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Cost and Time Variance Analysis Using The Earned Value Method: A Case Study of The Laju Lor Village Drainage Channel Construction Project In Tuban Regency

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ABSTRACT

This study aims to analyze the performance of the Drainage Development project in Laju Lor Village, Tuban District, using the Earned Value Management (EVM) method. The method integrates time and cost concepts through three main indicators: ACWP (Actual Cost of Work Performed), BCWP (Budgeted Cost of Work Performed), and BCWS (Budgeted Cost of Work Schedule). The research focuses on calculating Cost Variance (CV) and Schedule Variance (SV) to evaluate project performance. The method was applied to track the project's performance over a period of 5 weeks. In week 1, the project showed a delay of 0.38%, which increased to 4.84% by week 2. By the end of week 5, the results revealed that the Schedule Variance (SV) was Rp 74,378,242.82 (-), indicating that the project was behind schedule, while the Cost Variance (CV) was Rp 20,726,358.11 (+), showing that the costs incurred were less than the budgeted amount. The findings highlight the importance of using the Earned Value method to monitor project performance, ensuring that deviations in schedule and costs are promptly identified and addressed. The study concludes that implementing efficient control mechanisms and consistent supervision is essential for mitigating delays and improving project performance, specifically for the Laju Lor Village Drainage construction project in Tuban Regency. The research provides valuable insights for construction service providers to enhance project management practices and avoid further delays.

Keywords: cost variance analysis, schedule variance, cost

INTRODUCTION

Drainage is a vital infrastructure for rural areas that have a geographical location that is prone to overflowing water, so it has the function of draining surface water into water bodies (rivers) or artificial infiltration structures. Poorly planned drainage systems result in environmental degradation, decreased economic levels, decreased housing quality, puddles, flooding and damage to public facilities and existing infrastructure (Urgilés, Claver, & Sebastián, 2019). This can disrupt the function of community activities and the wheels of the economy, hamper human mobility, and cause various diseases. To revitalize these functions, the drainage system must be viewed as a unit of the water system with multidisciplinary completion efforts (Hambali, 2015).

With the development of infrastructure development which is the government's concern, companies in the construction sector are increasingly numerous and growing, seen from the fierce competition and the number of participants who will follow the mechanism to get work in the field of construction such as tenders, starting from businesses with small, medium and upper subquaification according to their specialty (Acebes, Pereda, Poza, Pajares, & Galán, 2015). To develop its business, it must have a good management system. The development of increasingly sophisticated technology to support construction activities is the

main factor that these companies must have competencies that match the sub-qualifications in the field of work to be carried out (Hardi, Witjaksana, & Patriadi, 2024). So that with the dynamics of competition, more and more contractors are expected to be able to carry out the right business strategy to increase superior competitiveness (Setiawan, 2016).

Construction budget financing whose value is getting bigger has a more complex scope of work from the beginning of planning to implementation so that it must have a good and targeted strategy in its management system such as technical implementation methods, scheduling plans and cost control (Tjendani, Anwar, & Wiguna, 2018). But it does not rule out the possibility with a small job allocation fee must also pay attention to this so that the management system within the company continues to run well. One of them is an important role in organizing projects, namely cost estimates. So that the implementation cost budget analysis can increase the effectiveness and efficiency of development in the construction sector (Sari, Arman, & Ridwan, 2021).

Prediction or forecasting of project schedule duration is needed in construction development. The future of the project is influential in making project management decisions related to schedule estimates, namely duration estimates so that they can determine the success of the project. Earned Value Method is a method commonly used by contractors in working on projects related to cost and time control. (Sugiyanto & Gondokusumo, 2020)

The development of the development sector has a significant impact on the growth of urban and rural environments, thus having a significant impact on changes in the value of surface runoff which further affects the work system of drainage and waterways (Babar, Thaheem, & Ayub, 2017). The increase in facilities in residential areas causes land use that was originally open to overflowing water that functions as an infiltration area, now turns into closed to impermeable pavement. So that the function of infiltration is reduced. In addition, changes in land use can also cause it to become critical for easy erosion (Adinata & Alfa, 2020).

