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COST AND TIME CONTROL STUDY USING EARNED VALUE MANAGEMENT METHODS IN FENCE AND GATE CONSTRUCTION PROJECTS POLYTECHNIC MUARA TEWEH

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ABSTRACT

This research focuses on controlling costs and time in the Fence and Gate Construction Project at Muara Teweh Polytechnic using the Earned Value Management method. This research aims to evaluate project performance by analyzing plan schedule data, weekly progress reports, and project budget (CBP) to assess the actual status of project costs and schedule. The results of direct interviews showed that the project experienced delays due to shortages of materials, delays in the arrival of materials, and unfavorable weather conditions, which caused deviations from the planned schedule. The analysis uses three main indicators: BCWS, BCWP, ACWP. The results show that from week 8 to week 15, the project experienced delays, although it did not cause cost overruns during the 16 week duration. This study concludes that the implementation of EVM can serve as a valuable reference for anticipating potential cost and time deviations in future project phases.

Keywords: *Earned Value Management, Time Performance, Cost Performance*

1. INTRODUCTION

In project work, it is very rare to find projects that are carried out as planned. In reality, unforeseen circumstances during the construction process can cause delays even though the project has a projected schedule and budget. According to Megawati (2021), delays and cost overruns can have a negative impact on both service users and especially service providers, which can be caused by many factors. In the implementation of the Muara Teweh Polytechnic Fence and Gate Construction project with a contract value of IDR 917,616,000.00 (including 11% VAT), in reality the work experienced delays from the planned schedule where there was a delay in the 8th week. The initial schedule for this project plan was 12 weeks which ultimately became 16 weeks. This is due to a shortage of materials that are not available in the area, delays in material delivery and unfavorable weather. By carrying out this control study, it can ultimately become a reference or know whether the project can be completed more quickly or according to the planned schedule.

In this evaluation, Earned Value Management is used, which has more advanced control for project performance. EVM is an important technique for analyzing and controlling project performance, allowing more precise measurement of project progress over a certain period of time and can estimate project progress in the next period, especially in terms of costs and time to determine the project completion point. There are three indicators used in this EVM method research, namely BCWS, BCWP and ACWP.

Of the other types of project control methods, EVM is a superior method because it combines cost, schedule and work performance. The Polytechnic Fence and Gate construction project has been completed, this evaluation is carried out so that it can be useful as a reference for subsequent projects so that it can anticipate project deviations that may occur in the next period and can become reference material for similar research.

2. THEORITICAL STUDY

Project Management

According to Bukit (2017), a construction project is a very complex work system because it involves many components or elements in it. Every component or part in the system plays an important role. The performance and quality of the system will be threatened if the performance of the selected components is incorrect. Therefore, a building project organization requires a management system that is outlined in the contract as a whole. According to Ismael (2013), to identify and achieve predetermined goals using human resources and other resources, management is a special process that includes planning, organizing, actuating and controlling.

Construction Costs

According to Tolangi (2012) in Nurdiana A (2015), the concepts of Cost Budget Plan (CBP) and Implementation Budget Plan (IBP) refer to expenses related to construction projects. The budget required to complete each work item is information collected in the CBP. Meanwhile, the IBP data obtained is for the expenditure required for each project resource, especially labor, materials and equipment. The formulation of the CBP and IBP can be described as follows:

a. Overhead and profit of 10% (obtained from interviews with consultants).
b. For 11% VAT the addition and inclusion is included in the CBP (Contract Value).

c. To calculate the project Implementation Budget Plan (IBP), the following formula is created:

CBP = IBP + Tax

IBP = CBP – VAT ... (2.1)

d. Actual costs or IBP, are broken down into the following categories :

1) Indirect costs

Based on the direction of the interview results to the project party, it is known that the Overhead and Profit values are 10% of the IBP and adjusted to the weekly realization weight data.

Indirect costs = 10% × (IBP) ... (2.2)

2) Direct costs

It's the price of doing the actual construction. The direct costs in this research are assumed to be 80% of the IBP because the Actual Cost value is definitely lower than the planned value.

Direct costs = 80% × (IBP) ... (2.3)

Earned Value Concept

According to Valle (2012) in Mahapatni (2019), Yield Value is a method for knowing actual income and losses on a project and offers a way to maximize profits while balancing profits and losses.

