THE IMPLEMENTATION OF EARNED VALUE MANAGEMENT (EVM) IN COST AND TIME CONTROL OF A ROAD IMPROVEMENT PROJECT

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ABSTRACT

The construction of road infrastructure in Indonesia continues to progress as a form of the Government's responsibility in providing safe and comfortable mobility facilities for the public. The increasing intensity of construction projects, particularly road development, is often faced with various challenges, one of which is project delays. These delays can cause significant losses to both contractors and project owners, thereby highlighting the need for effective project management to address such issues. One method that can be used for cost and time control in projects is the Earned Value Management (EVM) method. Earned Value Management is an integrated approach to controlling project cost and schedule by estimating the cost of the work that has been completed. This method can be used to assess the current condition of a project based on performance elements at the time of monitoring. This study was conducted by examining a road improvement project in Mukomuko Regency, Bengkulu Province. The results showed that the project performance condition could be classified as "Very Good," as indicated by the analysis of SV (Schedule Variance), SPI (Schedule Performance Index), CV (Cost Variance), and CPI (Cost Performance Index), where none of the values were negative or below zero (<0). This indicates that the project activities were carried out faster than scheduled, the work met expectations or was on time, and even exceeded planned targets during certain weeks. The estimated cost to complete the project is predicted to be IDR 25,***,***,***. The project is expected to be completed on time within 25 weeks. It is also predicted to yield a profit of IDR 37,***,*** or approximately ± 0.14%. Although this is not a significant profit margin, the project can still be considered successful and not financially detrimental.

Keyword: *Project Performance, Earned Value Management, Cost & Time Management of Construction Projects*

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1. BACKGROUND OF RESEARCH

The increasing intensity of construction projects, particularly road projects, is often accompanied by various issues, one of which is project delays. Such delays are highly detrimental to all parties involved—both contractors and project owners—thus emphasizing the need for effective project management to address these delay-related problems (Utami and Girsang, 2022). Cost and time control are crucial components of project management. Aside from quality assessment, a project's performance can also be evaluated in terms of cost and time. Significant deviations in cost and time indicate poor project management.

One method that can be used for cost and time control in a project is the Earned Value Management (EVM) method. According to Sudarsana (2008), Earned Value Management is an integrated method to control cost and schedule by estimating the value of the work performed. This method can be used to assess project status based on performance indicators during project monitoring. According to Sanjaya (2019), Earned Value Management is an analytical method that links cost and time, thereby providing performance information during project execution. Based on these definitions, it is evident that EVM can be used to analyze the performance of an ongoing project as well as to estimate the projected cost and time achievements up to the end of the project.

Previous studies have shown that the EVM method is quite effective and efficient in monitoring project performance. This method can also be applied to various types of projects, which led the author to implement the EVM method in this research report as part of the Professional Engineer Education Program at Universitas Andalas. The title of this study is "The Implementation of the Earned Value Management (EVM) Method in Cost and Time Control of a Road Improvement Project." The case study is conducted on the Road Improvement Project of the Simpang PT Maju–Talang Baru–Simpang Talang Arah–Simpang Perambah Hutan–Gajah Makmur section. The purpose of this study is to determine the progress or delays of the project. The research results are expected to serve as a reference for project control in the case study or for future projects in terms of cost and time efficiency.

2. RESEARCH PROBLEM

Based on the research background described above, the author summarizes several key research questions as follows:
1. What is the projected performance and current condition of the project based on the EVM analysis?
2. What is the estimated total cost at the end of the project according to the EVM analysis?
3. How long is the estimated time required to complete the project based on the EVM analysis?
4. What is the estimated profit or loss of the project based on the EVM analysis?

3. LITERATURE REVIEW

3.1 Project Management

According to Kerzner (2006), project management is the process of planning, organizing, directing, and controlling organizational resources to achieve short-term objectives that are carried out to meet specific goals. According to Chapman (1997), project management is a set of principles, practices, and techniques used to lead a project team and manage the project's schedule, cost, and performance risks to ensure customer satisfaction. The processes in project management consist of the initiating process, planning process, executing process, controlling process, and closing process.