Based on the development activities carried out by the Tuban Regency Government with the allocation of funds from the revised APBD 2024, one of them is the construction of drainage channels in Margomulyo Village, Kerek Subdistrict and Laju Lor Village, Singgahan Subdistrict, Tuban Regency (KhodaBandehLou, Parvishi, Taghifam, Lotfi, & Taleei, 2016). The project work has become one of the priorities of the Tuban Regency Government, especially the PUPR-PRKP Office of Cipta Karya to overcome the problem of flooding when the rainy season arrives. The drainage channel is expected to be an integrated development support in overcoming flooding problems to be correlated with other supporting facilities such as the utilization of reservoirs as water reservoirs during the rainy season to be utilized in the agricultural sector during the dry season.

Literature Review

Previous Research

In this study the authors used previous research in taking references, where in previous studies regarding cost and time control in a project, especially road works, can be applied using the earned value method. So that it can minimize the risk of delays and cost losses when the project takes place. The following is a list of previous research:

Toll road construction in its implementation requires control in terms of cost and time. Detecting as early as possible will be better so that there is no cost overrun or time delay by using the earned value method, based on the progress analysis on the Trans Sumatra Toll road project work of the Indralaya - Prabumulih Simpang Ruas obtained a cost appearance index worth 1.212 so that it shows CPI> 1 meaning that expenses are smaller than the planned budget. For the schedule appearance index worth 0.889 so that it shows SPI < 1 means that the progress is experiencing a delay from the plan. Based on the results of the calculation of the costs required to complete the project amounted to Rp. 19,035,289,952 Research (Anggraini, Nisumanti, & Hadiyana, 2022).

The contract value for the Ahmad Yani Airport Access Flyover construction project is Rp. 149,394,103,000 with an implementation period of 46 weeks. Devision of work in week 37 amounted to -8.574% so that it is necessary to control efforts in terms of time and cost to be carried out properly when the work takes place. The method used in control is the earned value method where it will focus on the financing and delay of a project. Supporting data needed include RAB contract value, S curve and HSPK Semarang city in 2020. After doing the analysis, it was obtained that the costs incurred were lower than the planned costs, namely the value at CPI of 1.105 at a cost of around Rp. 135,258,208,412.97, while the implementation time was slower than planned, namely SPI of 0.893 with an estimated completion time of 52 weeks so that it was 6 weeks late. Research (Junaidi, Supriyadi, Candradewi, & Pradikdya, 2022)

The Margaluyu road improvement project phase II (DAK) has been completed by the implementing contractor on time with quality in accordance with the work contract. As the project progresses there is a CCO (Contyract Change Order) where there is a change in the value of the contract which results in more or less volume (Konior & Szóstak, 2021). So to overcome this, it is necessary to control a project against what has been planned using the earned value method. After analyzing the data, the calculation of Cost Variance in week 13 and week 21 is positive, so the cost is smaller than what was planned. But inversely proportional to the calculation of Schedule Variance, a negative calculation is obtained, so there is a delay in the implementation of the planned schedule. CPI value week 13 = 1.100 and week 21 = 1.100 while for SPI value week 13 = 0.746 and SPI week 21 = 1.000. Research (Rudiantoro, 2020).

The novelty of this research lies in its use of the Earned Value Management (EVM) method to track and evaluate the cost and schedule performance of the Laju Lor Village drainage channel construction project in Tuban Regency. While the EVM method is commonly used in large-scale construction projects, this research applies it to a smaller, more localized public infrastructure project. The integration of EVM with real-time project monitoring and cost control in a regional development context provides new insights into the challenges of managing construction projects in rural areas. Additionally, the study highlights how cost and schedule variances can be directly linked to project management decisions, offering a deeper understanding of the factors influencing construction delays and budget adherence.