Analysis of Earned Value indicators is as follows (Rahmanto & Janizar, 2022) :

1. ACWP = Direct costs + Indirect costs ... (2.4)
2. BCWP = % (realized weight) × Contract Value (IBP) ... (2.5)
3. BCWS = % (plan weight) × Contract Value (IBP) ... (2.6)

Variance Analysis

This variance calculation is used to calculate differences or deviations. This variant is divided into two, namely cost variance (CV) and time variance (SV) (Mahapatni, 2019). The formula for calculating variance is :

CV = BCWP – ACWP ... (2.7)

SV = BCWP – BCWS ... (2.8)

Table 2.1 Analysis of Variance

SCHEDULE VARIANCE (SV)	COST VARIANCE (CV)	INFORMATION
Positive	Positive	The work was carried out faster than the planned schedule and the actual costs were less than the budget
Zero	Positive	Work was carried out exactly according to schedule with actual costs lower than budget
Positive	Zero	The work was carried out according to budget and ahead of schedule
Zero	Zero	The work was carried out on time and within budget
Negative	Negative	The work was completed late and cost more than the actual budget
Zero	Negative	Work was carried out according to schedule with actual costs exceeding budget
Negative	Zero	The work was delayed with costs within budget
Positive	Negative	The work was completed faster than the planned schedule with actual costs exceeding the budget
Negative	Positive	Work is delayed with actual costs lower than budget

Performance Index Analysis

According to Juliana (2016), the effectiveness of resource utilization, which can be represented as a productivity index or performance index, is something that project managers often want to understand. The Performance Index is divided into 2 parts, namely SPI (Schedule) and CPI (Cost). The formula for this calculation is :

$$CPI = BCWP / ACWP \quad \text{... (2.9)}$$

$$SPI = BCWP / BCWS \quad \text{... (2.10)}$$

Table 2.2 Performance Index Analysis

Index	Grade	Information
CPI	>1	AC output is less than the value of work gained (EV)
	<1	AC output is greater than the value of work gained (EV)
	1	AC output is equal to the value of work gained (EV)
SPI	>1	Project performance is faster than the planned schedule (PV)
	<1	Project performance is behind schedule (PV)
	1	Project performance is the same as the planned schedule (PV)

Project Time and Cost Prediction

In the value method the results are not only for project performance, but can also be used to predict project costs and completion time.

$$\text{Physical progress} < 50\%\ ETC = IBP - BCWP \quad \text{... (2.11)}$$

$$\text{Physical progress} > 50\%\ ETC = (IBP - BCWP) / CPI \quad \text{... (2.12)}$$

$$EAC = ACWP + ETC \quad \text{... (2.13)}$$

(Annas F.M, Solikin M, Harnaeni S.R, Sunarjono S, 2024)

$$ETS = (\text{remaining time}) / SPI \quad \text{... (2.14)}$$

$$EAS = \text{finish time} + ETS \quad \text{... (2.15)}$$

With an explanation of the formula, namely :

BAC = Budget at Complete (IBP)

CPI = Cost Performance Index

SPI = Schedule Performance Index

ETC = Estimate Temporary Cost

EAC = Estimate All Cost

EAS = Estimate All Schedule

ETS = Estimate Temporary Schedule

(Lamato F, Utiarahman A, Tuloli M.Y, 2022)

3. METHOD

Research Location

This research was carried out on the Fence and Gate Construction project for the Muara Teweh Polytechnic Private University which is located on Jl. Country Km. 7, Jingah, Teweh Baru District, North Barito, Central Kalimantan, 73814, Indonesia. The top view of the project location can be seen in Figure 3.1

Figure 3.1 Research Location

Research Data

There are two types of data collected, namely primary and secondary, which can be seen as follows:

1. Primary data was obtained from direct interviews with several project parties who obtained Overhead and Profit data, factors of project delays, as well as solutions to causes of project delays.

2. Secondary data takes the form of available report data. Secondary data needed in preparing this research is in the form of a Time Schedule, CBP (Cost Budget Plan), and Weekly Project Report.

Data Analysis Methods

The Earned Value Management (EVM) method is used to examine data in this research regarding project implementation time and cost control so that it is effective and efficient. After the data is collected, the data is then analyzed using several Result Value Analysis indicators.

4. RESULT AND DISCUSSION

Project Performance Evaluation.

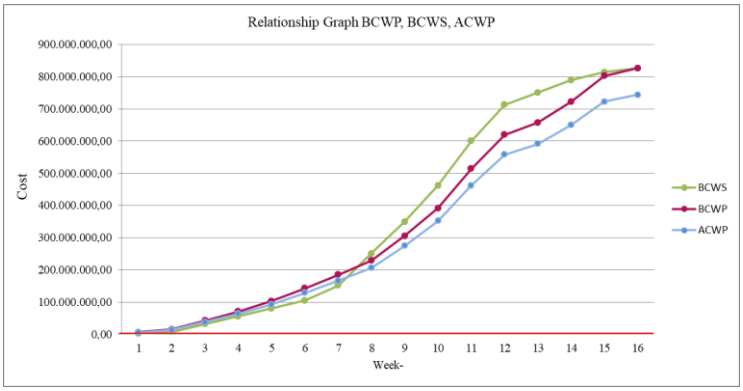

Figure 4.1 Relationship Graph between BCWS, BCWP, and ACWP

From Figure 4.1, it can be seen that in terms of scheduling in weeks 1 to 7, the BCWP graph is higher than BCWS, indicating faster project implementation. However, from weeks 8 to 15, BCWP was below BCWS, showing a delay. The project was completed in the 16th week and seen from the cost aspect in weeks 1 to 16, the BCWP graph above ACWP shows that there is no cost overrun.

