

Application of Earned Value Analysis Method on Building Rehabilitation and Renovation Project Works Iain Library and Laboratory, Sirimau District, Ambon City

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Keywords— Earned Value, Time and Cost Control.

Abstract— In one construction project, overall cost and time control is part of construction management. By applying the Earned Value method, cost control and completion time can be done well. Thus avoiding cost and time, project control can be carried out properly in terms of time and cost. The results of this study are to determine the cost and time aspects of project performance each month and predict the costs and time to be able to complete the rest of the work so that corrective actions will be taken next. The results of the analysis of the Rehabilitation and Renovation Work of the Library and Laboratory Building of IAIN Sirimau District, Ambon City, the SPI value at week 16 was 1.04 or (>1) while the CPI was 1.05 or (>1) which means the project was implemented more faster than planning on a smaller budget. ETC value of IDR. 20,831,175,738 and the EAC value of IDR. 31,160,101,437.

I. INTRODUCTION

A project is a series of temporary activities that take place for a limited period of time, with the allocation of certain resources and the puIDRose of carrying out the tasks whose targets have been clearly outlined (Soeharto, 1995). In project implementation, there are several important components that determine the success of a project. These components are in the form of cost, time and quality which are interrelated with each other. These three components must be processed as well as possible to obtain profits in accordance with the plan (Soeharto, 1995). In implementation in the field, it is not uncommon to find projects that experience delays in completion and even stop their implementation. Therefore, it is necessary to control so that the storage that occurs can be overcome, so that the project can be completed on time as planned. In an effort to succeed in a construction project, a good technique or management method is needed to increase efficiency, productivity and work quality. In this regard, it

is necessary to carry out supervisory and control measures in all sectors, especially time control. Project duration is the length of time a project lasts until it produces a product that has been planned. In a project, time planning is prepared by making a time schedule, in which there is a time division and sequence of project work from the beginning of the work to the final work. In the analysis of variance, it only shows the difference in work results at the time of reporting compared to the budget or schedule. The weakness of the Variant Analysis method is that it only analyzes the cost and schedule variants of each separately so that it cannot reveal the performance problems of the activities being carried out. Meanwhile, with the result value concept method, it can be seen the performance of the activities being carried out and can increase effectiveness in monitoring project activities.

Currently, the IAIN Ambon Library and Laboratory Rehabilitation and Renovation Project is underway. The contractor for this project is PT. Anugrah Putra Perkasa,

JO. PT. Laleva Indah Lestari. During project implementation, it is necessary to control the time aspect of what has been planned. In the work on the Rehabilitation and Renovation of the Library and Laboratory Building of IAIN Ambon, it is not known that deviations or delays occurred. Therefore, a study is needed to evaluate time control in the Library and Laboratory Rehabilitation and Renovation Project of IAIN Ambon, using the Earned value concept. Earned value concept is one of the methods used in project control methods that combines elements of schedule, cost, and job performance to calculate the estimated cost and time required to complete the project to completion. The results of the Earned value concept analysis in each project evaluation then provide information about the conditions of project implementation and can be used by project managers as a basis for making decisions that are needed to make improvements so that project implementation can achieve the project's initial goals.

II. LITERATURE REVIEW

2.1. Result Value Concept.

The project control method used is the Integrated Cost and Schedule Control Method (*Earned Value*). This method examines the trend of Schedule Variants and Cost Variants at a time period during the project (Soeharto , 1995).

1. Understanding *Earned Value Analysis*

The " *Eaned Value* " method is a control method used to control costs and project schedules in an integrated manner. This method provides information on the status of project performance in a reporting period and provides predictive information on the costs required and time for completion of all work based on performance indicators at the time of reporting.

2. The Concept of Earned Value (Earned Value)

The concept of value for results is the concept of calculating the amount of costs according to the budget in accordance with the work that has been completed or carried out (*budgeted cost of works performed*). When viewed from the amount of work completed, it means that this concept measures the size of the unit of work completed, at a time when assessed based on the amount of budget provided for the work. With this calculation, it is known the relationship between what has actually been achieved physically and the amount of the budget that has been issued (Soeharto, 1995).

In construction work, cost management is divided into 2 parts, namely the estimation of direct costs and indirect costs

2.2. Direct costs and indirect costs

1. Direct cost

Direct costs are costs that are directly allocated for the implementation of work on *the items* stated, such as:

- Provision of materials (direct effect on work)
- Provision of labor (direct effect on work)
- Equipment (direct effect on work)
- subcontracting services (direct effect on work)
- transportation and construction equipment such as cranes, trucks (direct effect on work) for project implementation according to plans and specifications within the scope of work

2. Indirect costs

Indirect costs are costs that must be incurred by the contractor for the implementation of activities but are not directly allocated for the implementation of work such as:

- Provision of working water (direct effect on work)
- Provision of work electricity (direct effect on work)
- Provision of wifi (does not directly affect work)
- provision of salaries of employees and staff in the field (does not directly affect the work)
- laboratory costs, field testing (does not directly affect the work)
- material and warehouse arrangement costs (direct effect on work)
- board of directors construction costs (no effect on work)

2.3. Basic Value Concept

According to Suharto (1995) the basic concept of result value can be used to analyze performance and make estimates of target achievement. For this puIDRose, 3 indicators are used, namely;

1. ACWP (*Actual Cost of Work Performed*)

Is the actual cost of the work that has been carried out. These costs are obtained from accounting or project financial data at the reporting date (eg month-end), which is a record of all actual cost expenditures from work packages or accounting codes including overhead calculations and others .

$$\text{ACWP} = \text{Planned weight (\%)} \times \text{contract value}$$

2. BCWP (Budgeted Cost of Work Performed)

Is an indicator that shows the value of the results from the point of view of the value of the work that has been completed on the budget provided to carry out the work. When the ACWP figure is compared with the BCWP, it will be seen a comparison between the costs that have been incurred for the work that has been carried out against the costs that should have been spent for that puIDRose (Soeharto, 1995).

$$\text{BCWP} = \text{Realized Weight (\%)} \times \text{contract value}$$

3. BCWS (Budgeted Cost of Work Scheduled)

It is the same as a budget for a work package, but is structured and linked to an implementation schedule. So here there is a combination of costs, schedules, and scope of work, where each element of work has been allocated a cost and schedule that can be used as a benchmark in carrying out work (Soeharto, 1995).