Project Management

Project management is a short-term achievement that has been determined in a company which consists of elements of resource control planning, organizing, controlling and leading. The system used for the flow of activities is the vertical and horizontal approach.
Project management consists of various concepts including:

1. Based on its function, the definition of management includes controlling human resources, planning, organizing and leading a company.
2. In terms of planning and control, special processing methods and techniques are required because the management is short-term and specific.
3. System approach to management
4. Horizontal flow of activities in addition to vertical hierarchy

Earned Value Indicator

1. Actual Cost of Work Performance (ACWP)

   The actual cost of a project work that has been carried out is called ACWP cost. To get these costs can be obtained from the project financial report in the form of records of all expenses and overheads during project activities. So ACWP is the actual cost used in meeting the needs during the work in a certain period. In the project work of the Tahulu Village - Kapu Village Package 3 Road Improvement Project in Tuban Regency consists of direct and indirect costs. to obtain direct costs, it is obtained from the calculation of the unit

price of work contained in the contract Budget Plan (RAB) multiplied by the actual work weight in each weekly project report. Meanwhile, indirect costs can be obtained from the costs used to support the ongoing work of a project including administrative costs, field office costs, security and other supporters.

$$ACWP = Biaya\ Langsung + Biaya\ Tak\ Langsung$$

$$ACWP\ = \%\ Penyelesaian\ (Realisasi)$$

2. Budgeted Cost of Work Performance (BCWP)

   The point of view of the value of work that has been completed to carry out the work using the available budget is an indicator in the value of the results. Comparison of the ACWP and BCWP values will obtain a comparison of the costs that have been incurred by the work completed against the costs that must be incurred.

$$BCWP\ = \%\ Realisasi\ Kumulatif\ \times\ Nilai\ Kontrak$$

3. Budgeted Cost of Work Schedule (BCWS)

   BCWS will show the combination of cost, schedule, and scope of work, so that each element will be given a cost allocation and schedule that is used as a benchmark in the implementation of the work. The resulting figure will be seen in the budget of a work package that is classified and arranged based on the implementation schedule.

$$BCWS\ = \%\ Rencana\ Kumulatif\ \times\ Nilai\ Kontrak$$

The relationship between the actual progress achieved physically and the amount of budget that has been spent is known. So it can be calculated using the following formula:

$$Nilai\ hasil\ = (\%\ Penyelelesaian)\ x\ (Anggaran)$$

Earned Value Variance Analysis

Factors that indicate the progress and performance of project implementation can be calculated using these 3 indicators:

1. Cost variance (CV) is the difference between the value obtained after completing the work and the actual costs incurred during project activities. So the formula for calculating cost variation is obtained as follows:
   CV = BCWP - ACWP
2. Schedule variant (SV) is the difference between the value obtained after completing the work package and the budget value for a work package. So that the formula for calculating schedule variance is obtained as follows:
   SV = BCWP - BCWS
   The Erned Value variant has provisions that can be seen in:

Table 1. Terms of Analysis of Variance

Variants Schedule (SV)	Cost Variant (CV)	Description
Positive	Positive	Work is accomplished ahead of schedule and actual costs are higher. small than the budget
Zero	Positive	Work is done right schedule with more actual cost lower than the budget
Positive	Zero	The work was done budget and faster than expected. schedule
Zero	Zero	Work is done on time and within budget
Negative	Negative	Work was completed late and cost more than the actual cost.

		on budget
Zero	Negative	Work accomplished on schedule at actual cost exceeded budget
Negative	Zero	Work has been delayed with costs within budget
Positive	Negative	Work is completed ahead of schedule at a cost of actuals exceeded budget
Negative	Positive	Work has been delayed at a higher actual cost lower than budget

Project Cost Control

The implementation of Project Management affects the final result of a project's performance. Efforts to avoid or minimize the occurrence of a deviation during the project, there is a need for control. In the control stage, it is necessary to make systematic efforts to determine standards in accordance with planning, then form an information system, compare, then take efficient and effective actions to achieve goals and objectives.

Steps in project control include:

1. Goals must be defined in advance
2. In achieving goals, there needs to be appropriate standards and criteria.
3. Summarize the information system during the design stage, then carry out monitoring measures and report on the results of the work implementation.
4. Implementation of the resulting data collection
5. The provision of standards, criteria and objectives is used in the assessment that has been determined.

During the process of controlling the quantity and price factors, the cost components consisting of :

1. Engineering design activity costs
2. Procurement of materials and equipment
3. Main construction activities at field cost
4. Costs on subcontracting

Project Schedule Control

The information obtained related to the project activity schedule is a component of the results of planning so that the progress of a project can be known which consists of elements in a project including resources, personnel, equipment, materials and drasi a project. In conducting project evaluation, the planning stage must be carried out in more detail and in great detail to facilitate the evaluation stage. The progress of a project in the scheduling stage will occur various problems that arise when the project takes place. The plan on a project must be realistic so that it needs monitoring and updating to ensure resource allocation and duration decisions are in line with project objectives.

