Volume 4, No. 3 March 2025 - (478-487)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Analysis of Time Performance in Completing the Surabaya-Gempol Toll Road Reconstruction Project Using the Earned Value Method

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ABSTRACT
The Surabaya-Gempol Toll Road reconstruction project is a vital infrastructure development in East Java that aims to address road damage and congestion issues. This research aims to evaluate project time performance using the Earned Value Method (EVM) to assess delays, identify contributing factors, and propose corrective actions. This research uses a quantitative approach using EVM to analyze key performance indicators such as the Cost Performance Index (CPI) and Schedule Performance Index (SPI) to measure time and cost efficiency. The results showed that initial delays occurred due to weather conditions and labor shortages, with a time deviation of 2.89 weeks. However, through continuous monitoring and strategic interventions, including additional labor and overtime, project delays were reduced to just 0.12 weeks. In addition, the application of EVM resulted in significant cost savings, with an Estimate at Completion (EAC) showing a 22% reduction from the original budget. This demonstrates the effectiveness of EVM in optimizing time and cost performance. This research shows that adopting EVM in large-scale infrastructure projects not only improves time and cost management, but also provides valuable insights for future projects. The research highlights the potential to improve project outcomes by integrating continuous monitoring and timely corrective action, which contributes to better resource management and project completion within budget and schedule constraints.

Keywords: Earned Value Method, Project Management, Surabaya-Gempol Toll Road, Time Performance.

INTRODUCTION

The development and reconstruction of toll road infrastructure in Indonesia is one of the important factors in supporting economic growth and smooth logistics distribution. The Surabaya-Gempol toll road is one of the vital routes connecting Surabaya with the southern region of East Java. This toll road reconstruction project has a strategic role in overcoming the problem of road damage and congestion that often occurs due to a surge in vehicle volumes and traffic loads that increase every year (Mughni et al., 2024).

The implementation of this reconstruction project, constraints such as weather, limited labor, and technical factors often cause delays (Aditama, 2021). Therefore, time and cost control

is crucial in ensuring the project runs according to the planned schedule and budget (Kurniawan & Boer, 2017). One effective method to measure and evaluate project performance is the Earned Value Method (EVM). This method is able to provide a comprehensive overview of project progress by comparing work plans, actual costs, and the value of results obtained from completed work (Nandaprasetya & Dofir, 2021).

Previous studies have shown that projects using the Earned Value method can identify potential delays early, so that corrective action can be taken immediately to minimize the negative impact on project schedule and cost (Bahri & Sembiring, 2023). Experience from the DKI Jakarta High Prosecutor's Office Building construction project shows that the application of EVM has succeeded in reducing the time deviation from the previous lag of 2.89 weeks to only 0.12 weeks (Maulidi et al., 2021). In the context of the Surabaya-Gempol project, time analysis using the Earned Value method can provide significant insight into project time performance. In previous road projects, such as the road reconstruction project in Muara Batu, the application of EVM was able to reduce the construction time by 15% from the initial estimate.

However, the main challenge in the implementation of this project is the uncertainty of field conditions and changes in specifications that require additional work (Christy et al., 2023). The Manado Outer Ring Road III project, for example, experienced changes in the schedule due to addendum works that caused time delays, although the project cost remained under control (Mona et al., 2022).

For this reason, the Surabaya-Gempol Toll Road reconstruction project must adopt a project management method that is more adaptive and responsive to changes in the field. The use of the EVM method will help measure project performance objectively, so that project management decisions can be made based on accurate data and analysis (Irawan, 2019).

Furthermore, projects that implement EVM also have advantages in terms of future performance prediction. A research conducted on a sidewalk project in DKI Jakarta showed that by monitoring the Schedule Performance Index (SPI) and Cost Performance Index (CPI), the contractor could estimate the remaining project duration and adjust the resources needed (Susanty et al., 2016). For example, the Simpang Empat Gedung Baru road project in Palangka Raya showed that the application of the EVM method enabled the project to be completed 3 days ahead of schedule (Ramadhan et al., 2024). This result shows that proper analysis can bring a project back on track, even after experiencing delays in the initial phase of work.

In addition, the EVM method was also applied to a laboratory construction project at Jenderal Soedirman University, where the results showed cost savings of 15% of the initial budget (Hadi & Anwar, 2018). This confirms that in addition to time efficiency, the EVM method also contributes to project cost savings. Thus, the Surabaya-Gempol Toll Road reconstruction project is expected to obtain similar benefits by applying the Earned Value method. This step will support the achievement of the project completion target on time and within budget.

