32 |
| **31** | 9.474.695.098 | 88.01 | 8.338.313.741,69 |
| **32** | 9.474.695.098 | 98.19 | 9.302.952.610,98 |

• Calculation of Actual Cost of Work Performed (ACWP)

The ACWP value is calculated by summing the direct and indirect costs.

1. Calculation of Direct Costs

Based on project information, direct project costs account for 85% of the total, with the following breakdown:

Table 4. Breakdown of Direct Costs

| NO | COST ITEM | % | DIRECT COST 85% | TOTAL (Rp) |
|---|---|---|---|---|
| 1 | DIRECT LABOR COST | 50% | 8.053.490.832,88 | 4.026.745.416,44 |
| 2 | MATERIAL COST | 30% | 8.053.490.832,88 | 2.416.047.249,86 |
| 3 | EQUIPMENT COST | 10% | 8.053.490.832,88 | 805.349.083,29 |
| 4 | SUBCONTRACTOR COST | 10% | 8.053.490.832,88 | 805.349.083,29 |
| 5 | SUBCONTRACTOR COST | 10% | 8.053.490.832,88 | 805.349.083,29 |
| total | | | 8.053.490.832,88 | 8.053.490.832,88 |

Direct costs = 85% x Total cost budget
= 85% x Rp. 9,474,695,098
= Rp. 8,053,490,832.88

Then multiply by the cumulative weekly work completion percentage. Example calculation for Week 5:
= 1.60% x Rp. 8,053,490,832.88
= Rp. 129,226,245

1. Indirect Cost Calculation

Based on project information, the project's indirect costs amount to 15%. The following is the calculation and breakdown of indirect costs:

Indirect costs = 15% × total budget
= 15% × Rp. 9,474,695,098
= Rp. 1,421,204,264.63

Then calculate the weekly indirect costs by dividing the total indirect costs by the planned duration.
Indirect costs per week
= indirect costs / 32
= Rp. 1,421,204,265 / 32
= Rp. 44,412,633.27

Table 5. Breakdown of Indirect Costs

| NO | COST | % | INDIRECT COST 15% | TOTAL (Rp) |
|---|---|---|---|---|
| 1 | OVERHEAD | 50% | 44,412,633.27 | 22,206,316.63 |
| 2 | ADMINISTRATION & MANAGEMENT | 30% | 44,412,633.27 | 13,323,789.98 |
| 3 | DEPRECIATION | 10% | 44,412,633.27 | 4,441,263.33 |
| 4 | SECURITY & SAFETY | 10% | 44,412,633.27 | 4,441,263.33 |
| 5 | total | | | 44,412,633.27 |

To calculate the ACWP, simply add the direct costs for week 5 and the indirect costs for week 5 as follows:

ACWP = Direct costs + Indirect costs

ACWP = Rp. 129,226,245 + Rp. 44,412,633.27

ACWP = Rp. 173,638,878.63

The ACWP calculation, obtained by summing the direct and indirect costs for Week 5, yields Rp. 173,638,878.63. The summary of ACWP calculations for Weeks 1–32 is shown in Table 6 below:

Table 6. ACWP Calculation Results

| SUNDAY | BUDGET COST (BAC) | CUMULATIVE REALIZATION WEIGHT (%) | DIRECT COST 85% (Rp) | INDIRECT COSTS 15% (Rp) | ACWP |
|---|---|---|---|---|---|
| | | | | | CUMULATIVE (Rp) |
| **1** | 9,474,695,098 | 0.003 | 231,590 | 44,412,633 | 44,644,223.29 |
| **2** | 9,474,695,098 | 0.14 | 10,968,846 | 44,412,633 | 55,381,478.98 |
| **3** | 9,474,695,098 | 0.29 | 23,633,972 | 44,412,633 | 68,046,605.07 |
| **4** | 9,474,695,098 | 0.57 | 46,125,504 | 44,412,633 | 90,538,137.27 |
| **5** | 9,474,695,098 | 1.60 | 129,226,245 | 44,412,633 | 173,638,878.63 |
| **6** | 9,474,695,098 | 3.92 | 315,971,049 | 44,412,633 | 360,383,682.42 |
| **7** | 9,474,695,098 | 4.69 | 377,453,739 | 44,412,633 | 421,866,372.08 |
| **8** | 9,474,695,098 | 6.54 | 526,563,867 | 44,412,633 | 570,976,499.79 |
| **9** | 9,474,695,098 | 8.57 | 690,564,749 | 44,412,633 | 734,977,382.14 |
| **10** | 9,474,695,098 | 10.60 | 853,780,213 | 44,412,633 | 898,192,846.59 |
| **11** | 9,474,695,098 | 12.49 | 1,005,574,671 | 44,412,633 | 1,049,987,304.34 |
| **12** | 9,474,695,098 | 18.64 | 1,500,946,027 | 44,412,633 | 1,545,358,660.13 |
| **13** | 9,474,695,098 | 25.37 | 2,043,094,014 | 44,412,633 | 2,087,506,647.37 |
| **14** | 9,474,695,098 | 30.25 | 2,436,295,525 | 44,412,633 | 2,480,708,158.62 |
| **15** | 9,474,695,098 | 32.16 | 2,590,013,538 | 44,412,633 | 2,634,426,171.31 |
| **16** | 9,474,695,098 | 35.22 | 2,836,360,784 | 44,412,633 | 2,880,773,417.51 |
| **17** | 9,474,695,098 | 42.00 | 3,382,420,885 | 44,412,633 | 3,426,833,518.44 |
| **18** | 9,474,695,098 | 42.87 | 3,452,822,100 | 44,412,633 | 3,497,234,733.75 |
| **19** | 9,474,695,098 | 43.63 | 3,513,810,915 | 44,412,633 | 3,558,223,548.46 |

| | | | | | |
|---|---|---|---|---|---|
| **20** | 9,474,695,098 | 44.42 | 3,577,425,499 | 44,412,633 | 3,621,838,132.22 |
| **21** | 9,474,695,098 | 45.67 | 3,678,301,373 | 44,412,633 | 3,722,714,005.88 |
| **22** | 9,474,695,098 | 47.12 | 3,794,635,998 | 44,412,633 | 3,839,048,631.69 |
| **23** | 9,474,695,098 | 52.18 | 4,202,599,609 | 44,412,633 | 4,247,012,242.39 |
| **24** | 9,474,695,098 | 55.70 | 4,485,590,176 | 44,412,633 | 4,530,002,808.86 |
| **25** | 9,474,695,098 | 57.60 | 4,639,045,850 | 44,412,633 | 4,683,458,483.59 |
| **26** | 9,474,695,098 | 61.45 | 4,948,851,681 | 44,412,633 | 4,993,264,314.17 |
| **27** | 9,474,695,098 | 68.69 | 5,532,152,285 | 44,412,633 | 5,576,564,918.03 |
| **28** | 9,474,695,098 | 75.95 | 6,116,554,807 | 44,412,633 | 6,160,967,440.39 |
| **29** | 9,474,695,098 | 81.01 | 6,523,806,365 | 44,412,633 | 6,568,218,997.95 |
| **30** | 9,474,695,098 | 88.09 | 7,093,942,287 | 44,412,633 | 7,138,354,920.29 |
| **31** | 9,474,695,098 | 88.01 | 7,087,566,680 | 44,412,633 | 7,131,979,313.70 |
| **32** | 9,474,695,098 | 98.19 | 7,907,509,719 | 44,412,633 | 7,951,922,352.60 |

The following is a summary of the calculation results and graphs for the three Earned Value indicators (BCWS, BCWP, and ACWP) described above. These can be seen in the table below:

Table 7. Summary of BCWS, BCWP, and ACWP

| SUNDAY | BCWS | BCWP | ACWP |
|---|---|---|---|
| **1** | 47,208,555.27 | 272,458.85 | 44,644,223.29 |
| **2** | 94,417,110.54 | 12,904,524.36 | 55,381,478.98 |
| **3** | 238,186,801.64 | 27,804,672.70 | 68,046,605.07 |
| **4** | 334,747,937.46 | 54,265,298.82 | 90,538,137.27 |
| **5** | 431,309,073.28 | 152,030,876.89 | 173,638,878.63 |
| **6** | 527,870,209.10 | 371,730,646.05 | 360,383,682.42 |
| **7** | 624,431,344.92 | 444,063,222.13 | 421,866,372.08 |
| **8** | 720,992,480.74 | 619,486,901.78 | 570,976,499.79 |
| **9** | 973,779,004.20 | 812,429,116.32 | 734,977,382.14 |
| **10** | 1,130,004,391.84 | 1,004,447,309.79 | 898,192,846.59 |
| **11** | 1,286,229,779.48 | 1,183,029,024.78 | 1,049,987,304.34 |
| **12** | 1,699,605,646.15 | 1,765,818,855.13 | 1,545,358,660.13 |
| **13** | 2,014,189,110.32 | 2,403,640,016.58 | 2,087,506,647.37 |
| **14** | 2,328,772,574.49 | 2,866,230,029.82 | 2,480,708,158.62 |
| **15** | 2,643,356,038.66 | 3,047,074,750.64 | 2,634,426,171.31 |
| **16** | 3,094,562,436.91 | 3,336,895,040.28 | 2,880,773,417.51 |
| **17** | 3,460,717,677.24 | 3,979,318,688.44 | 3,426,833,518.44 |
| **18** | 4,060,588,729.64 | 4,062,143,647.63 | 3,497,234,733.75 |
| **19** | 4,717,892,767.16 | 4,133,895,194.34 | 3,558,223,548.46 |
| **20** | 5,228,008,035.85 | 4,208,735,881.12 | 3,621,838,132.22 |
| **21** | 5,697,676,822.33 | 4,327,413,379.54 | 3,722,714,005.88 |
| **22** | 5,968,253,414.38 | 4,464,277,645.20 | 3,839,048,631.69 |

| | | | |
|---|---|---|---|
| **23** | 6,463,877,948.19 | 4,944,234,834.26 | 4,247,012,242.39 |
| **24** | 6,959,502,482.00 | 5,277,164,912.46 | 4,530,002,808.86 |
| **25** | 7,460,631,818.38 | 5,457,701,000.38 | 4,683,458,483.59 |
| **26** | 7,659,405,950.81 | 5,822,178,448.12 | 4,993,264,314.17 |
| **27** | 8,163,175,929.05 | 6,508,414,452.66 | 5,576,564,918.03 |
| **28** | 8,542,319,814.03 | 7,195,946,831.91 | 6,160,967,440.39 |
| **29** | 8,921,463,699.01 | 7,675,066,311.39 | 6,568,218,997.95 |
| **30** | 9,342,529,821.16 | 8,345,814,455.32 | 7,138,354,920.29 |
| **31** | 9,466,647,597.50 | 8,338,313,741.69 | 7,131,979,313.70 |
| **32** | 9,474,695,097.50 | 9,302,952,610.98 | 7,951,922,352.60 |

**Interpretation of BCWS, BCWP, and ACWP Trends**.

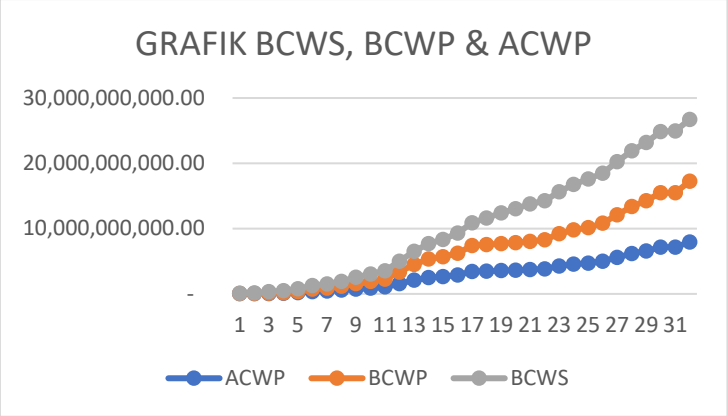
Based on the comparison of BCWS, BCWP, and ACWP, the project performance shows different cost and schedule characteristics during the implementation period. BCWS represents the planned value of work that should have been completed, while BCWP represents the value of work actually completed. ACWP represents the actual cost incurred to complete the work. Therefore, the relationship among these three indicators is important for identifying whether the project is running efficiently in terms of cost and whether the physical progress follows the planned schedule.

In the early weeks, the BCWP value was lower than BCWS, indicating that the actual physical progress was still below the planned progress. This condition commonly occurs during the initial stage of construction because mobilization, site preparation, administrative work, procurement preparation, and work coordination require time before significant physical progress can be achieved. Although costs had already been incurred, the earned value of completed work was still relatively low. This explains why project performance in the early period appeared less efficient.