Benefits when doing project scheduling include:

1. A guideline for an activity regarding the time limit from the start of work to the end of work.
2. A means to systematically and realistically coordinate the prioritized allocation of resources and time.
3. A means of assessing the progress of the performance of a job in the project.
4. Minimize the use of excessive resources in the hope that the project is completed before the set time.
5. Work execution time is more certain

6. Tools in project control.

A construction work project can be in accordance with the target and specifications, it is necessary to choose a project scheduling method that is in accordance with the characteristics.

The main objective of this study is to assess the time and cost performance of the Laju Lor Village drainage project using the Earned Value Management (EVM) method, by analyzing key performance indicators such as Cost Variance (CV) and Schedule Variance (SV). The study aims to provide a comprehensive analysis of the causes of delays and cost overruns and offer practical solutions for future project management. The benefits of this research include the provision of actionable recommendations for project managers and contractors to improve efficiency, reduce delays, and optimize resource allocation. The findings will also help local government agencies improve their project planning and control measures, ultimately leading to better management of public infrastructure projects in Tuban Regency and similar regions.

METHOD

Research Subjects and Locations

The subject of the research was the construction of drainage channels in Laju Lor Village, Singgahan Subdistrict, Tuban Regency. The research location is in Singgahan Sub-district, Tuban Regency.

Data

Data collection must be done carefully so that the data obtained is complete and reliable. This research uses secondary data as the main source. Secondary data was obtained from the contractor in the form of relevant project documents. The documents became the main material for analysis in the study. The types of secondary data utilized include *time schedules* and weekly project reports.

Data Analysis Technique

a. The preparation stage by looking for theoretical references or literature studies (construction management, scheduling techniques, implementation cost budget analysis, and earned value method).
b. The data collection stage includes finding data on cost budget plans (RAB), time schedules, weekly and monthly reports and recapitulating cost calculations.
c. The data processing stage is by calculating BCWS, BCWP, ACWP. ACWP is the result of the project financial accountant, BCWS is calculated from the weight of the work against the cost budget plan. BCWP is calculated from the actual weight of all work against the contract value.
d. Calculating based on time is SV and calculating based on CV costs. SV is calculated from the difference between BCWP and BCWS. SPI is calculated from the ratio of BCWP to BCWS. ECD is calculated from the remaining work time divided by SPI and multiplied by the time traveled. CV is calculated from the difference between BCWP and ACWP.

RESULTS AND DISCUSSION

BCWS Calculation Analysis

BCWS is the cost that has been allocated to the work according to the budget set and scheduled in a certain period. The first step to calculate the BCWS value is to refer to the S curve of the project Time Schedule. This S curve shows the percentage of the work plan, where the BCWS value is obtained by multiplying the amount of the Cost Budget Plan (RAB) by the percentage of the plan. In this study, the calculation of BCWS is done in the following way.

Table 2. BCWS calculation

Sunday	Cumulative Plan	Budget	BCWS
1	0,38%	IDR 1,061,030,568	IDR 4,031,916
2	5,58%	IDR 1,061,030,568	IDR 59,205,506
3	6,52%	IDR 1,061,030,568	IDR 69,179,193
4	10,82%	IDR 1,061,030,568	IDR 114,803,507
5	16,36%	IDR 1,061,030,568	IDR 173,584,601

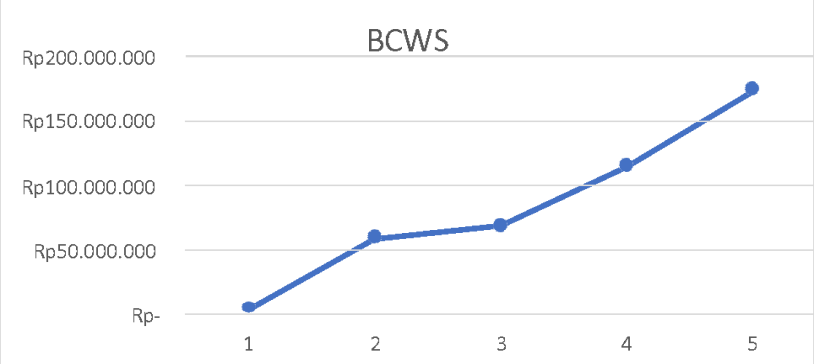


Figure 1. BCWS graph

Based on the table and figure, it is shown that the BCWS value increases over time from the first week to the fifth week. It peaks with a value of IDR 173,584,601.

