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COST AND TIME ANALYSIS USING EARNED VALUE METHOD ON THE CONSTRUCTION OF THE NATIONAL KEDIRI AIRPORT ACCESS ROAD PHASE 1 KEDIRI - NGANJUK

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Abstract

Project completion delays have adverse consequences on a contractor's credibility and result in additional penalty costs, reducing potential profits. To mitigate these issues and optimize project outcomes, refining activity schedules and budgets is crucial. The Earned Value Method proves effective in monitoring and controlling project activities. In the case of the Kediri airport access road construction project, weeks 1 to 6 revealed a negative Cost Variance (CV), indicating higher-than-planned costs, while weeks 7 to 8 showed a positive CV, suggesting costs were lower than anticipated. Schedule Variance (SV) for the 1st week was unfavorable, indicating a delay, and SV>1 from weeks 2 to 8 signaled a project delay. The Estimate to Complete (ETC) is IDR 17,470,510,292.77, and the Estimate at Complete (EAC) is IDR 32,509,153,464.05. The Time Estimate (TE) forecasts project completion in 89 calendar days, five days beyond the contracted 84 days. Employing the Earned Value Method enhances project performance evaluation and decision-making to avoid delays and cost overruns.

Keywords: *Time and cost analysis, Earned value method, National Access Road, Airport*

1. INTRODUCTION

Delays in project completion are things that must be avoided by any project contractor. Because in addition to adversely affecting the credibility of the project contractor, delays in project completion also cause penalties that must be borne by the contractor, so that the benefits to be obtained are reduced (soeharto, 1999). To prevent delays and wasteful use of costs in a project, it is necessary to improve the schedule of activities and budgeting to a minimum, so that the completion time and costs used can provide maximum benefits for the contractor (Maulidi et al., n.d.).

The process of controlling a project includes all activities included in the project life cycle, so that in completing a project, you must look at the implementation by paying attention to the project control system so that the control can consider resources including time, cost and performance of the project work so that it can be controlled. The purpose of control is to ensure project completion in accordance with specifications, on time and able to utilize the resources that have been allocated. In the process of project implementation, it is always related to the cost, time and quality of construction. The initial stage in a construction project is the planning stage. Planning project activities is a very important issue because planning activities is the basis for the project to run and so that the implemented project can be completed with the optimal time.

In the process of implementing a construction project, it will always be influenced by previous activities, starting from the planned ideas and planning. In the construction

of a construction project, project cost control is important in the process of managing project costs. In the activities of a project, there will be many problems such as wasteful use of materials, unskilled labor and untimely project completion time, causing wasteful costs that are not in accordance with planning. Planning, cost and time control are part of overall construction project management. In addition to the assessment of the quality aspect, the performance of a project can also be assessed from the aspects of cost and time(Aditama, 2021). The costs that have been incurred and the time used to complete a job must be measured continuously for deviations from the plan(Meliasari & Indrayadi, 2011).

The existence of significant cost and time deviations provides an indication of poor project management(Imam, 1999). In addition, time is very important in project implementation. With time, it can be determined when a job ends. In fact, it can also be known whether a job is wasteful or efficient if it cannot be managed properly. At the project planning stage, it is necessary to estimate the duration of the project implementation time. The reality in the field shows that the completion time of a project varies, as a result the estimated completion time of a project cannot be ensured to be kept(Handoko, 1984).

The level of accuracy of the estimated project completion time is determined by the level of accuracy of the estimated duration of each activity in the project. In addition to the accuracy of time estimates, confirmation of the relationship between project activities is also needed for project planning. To estimate time and cost in a project, optimization is required. In the implementation of a project, it is very rare to find a project that runs exactly as planned. Generally there is a delay from the planned, both the time and progress of the work, but there are also projects that experience acceleration from the original planned schedule. A very important thing in planning or implementing a construction is the management of the project itself. A project requires planning (planning consultants), executors (contractors), and construction management (supervisory consultants).(Barry, 2005) Consultant services are usually required for large projects with high costs. Currently there are many consultant offices for construction projects, in the field of planning or supervision. Consultants have a very important role in coordinating the work of project participants at the planning and supervision stages. Although it cannot be separated from the support of the project owner (owner) as the funder and the contractor as the executor in the field, the consultant greatly assists the project owner in improving the performance of the implementation of the construction project, so that the total cost obtained is optimum and the project implementation is on time(Witjaksana & Reresi, 2012). The criteria and standards for measuring consultant qualifications are not easy to determine. This is also supported by. Yang argues that some of the criteria for selecting consultants are intangible.