3.2 Project Management Cycle

Based on the PMBOK Guide developed by the Project Management Institute (PMI), the project management cycle consists of five distinct phases: Project Initiation, Project Planning, Project Execution, Project Monitoring, and Project Closure. The project management cycle can be seen in the figure below:
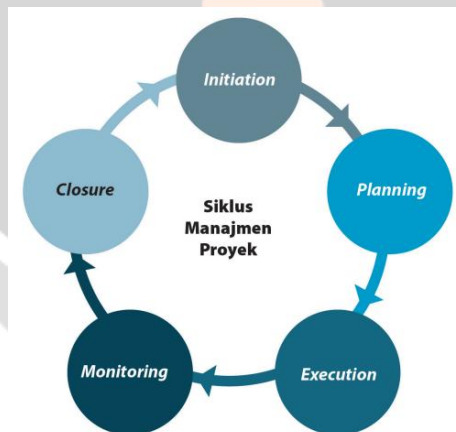

Fig-1. Project Management Cycle

3.3 Cost and Time Management

Cost and time planning and control are integral parts of overall construction project management. In addition to quality evaluation, project performance can also be assessed in terms of cost and time. The costs incurred and the time spent to complete a task must be continuously measured against the planned values. Significant deviations in cost and time indicate poor project management. By monitoring project performance indicators in terms of cost and time, preventive actions can be taken to ensure that project implementation proceeds according to plan.

3.4 Earned Value Management (EVM)

Earned Value Management (EVM) is one of the tools used in project management that integrates cost and time. EVM presents three dimensions: the physical completion of the project (the percent complete), which reflects the planned budget (budgeted cost); the actual cost incurred (actual cost); and the value earned for the work performed (earned value). Based on these three dimensions, EVM can link cost performance with schedule performance through the calculation of cost and schedule variances (Flemming and Koppelman, 1994).

4. RESEARCH METHODOLOGY

4.1 Research Design and Process

The research design and process include several stages: identifying and selecting the problem, formulating and defining the research problem, conducting a preliminary study and literature review, building the investigation, determining data sources, establishing data analysis procedures, collecting data, analyzing the data based on the specified analysis procedures, drawing conclusions, and compiling the research report. Based on the explanation above, the research process design is presented in Figure 2 below.
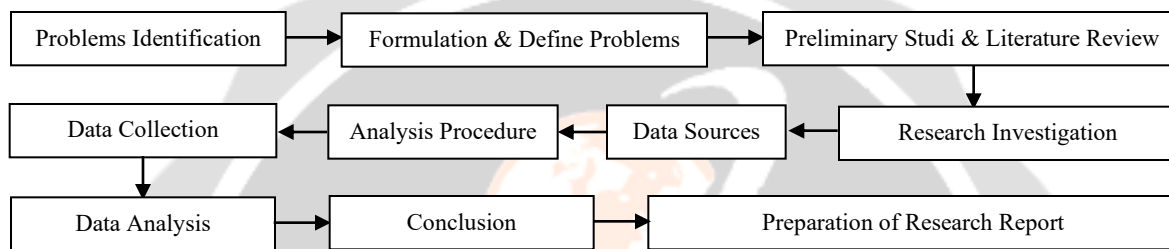

Fig-2. Research Design and Process

3.2 Research Location and Time

This study was conducted on the road improvement construction project of the Simpang PT Maju–Talang Baru–Simpang Talang Arah–Simpang Perambah Hutan–Gajah Makmur road section, located in Mukomuko Regency, Bengkulu Province. The research reviewed project performance based on aspects of cost and time control. The location map of the research is provided in the appendix. The time schedule for the Road Improvement Construction Project spans from July 20, 2023, to December 29, 2023. For this study, observations were conducted between July 20, 2023, and September 15, 2023 (week 1 to week 10).