BCWP Calculation Analysis

BCWP is the budgeted cost of work completed in a given time period. The first step to calculating the BCWP value is to check the weekly progress of the project. In the report, there is a percentage of actual progress in the field. BCWP is calculated by multiplying the percentage of actual progress in the field by the total planned cost budget for the work (BAC).

Table 3. BCWP Calculation

Sunday	Plan Cumulative		Budget	BCWP
1	0,00%	Rp	1.061.030.568	Rp..
2	1,11%	Rp	1.061.030.568	IDR 11,777,439.30
3	14,77%	Rp	1.061.030.568	IDR 156,714,214.89
4	14,84%	Rp	1.061.030.568	IDR 57,456,936.29
5	9,35%	Rp	1.061.030.568	IDR 99,206,358.11

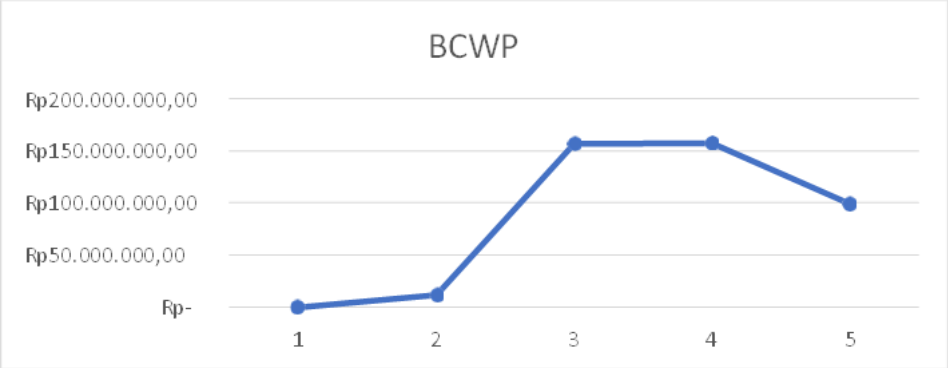


Figure 2. BCWP graph

Based on the table and figure, it is shown that the BCWS value fluctuates over time from the first week to the fifth week. It peaks with a value of IDR 156,714,214.89.

ACWP Calculation Analysis

ACWP is the actual cost incurred for work that has been carried out in a certain period of time. The ACWP calculation consists of direct costs (Direct Cosr) and indirect costs (Indirect Cost) of the project activities.

Table 4. ACWP Calculation

Sunday	ACWP	
1	Rp	-
2	Rp	9.990.000
3	Rp	105.880.000
4	Rp	107.530.000
5	Rp	78.480.000

The highest ACWP value is shown in week 4 with Rp. 107,530,000. Calculation of material costs, materials and workers' wages and indirect costs can be obtained from the contractor's financial department.

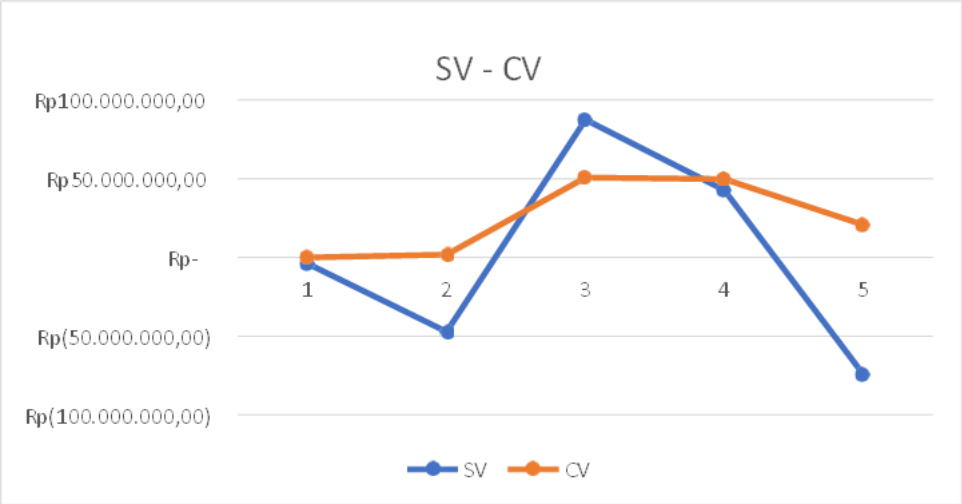
Schedule and Cost Variance Calculation Analysis