Project Scheduling Performance

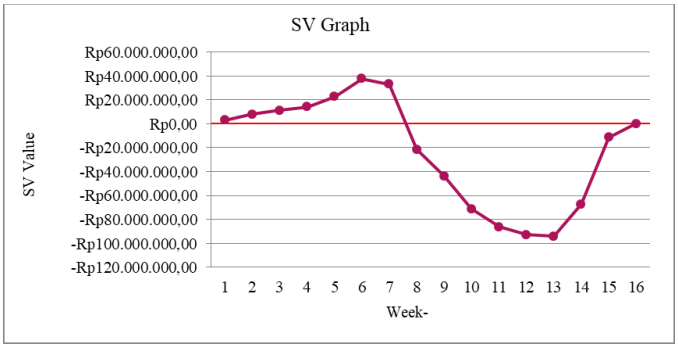

Figure 4.2 Graph of SV Values Every Week

From Figure 4.2 SV graph, it can be seen that from week 1 to week 7 SV is positive. However, at week 8, the SV value became negative, indicating project delays. The SV value continued to decrease until the 15th week, and the project was completed in the 16th week.

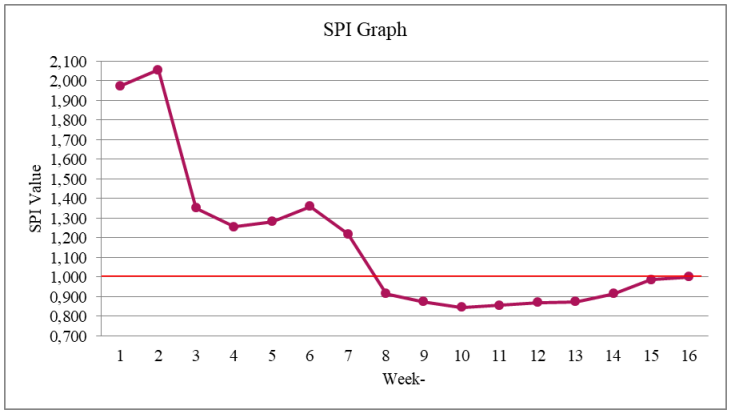

Figure 4.3 SPI Value Graph Every Week

From Figure 4.3, the SPI value graph shows that project performance increased in the first and second weeks, but decreased drastically from the 3rd week to the 15th week, finally in the 16th week the project was completed.

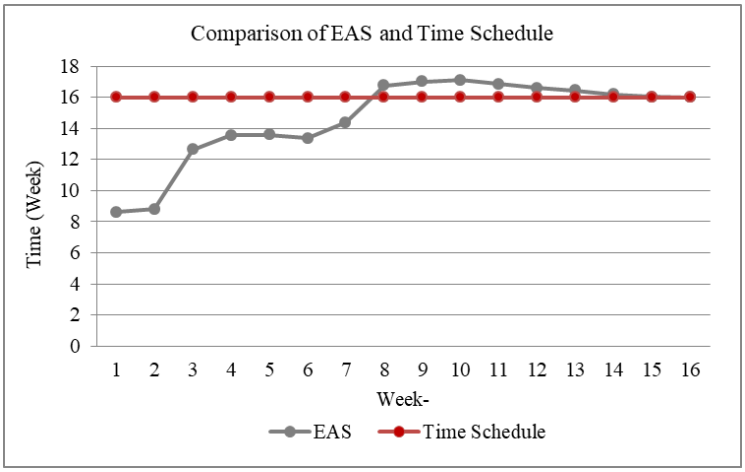

Figure 4.4 Comparison of EAS with Plan Schedule

From Figure 4.4, the project experiences acceleration when the EAS graph is below the planned schedule graph, with the greatest acceleration in week 1. However, from weeks 8 to 12, the EAS graph is above the planned schedule graph by a value of 17 weeks as project performance decreases. In weeks 13 to 16, the EAS value is almost equal to the planned schedule graph, and the project is completed when the EAS graph touches the planned schedule graph.

