International Journal of Mechanical, Industrial and Control Systems Engineering
Volume.2, Nomor.1 Year 2025
e-ISSN: 3047-4566; p-ISSN: 3047-4558, Page 01-08
DOI: https://doi.org/10.61132/ijmicse.v2i1.155
Available online at: https://international.aritekin.or.id/index.php/IJMICSE

Analysis of Project Delays Impact by Cost in The Construction of A Light Brick Factory in Lamongan Using The Earned Value Method

M. Hery Indra Setiawan[1] , Budi Witjaksana[2] , Jaka Purnama[3]
[1] Magister Civil Engineering, Faculty of Engineering, University of 17 August 1945 Surabaya, Indonesia
[2, 3] Lecturer Civil Engineering, Faculty of Engineering, University of 17 August 1945 Surabaya, Indonesia
herryindra28@gmail.com , budiwitjaksana@untag-sby.ac.id , jakapurnama@untag-sby.ac.id

Abstract. *A factory is an industrial building that designed for processing raw materials into products, such as Light Weight Brick Factory that produce light weight brick and other products. The construction of a Lightweight Brick Factory plays a significant role in fostering regional economic development. However, the construction process for this factory has faced several issues leading to delays. This study focuses on the delays encountered in the lightweight brick factory construction project in Lamongan, which had a planned completion timeline of 15 weeks and a contract value of IDR 1,835,474,186. By week 10, the project was delayed by -42.73%, followed by delays of -42.66% in week 11, -44.84% in week 12, -48.08% in week 13, -46.18% in week 14, and -44.68% in week 15 compared to the planned schedule. The project cost performance index (CPI) of 1.32 shows that the actual project costs are smaller than budgeted, The primary factor contributing to the delay was attributed to the contractor or vendor, who faced cash flow issues due to other ongoing challenges.*

Keywords *Earned Value, Construction, CPI*

1. INTRODUCTION

The establishment of the factory aims to boost the local economy and generate new employment opportunities. It will incoIDRorate a mixed-use center concept that includes facilities such as meeting rooms, leadership offices, staff rooms, and other functional spaces. Both the development and utilization aspects are crucial to the project's overall success.

The extensive scope of work and the complexity of challenges encountered in the field, such as factory construction requiring significant costs and extended timelines, highlight the critical role of scheduling. Scheduling helps project managers and stakeholders establish time parameters for project activities and estimate costs at various stages, enabling effective coordination in project control. In this context, utilizing the earned value method becomes essential to ensure accurate monitoring and management.

R.J. Mockler 1972 said (Mockler, 1972) control is a structured approach aimed at establishing standards aligned with planned objectives, designing an information system, evaluating performance against these standards, and implementing corrective actions as needed to ensure all resources are utilized effectively and efficiently to achieve the desired goals.

The concept of earned value introduces an additional dimension to the analysis of project performance, complementing both actual costs and planned costs. This additional

Received: December 09, 2024; Revised: December 23, 2024; Accepted: January 18, 2025; Online Available: January 23, 2025

dimension represents the physical quantity of work that has been accomplished, commonly referred to as earned value or percent complete (Fleming & Koppelman, 1994). By adding this third dimension, a project manager will gain a deeper understanding of how performance is affected by the related costs.

2. PROPOSED APPROACH

Research conducted by Ali Taufan et al., (Taufan et al., 2018), aims to evaluate a project to identify and anticipate delays in project progress. To be able to determine the performance of a project which must always be in accordance with the planned targets, the method used is the Earned Value Method (EVM) with indicators: Actual Cost of Work Perform (ACWP), Budgeted Cost of Work Perform (BCWP), Budgeted Cost of Work Scheduled (BCWS). The results of the Earned Value Method (EVM) calculation show an ACWP value of IDR. 430,164,472 as actual costs that must be paid in the 15th week with a delay of -22.385%, the BCWP value was obtained at IDR 452,804,707 until the 15th week for implementation costs and for BCWS calculations in the 15th week with work progress reaching 36,478 % requires a budget of IDR 1,172,029,385. So in this research the project experienced a delay up to the 15th week of -22.385% and it was estimated that it would experience a loss of IDR. 946.370.216.