The process of selecting consultants on privately owned construction projects does not yet have standardized guidelines, it is highly dependent on the policies of the relevant companies. This is different from the consultant selection process on government projects. Service providers on government projects require more competitive procedures than on private projects. In the implementation of construction projects, the time for completion of work can be influenced in terms of the methods used, the distribution of human resources, and the accuracy of material stock scheduling estimates in implementation. In solving these problems, a project control method is needed, one of

which can use the Earned Value Analysis (EVA) method(Sari et al., 2021). Earned Value Analysis is one of the tools used in project management that integrates cost and time(Atmaja et al., 2020). The earned value concept presents three dimensions, namely the physical completion of the project (the percent complete) which reflects the planned absorption of costs (budgeted cost), the actual costs that have been incurred or what is called actual cost and what is obtained from the costs that have been incurred or what is called earned value(Kusnadi, 2015). From these three dimensions, with the concept of earned value, it can be connected between cost and time performance derived from the calculation of the variance of cost and time(Widayanti et al., 2017).

Thus project control is a resource control consisting of time control, cost control and quality control or in other words, the three elements are commonly called project control elements, these three elements of project control are important parameters for project implementation which are often associated as project goals or project objectives(Pujihastuti & Priyo, 2012). The purpose of project time/schedule control is that it must be carried out to the maximum within the time period and end date specified before the implementation of the work, and cost control is project control that must be completed at a cost that does not exceed the project budget, while quality control is the result of activities or work that must meet the required specifications or criteria. Many factors cause additional costs or time delays as well as those that occur in the Kediri Airport Access Road Construction Project Phase 1.

These factors include material delays, less than optimal mobilization of labor and equipment, changes in image and structural planning, weather and many other things that cause the delay. Thus to increase the effectiveness in monitoring and controlling project activities, it is necessary to use a method, one of the methods that meets the problems above is using the Earned Value Method(Nisrina & Hisjam, 2022). This method is used to determine project performance in terms of cost at a time, determine project performance in terms of schedule / time at a time, predict the cost to complete the project after the evaluation time and predict the time to complete the project after evaluation(WP et al., n.d.). Based on the background above, the purpose of this study is to determine the amount of cost estimate of Kediri Airport access road construction. As well as determining the amount of the estimated final time of the Kediri Airport access road construction project.

2. RESEARCH METHODS

In the research conducted on the Construction of Kediri Airport Access Road Phase 1 Nganjuk - Kediri National Road, data collection was obtained from the executing contractor and some from the supervisory consultant. The types of data collected include cost and time analysis planning earned value method(Aditama, 2021). The stages of research analysis are the stages carried out by researchers sequentially during the research. The stages of this research provide an outline of the steps of conducting research that will guide researchers to be more directed during the course of the research. The stages of research implementation in the preparation of this research are as follows:

1. Calculating the value of ACWP (Actual Cost of Work Performance), BCWS (Budgeted Cost Work Schedule), BCWP (Budgeted Cost for Work Performed).

ACWP value is obtained from direct and indirect costs incurred in project implementation. BCWS is calculated from the weight of the work plan against the cost budget plan. BCWP is calculated from the actual weight of the work against the cost budget plan.

2. Calculations based on cost aspects Calculate the value of CV (Cost Variance), CPI (Cost Performance Index), ETC (Estimate to Complete), EAC (Estimate at Complete).
3. Calculations based on time aspects Calculate the value of SV (Schedule Variance), SPI (Schedule Performance Index), TE (Time Estimate).

3. DATA ANALYSIS AND DISCUSSION

3.1. BCWS (Budgeted Cost of Work Schedule)

Table 1. Recapitulation of BCWS Analysis Results

Week	Project Budget Value	Weight (%)	BCWS (Rp)
1	IDR 35,700,466,881.00	0.94	IDR 335,584,388.68
2	IDR 35,700,466,881.00	1.76	IDR 628,328,217.11
3	IDR 35,700,466,881.00	3.4	IDR 1,213,815,873.95
4	IDR 35,700,466,881.00	5.13	IDR 1,831,433,951.00
5	IDR 35,700,466,881.00	8.6	IDR 3,070,240,151.77
6	IDR 35,700,466,881.00	14.96	IDR 5,340,789,845.40
7	IDR 35,700,466,881.00	27.27	IDR 9,735,517,318.45
8	IDR 35,700,466,881.00	46.49	IDR 16,597,147,052.98
9	IDR 35,700,466,881.00	68.22	IDR 24,354,858,506.22
10	IDR 35,700,466,881.00	86.42	IDR 30,852,343,478.56
11	IDR 35,700,466,881.00	95.63	IDR 34,140,356,478.30
12	IDR 35,700,466,881.00	100	IDR 35,700,466,881.00