Project Cost Performance

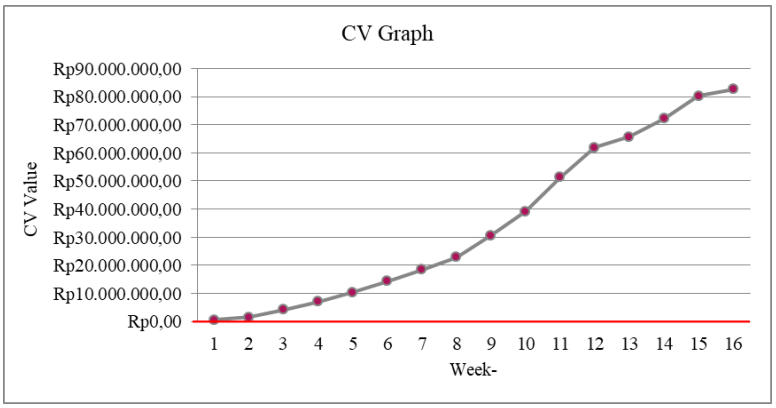

Figure 4.5 Graph of CV Values Every Week

From Figure 4.5, the CV value graph shows that even though there is a delay in the project, the project costs remain stable and there is no loss

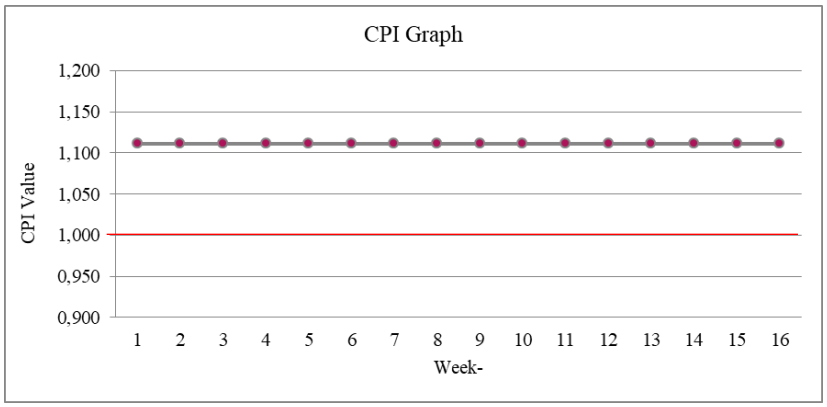

Figure 4.6 Graph of CPI Values Every Week

From Figure 4.6 CPI value graph, it can be seen that from week 1 to week 16, the CPI value graph shows > 1 with the number 1.011, which means that the project cost performance did not experience a loss.

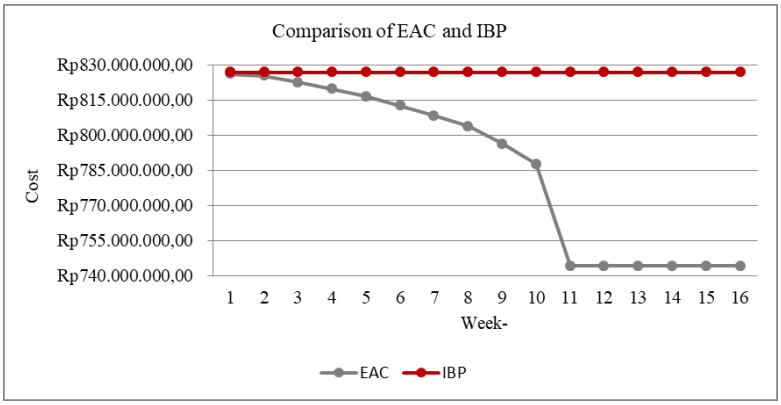

Figure 4.7 Comparison of EAC with IBP

From Figure 4.7, it can be seen that the project did not experience cost overruns or losses at the end of the project. This can be proven by the EAC line being below the IBP line from week 1 to week 16.

Factors and Solutions

Based on the results of interviews with project parties, it was found that the factors for project delays were empty material in the area, late delivery because the main road was impassable, and bad weather. The solution implemented is ordering outside the region, delivery via alternative routes that are farther away, and longer working hours.

5. CONCLUSION

Time performance based on SV and SPI data shows that at the end of the 16th week of the project there were no delays and the project was completed according to the planned schedule after the addendum. Cost performance based on CV and CPI data shows that no cost overruns have occurred. Time estimates based on ETS and EAS data show that from weeks 8 to 12, ETS and EAS results exceed schedule, but from weeks 13 to 16, EAS values are equivalent to the planned schedule. Cost estimates based on ETC and EAC data show that the total final project costs are less than the IBP value, proving that the project does not experience losses.

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