

Analysis of Cost Control and Project Time in Performance Process with Earned Value Method, Case Study: Improvement of Maluku-Bantanan Road in Pulang Pisau District, Indonesia

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Abstract:- A construction project is an activity that requires a detailed calculation in its planning. It is not only planning that needs attention, but construction projects have their complexities in terms of management. The management of a construction project has targets that must be fulfilled by a contractor in terms of quality, implementation time, and cost. This study aimed at determining how the application of Earned Value in estimating the cost and project time. This study took a case study on the 8.505 m Maluku-Bantanan road improvement project located in Maluku and Sebangau Kuala sub-district, Pulang Pisau district, Central Kalimantan province, Indonesia. This earned value included budget and cost plans, unit price analysis, and project progress reports processed to obtain BCWS (Budgeted Cost of Work Scheduled), ACWP (Actual Cost of Work Performance), and BCWP (Budgeted Cost of Work Performance) which affected the control of the implementation time and project costs. The results showed that in the fifth month, the BCWP value was IDR 13,668,602,892.99 and the BCWS value was IDR 13,513,565,248.85 from the second calculation. The value of BCWS was smaller than the value of BCWP, which was 1.13% of the budget plan. The conditions indicated that the implementation of activities in the field has been following the planned schedule at a lower cost. These results are expected to be used as a guide for contractors and consultants in project planning that are more effective and efficient as well as on quality, time, and cost.

Keywords:- Earned Value (EV), Construction Project, BCWS, BCWP.

I. INTRODUCTION

The rapid development of the world of construction services in Indonesia is marked by the number of very large-scale projects built by the government, the private sector, or a combination of both. However, in practice, a construction project has limited resources, either in the form of labour, equipment, methods, materials, or costs [1,2]. This limitation required project management from the initial phase to the project completion phase. The management of a

construction project has targets that must be fulfilled by a contractor in terms of quality, implementation time, and cost [3,4].

II. REVIEW OF RESEACH

Construction is one of the important economic sectors for a country which summarizes the implementation of several activities that produce certain construction building products [5,6]. A construction project is said to be successful if it fulfils six factors, such as the project runs on time, according to capital, achieves client satisfaction, the satisfaction of the project manager and work team, according to its function, and according to the measure of success [7,8]. A simple and general project is a series of activities that are planned and carried out sequentially with logic and using many types of resources, which are limited by the dimensions of cost, quality, and time [9, 10,11].

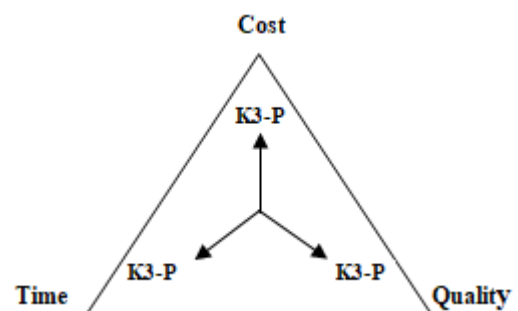


Fig. 1. The Project Management Goal Triangle [9]

Costs that have been incurred and the time that has been used to complete a job must be further measured in deviation from a plan. The existence of significant deviation in cost and time is a sign of poor project management [12,13]. The existence of performance indicators in terms of cost and time can allow preventive action so that the project can be carried out as planned. There is a dependency between the costs incurred on the time of project implementation, where optimal activity scheduling is needed so that the costs incurred are minimum [14, 15]. Project control is needed to maintain the suitability between planning and implementation. Project control is a methodology to collect, create, analyze, and distribute

schedules, financial data, and work scopes to support the project management process [16]

According to Soeharto, in general, there are 4 (four) control methods in carrying out construction, namely Earned Value, Variant Analysis, Cost/Schedule - Control System Criteria (C/S - CSC), and Value Engineering [14]. The Earned Value is used to predict the suitability of the initial project schedule in each reporting period and the amount of gain or loss at the end of the project with project

implementation. The Earned Value method also provides information about the Cost Variance, Schedule Variance, Cost Performance Index, and Schedule Performance Index for the reporting period [17, 18]. The Earned Value presents three dimensions, namely the actual costs that have been incurred which are called the actual cost, the physical completion of the project that reflects the cost absorption plan, and what has been spent or what is called as Earned Value [11, 19].