(Source: Data Analysis, 2023)

Table 1 from week 1 to week 8 uses the initial contract value of Rp.35,700,446,881.00. To get the result of the budgeted work schedule cost, this project budget value is multiplied by the weight of the work plan and results in the work schedule cost. The BCWS value from week 1 to month 12 costs incurred increase every month.

3.2. BCWP (Budgeted Cost of Work Performed)

Table 2. Recapitulation of BCWP Analysis

Recapitulation of BCWP Analysis			
Week	**Project Budget Value**	**Weight (%)**	**BCWP (Rp)**
1	IDR 35,700,466,881.00	0.83	IDR 296,313,875.11
2	IDR 35,700,466,881.00	1.77	IDR 631,898,263.79

3	IDR 35,700,466,881.00	3.2	IDR 1,142,414,940.19
4	IDR 35,700,466,881.00	5.1	IDR 1,820,723,810.93
5	IDR 35,700,466,881.00	8.5	IDR 3,034,539,684.89
6	IDR 35,700,466,881.00	14.7	IDR 5,247,968,631.51
7	IDR 35,700,466,881.00	26.98	IDR 9,631,985,964.49
8	IDR 35,700,466,881.00	46.17	IDR 16,482,905,558.96

(Source: Data Analysis Results, 2023)

It can be seen from table 2 the use of realized costs against the budget issued every month of physical work. BCWP value from week 1 to week 8. The value of the results from the point of view of the value of the work that has been completed against the budget provided to carry out the work. The BCWP value from week 1 to week 8 has increased significantly.

3.3. ACWP (Actual Cost Of Work Performanced)

Table 3. Recapitulation of ACWP Analysis

Recapitulation of ACWP Analysis			
Week	**Direct Cost**	**Indirect Cost**	**ACWP**
1	Rp 536,935,021.89	Rp 16,779,219.43	Rp 553,714,241.32
2	Rp 771,130,084.63	Rp 14,637,191.42	Rp 785,767,276.05
3	Rp 1,280,504,346.09	Rp 29,274,382.84	Rp 1,309,778,728.93
4	Rp 1,774,598,807.72	Rp 30,880,903.85	Rp 1,805,479,711.57
5	Rp 3,446,987,178.76	Rp 61,940,310.04	Rp 3,508,927,488.80
6	Rp 5,308,837,927.54	Rp 113,527,484.68	Rp 5,422,365,412.22
7	Rp 9,000,409,004.90	Rp 219,736,373.65	Rp 9,220,145,378.55
8	Rp 14,695,561,684.56	Rp 343,081,486.73	Rp 15,038,643,171.29

(Source: Data Analysis Results, 2023)

From Table 3 it can be seen that the value of ACWP results until the 3rd month of costs that have been done with a total cost of Rp32,130,420,192.90 with a weight of 100%. Actual cost costs increase every month. ACWP costs were incurred for the project from week 1 to week 8 with a total cost of Rp15,038,643,171.29.

3.4. Variance Calculation

This Variance component has several calculations including:

3.4.1. Time Variant (SV)

Table 4. Calculation of Time Variance Value (SV)

WEEK	BCWP	BCWS	SV
1	IDR 296,313,875.11	IDR 335,584,388.68	-Rp 39,270,513.57
2	IDR 631,898,263.79	IDR 628,328,217.11	IDR 3,570,046.69

3	IDR 1,142,414,940.19	IDR1,213,815,873.95	-Rp 71,400,933.76
4	IDR 1,820,723,810.93	IDR1,831,433,951.00	-Rp 10,710,140.06
5	IDR 3,034,539,684.89	IDR3,070,240,151.77	-Rp 35,700,466.88
6	IDR 5,247,968,631.51	IDR5,340,789,845.40	-Rp 92,821,213.89
7	IDR 9,631,985,964.49	IDR9,735,517,318.45	-Rp 103,531,353.95
8	IDR 16,482,905,558.96	IDR16,597,147,052.98	-Rp 114,241,494.02

(source: data analysis, 2023)

It can be seen from table 4 the implementation of project work from week 1 to week 8. The implementation of the project in the 1st month of work implementation is appropriate, while the 2nd month to experience delays due to material delays. The SV value from week 1 to week 8 can be seen that if the number (SV) is obtained in week 1, the SV value shows that the work is late, while week 2, the SV value shows that the work is on schedule, and week 3 to week 8 Experiencing delays due to late arriving materials.