To figure axis labels, use words rather than symbols. Do not label axes only with units. Do not label axes with a ratio of quantities and units. Figure labels should be legible, about 9-point type.

3. WORK METHOD

3.1. Cost/Schedule Control System Criteria

The Earned Value concept, commonly known as C/SCSC (Cost/Schedule Control System Criteria), includes several key parameters that are crucial for effectively managing project costs, BCWS represents the planned cost budget aligned with the project implementation schedule. It serves as a benchmark for evaluating the project's time performance. BCWS indicates the cumulative planned cost absoIDRtion for each work package, organized sequentially according to the planned timeline.

BCWP represents the value obtained from completing tasks within a specific time frame and is commonly referred to as earned value. It is determined by accumulating the value of completed work. The primary challenge in calculating BCWP lies in estimating the progress of tasks that have begun but remain unfinished during the reporting period.

ACWP reflects the total costs expended to complete work within a defined time frame. This value can be reported either as a cumulative total up to the performance evaluation period or as the specific expenses incurred during a particular time period. By tracking ACWP, project managers can monitor actual spending and compare it with planned budgets, enabling effective cost control and ensuring financial resources are utilized efficiently.

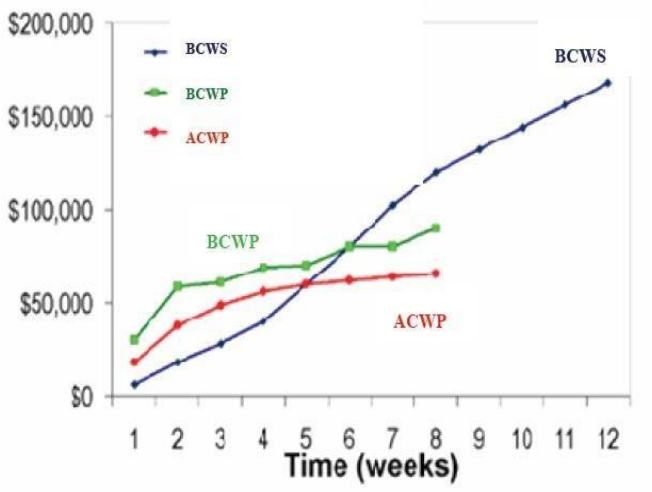

Fig. 1 BCWP,BCWS, and ACWP Graphics

3.2. Earned Value Concept

As the complexity of a project increases, it is common for delays in completion and cost overruns to arise. Typically, the management system divides the accounting for costs from the scheduling of the construction project. The cost accounting system can generate performance reports and forecasts of project costs, while the scheduling system provides reports on the status of project completion. The project management information derived from these two systems is complementary but can yield different insights regarding the project's status.

Cost Variance (CV) refers to the difference between the anticipated costs for completing work within a specific timeframe and the actual progress made during that period, reflecting the financial status of the work for that timeframe.

$$CV = BCWP - ACWP \quad (1)$$

The CV value provides information that the project costs are in accordance with the plan or there is a cost deviation. A positive CV indicates that the value of the work packages obtained is greater than the costs incurred to carry out the work packages. On the other hand, a negative value indicates that the value of the work packages completed is lower than the costs incurred.

Cost Performance Index (CPI) is an index that shows financial productivity (cost efficiency) or finance based on the absoIDRtion of costs that actually occur up to project absoIDRtion based on the absoIDRtion of costs that actually occur in a certain period. CPI can be used to assess or evaluate various parties involved in a construction project. This is a very sensitive matter in construction projects when it comes to financial matters. Whether or not the flow of money in a project runs smoothly depends on various elements of the project manager, for example, the contractor, owner and field supervisor.

$$CPI = BCWP / ACWP \quad (2)$$

3.2. Estimated At Complete

Cost estimation is valuable because it serves as an early warning system, providing insights into potential future outcomes if the current trends at the time of reporting remain unchanged. By identifying these trends early, project managers can take proactive measures to address potential issues, ensuring better control over the project's budget and reducing the risk of cost overruns.