From the middle stage of implementation, the BCWP value increased significantly. This indicates that construction productivity improved after the initial preparation stage. The increase in earned value may have been influenced by better field coordination, more stable labor productivity, improved material availability, and more continuous execution of major work items. However, in several reporting periods, BCWP remained lower than BCWS, which means that the project still experienced schedule pressure. This condition suggests that the project team needed to control not only cost efficiency but also the achievement of planned work progress.

At the end of the observation period, BCWP reached Rp9,302,952,610.98, while BCWS reached Rp9,474,695,097.50. This indicates that the value of completed work was still slightly lower than the planned value. The implication is that, although the project showed relatively good cost performance, there was still a remaining gap in schedule performance. Therefore, project management should pay attention to the remaining work items, especially activities that may affect project handover, final inspection, and administrative completion.

Table 8. BCWS, BCWP, ACWP Graphs




• Variance Analysis

- Cost Variance (CV) Calculation

Cost variance is the difference between the value obtained after completing work packages and the actual costs incurred during project implementation. Below is an example of a Cost Variance (CV) calculation for week 5, referring to equation 4 in Chapter II:

CV = BCWP WEEK 5 – ACWP WEEK 5

CV = Rp. 152,030,876.89 - Rp. 173,638,878.63

CV = Rp. - 21,608,001.74

The CV calculation for week 5 shows a negative (-) value, meaning that costs exceeded the budget. The calculation and description of the Cost Variance (CV) for weeks 1-32 can be seen in Table 4.8 on the next page.

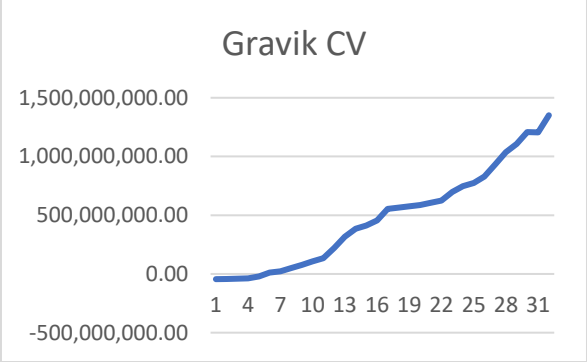
Table 9. CV Calculation Results

| SUNDAY | BCWP (Rp) | ACWP (Rp) | CV (Rp) | INFORMATION |
|---|---|---|---|---|
| **1** | 272,458.85 | 44,644,223.29 | -44,371,764.44 | The CV values from the first week through the fifth week are negative (–), indicating that actual costs exceeded the budget. |
| **2** | 12,904,524.36 | 55,381,478.98 | -42,476,954.62 | |
| **3** | 27,804,672.70 | 68,046,605.07 | -40,241,932.36 | |
| **4** | 54,265,298.82 | 90,538,137.27 | -36,272,838.45 | |
| **5** | 152,030,876.89 | 173,638,878.63 | -21,608,001.74 | |
| **6** | 371,730,646.05 | 360,383,682.42 | 11,346,963.64 | The CV values from week 6 through week 32 are positive (+), indicating that actual costs were lower than the budget. |
| **7** | 444,063,222.13 | 421,866,372.08 | 22,196,850.05 | |
| **8** | 619,486,901.78 | 570,976,499.79 | 48,510,402.00 | |
| **9** | 812,429,116.32 | 734,977,382.14 | 77,451,734.18 | |
| **10** | 1,004,447,309.79 | 898,192,846.59 | 106,254,463.20 | |
| **11** | 1,183,029,024.78 | 1,049,987,304.34 | 133,041,720.45 | |
| **12** | 1,765,818,855.13 | 1,545,358,660.13 | 220,460,195.00 | |
| **13** | 2,403,640,016.58 | 2,087,506,647.37 | 316,133,369.22 | |
| **14** | 2,866,230,029.82 | 2,480,708,158.62 | 385,521,871.20 | |
| **15** | 3,047,074,750.64 | 2,634,426,171.31 | 412,648,579.33 | |
| **16** | 3,336,895,040.28 | 2,880,773,417.51 | 456,121,622.77 | |
| **17** | 3,979,318,688.44 | 3,426,833,518.44 | 552,485,170.00 | |