3.4.2. Cost Variance (CV)

Table 5. Calculation of Cost Variant Value (CV)

WEEK	BCWP	ACWP	CV
1	IDR 296,313,875.11	IDR 553,714,241.32	-Rp 257,400,366.21
2	IDR 631,898,263.79	IDR 785,767,276.05	-Rp 153,869,012.26
3	IDR 1,142,414,940.19	IDR 1,309,778,728.93	-Rp 167,363,788.74
4	IDR 1,820,723,810.93	IDR 1,805,479,711.57	IDR 15,244,099.36
5	IDR 3,034,539,684.89	IDR 3,508,927,488.80	-Rp 474,387,803.91
6	IDR 5,247,968,631.51	IDR 5,422,365,412.22	-Rp 174,396,780.71
7	IDR 9,631,985,964.49	IDR 9,220,145,378.55	IDR 411,840,585.94
8	IDR 16,482,905,558.96	IDR 15,038,643,171.29	IDR 1,444,262,387.67

Table 5 shows the cost variance (CV) value from week 1 to week 8. The Cost Variance (CV) value is the difference in value obtained after completing the work section with the actual value of the project implementation, the CV value is used to determine whether the project is still within budget or exceeds the budget. Cost Variance (CV) shows negative meaning, the costs incurred are greater or wasteful.

The value of cost variance (CV) from week 1 to week 8. In week 1 to week 3 the project cost is greater than the plan or wasteful week 4 is smaller or economical. While the costs incurred from week 5 to week 6 were greater and there was waste due to the implementation of work that was not in accordance with the plan, week 7 to week 8 began to experience savings again.

3.5. Performance Index Calculation

3.5.1. Schedule Performance Index (SPI)

Table 6. SPI calculation

WEEK	BCWP	BCWS	SPI
1	IDR 296,313,875.11	IDR 335,584,388.68	0.88

2	IDR 631,898,263.79	IDR 628,328,217.11	1.01
3	IDR 1,142,414,940.19	IDR 1,213,815,873.95	0.94
4	IDR 1,820,723,810.93	IDR 1,831,433,951.00	0.99
5	IDR 3,034,539,684.89	IDR 3,070,240,151.77	0.99
6	IDR 5,247,968,631.51	IDR 5,340,789,845.40	0.98
7	IDR 9,631,985,964.49	IDR 9,735,517,318.45	0.99
8	IDR16,482,905,558.96	IDR 16,597,147,052.98	0.95
AVERAGE			0.94

(source: data analysis, 2023)

Table 6 shows the SPI value from week 1 to week 8. Based on this table, week 1 gets SPI 0.88, meaning that it is below 1 delay, week 2 gets SPI above 1 the project is ahead of schedule, week 3 to week 8 gets SPI values below 1, meaning that the work is delayed, however, the average SPI is 0.95 which means the work is late. SPI value from month 1 to month 3. In the 1st month, the SPI value shows a value of 1, which means that the project work is in accordance, the 2nd month SPI value < 1, which means that the work is late. In the 3rd month the SPI value = 1 which means the work is in accordance.

3.5.2. Cost Performance Index (CPI)

Table 7. CPI calculation

WEEK	BCWP	ACWP	CPI
1	Rp 296,313,875.11	Rp 553,714,241.32	0.54
2	Rp 631,898,263.79	Rp 785,767,276.05	0.80
3	Rp 1,142,414,940.19	Rp 1,309,778,728.93	0.87
4	Rp 1,820,723,810.93	Rp 1,805,479,711.57	1.01
5	Rp 3,034,539,684.89	Rp 3,508,927,488.80	0.86
6	Rp 5,247,968,631.51	Rp 5,422,365,412.22	0.97
7	Rp 9,631,985,964.49	Rp 9,220,145,378.55	1.04
8	Rp 16,482,905,558.96	Rp 15,038,643,171.29	1.10
AVEREGE			**0.90**