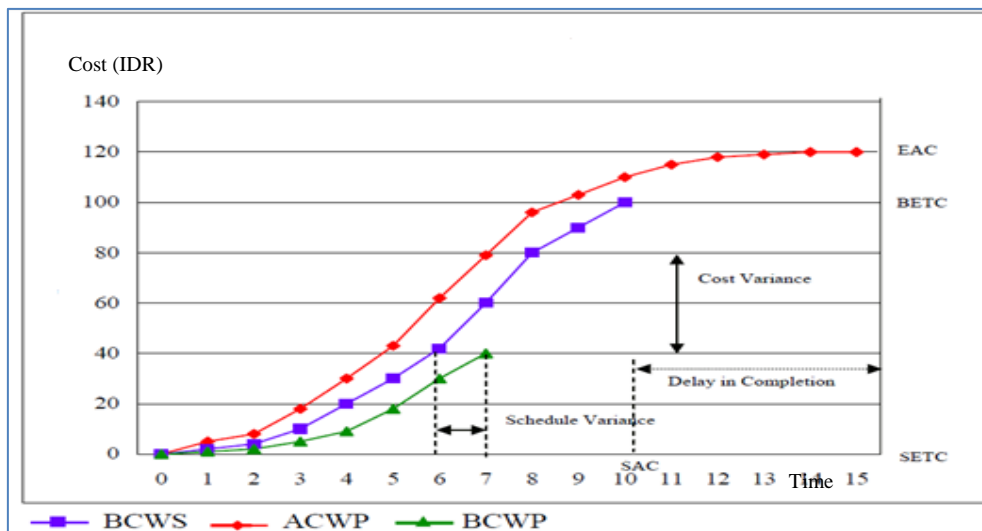


Fig. 2.The Graph of S Curve of Earned Value[2]

TABLE I. THE CONCEPT AND CALCULATION FORMULA OF EARNED VALUE (EV)

Analysis	Description	Formula
Earned Value (EV)	Costs are budgeted from the work that has been carried out. The calculation of the Earned Value is done by multiplying the percent of work completion by the contract value.	$EV = (\text{Progress} (\%)) \times (\text{Contract Value})$
Cost Variance (CV)	The difference between the value obtained after completing work items and the actual costs during project implementation. Budget Cost for Work Performed (BCWP) is the value received from the completion of work during a certain period. Actual Cost for Work Performed (ACWP) or Actual Cost (AC) is the number of actual costs of work that has been performed.	$CV = BCWP - ACWP$
Schedule Variance (SV)	To calculate the deviation between BCWP and BCWS. Budget Cost for Work Scheduled (BCWS) or Plan Value (PV) is a cost that is allocated based on a work plan compiled against time. BCWS is calculated from the sum of the costs planned for work in a certain period.	$SV = BCWP - BCWS$
Cost Performance Index (CPI)	The cost dimension factor that has been incurred in project implementation.	$CPI = BCWP/ACWP$
Schedule Performance Index (SPI)	Performance efficiency factor in completing work.	$SPI = BCWP/BCWS$
Budget Estimate to Completion(BETC)	An estimate of the costs required to complete the remaining work	$BETC = \frac{BAC - BCWP}{CPI}$
Budgeted Estimate at Completion (BEAC)	Total expenses until the date of reporting plus estimated costs for remaining work	$BEAC = ACPW + BETC$
Schedule Estimate to Complete(SETC)	The remaining work time is divided by the schedule performance index	$SETC = \frac{(SAC - tBCWP)}{SPI}$
Schedule Estimate at Completion(SEAC)	The time of the work is carried out until the time of reporting plus the estimated time to complete the remaining work.	$SEAC = tBCWP + SETC$

This study aims to measure performance and costs in project implementation so that the conditions of progress realization (progress/delay) of the implementation can be identified until the end of the construction project.

in the field, then analyzed using the formulas in Table 1. The data required included the data of realization percentage during the reporting month, the time of the activity plan, the contract value, and the actual cost of each reporting month. The research location was in the Maluku sub-district and Sebangau Kuala sub-district, Pulang Pisau district, Central Kalimantan, Indonesia. The following is the data of the research project condition:

III. METHODOLOGY

The research method was carried out using quantitative research methods, where the data obtained from project data

Project's Name	: Improvement of Jalan Maluku Bantanan
Owner	: Department of Public Works
Location	: Maluku sub-district and Sebangau Kuala sub-district, Pulang Pisau, Central Kalimantan, Indonesia.
Road Length	: 8550 m
Road width	: 9 m
Project Owner	: PT. Pancar Kurnia Raya
Implementation Time	: 180 days
Contract Value	: IDR. 15,700,000,000.00 (Include Tax)