Estimated To Complete (ETC) is a costs required to complete the project are calculated based on the latest productivity data that has been achieved. This approach allows for more accurate cost estimates, as it is based on actual performance in the field, thereby assisting in budget planning and overall project cost control

$$ETC = (BAC - BCWP) / CPI \quad (3)$$

Estimated At Complete (EAC) is an amount of costs that will be absorbed as a whole by the project is determined based on the latest productivity data that has been achieved. This approach provides a realistic picture of the final budget requirements, because it is based on actual performance in the field. Thus, this method helps project managers manage resources more efficiently and minimize the risk of cost overruns.

$$EAC = ACWP + ETC$$

4. ANALYSIS

4.1. Data

The data utilized in this research is the Budget Plan, which refers to the costs assigned to each work item. The Budget Plan (RAB) is included in the contract between the project owner and the contractor responsible for implementation. This contract also encompasses an analysis of unit prices, as well as a list of wages and material costs. The RAB data is employed in the calculations of Planned Value and Earned Value.

Table 1. Budget Plan

BLESSCON
Pilihan Tepat, Membangun Cepat

Project : BLESSCON
Location : lamongan
Scope : Pekerjaan Bangunan Mess Alu Plant 2 Lamongan

Estimasi Biaya :

No.		Pekerjaan	Jumlah	Total
A				**1.008.084.965**
	I	PEKERJAAN PERSIAPAN	1.250.000	
	II	PEKERJAAN TANAH	10.696.693	
	III	PEKERJAAN PONDASI	61.463.626	
	IV	PEKERJAAN STRUKTUR	727.772.525	
	V	PEKERJAAN ATAP	162.024.047	
	VI	PEKERJAAN TANGGA	29.398.425	
	VII	PEKERJAAN SAPITENK & SUMUR RESAPAN	15.479.649	
B		**PEKERJAAN ARSITEKTUR & MEP**		**645.495.383**
	I	PEKERJAAN TOPI-TOPI & MEJA DAPUR	6.534.264	
	II	PEKERJAAN DINDING	195.958.832	
	III	PEKERJAAN PLAFOND	69.821.900	
	IV	PEKERJAAN FINISHING LANTAI & DINDING	170.126.988	
	V	PEKERJAAN PINTU & JENDELA	94.272.000	
	VI	PEKERJAAN PLUMBING	63.769.900	
	VII	PEKERJAAN INSTALASI AC DAN EXHAUST FAN	21.951.500	
	VIII	PEKERJAAN ELECTRICAL	23.060.000	
TOTAL				1.653.580.348
PPN 11%				181.893.838
GRAND TOTAL				1.835.474.186

4.2. Earned Value

Earned Value is calculated by multiplying the cumulative percentage of progress achieved by the total Budget At Completion (BAC). The cumulative percentage of progress reflects the overall completion of the project as of a specific week, which is obtained from the weekly progress report. The Budget At Completion (BAC) indicates the total value of the contract after deducting value-added tax (VAT). The BAC value is derived from the summary of the Budget Plan, as illustrated below:

$$EV = Cumulative\ Progress\ Percentage \times BAC \quad (6)$$

Table 2. Earned Value from week 10 - 15

Week	Cumulative Progress Percentage	EV
10	24,73%	IDR 408.930.420,03
11	37,36%	IDR 617.777.617,97
12	42,29%	IDR 699.299.129,12
13	46,22%	IDR 764.284.836,79
14	50,79%	IDR 839.853.458,69
15	54,14%	IDR 895.248.400,34

4.3. Actual Cost

Actual Cost (AC) is the actual cost incurred to complete work during a certain period. Actual Cost (AC) consists of direct cost and indirect cost.