According to (Soeharto 1995) using the 3 indicators above, various factors can be calculated that indicate the progress and performance of project implementation, such as:

- Cost Variance Cost Variance (CV) and Schedule Variance (SV) schedule integrated;
- Determine the variance change against the standard number;
- Productivity and performance index;
- Estimated project completion costs

The criteria for the cost performance index (CPI) and schedule performance index (SPI) are as follows:

- If the performance index is less than one (<1), the expenditure is greater than the budget or the implementation time is longer than the planned schedule. And if the budget and schedule have been made realistically, then there are irregularities in the implementation of the work .
- If the performance number is more than one (>1), then the performance in project implementation is better than planning, in the sense that the project expenditure is smaller than the budget or the schedule is ahead of the predetermined plan.
- The greater the difference from the number one (1), the greater the deviation from the basic planning or budget. If the number is too high, which means that the performance of the work is very good, then it is necessary to cross-check whether the planning or budget is unrealistic.

The results of the final project analysis are:

- Cost Performance Index* (CPI) that is, the main indicator used to analyze costs. For the calculation of CPI can be used using the following formula

$$CPI = BCWP / ACWP$$
- Schedule Performance Index* (SPI), that is, an indicator used to analyze time performance. To get the SPI value can be used by using the following formula

$$SPI = BCWP / BCWS$$
- Cost variance* (CV) is the difference between the project value and the actual cost, or can also be said to be the budget value that occurs between BCWP and ACWP. To calculate the cost variance can be used the formula;

$$\text{Cost Variance (CV)} = BCWP - ACWP$$

If CV :

- Negative (-) = Cost above budget
- Zero (0) = On budget
- positive (+) = Cost under budget

- Estimated cost for remaining work / *Estimate to Completion* (ETC) is the estimated cost required to complete the remaining work costs. The estimated cost for the remaining work can be calculated using the following formula

$$ETC = \text{Total Project Budget (BAC)} - BCWP/CPI$$

- Estimate at Completion (EAC) is an estimate of the total cost at the end of the project obtained from

$$EAC = ACWP + [(BAC - BCWP)/(CPI \times SPI)]$$

2.4. Previous Research

Lucy Octafiani, 2018 has the research title "Earned value analysis of cost control and building construction time" which contains several conclusions, namely: project performance in terms of cost and time in the construction of the Kalibokor type B building at CV.Trinedyatekama for 5 (five) months when viewed from the results of the CPI (Cost Performance index) the results obtained are good, the project status when reporting at the end of the month benefits with an estimated profit of IDR. 235,245,016 or if the percentage is 19.788%.

Eka regitra deska febr, 2015 research title is "cost and time performance analysis using the earned value analysis method which contains several conclusions and suggestions, namely: project implementation costs are the same as the contract value, final cost estimates in the last week, namely week 13 of the final cost estimation results. the project obtained EAC (Estimated Temporary Cost): the estimated total cost of IDR. 681,818,606.91, the value of SPI (cost performance index) is positive (1.00) in week 1 to week 10 this means that the work is carried out exactly according to plan (on schedule), but in week 11 to week the 13 jobs did not go according to plan. The suggestions in this research are: based on the results of the analysis and discussion on this project, the work was *off schedule*, but in the end the work went exactly as planned. In carrying out the project, one should pay attention to the cost and time factors in order to achieve maximum results, in using the *Eraned Value method* for project control, accuracy of data in the field is needed in weekly reports, budget plans, implementation budget plans and *time schedules* . Good communication and coordination between the project management parties is needed so as not to cause work obstacles that result in delays in work in the field.

Fandi Achmad Pahalawan, 2015 This research is entitled "Analysis of the concept of the value of the results (Earned Value Analysis) of the time and cost of the project work on the construction of the MCS SBU II Surabaya building." This research has several conclusions, namely at the end of the review at week 21, the performance of the project schedule (SPI) of 0.858 is smaller than 1, indicating that the project experienced a delay of 10.99% from the initial plan of the project which was planned at 70.023% with the realization of work 59.033% while the cost performance CPI value was 1.061 greater than 1 which means there is savings or costs which is smaller than the work that has been done. The conditions in which the completion time is experienced must be anticipated by predicting the progress of the project at the next time, namely by calculating the project completion time (ECD). Estimated project completion time increased from 28 weeks to 29 weeks while the estimated cost for remaining work (ETC) is IDR. 2,763,530,293 and the total project cost (EAC) is IDR. 6,662,540,478. based on reporting in the last week the CV at the end of the review was IDR. 237,035,975 where there were fewer actual expenses or the contractor experienced profits during the project. as for suggestions from this research, namely good communication and coordination between project managers is needed so that there are no work obstacles that result in delays in work, accurate data is needed including RAB, Time Schedule, daily reports on work implementation and weekly project reports. So that it can correctly predict the condition of project performance, due to delays, it is recommended that the relevant parties control the progress of performance in the following weeks and find solutions so that the project is completed on time with remaining costs.

III. METHODOLOGY

3.1. Research Sites

IAIN Ambon Library and Laboratory Building Project Location Located at Jl. Dr. H. Tarmizi Taher, Sirimau sub-district, Ambon city

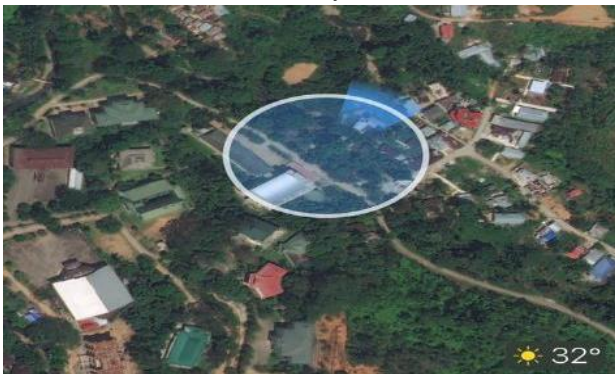


Fig.1 : Map of Research Locations

3.2. Data Type

The types of data used in this writing are:

- Primary data

Primary data is data obtained by researchers directly. Primary data collection is done by conducting interviews or discussions about the application of the value of the results on the project

- Secondary Data

Secondary data is data obtained by researchers from existing sources. In this study, secondary data were obtained from PT. LALEVA INDAH LESTARI, which is the project implementing contractor. The data obtained are project location map data, company organizational structure and project work items.