Fig. 3. Research Project Location



Fig.4.Site Condition on The Maluku Bantanan Road

IV. RESULT AND DISCUSSION

TABLE II. THE ANALYSIS CALCULATION OF EARNED VALUE (EV)

Month	1	2	3	4	5
Planning (%)	1.46	11.25	36.4	62.36	86.07
Realization (%)	1.48	7.59	37.82	67.3	87.06
BCWS (IDR)	229,624,969.25	1,766,722,286.76	5,715,117,369.23	9,791,017,502.92	13,513,565,248.85
BCWP (IDR)	231,969,780.95	1,191,808,608.58	5,937,170,299.17	10,566,205,723.63	13,668,602,892.99
ACWP (IDR)	180,303,784.28	741,693,639.53	4,215,641,023.45	6,259,024,775.25	8,066,622,762.61
CV (IDR)	52,720,404.76	925,082,268.49	1,721,529,275.73	4,307,180,948.38	5,601,980,130.38
SV (IDR)	2,344,811.70	- 574,913,678.18	222,052,929.95	775,188,220.70	155,037,644.14
CPI	1.29	1.29	1.62	2.68	5.18
SPI	1.01	0.67	1.04	1.08	1.01
BEAC (IDR)	11,064,611,917.44	11,078,496,016.80	10,134,237,620.86	8,454,629,405.01	8,423,151,042.14
SEAC	178 days	240 days	176 days	175 days	179 days

Table 2 shows the results of the analysis of the Earned Value (EV) calculation in five months of project implementation. The budget used in the calculation was the

total cost of the project as stated in the cost budget, while the percentage of project completion was obtained from the project work performance report data.

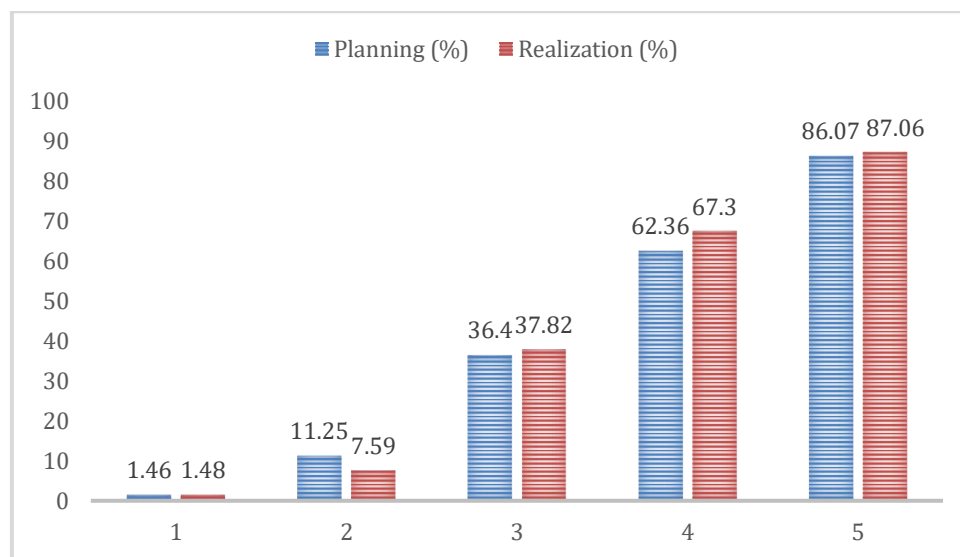


Fig. 5. The Progress of Project Planning and Realization in Percentage

Figure 5 shows the project activities in five months. The work plan has relatively fulfilled the realization target. In the second month, it has been delayed due to the influence of the

length of time distribution of materials to the project site due to road damage and the impact of implementing health protocols in preventing the spread of Covid-19.