(source: data analysis, 2023)

It can be seen in table 7 that the CPI value in week 1 to week 3 CPI value below 1 costs more than the plan or wasteful. In the 4th week the cost is more economical than the plan, week 5 to week 6 the project cost is more economical, week 7 to month 8 the CPI value is greater than 1, meaning that the costs incurred are small or economical. CPI costs from week 1 to week 8. The CPI value from week 1 to week 8 shows that it varies, meaning that the costs incurred are smaller or more efficient if the CPI is greater than 1, while if the CPI is below the value of 1, it means that the project costs are more wasteful than planned.

Earned Value Analysis in this research will be presented using Microsoft Exel 2010, the review will be conducted from week 1 to week 8(Janizar, 2023). Graphical comparison between BCWS, BCWP, and ACWP can be seen in graph 4.9.

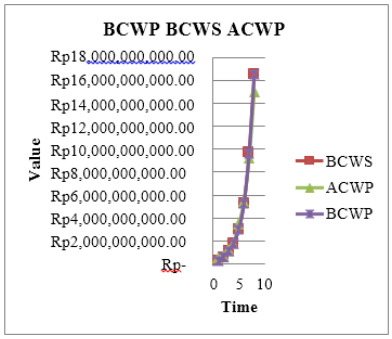

Figure 1. Comparison of Outcome Value Concepts

From Figure 1, it can be seen the comparison of the concept of the value of the results from week 1 to week 8. In week 1 to week 5, the value of BCWP is less than the BCWS value, meaning that the work is slower than the planned time, the ACWP value is greater than BCWP, meaning that the actual costs incurred are greater than the planned budget costs. In week 6 the BCWP value is less than BCWS meaning, the work is slower than the planned schedule, while the ACWP value is greater than BCWP meaning, the actual costs incurred are greater than the planned budget costs. week 8 the BCWP value is less than BCWS meaning, the project is delayed from the planning schedule, while the ACWP value is less than BCWP meaning, the actual costs incurred are less than the planned budget costs.

3.6. Discussion of Project Conditions Based on SPI and CPI Analysis Results

Review of Schedule Performance Index (SPI) and Cost Performance Index (CPI) values from week 1 to week 8. Can be seen in Figure 5.9.

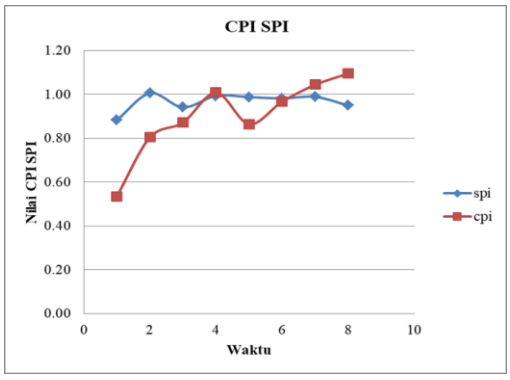

Figure 2. SPI and CPI values

Figure 2 shows that the SPI and CPI values from month 1 to month 3. In the 1st month the SPI value shows a value of 1 which means that the project work is in accordance, the 2nd month SPI value < 1 which means that the work is delayed. In the 3rd month the SPI value = 1 which means the Road project work is on schedule.

3.7. Project Performance Level

The level of project performance is assessed based on the components of the Eanred value analysis(Kartikasari & Inayaturrochmah, 2018). (Yomelda & Utomo, 2015)The results of performance research on the Kediri Pekanbatu Airport Access Road Development Project as in table 8.

Table 8. Grand total score

WEEK	SV	CV	SPI	CPI
1	-Rp 39,270,513.57	-Rp 257,400,366.21	0.88	0.54
2	Rp 3,570,046.69	-Rp 153,869,012.26	1.01	0.80
3	-Rp 71,400,933.76	-Rp 167,363,788.74	0.94	0.87
4	-Rp 10,710,140.06	Rp 15,244,099.36	0.99	1.01
5	-Rp 35,700,466.88	-Rp 474,387,803.91	0.99	0.86
6	-Rp 92,821,213.89	-Rp 174,396,780.71	0.98	0.97
7	-Rp 103,531,353.95	Rp 411,840,585.94	0.99	1.04
8	-Rp114,241,494.02	Rp1,444,262,387.67	0.95	1.10
TOTAL	**Rp16,482,905,558.96**	**Rp16,482,905,558.96**	**Rp7.73**	**Rp7.19**
AVEREGE	**Rp 2,060,363,194.87**	**Rp 2,060,363,194.87**	**Rp0.97**	**Rp0.90**