3.3 Data Collection Methods

The data collected consist of literature study data, primary data, and secondary data:
1. Literature study data: Data collected from various references related to the Earned Value Management (EVM) method. These include books and previous research journals relevant to the topic.
2. Primary data: Obtained through field observation by directly observing and monitoring the ongoing work processes. Data collection techniques include field interviews with relevant parties such as contractors and consultants. These interviews helped identify obstacles faced in the road improvement project of Simpang PT Maju–Talang Baru–Simpang Talang Arah–Simpang Perambah Hutan–Gajah Makmur.
3. Secondary data: Collected indirectly through project-related documents, including the project's master schedule, time schedule, weekly reports, and the budget plan.

3.4 Research Analysis Method

The research analysis used is the Earned Value Management (EVM) method, which integrates project cost and time performance. Three fundamental elements serve as the basis for analyzing project performance using EVM:
1. Budgeted Cost for Work Scheduled (BCWS): The planned budget allocated according to the work schedule over time.
2. Budgeted Cost for Work Performed (BCWP): The value earned from the work completed during a specific time period.
3. Actual Cost for Work Performed (ACWP): The total cost incurred for the work completed in a given time period.

The analysis using Earned Value Management (EVM) is supported by Microsoft Excel. The following formulas are used:

1. Schedule Variance (SV) and Schedule Performance Index (SPI)
   Used to analyze performance based on time parameters:
   a. Schedule Variance (SV)
      SV = BCWP – BCWS
      Decision Criteria:
      SV = 0: project is on schedule
      SV > 0: project is ahead of schedule
      SV < 0: project is behind schedule
   b. Schedule Performance Index (SPI)
      SPI = BCWP / BCWS
      Decision Criteria:
      SPI = 1: project is on schedule
      SPI > 1: project is ahead of schedule
      SPI < 1: project is behind schedule

2. Cost Variance (CV) and Cost Performance Index (CPI)
   Used to analyze performance based on cost parameters:
   a. Cost Variance (CV)
      CV = BCWP – ACWP
      Decision Criteria:
      CV = 0: project cost is as planned
      CV > 0: cost is lower than planned
      CV < 0: cost is higher than planned
   b. Cost Performance Index (CPI)
      CPI = BCWP / ACWP
      Decision Criteria:
      CPI = 1: project cost is as planned
      CPI > 1: cost is lower than planned
      CPI < 1: cost is higher than planned

3. Estimate at Completion (EAC), Estimate to Complete (ETC), and Time Estimate (TE)
   Used for estimating final cost and project duration:
   a. Estimate to Complete (ETC)
      ETC = (BAC – BCWP) / CPI
      Explanation:
      BAC (Budget at Completion) is the total project budget excluding VAT.
   b. Estimate at Completion (EAC)
      EAC = ACWP + ETC
   c. Time Estimate (TE)
      TE = ATE + {(OD – (ATE × SPI)) / SPI}
      Explanation:
      TE: Estimated time to complete the project
      ATE: Actual time elapsed
      OD: Original duration (planned time)

4. RESULT AND DISCUSSION

4.1 General Project Information

The general information of the project that forms the basis for EVM analysis in this research is presented below:

Project Name   : Road Improvement Project of Simpang PT Maju – Talang Baru – Simpang Talang Arah – Simpang Perambah Hutan – Gajah Makmur
Contract Number : Confidential
Contract Date   : July 20, 2023
Project Location : Mukomuko Regency, Bengkulu Province
Fiscal Year   : 2023
Project Owner   : Kementerian PUPR, Direktorat Jenderal Bina Marga, Balai Pelaksana Jalan Nasional Bengkulu

Contractor   : Confidential
Supervising   : Confidential
Contract Value : IDR 26,***,***,***
Duration   : 165 calendar days

4.2 Field Observation Schedule

The road improvement project was carried out from July 20, 2023, to December 29, 2023. The observation period for this research was conducted from July 20, 2023, to September 15, 2023 (Week 1 to Week 10).