The data - the data obtained are as follows:

1. Time schedule
2. Plan drawing
3. Material price list and wages
4. Weekly/daily reports
5. Project cost calculation recapitulation

3.3. Data collection technique

Data collection techniques are the methods used to obtain data.

1. Through Study Literature
2. Collecting data from the field
3. Research / Data Processing Independently,

3.4. Data source

The data obtained for this writing is sourced from the library method, books, journals and from the PT. LALEVA INDAH LESTARI as the implementing contractor.

3.5. Analysis Method

From the data obtained, the authors grouped the data, then tabulated it, after that the calculations were carried out based on the research flow chart as follows:

1. Applying the method of analysis of the concept of value of results (*Earned Value Concept*)
2. Define BCWP and BCWS.
3. Determining the SV Schedule Variance.
4. Calculating SPI.
5. Calculating ETC and EAC

3.6. Research Flowchart

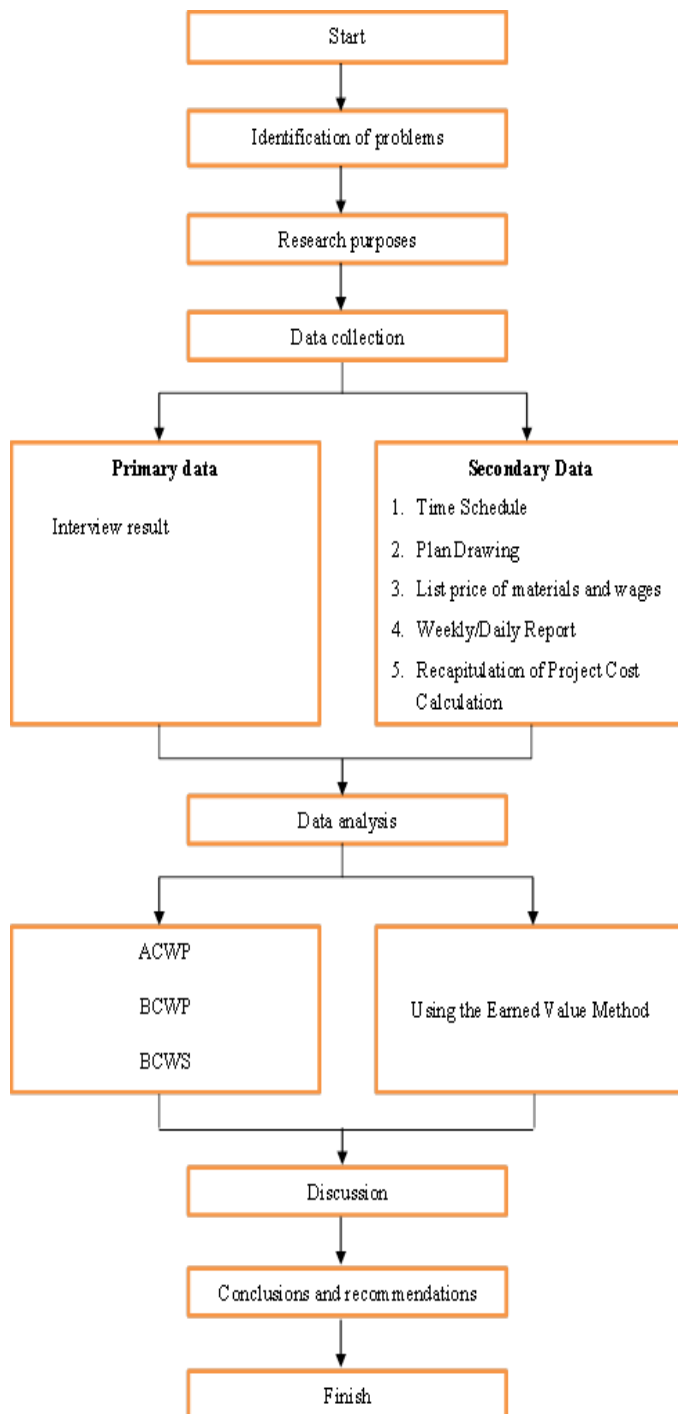


Fig.2: Research Flowchart

IV. ANALYSIS AND DISCUSSION

4.1. Project Overview

In order to increase students' enthusiasm for learning so that they can study actively to develop their knowledge, the construction of a Library and Laboratory building which has project specification data is as follows:

Project Name : Rehabilitation And Renovation

IAIN Libraries and Labs

Ambon

Contract Number : HK 0102/PPWM-PBL/2020/07

Contract Value : IDR. 32,953,631,000.-

Contract Date : 01 September 2020

Location : Ambon City

Execution time : 240 Calendar Days

Implementing Contractor : PT. Anugrah Putra Perkasa JO

PT. Laleva Indah Lestari

Supervisory Consultant : PT. True Mighty Star JO

CV. Charm Consultant

4.2. Calculating ACWP (Actual Cost Of Work Performed).

Formula : $ACWP = \text{Planned Weight} \times \text{Contract Value}$.

$$\text{Planned Weight} = \frac{\text{8th Week Total Cost}}{\text{Contract Value}} \times 100$$

Note: Contract Value = IDR. 29,355,921,900 .