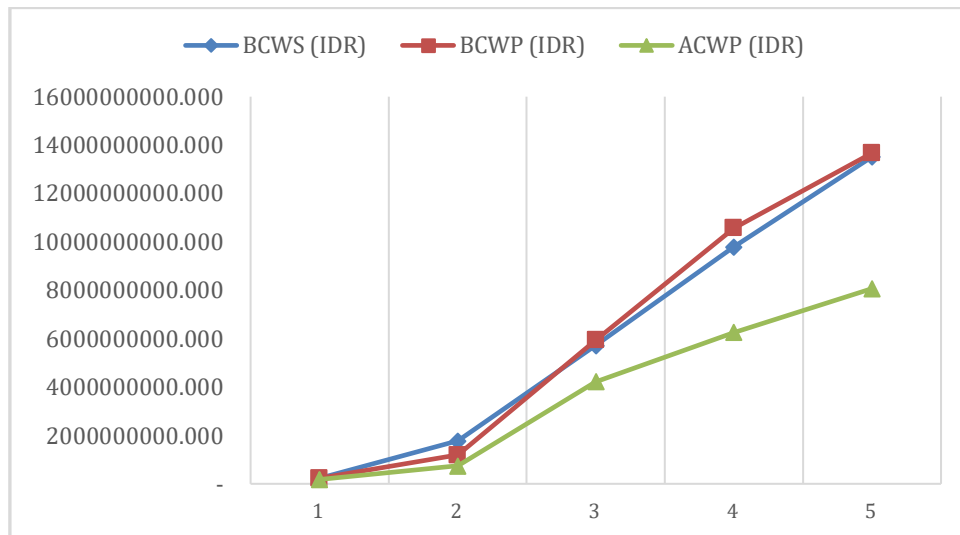


Fig. 6. Project Progress based on Calculation of BCWS, BCWP, and ACWP

Figure 6 shows the progress of the project activity according to the results of the analysis of BCWS, BCWP, and ACWP. In the second month, the value of BCWP has decreased against the BCWS which indicated that the project condition was delayed from the planned time. At the end of the project in the fifth month, the value of BCWP was slightly higher than BCWS, which meant that the project

costs were less than the planning costs, resulting in savings. This saving value was IDR 155,037,644.14 or 1.13% saving from the contract value. This was also indicated by the low value of ACWP against BCWP with a value selection of IDR 5,601,980,130.38. This condition had a positive impact on cost and time efficiency during construction activities.

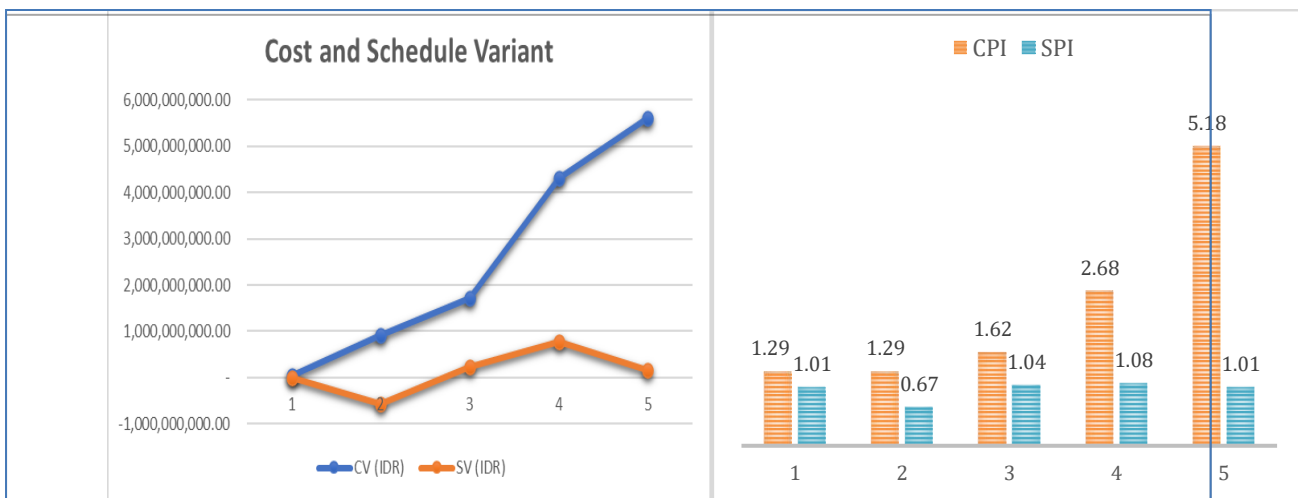


Fig. 7.a. Analysis Cost and Schedule Variance b. CPI and SPI Analysis

Figure 7a shows the value of the cost variance (CV) and schedule variance (SV) which has a fairly varied level of project values achievement. In the second month, the value of CV showed an increase in the use of costs, while SV has decreased. This condition occurred because the level of cost consumption was fixed but the project schedule was delayed. This delay could be caused by several factors such as material supply conditions which were hampered by weather, the project location, and other non-technical factors. In the fourth month, the CV value has increased significantly. This was also followed by an increase in the SV value. Generally, this

happened when the project was at the peak of its main work, where the cost requirements were higher. Figure 7b shows the Cost Performance Index (CPI) and Schedule Performance Index(SPI) values that occurred during project implementation. Most of the CPI and SPI values had more than 1. This indicated that the work performance was not wasteful and was as expected since it was able to achieve the work targets as planned. In the second month, there was an SPI value below 1 which indicated a delay and waste of project costs.