Table 3. Direct Cost, Indirect Cost, and Actual Cost

Week	Direct Cost	Indirect Cost	Actual Cost (AC)
10	IDR 574.964.517	IDR 14.650.000	IDR 589.614.517
11	IDR 586.028.517	IDR 15.400.000	IDR 601.428.517
12	IDR 560.695.792	IDR 16.450.000	IDR 577.145.792
13	IDR 651.674.317	IDR 17.400.000	IDR 669.074.317
14	IDR 659.114.317	IDR 18.150.000	IDR 677.264.317
15	IDR 660.494.317	IDR 19.100.000	IDR 679.594.317

4.4. Cost Varians (CV) and Cost Performance Index(CPI)

Calculation of the Cost Varians (CV) and Cost Performance Index (CPI) for the 10th week is as follows:

$$CV = Earned\ Value\ (EV) - Actual\ Cost\ (AC) \quad (7)$$

$$CPI = Earned\ Value\ (EV) / Actual\ Cost\ (AC) \quad (8)$$

Table 4. Cost Varians (CV) and Cost Performance index (CPI) week 10 - 15

Week	Eearned Value (EV)	Actual Cost (AC)	Cost Variance (CV)	CPI
10	IDR 408.930.420	IDR 589.614.517	-IDR 180.684.097	0,69
11	IDR 617.777.618	IDR 601.428.517	IDR 16.349.101	1,03
12	IDR 699.299.129	IDR 577.145.792	IDR 122.153.337	1,21
13	IDR 764.284.837	IDR 669.074.317	IDR 95.210.520	1,14
14	IDR 839.853.459	IDR 677.264.317	IDR 162.589.142	1,24
15	IDR 895.248.400	IDR 679.594.317	IDR 215.654.083	1,32

A negative Cost Variance (CV) indicates that actual expenditures surpass the allocated budget. The calculation for the upcoming week can be executed using the previously outlined methodology. Furthermore, a Cost Performance Index (CPI) value exceeding 1 suggests that expenditures are under the budget.

4.5. Estimated To Complete (ETC) and Estimated At Complete (EAC)

Represents the estimated cost for the remaining work. Calculation of the 15th week Estimate To Complete (ETC) with a Progress Value > 50% as follows:

ETC = (BAC – EV)/ CPI

= (IDR. 1.653.580.348 – 895.248.400) / 1,32

= IDR. 575.659.316

Estimated At Complete (EAC) is the estimated total cost at the end of the project. Calculation of Estimate At Complete (EAC) for week 15 is as follows:

EAC = ETC + AC

= IDR. 575.659.316 + IDR. 679.594.317

= IDR. 1.255.253.633

5. CONCLUSION

The Project Cost Performance Index (CPI) of 1.32 indicates that the actual project costs are smaller than budgeted. Although this indicates efficiency in budget use, a CPI value higher than 1 can also indicate a mismatch between the costs incurred and the progress achieved. As a result, the project experienced delays, because even though costs were lower, the work that should have been completed had not been achieved according to the planned schedule.

Based on the Estimate To Complete (ETC) and Estimate At Completion (EAC) values obtained, the costs required to achieve the work target are IDR 575,659,316. Meanwhile, the total costs required to complete this project are estimated at IDR 1,255,253,633. This calculation provides a clear picture of the budget that must be prepared to complete the work according to plan and ensures the project can be completed at a controlled cos

6. REFERENCES

Fleming, Q. W., & Koppelman, J. M. (1994). *Earned Value Project Management*. Project Management Institute.

Mockler, R. J. (1972). *The Management Control Process*. Appleton-Century-Crofts.

Taufan, A. A., Paryati, N., & Yulius, E. (2018). Evaluasi Pelaksanaan Pekerjaan Proyek Rehabilitasi Gedung Dinas Kependudukan dan Catatan Sipil dan Bappeda Kota Bekasi. *Bentang : Jurnal Teoritis dan Terapan Bidang Rekayasa Sipil*, *6*(1), 78–92. https://doi.org/10.33558/bentang.v6i1.538

A. Marhendra and S. Qomariyah, "Analysis of Yield Value Against Time in Construction Projects (Case Study of the Eastparc Yogyakarta Hotel Construction Project)," 2013.

S. Wajhi and M. I. Triana, "TIME AND COST CONTROL ON PERIODIC MAINTENANCE PROJECT OF ROAD SECTION STRUCTURE USING EARNED VALUE ANALYSIS," *Journal of Scientech Research and Development ,* pp. 372-383, 2024.