ACWP value at the time of the 8th Week Reporting

$$ACWP = \text{Planned Weight \%} \times \text{Contract Value}.$$

$$ACWP = 4,671 \% \times \text{IDR. } 29,355,921,900$$

$$= \text{IDR. } 1,371,273,990,00$$

ACWP value at the time of the 12th Week Reporting

$$ACWP = \text{Planned Weight \%} \times \text{Contract Value}.$$

$$ACWP = 17.955 \% \times \text{IDR. } 29,355,921,900 .-$$

$$= 5,270,886,134,290$$

ACWP value at the time of the 16th Week Reporting

$$ACWP = \text{Planned Weight \%} \times \text{Contract Value}.$$

$$ACWP = 35.185 \% \times \text{IDR. } 29,355,921,900 .-$$

$$= \text{IDR. } 10,328,925,699,480$$

For the next week's calculations can be done in the same way as above, as follows This ACWP calculation result from week 8 to week 16 can be seen in the table below

Table .1: ACWP (Actual Cost Of Work Performance) Value.

Week-	% Cumulative	ACWP Value (IDR)
1	0%	0
2	0%	0
3	0.043%	12,742,532
4	0.188%	55,308,411
5	0.689%	202,256,003

6	1.682%	493,654,409
7	3.198%	938,835,466
8	4.671%	1,371,273,990
9	6.631%	1,946,532,158
10	9.167%	2,691,166,663
11	13.648%	4,006.376,243
12	17.955%	5,270,886,134
13	22.263%	6,535,396,026
14	26.570%	7,799,905,917
15	30.878%	9,064,415,808
16	35.185%	10,328,925,699

Source: Analysis Results (2021)

4.3. Calculating BCWP (Budgeted Cost Of Work Performed)

Formula : $BCWP = \frac{\% \text{ Actual Weight}}{100} \times \text{Contract Value.}$

Note: Contract Value = IDR 32,953,631,000

BCWP value at the time of the 8th Week Reporting.

$$BCWP = \frac{\% \text{ Actual Weight}}{100} \times \text{Contract Value.}$$

$$BCWP = 9.08 \% \times 32,953,631,000$$

$$= \text{IDR } 2,992,189,694,80$$

BCWP value at the time of the 12th Week Reporting.

$$BCWP = \frac{\% \text{ Actual Weight}}{100} \times \text{Contract Value.}$$

$$BCWP = 23,85 \% \times 32,953,631,000$$

$$= \text{IDR } 7,859,440,993,50$$

BCWP value at the time of the 16th Week Reporting.

$$BCWP = \frac{\% \text{ Actual Weight}}{100} \times \text{Contract Value.}$$

$$BCWP = 32.81 \% \times 32,953.631.000$$

$$= \text{IDR } 10,812,086,331,10$$

For the next week's calculation can be done in the same way as above, the following is the result of BCWP calculation from week 1 to week 16 can be seen in the taber below.

Table .2: Value of BCWP (Budgeted Cost Of Work Performance).

Week -	% BCWP Plan Weight	BCWP (IDR)
1	0.00%	-
2	0.00%	-
3	0.04%	13,181,452
4	0.23%	75,793,351
5	0.82%	270,219,774
6	3.75%	1,235,761,163
7	6.03%	1,987,103,949
8	9.08%	2,992,189,694.80
9	9.91%	3,265.704,832.10
10	14.61%	4,814,525,489.10
11	18.79%	6,191,987,264.90
12	23.85%	7,859,440,993.50
13	26.63%	8,775.551,935.30
14	28.73%	9,467,578,186.30
15	30.78%	10,143,127,621.80
16	32.81%	10,812,086,331.10
Project Value	100%	32,953,631,000

Source: Analysis Results (2021)

4.4. Calculating BCWS (Budgeted Cost Of Work Schedule)

Formula : $BCWS = \frac{\% \text{ Planned Weight}}{100} \times \text{Contract Value.}$

Note: Contract Value = IDR 32,953,631,000

BCWS value at the time of the 8th Week Reporting.

$$BCWS = \frac{\% \text{ Planned Weight}}{100} \times \text{Contract Value.}$$

$$BCWS = 4,94 \% \times \text{IDR } 32,953,631,000$$

$$= \text{IDR } 1,627,909,371,40$$

BCWS value at the time of the 12th Week Reporting.

$$BCWS = \frac{\% \text{ Planned Weight}}{100} \times \text{Contract Value.}$$

$$BCWS = 17,14 \% \times \text{IDR } 32,953,631,000$$

$$= \text{IDR } 5,648,252,353,40$$

BCWS value at the time of the 16th Week Reporting

$$BCWS = \frac{\% \text{ Planned Weight}}{100} \times \text{Contract Value.}$$

$$BCWS = 31,43 \% \times \text{IDR } 32,953,631,000$$

$$= \text{IDR } 10.357.326.223,30$$

For the next week's calculation, it can be done in the same way as above, the following results of the BCWS calculation from week 1 to week 16 can be seen in the table below.

Table .3: Value of BCWS (Budgeted Cost Of Work Schedule).

Week -	% BCWS Plan Weight	BCWS (IDR)
1	0.00%	-
2	0.00%	-
3	0.04%	13,181,452.40
4	0.19%	62,611,898,90
5	0.49%	161,472,791.90
6	0.96%	316,354,857.60
7	1.75%	576,688,542.50
8	4.94%	1,627,909,371,40
9	6.38%	2,102.441,657.80
10	9.41%	3,100,936,677,10
11	13.44%	4.428.968.006.40
12	17.14%	5,648,252,353.40
13	20.85%	6,870,832,063.50
14	24.41%	8,043.981,327.10
15	28.68%	9,451,101,370.80
16	31.43%	10,357,326.23.30
Project Value	100%	32,953,631,000

Source: Analysis Results (2021)

4.5. Analysis of the result value indicators CV (Cost Variance) and SV (Shedule Variance)

Formula: $CV = BCWP - ACWP$

$$SV = \% BCWP - \% BCWS$$

CV and SV value at the time of the 8th Week Reporting.

$$CV = BCWP - ACWP$$

$$= \text{IDR } 2,992,189,695 - \text{IDR } 1,371,273,990$$

$$= \text{IDR } 1,620,915,705$$

$$SV = \% BCWP - \% BCWS$$

$$= 9,08 \% - 4,94 \%$$

$$= +4,14 \%$$

CV and SV value at the time of the 12th Week Reporting.