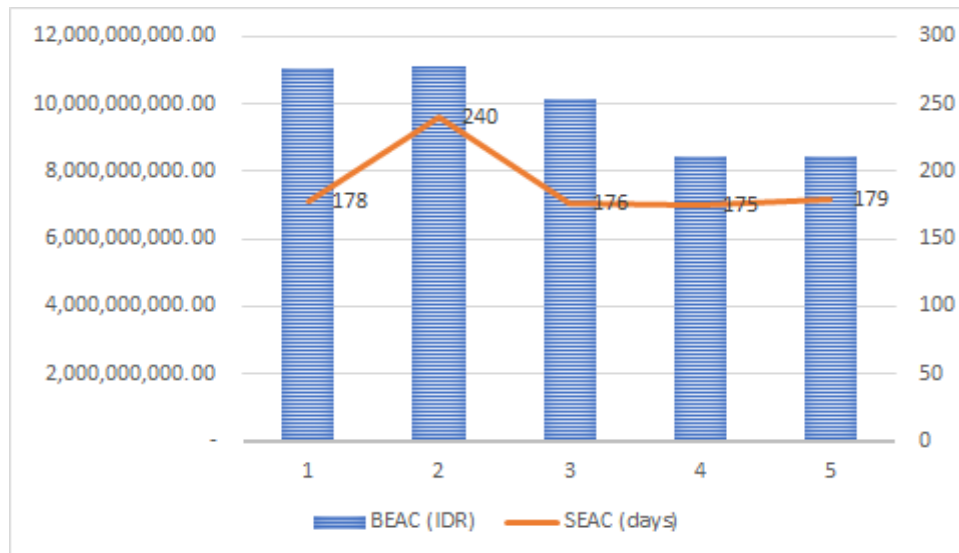


Fig. 8. BEAC and SEAC Calculation Results

Figure 8 shows the total cost estimate (BEAC) and project scheduling (SEAC) that occurred based on conditions in the field. The increase in the number of days used in the second month of 60 days from the initial planning schedule of 180 days showed a time waste for implementation and would impact the future project activities. To overcome this, it was necessary to save time in the following month, so that the time allocation could be as planned. Based on the cost prediction (BEAC) in the fifth month, the calculation of the estimated total cost until the end of the project was IDR 8,423,151,042.14. This value meant that it was smaller than the total budget of IDR 15,700,000,000.00 (Include Tax). Based on the prediction of the fifth schedule, the predicted project completion time was 179 calendar days, one day faster than the planning schedule, which was 180 calendar days.

V. CONCLUSION

Based on the results of project data processing using the Earned Value method, it is known that project activities are generally following the plan. This study also found some delays in the progress of project implementation that occurred in the second month. Conditions were caused by external factors such as damaged road conditions that hindered the material distribution, the project location, and the Covid-19 pandemic prevention which required all workers to implement health protocols.

The calculation result showed that the value of the Budget Cost for Work Scheduled (BCWS) at the end of the project, namely in the fifth month was IDR. 13,513,565,248.85, budget Cost for Work Performance (BCWP) was IDR. 13,668,602,892.99, and the Actual Cost for Performance (ACWP) was IDR 8,066,622,762.61.

The calculation of Cost Variance (CV) and Schedule Variance (SV) showed positive numbers. This meant that the cost to complete the project was less than the plan and the work was carried out as planned. The result of the calculation of the Cost Performance Index (CPI) in the fifth month was

5.18. This showed that the performance was better than the planning, in the sense that the cost was less than the budget, and reporting activities from field supervision were going well. Judging from the calculation of the Schedule Performance Index (SPI), the value was 1.01 which indicated the project was following the planned target.

The Budget Estimate at Completion (BEAC) value was obtained as IDR. 8,423,151,042.14 showed the total remaining cost of project completion at the time of reporting at the end of the project (cost savings). The Schedule Estimate at Completion (SEAC) value obtained an estimated time of 179 days; one day faster than the planning schedule (180 days). This showed that the project estimation was running according to the planned schedule.

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