(source: data analysis, 2023)

Table 8 shows the performance obtained from the overall total Index value from week 1 to week 8. Based on the Variance value, the SV value in general gets an average value of IDR 2,060,363,194.87, meaning that the work is carried out ahead of schedule, while the CV value in general gets an average value of IDR 2,060,363,194.87, which means that the costs incurred are less than the budget. Based on the performance index value, the SPI value in general gets an average value of 0.97 which means the project is delayed, while the CPI value in general gets an average value of 0.9 which means that the costs incurred are more wasteful.

3.8. Estimate To Complete (ETC)

Because the percentage of work up to week 8 has only reached 46.49%, the assumption used to predict the budget for the remaining work uses the formula:

ETC = (Rab - BCWP) / CPI
= (IDR 35,700,446,881.00 - IDR 9,631,985,964.49) / 1.1
= IDR 17,470,510,292.77

The EAC calculation is an estimate of the total cost at the end of the project obtained from ACWP added to the cost of the remaining work or ETC.

EAC = ACWP + ETC
= IDR 15,038,643,171.29 + IDR 17,470,510,292.77
= IDR32,509,153,464.05

The estimated funds absorbed when the implementation of this work has been completed is IDR 32,509,153,464.05.

3.9. Variant at Complet (VAC)

Calculations
VAC = RAB - EAC
VAC = IDR 35,700,446,881.00 - IDR 32,509,153,464.05 VAC
= IDR 3,191,313,416.95
The predicted profit obtained if the work has been completed is IDR 3,191,313,416.95.

3.10. Schedule Estimate To Completion (SETC)

SETC calculation is an estimate of the time for the remaining work calculated by the formula with the assumption that the situation takes place as it was during the evaluation:
SETC = Remaining time / SPI
= 4 / 0,90
= 4,5

From the Estimate Temporary Schedule (ETC) calculation above, it is estimated that the total project completion time is 4.5 weeks.

3.11. Schedule Estimate At Completion (SEAC)

SEAC calculation is an estimate of the total project completion time plus the remaining work time calculated by the formula:
SEAC = Reporting time + SETC
= 8 + 4,5
= 12.5 Weeks

From the above value, it can be seen that when analyzing in week 2 the project was delayed from the initial project completion plan from 8 weeks to 12.5 weeks.

3.12. Time Estimate (TE)

Time Estimate (TE) is an estimate of the project completion time to completion. TE is calculated with the following formula:
TE = ATE+ ((OD-(ATE × SPI))/SPI) ATE= 56 Days
OD = 84 Days
SPI = 0.95
TE = 56+((84-(56×0,95))/0,95)
TE = 56+((56-(53,2))/0,95)
TE = 88.42≈89 days

So the estimated time required to complete the project is 89 days, which is 5 days later than the planned schedule.

4. CONCLUSION

Based on the analysis of the calculations that have been done, the things that can be concluded from this research are:

1. From the results of the calculation analysis, the total BCWP value of the project is IDR 35,700,446,881.00 ACWP value up to week 8 IDR 16,482,905,558.96 ETC value obtained the estimated budget required for completion is IDR

17,470,510,292.77 while the EAC value obtained the estimated final total cost of the project is IDR 32,509,153,464.05.

2. From the results of the calculation analysis, the value of the project contract time is 84 days, the SV value of 0 means that there is a delay. The TE value or the estimated time required to complete the project is 89 days, with a difference of 5 days later than the planned schedule.

5. ADVICE

Suggestions from this research that can be conveyed are as follows:

1. Project implementation should use a detailed schedule breakdown so that a critical trajectory is obtained to make it easier to monitor the implementation of the project being carried out so that there is no delay in project work.
2. We recommend that the scheduling method use a more detailed method such as adding material tools and man power to each work item to facilitate project acceleration if there is a project delay.

REFERENCES

Aditama, R. (2021). *Analisis Biaya Dan Waktu Menggunakan Metode Evm (Earned Value Method) Pada Proyek Konstruksi (Studi Kasus Pada Proyek Pembangunan Gedung Laundry Rsud Sidaorjo)*. Universitas 17 Agustus 1945 Surabaya.