4.3 Research Analysis Process

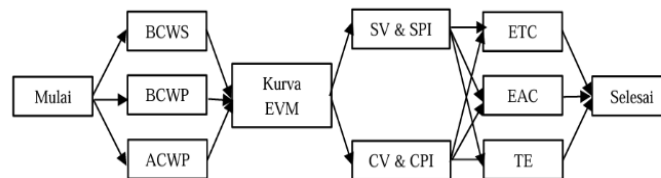The research analysis process using the EVM method is illustrated in Figure 3 below:

Fig-3. Research Analysis Process

4.4 Data Analysis
The data required for this research include: contract value, planned costs, actual project progress up to Week 10, and actual expenditures:
1. Contract Value: IDR 26,***,***,***
2. Weekly cumulative planned progress, actual cumulative progress, and actual cost.

4.5 EVM Calculations Summary (BCWS, BCWP, ACWP, SV, SPI, CV, CPI)

1. All results show that the project progress from Week 1 to Week 10 was ahead of schedule.
2. Schedule Variance (SV) values are consistently positive, indicating early task completions.
3. Schedule Performance Index (SPI) values are equal to or greater than 1.00, confirming time efficiency.
4. Cost Variance (CV) values are also positive, indicating cost savings.
5. Cost Performance Index (CPI) values show cost efficiency throughout the period, with no indication of cost overruns.
6. The project remained within budget while achieving faster-than-expected physical progress**.**

4.11 Estimate to Complete (ETC), Estimate at Completion (EAC), and Time Estimate (TE)

1. The Estimate to Complete (ETC), or the projected cost for the remaining work (week 11 to week 24), is estimated at **IDR 24,***,***,*** (Prediction).
2. The Estimate at Completion (EAC), or the total projected cost at project completion, is estimated at **IDR 25,***,***,*** (Prediction).
3. The Time Estimate (TE) predicts that the project will be completed on time, within **25 weeks**.
4. The project is estimated to gain a **profit of IDR 37,***,*** (Prediction).
5. The profit percentage is ± **0.14%** of the total contract value. Although not a significant amount, the project can still be considered successful and not incurring a loss.

4. CONCLUSIONS

Based on the analysis that has been conducted, the results can be summarized as follows:
1. The contract value or Budget at Completion (BAC) is the total value of the work based on the contract, amounting to **IDR 26,***,***,***.
2. Actual Time Expended (ATE) refers to the number of weeks that have been executed according to the project schedule.
3. Original Duration (OD) is the total number of weeks in the schedule until the project is completed.
4. The BCWS (Budgeted Cost for Work Scheduled) in week 10 is obtained by multiplying the cumulative planned progress percentage in week 10 by the contract value.

5. The BCWP (Budgeted Cost for Work Performed) in week 10 is obtained by multiplying the cumulative actual progress percentage in week 10 by the contract value.

6. The ACWP (Actual Cost for Work Performed) in week 10 is the cumulative total of direct and indirect costs in that week.

7. The Schedule Variance (SV) in week 10 shows a **positive value**, indicating that the project performance is relatively good as the work packages were completed ahead of the planned schedule.

8. The Schedule Performance Index (SPI) in week 10 is **1.00**, indicating that the project execution is efficient in terms of time, achieving or even exceeding the planned target.

9. The Cost Variance (CV) in week 10 shows a **positive value**, indicating that the actual cost incurred is less than the planned cost.

10. The Cost Performance Index (CPI) in week 10 is **1.00**, indicating efficient cost performance, where the actual costs are equal to the value of the completed work, meaning there is no cost overrun.

11. The Estimate to Complete (ETC), or the projected cost for the remaining work (week 11 to week 24), is estimated at **IDR 24,***,***,***** (Prediction).

12. The Estimate at Completion (EAC), or the total projected cost at project completion, is estimated at **IDR 25,***,***,***** (Prediction).

13. The Time Estimate (TE) predicts that the project will be completed on time, within **25 weeks**.

14. The project is estimated to gain a **profit of IDR 37,***,***** (Prediction).

15. The profit percentage is ± **0.14%** of the total contract value. Although not a significant amount, the project can still be considered successful and not incurring a loss.

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