Schedule Variance is used to calculate the difference between BCWS and BCWP. Meanwhile, Cost Variance is the difference between the value obtained after completing the work item and the actual costs incurred during the project activities

Table 5. SV and CV Calculation Table

Sunday	SV		CV
1	-Rp	4.031.916,16	Rp...
2	Rp	47.428.066,39	IDR 1,787,439.30
3	Rp	87.535.021,86	IDR 50,834,214.89
4	Rp	42.653.428,83	IDR 49,926,936.29
5	-Rp	74.378.242,82	IDR 20,726,358.11

Comparison Chart of SV and CV



Through the table and figure it can be seen that, in the initial week, namely week 1, the SV variant value (-) and CV value (0), means that the work is slower than the schedule and the costs incurred are in accordance with the budget. Then, in week 5, the SV variant value (-) and CV value (-), means that the work is slower than the schedule and the costs incurred are greater than the budget.

Discussion

The findings of this study reveal the utility of the Earned Value Method (EVM) in analyzing cost and time performance for construction projects, particularly in the Laju Lor Village drainage channel project in Tuban Regency. The analysis demonstrates that while cost management was efficient, as indicated by a positive Cost Variance (CV) of Rp. 20,726,358.11, schedule adherence faced challenges, as reflected in the negative Schedule Variance (SV) of Rp. 74,378,242.82. These outcomes emphasize the critical need to balance both time and cost efficiency to ensure the successful completion of infrastructure projects.

The negative SV highlights delays in project execution, which can be attributed to various factors, including procurement delays, unforeseen weather conditions, and coordination inefficiencies among stakeholders. These delays suggest the need for better project planning, particularly in integrating contingency measures and risk assessments during the pre-construction phase. Enhanced coordination between contractors and suppliers, along with proactive scheduling adjustments, could help mitigate these challenges in future projects.

In contrast, the positive CV indicates effective cost control measures. The under-budget spending reflects prudent resource allocation and efficient material usage. However, the discrepancy between cost and schedule performance highlights the importance of aligning financial efficiency with project timelines. Strategies such as extending working hours, increasing labor resources, and incorporating real-time progress tracking could be explored to address this misalignment.

This study underscores the value of EVM as a comprehensive tool for project management. By integrating cost and schedule performance analysis, EVM provides actionable insights that enable project managers to implement timely corrective actions. For instance, real-time monitoring and regular evaluations can help identify variances early, ensuring that projects remain on track.

Moreover, the findings have broader implications for construction project management in rural areas, where limited resources and logistical challenges often pose constraints. The efficient application of EVM can improve accountability and resource utilization in public infrastructure projects, ultimately supporting regional development.

In conclusion, the application of EVM in this project demonstrates its effectiveness in identifying and addressing performance variances. By leveraging EVM, project stakeholders can enhance decision-making processes and achieve better outcomes. Future studies could explore integrating advanced technologies, such as digital dashboards or Building Information Modeling (BIM), to further enhance the precision and efficiency of cost and time management in similar projects.

CONCLUSION

The conclusion is the final part of a presented with a summary of the findings in the form of a main report obtained based on the analysis of the data that has been collected. This conclusion aims to provide the results of the research that has been carried out through a clear and systematic understanding, and can be used to answer research questions or test hypotheses that have been formulated in previous research before.

Based on the performance analysis that has been carried out, it can be concluded as follows At the end of the review week, namely week 5, the SV variant value is Rp 74,378,242.82 (-) and the CV value is Rp 20,726,358.11 (+), meaning that the work is behind schedule and the costs incurred are less than the budget.

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