Atmaja, J., Suhelmidawati, E., Alexander, H., Natalia, M., Misriani, M., & Nola, R. (2020). Analisa Kinerja Proyek Menggunakan Metoda Earned Value Management Dan Pengendalian Dengan Metoda Time Cost Trade Off (Studi Kasus Proyek Pembangunan Jembatan Silaosinan Kabupaten Mentawai). *Jurnal Teknik Sipil Institut Teknologi Padang*, *7*(2), 6.

Barry. (2005). *Operations Management*. Global Edi. Pearson.

Handoko, T. H. (1984). *Dasar-Dasar Manajemen Produksi Dan Operasi Edisi 1*.

Imam, S. (1999). *Manajemen Proyek Jilid 1*. Surabaya: Erlangga.

Janizar, S. (2023). Penerapan Metode Earned Value Analysis Terhadap Waktu Penjadwalan. *Jurnal Konstruksi*, *21*(1), 113–120.

Kartikasari, D., & Inayaturrochmah, I. (2018). Analisis Kinerja Proyek "Y" Menggunakan Metode Earned Value Management (Studi Kasus Di Pt Asian Sealand Engineering). *Journal Of Applied Business Administration*, *2*(1), 1–12.

Kusnadi, A. (2015). Earned Value Management (Evm) Dalam Estimasi Biaya Proyek Piranti Lunak Menggunakan Spiral Development. *Ultima Infosys: Jurnal Ilmu Sistem Informasi*, *6*(1), 36–42.

Maulidi, N., Huda, M., & Tjendani, H. T. (N.D.). *Analisis Biaya Dan Waktu Pada Pembangunan Gedung Trauma Center Dan Intensive Care Tahap Iv Rsud Dr. Soedono Madiun Dengan Metode Earned Value*.

Meliasari, I., & Indrayadi, M. (2011). Earned Value Analysis Terhadap Biaya Dan Waktu Pada Proyek Konstruksi. *Jelast: Jurnal Pwk, Laut, Sipil, Tambang*, *2*(2).

Nisrina, S., & Hisjam, M. (2022). Earned Value Method Untuk Analisis Pengendalian

Jadwal Dan Biaya Pada Sebuah Proyek Konstruksi Pump House. *Jurnal Teknik Industri: Jurnal Hasil Penelitian Dan Karya Ilmiah Dalam Bidang Teknik Industri*, *8*(1), 71–84.

Pujihastuti, S. Y., & Priyo, M. (2012). Aplikasi Metode Nilai Hasil (Earned Value Method) Pada Sistem Pengendalian Proyek. *Semesta Teknika*, *15*(2), 159–166.

Sari, H. M., Hendriyani, I., & Widyaningrum, A. E. (2021). Earned Value Analysis Pada Proyek Pembangunan Gedung Arsip Kantor Bpn: Earned Value Analysis Of Bpn Office Archives Building Projects. *Jurnal Ilmiah Teknik Sipil Transukma*, *3*(2), 154–167.

Widayanti, D. A., Hartono, W., & Sugiyarto, S. (2017). Pengendalian Biaya Dan Waktu Dengan Menerapkan Metode Earned Value Analysis (Eva) Menggunakan Software Primavera Project Planner P6 (Studi Kasus Proyek Pembangunan Hotel Brothers 2 Solo Baru, Sukoharjo). *Matriks Teknik Sipil*, *5*(4).

Witjaksana, B., & Reresi, S. P. (2012). Analisis Biaya Proyek Dengan Metode Earned Value Dalam Proses Kinerja. *Jurnal Teknik Sipil Untag Surabaya*, *5*(2), 45–56.

Wp, S. N., Pujotomo, D., & Purwanto, I. Z. (N.D.). Aplikasi Metode Earned Value Analysis Untuk Evaluasi Performansi Pekerjaan Proyek Pembangunan (Studi Kasus Gedung Sentraland Semarang). *Penelitian Dan Aplikasi Sistem Dan Teknik Industri*, *11*(3), 328401.

Yomelda, Y., & Utomo, C. (2015). Analisa Earned Value Pada Proyek Pembangunan Vimala Hills Villa & Resort Bogor. *Jurnal Teknik Its (Sinta: 4, If: 1.1815)*, *4*(1), D76–D81.

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