$$CV = BCWP - ACWP$$

$$= \text{IDR } 7,859,440,994 - \text{IDR } 1,371,273,990$$

$$= \text{IDR } 2,588,554,859$$

$$SV = \% BCWP - \% BCWS$$

$$= 23,85 \% - 17,14 \%$$

$$= + 6,71 \%$$

CV and SV value at the time of the 16th Week Reporting.

$$CV = BCWP - ACWP$$

$$= \text{IDR } 10,812,086,331 - \text{IDR } 10,328,925,699$$

$$= \text{IDR } 483,160,623$$

$$SV = \% BCWP - \% BCWS$$

$$= 32.81 \% - 31.43 \%$$

$$= +1,38 \%$$

Table .4: ACWP, BCWS, and BCWP values

Week -	BCWS (IDR)	ACWP (IDR)	BCWP (IDR)
1	-	-	-
2	-	-	-
3	13,181,452.40	12,742,532	13,181,452
4	62,611,898,90	55,308,411	75,793,351
5	161,472,791.90	202.256003	270,219,774
6	316,354,857.60	493.654,409	1,235,761,163
7	576,688,542.50	938,835,466	1,987,103,949
8	1,627,909,371.40	1,371,273,990	2,992,189,695
9	2,102.441,657.80	1,946,532,158	3,265,704,832
10	3,100,936,677.10	2,691,166,663	4,814,525,489
11	4,428,968,006.40	4,006.376,243	6,191,987,265
12	5,648,252,353.40	5,270,886,134	7,859,440,994
13	6,870,832,063.50	6,535,396,026	8,775,551,935
14	8,043,981,327.10	7,799,905,917	9,467,578,186
15	9,451,101,370.80	9,064,415,808	10,143,127,622
16	10,357,326,223.30	10,328,925,699	10,812,086,331

Source: Analysis Results (2021)

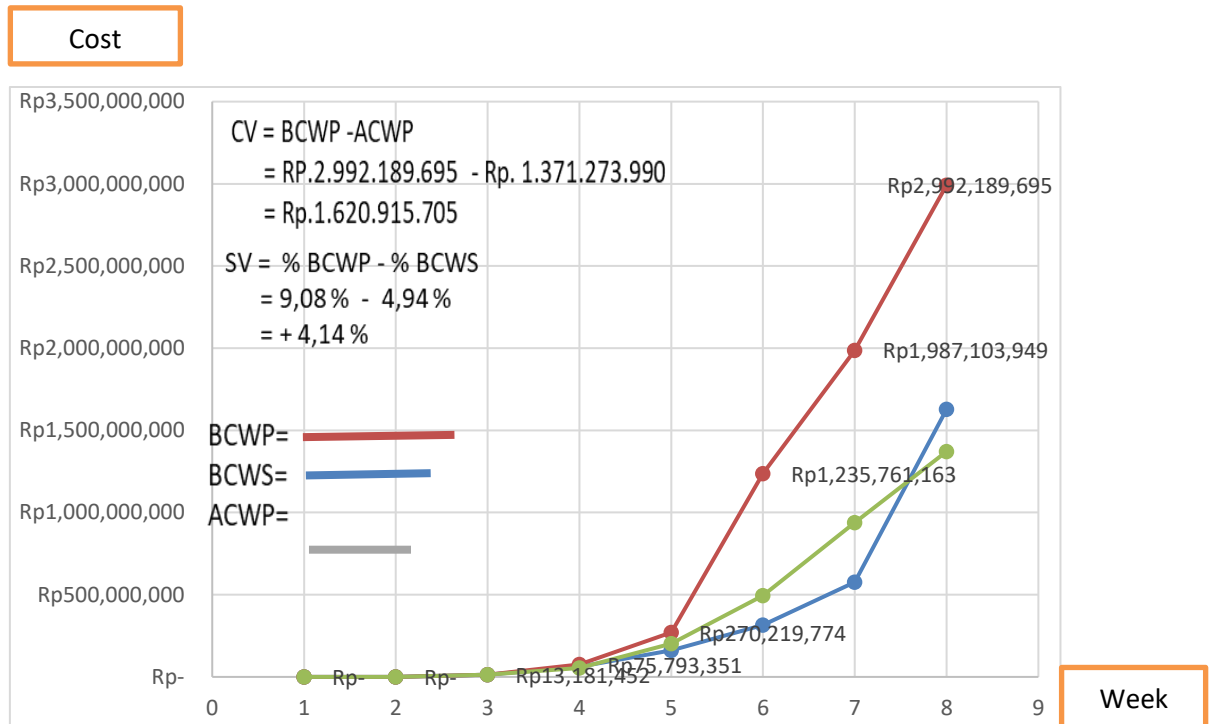


Fig.3: Graph of the S Earned Value Curve at Week 8.

So, in the picture above, the blue graph is the result of the calculation of the BCWS (Budgeted Cost Of Work Schedule) week 1 to week 8, the orange colored graph is the result of the calculation of the BCWP (Budgeted Cost Of Work Pervormanced) week 1 to week 8. 8th week where SV (Schedule Variance) got a positive result which means the work was faster than the planned

time by 4.14% and the gray graph is the result of the ACWP (Actual Cost Of Work Performance) calculation from week 1 to week 1. 8 where CV (Cost Variance) gets a negative result which means that the cost of the ACWP that is issued is smaller than the BCWP so that it has an excess cost in the 8th week of IDR. 1,620,915,705