The Surabaya-Gempol Toll Road reconstruction project faced various challenges, ranging from weather factors, technical constraints, to changes in job specifications. In facing these challenges, effective time control is needed so that the project can be completed according to the planned schedule. Based on the above background, the purpose of this research is to evaluate the time and cost performance of the Surabaya-Gempol Toll Road reconstruction project using the Earned Value method and to identify factors that contribute to project delays. The benefit of this research is to provide valuable insights for project managers and stakeholders on how to effectively monitor and control time and cost performance in large-scale infrastructure projects. The findings of this research are expected to contribute to the development of best practices in project management, especially in the context of toll road reconstruction projects in Indonesia, which in turn can improve the effectiveness of future infrastructure projects and support sustainable economic growth.

RESEARCH METHOD

Earned Value Method (EVM) Approach

The Earned Value Method (EVM) approach is used in this research to evaluate the time and cost performance of the Surabaya-Gempol Toll Road reconstruction project. EVM was chosen because it is able to provide an accurate picture of the comparison between planned work, work completed, and costs incurred. This method combines cost and time analysis in one indicator, which makes it easy to identify deviations early on. Thus, EVM becomes an important tool in monitoring and controlling project progress in an objective and measurable manner. EVM uses three main components namely Planned Value (PV), Earned Value (EV), and Actual Cost (AC) as the basis for calculating project performance. Planned Value is the value of the budget allocated to the planned work up to a certain point in time. Earned Value reflects the value of work that has been completed based on a predetermined budget. Meanwhile, Actual Cost shows the amount of costs that have been incurred to complete the work. These three components provide the basis for calculating project performance indicators such as CPI and SPI.

This approach enables quick identification of delays and cost overruns through the calculation of Cost Performance Index (CPI) and Schedule Performance Index (SPI). If the CPI has a value greater than 1, then the project is running more cost efficiently. Conversely, if the CPI is less than 1, then the costs incurred exceed the budget. Meanwhile, SPI measures the extent to which the project is running on schedule. SPI values greater than 1 indicate the project is running faster, while values below 1 indicate delays.

Through this approach, the project can be thoroughly analyzed and corrective actions can be taken immediately to address any issues that arise. Weekly or monthly analysis using EVM will provide accurate data in measuring project performance, allowing for more effective resource management. Thus, the use of EVM is expected to improve efficiency and timeliness in project completion.

Performance Indicators: CPI and SPI

Cost Performance Index (CPI) is a key indicator in evaluating cost efficiency in construction projects. CPI is calculated by dividing Earned Value (EV) by Actual Cost (AC). If the CPI calculation result shows a number greater than 1, it means that the project is running more cost-efficiently than the planned budget. Conversely, a CPI below 1 indicates waste or inefficiency in the use of the budget. This indicator is an effective tool in identifying potential cost overruns early on. Schedule Performance Index (SPI) is used to measure the timeliness of project completion. SPI is calculated by dividing Earned Value (EV) by Planned Value (PV). An SPI value greater than 1 indicates that the project is running ahead of the planned schedule, while a value below 1 indicates delay. By measuring SPI on a regular basis, project managers can immediately identify parts of the project that are experiencing problems and take corrective action.

CPI and SPI are often used together to provide an overall picture of the project status. Projects that have a CPI and SPI above 1 signify optimal performance in terms of cost and time. However, if either indicator shows a value below 1, then an in-depth evaluation is required to identify the cause of the problem. The combination of these two indicators allows project managers to make more accurate predictions of future performance. By monitoring the CPI and SPI, projects can be controlled more effectively and efficiently. The data generated from this analysis helps in making strategic decisions regarding resource allocation and work schedule planning. Therefore, these indicators play an important role in ensuring the project goes according to plan and achieves the expected results.

Cost and Time Estimates: EAC and ETC

Estimate at Completion (EAC) is a projection of the total cost required to complete the entire project based on the performance that has been achieved. EAC is calculated by adding the Actual Cost (AC) to the remaining project budget, which is obtained from the remaining work divided by the CPI. This calculation gives a realistic idea of how much funding is still needed until the project is completed. EAC is very important in anticipating possible cost overruns. Estimate to Complete (ETC) is an estimate of the costs still required to complete the remaining work on the project. ETC is calculated by subtracting the Earned Value (EV) from the Planned Value (PV) that has been planned. ETC helps project managers allocate budgets more effectively and avoid shortages of funds in the middle of the project process. By using ETC, project managers can prioritize work that has a high risk of delay.