| | | | |
|---|---|---|---|
| **18** | 4,062,143,647.63 | 3,497,234,733.75 | 564,908,913.87 |
| **19** | 4,133,895,194.34 | 3,558,223,548.46 | 575,671,645.88 |
| **20** | 4,208,735,881.12 | 3,621,838,132.22 | 586,897,748.90 |
| **21** | 4,327,413,379.54 | 3,722,714,005.88 | 604,699,373.66 |
| **22** | 4,464,277,645.20 | 3,839,048,631.69 | 625,229,013.51 |
| **23** | 4,944,234,834.26 | 4,247,012,242.39 | 697,222,591.87 |
| **24** | 5,277,164,912.46 | 4,530,002,808.86 | 747,162,103.60 |
| **25** | 5,457,701,000.38 | 4,683,458,483.59 | 774,242,516.79 |
| **26** | 5,822,178,448.12 | 4,993,264,314.17 | 828,914,133.95 |
| **27** | 6,508,414,452.66 | 5,576,564,918.03 | 931,849,534.63 |
| **28** | 7,195,946,831.91 | 6,160,967,440.39 | 1,034,979,391.52 |
| **29** | 7,675,066,311.39 | 6,568,218,997.95 | 1,106,847,313.44 |
| **30** | 8,345,814,455.32 | 7,138,354,920.29 | 1,207,459,535.03 |
| **31** | 8,338,313,741.69 | 7,131,979,313.70 | 1,206,334,427.98 |
| **32** | 9,302,952,610.98 | 7,951,922,352.60 | 1,351,030,258.38 |

- The table above shows that from the first week through the fifth week, the CV value was negative (–), meaning that actual costs exceeded the planned budget—in other words, there was overspending—while from the sixth through the 32nd week, the CV value was positive (+), meaning that actual costs were lower than the budget.

Table 10. Cost variance (CV) chart




**Discussion of Causes and Implications of Cost Variance Results**

The Cost Variance (CV) results show that during Weeks 1 to 5, the project experienced negative CV values. This means that the actual cost incurred was higher than the earned value of the completed work. The main cause of this condition was the high initial expenditure during the early stage of the project, while the physical progress was still low. Initial costs such as mobilization, preparation work, site facilities, labor readiness, procurement arrangements, and indirect costs were incurred before the project produced significant measurable progress. As a result, ACWP became higher than BCWP during the early weeks.

Starting from Week 6 until Week 32, the CV values became positive. This indicates that the earned value of completed work was higher than the actual cost incurred. This condition suggests that the project became more efficient in terms of cost after the initial stage. The positive CV trend may have been caused by improved productivity, better

utilization of labor and equipment, more effective work sequencing, and more controlled use of project resources. It also indicates that the actual expenditure was lower than the budgeted value of the completed work.

However, the positive CV result should be interpreted carefully. A positive CV does not automatically mean that the project generated profit or that there were no financial risks. In construction projects, actual cost records may be affected by delayed invoices, unpaid subcontractor claims, pending material payments, or administrative recording delays. Therefore, the positive CV value must be verified with actual payment records, material procurement reports, subcontractor billing, and project cash-flow data. Without this verification, the cost performance may appear better than the actual financial condition of the project.

The implication of these results is that the project had different control priorities in different implementation stages. In the early stage, the project required stricter control of mobilization costs, indirect costs, and initial resource allocation. In the middle and final stages, the project required stronger schedule control because the final BCWP value was still slightly lower than BCWS. This means that the project showed good cost efficiency but still needed attention in terms of progress achievement. Therefore, corrective actions should focus on accelerating remaining work, improving coordination among work teams, ensuring timely material delivery, and monitoring critical activities that may affect project completion.

Overall, the EVM results indicate that the North Minahasa Regency Government Library Building project had favorable cost performance after the initial implementation stage, as shown by the positive CV values from Week 6 to Week 32. Nevertheless, the gap between planned value and earned value at the end of the observation period shows that schedule performance still required attention. Thus, Earned Value Management can be used not only to measure cost efficiency but also as an early warning tool for identifying project control problems and supporting timely managerial decisions.

## CONCLUSION

The conclusion should address the issues discussed earlier and clearly outline the findings, strengths, and weaknesses, as well as potential avenues for further development. The conclusion may be written as a paragraph summarizing the research findings and offering suggestions for future research.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