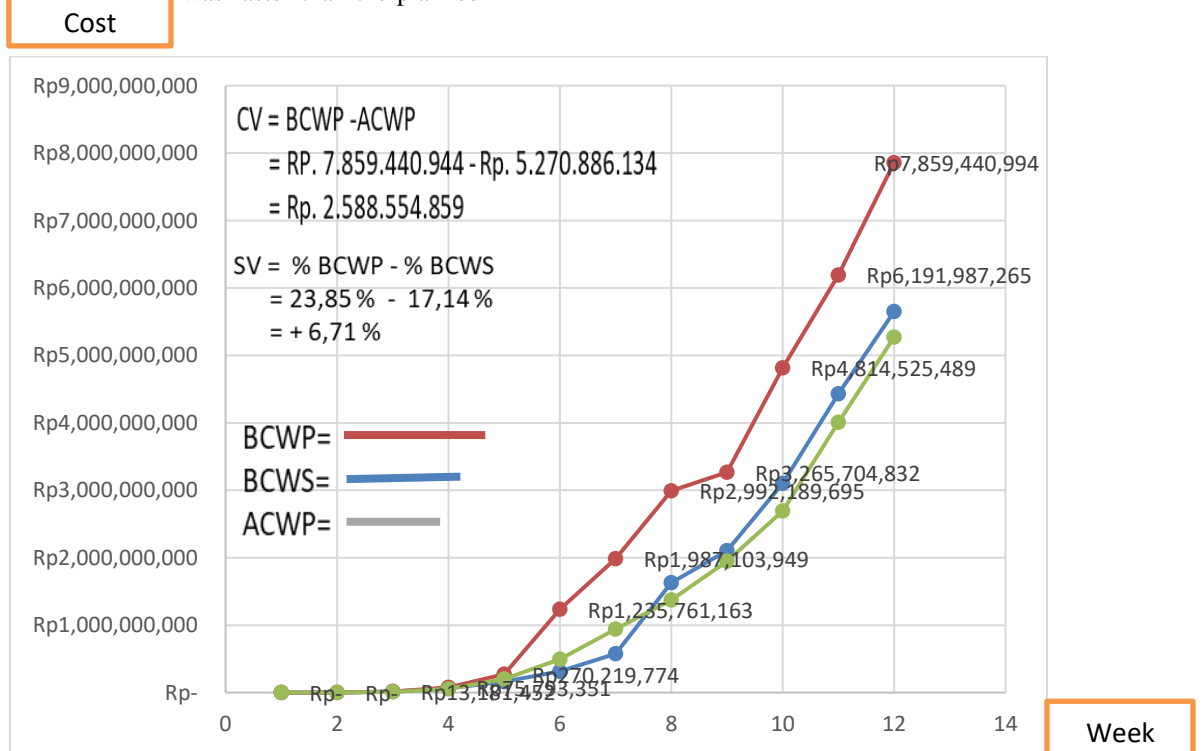


Fig.4: Graph of the S Earned Value Curve at Week 12.

So, in the picture above, the blue graph is the result of calculations from the 1st week of bcws (Budgeted Cost Of Work Schedule) week 12, the orange colored graph is the result of the calculation of the 1st week of BCWP (Budgeted Cost Of Work Pervormanced) . until the 12th week where SV (Schedule Variance) got a positive result which means that the work was faster than

the planned time by 6.71% and the gray graph is the result of the calculation of ACWP (Actual Cost Of Work Performance) week 1 to week 12th where CV (Cost Variance) gets a negative result, which means that the cost of the ACWP that is issued is smaller than the BCWP so that it has an excess of costs in the 12th week of IDR. 2,588,554,859

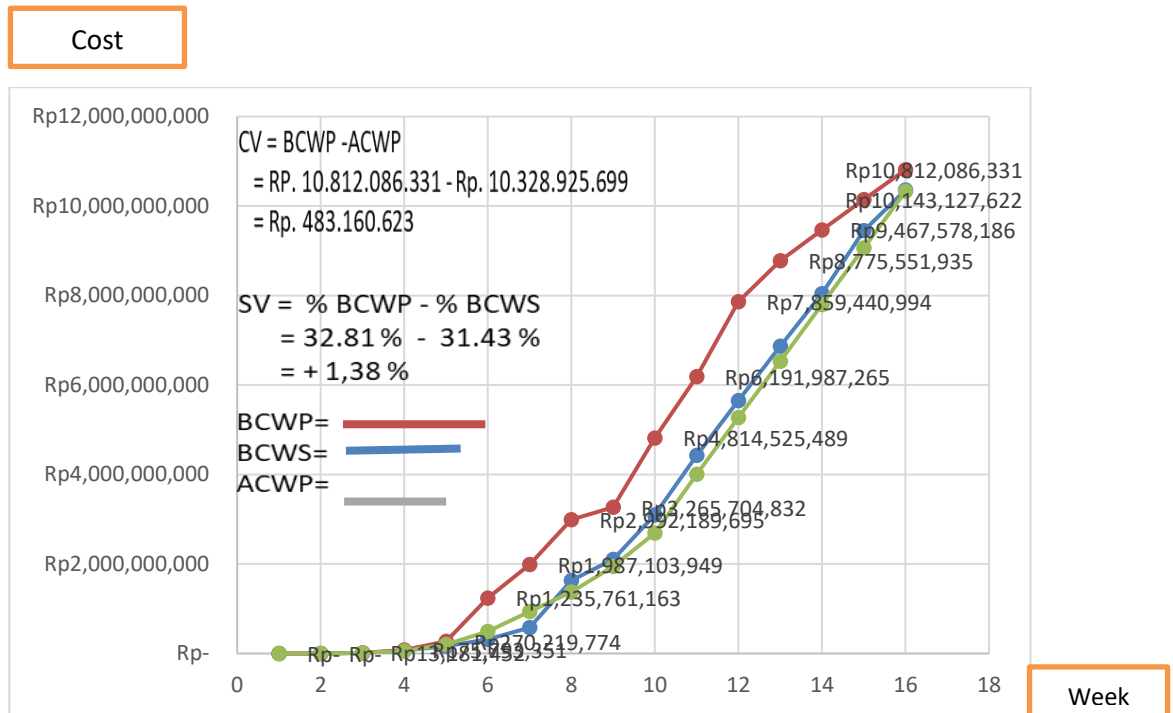


Fig . 5: Graph of the S Earned Value Curve on Week 16

So, in the picture above, the blue graph is the result of calculations from the 1st week to 16th week of bcws (Budgeted Cost Of Work Schedule) . week 16 where SV (Schedule Variance) got a positive result which means the work was faster than the planned time by 1.38% and the gray graph is the result of calculating ACWP (Actual Cost Of Work Performance) week 1 to week 1. 16 where CV (Cost Variance) gets a negative result which means that the cost of the ACWP that is issued is smaller than the BCWP so that it has an excess cost in the 16th week of IDR. 483.160,623

4.6. Calculating SPI (Schedule Performance Index)

$$\text{Formula : SPI} = \frac{\text{BCWP}}{\text{BCWS}}$$

SPI value at the time of reporting week 8.

$$\begin{aligned} \text{SPI} &= \frac{\text{BCWP}}{\text{BCWS}} \\ &= \frac{9,08}{4,94} \\ &= 1.84 \% \end{aligned}$$

1,84 > 1 means the project performance is ahead of the planned schedule.

SPI value at the time of reporting week 12.

$$\begin{aligned} \text{SPI} &= \frac{\text{BCWP}}{\text{BCWS}} \\ &= \frac{23,85}{17,14} \\ &= 1.39 \% \end{aligned}$$

1,39 > 1 means the project performance is ahead of the planned schedule.

SPI value at the time of reporting week 16.

$$\begin{aligned} \text{SPI} &= \frac{\text{BCWP}}{\text{BCWS}} \\ &= \frac{32,81}{31,43} \\ &= 1.04 \% \end{aligned}$$

1,04 > 1 means the project performance is ahead of the planned schedule.

calculation for the next week can be done in the same way as above, the following is the result of the SPI calculation from week 1 to week 16, which can be seen in the table below.

Table .7: Calculation of SPI (Schedule Performance Index).

Week-	% BCWP	%BCWS	SPI
1	0.00	0.00	0
2	0.00	0.00	0
3	0.04	0.04	1
4	0.23	0.19	1.21
5	0.82	0.49	1.67
6	3.75	0.96	3.91
7	6.03	1.75	3.45
8	9.08	4.94	1.84
9	9.91	6.38	1.55
10	14.61	9.41	1.55
11	18.79	13.44	1.40
12	23.85	17.14	1.39
13	26.63	20.85	1.28
14	28.73	24.41	1.18
15	30.78	28.68	1.07
16	32.81	31.43	1.04

Source: Analysis Results (2021)

4.7. Calculating CPI (Cost Performance Index).

$$\text{Formula : CPI} = \frac{\text{BCWP}}{\text{ACWP}}$$

SPI value at the time of reporting week 8.

$$\begin{aligned} \text{CPI} &= \frac{\text{BCWP}}{\text{ACWP}} \\ &= \frac{\text{IDR.2.992.189.695}}{\text{IDR.1.371.273.990}} \\ &= 2.18 \% \end{aligned}$$

2,18 > than 1 , it means the actual cost (ACWP) incurred is smaller than the planned work (BCWP)

SPI value at the time of reporting week 12.

$$\begin{aligned} \text{CPI} &= \frac{\text{BCWP}}{\text{ACWP}} \\ &= \frac{\text{IDR 7.859.440.994}}{\text{IDR 5.270.886.134}} \\ &= 1.49 \% \end{aligned}$$

1,49 > from 1 , it means the actual cost (ACWP) incurred is smaller than the planned work (BCWP)

SPI value at the time of reporting week 16.

$$\begin{aligned} \text{CPI} &= \frac{\text{BCWP}}{\text{ACWP}} \\ &= \frac{\text{IDR 10.812.086.331}}{\text{IDR 10.328.925.699}} \\ &= 1.05 \% \end{aligned}$$

1,05 > than 1 , it means the actual cost (ACWP) incurred is smaller than the planned work (BCWP)

For the next week's calculation can be done in the same way as above, the following is the result of the CPI calculation from week 1 to week 16 can be seen in the table below.

Table .8: Calculation of CPI (Cost Performance Index).

Week-	BCWP (IDR)	ACWP (IDR)	CPI%
1	-	-	-
2	-	-	-
3	3,181,452	12,742,532	1.03%
4	5,793,351	55,308,411	1.37%
5	270,219,774	202,256,003	1.34%
6	1,235,761,163	493,654,409	2.50%
7	1,987,103,949	938,835,466	2.12%
8	2,992,189,695	1,371,273,990	2.18%
9	3,265,704,832	1,946,532,158	1.68%
10	4,814,525,489	2,691,166,663	1.79%
11	6,191,987,265	4,006,376,243	1.55%
12	7,859,440,994	5,270,886,134	1.49%
13	8,775,551,935	6,535,396,026	1.34%
14	9,467,578,186	7,799,905,917	1.21%
15	10,143,127,622	9,064,415,808	1.12%
16	10,812,086,331	10,328,925,699	1.05%

Source: Analysis Results (2021)

4.8. Calculating CV (Cost Variance).

$$\text{Formula: CV} = \text{BCWP} - \text{ACWP}$$

CV value at the time of reporting week 8.

$$\begin{aligned} \text{CV} &= \text{BCWP} - \text{ACWP} \\ &= \text{IDR. 2,992,189,695} - \text{IDR. 1,371,273,990} \\ &= \text{IDR. 1,620,915,705} \end{aligned}$$

In the 8th week analysis the results are negative (-) which means the cost is above the plan (Cost Overrun) so that the amount of cost deviation in the 8th week is IDR. 1,620,915,705

CV value at the time of reporting week 12.

$$CV = BCWP - ACWP$$

$$= \text{IDR } 7,859,440,994 - \text{IDR } 5,270,886,134$$

$$= \text{IDR } 2,588,554,859$$

In the 12th week analysis the results are negative (-) it means the cost is above the plan (*Cost Overrun*) so that the amount of deviation costs in the 12th week is IDR. 2,588,554,859

CV value at the time of reporting week 16.

$$CV = BCWP - ACWP$$

$$= \text{IDR. } 10,812,086,331 - \text{IDR. } 10,328,925,699$$

$$= \text{IDR. } 483.160.632$$

In the analysis of the 16th week the results are negative (-) which means the cost is above the plan (*Cost Overrun*) so that the amount of deviation in costs in the 16th week is IDR. . 483.160.632

calculation for the next week can be done in the same way as above, the following is the result of calculating CV from week 1 to week 16, which can be seen in the taber below.

Table .9: Calculation of CV (Cost Variance).

Week-	% BCWP	%ACWP	CV
1	IDR -	IDR -	IDR -
2	IDR -	IDR -	IDR -
3	IDR 13,181,452	IDR 12,742,532	IDR 438,920
4	IDR 75,793,351	IDR 55,308,411	IDR 20,484,940
5	IDR 270,219,774	IDR 202,256,003	IDR 67,963,771
6	IDR 1,235,761,163	IDR 493,654,409	IDR 742,106,753
7	IDR 1,987,103,949	IDR 938,835,466	IDR 1,048,268,483
8	IDR 2,992,189,695	IDR 1,371,273,990	IDR 1,620,915,705
9	IDR 3,265.704,832	IDR 1,946,532,158	IDR 1.319.172.674
10	IDR 4,814,525,489	IDR 2,691,166,663	IDR 2,123,358,826
11	IDR 6,191,987,265	IDR 4,006.376,243	IDR 2,185,611,022
12	IDR 7,859,440,994	IDR 5,270,886,134	IDR 2,588,554,859
13	IDR 8,775.551.935	IDR 6,535,396,026	IDR 2,240,155,910
14	IDR 9,467,578,186	IDR 7,799,905,917	IDR 1,667,672,269
15	IDR 10,143,127,622	IDR 9,064,415,808	IDR 1,078,711,814
16	IDR 10,812,086,331	IDR 10,328,925,699	IDR 483.160.632

Source: Analysis Results (2021)

4.9. Calculating ETC (*Estimate Temporary Cost*).

$$\text{Formula : ETC} = \frac{BAC - BCWP}{CPI}$$

Estimated time for work remaining week 8

$$\begin{aligned} \text{ETC} &= \frac{BAC - BCWP}{CPI} \\ &= \frac{\text{IDR } 32.617.691.000 - \text{IDR } 2.992.189.695}{2,18} \\ &= \text{IDR. } 13,576,906,388 \end{aligned}$$

Estimated time for work remaining week 12

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

$$= \frac{\text{IDR } 32.617.691.000 - \text{IDR } 7.859.440.994}{1,49} \text{ IDR .}$$

$$= \text{IDR. } 16,603,969,261$$

Estimated time for work remaining week 16

$$\begin{aligned} \text{ETC} &= \frac{BAC - BCWP}{CPI} \\ &= \frac{\text{IDR } 32.617.691.000 - \text{IDR } 10.812.086.331}{1,05} \\ &= \text{IDR. } 20,831,175,738 \end{aligned}$$

For the next week's calculation can be done in the same way as above, the following is the result of ETC

calculation from week 1 to week 16 can be seen in the taber below.

Tabel.10: Calculation of ETC (Estimate Temporary Cost).

ETC= (BAC – BCWP) / CPI				
Week-	BAC	BCWP (IDR)	CPI	ETC (IDR)
1	IDR 32,617,691,000			
2				
3		13,181,452	1.03	31,518.834,675
4		75,793,351	1.37	23,746,682,628
5		270,219,774	1.34	24,211,663,461
6		1,235,761,163	2.50	12,536,263,889
7		1,987,103,949	2.12	14,471,855,623
8		2,992,189,695	2.18	13,576,906,388
9		3,265.704,832	1.68	17,495,330,384
10		4,814,525,489	1.79	15,541,085,473
11		6,191,987,265	1.55	17,098,115,212
12		7,859,440,994	1.49	16,603,969,261

13		8,775.551.935	1.34	17,755,899,804
14		9,467,578,186	1.21	19,072,322,231
15		10,143,127,622	1.12	20,084,415,297
16		10,812,086,331	1.05	20,831,175,738

Source: Analysis Results (2021)

4.10. Calculating EAC (Estimate At Completion).

Formula : EAC = ACWP + ETC

Estimated time for work remaining week 8

EAC = ACWP + ETC

= IDR . 1,371,273,990 + IDR. 13,576,906,388

= IDR. 14,948,180,378

Estimated time for work remaining week 12

EAC = ACWP + ETC

= IDR . 5,270,886,134 + IDR. 16,603,969,261

= IDR. 21,874,855,396

Estimated time for work remaining week 16

EAC = ACWP + ETC

= IDR . 10,328,925,699 + IDR. 20,831,175,738

= IDR. 31,160,101,437

For the next week's calculation, it can be done in the same way as above, the following results of the EAC calculation from week 1 to week 16 can be seen in the taber below.

Table .11: Calculation of EAC (Estimate At Completion).

Week-	ACWP (IDR)	ETC (IDR)	EAC (IDR)
1	12,742,532	31,518.834,675	31,531,577,207
2	55,308,411	23,746,682,628	23,801,991,040
3	202,256,003	24,211,663,461	24,413,919,464
4	493.654,409	12,536,263,889	13,029.918,298
5	938,835,466	14,471,855,623	15,410,691,089
6	1,371,273,990	13,576,906,388	14,948,180,378
7	1,946,532,158	17,495,330,384	19,441,862,542
8	2,691,166,663	15,541,085,473	18,232,252,136
9	4,006.376,243	17,098,115,212	21,104,491,455
10	5,270,886,134	16,603,969,261	21,874,855,396

11	6,535,396,026	17,755,899,804	24,291,295,829
12	7,799,905,917	19,072,322,231	26,872,228,147
13	9,064,415,808	20,084,415,297	29,148,831,105
14	10,328,925,699	20,831,175,738	31,160,101,437

Source: Analysis Results (2021)

V. CONCLUSION

1. From the results of cost performance, in the 16th week the cost performance index (CPI) was 1.05 % or greater than one (>1) which means that there are savings or actual costs are smaller than the work that has been done.
2. From the results of the last analysis in the 16th week, the project schedule performance (SPI) was 1.04% greater than 1, indicating that the project performance was faster than the planned schedule, or 1.38% from the initial project plan. plan at 31.43%. with the realization of 32.81%

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