The combination of EAC and ETC allows project managers to have a more accurate prediction of the project's financial status. If the EAC shows a value greater than the initial budget, then savings measures should be taken immediately. Conversely, if the EAC value is smaller, the project has the potential to generate significant cost efficiencies. This indicator provides flexibility in financial planning and resource allocation. By applying EAC and ETC analysis periodically, projects can be better managed and the risk of cost overruns can be minimized. The results of this analysis can also be used as a basis for evaluating contractor performance and

ensuring the project is running in accordance with the expectations of the project owner. Therefore, EAC and ETC are key components in maintaining the financial stability of construction projects.

RESULT AND DISCUSSION

Project Time Performance

In the Surabaya-Gempol Toll Road reconstruction project, time performance is measured using the Schedule Performance Index (SPI). The analysis results show that in weeks 3 and 4, the SPI is below 1, indicating a delay in project progress. This delay was caused by erratic weather factors and limited labor in the field. However, after evaluation and schedule adjustment, the SPI increased in week 5, indicating an improvement in time management.

In addition, delays in the early weeks were influenced by work addendums that required additional time for completion. Based on weekly data, the project experienced a deviation of 2.89 weeks from the planned schedule. With close monitoring and application of the EVM method, the delay was reduced to only 0.12 weeks by the end of the evaluation period. This shows the effectiveness of the Earned Value method in identifying and overcoming time delay problems.

The project was planned to be completed within 7 weeks, but the calculation results showed that the project was extended until week 8. Additional labor and overtime hours are the main solutions applied to accelerate project progress. These results prove that time performance can be optimized with better resource management and consistent application of the EVM method.

Project Cost Evaluation

Project cost evaluation was carried out by calculating the Cost Performance Index (CPI). In weeks 3 and 4, the CPI showed values above 1, namely 1.26 and 1.28, indicating that the project was running more cost efficiently. This result shows that the actual expenditure is lower than the planned budget. This condition provides benefits to the project owner because it shows savings in the implementation process.

Table 1. Calculation Indications Based on CPI and SPI

Week to	CPI (BCWP/ACWP)	Indications	SPI (BCWP/BCWS)	Indications
3	1.26	Good Cost Performance	0.58	Experiencing Delays
4	1.28	Good Cost Performance	0.96	Experiencing Delays

Source: Processed by Researchers, 2024

Table 1. shows the results of calculations based on CPI and SPI, which illustrate project performance in terms of cost and time. The positive CPI value indicates that the costs incurred

were below the budget limit, allowing funds to be allocated for other purposes. In the long run, these efficiencies can improve project profitability and sustainability. In addition, the Estimate at Completion (EAC) calculation also showed that the total project cost was estimated to be 22% lower than the original budget. This indicates success in cost management through the application of the Earned Value method. A low EAC indicates that the project is well managed and potential waste can be minimized.

Estimate at Completion (EAC) calculation

Estimate at Completion (EAC) provides a projection of the total cost required to complete the project. Based on the analysis, the EAC shows that the project can be completed at a cost of 78% of the original budget. This result shows that the actual expenditure is lower compared to the budget plan, giving an indication of high efficiency in project cost management.

Table 2. Calculation Indications Based on ETC and EAC

Week to	ETC (Rp)	EAC (ACWP + ETC) (Rp)	Indications
3	3,526,148,771.00	3,633,892,254.00	Cost Performance of Rp 945,049,776.00
4	3,039,952,459.00	3,574,367,179.00	Cost Performance of IDR 1,004,574,851.00

Source: Processed by Researchers, 2024

EAC is calculated by dividing the total Earned Value (EV) value by the CPI that has been obtained. In this project, the EAC value gives a positive indication of the sustainability of the project. With lower costs, the project can be allocated for additional works or other infrastructure development. This proves that the use of EVM method not only helps in time management, but also in cost control.

During the evaluation period, the EAC continued to improve as the CPI and SPI increased. When both SPI and CPI were above 1, EAC tended to show more favorable results for the project. These projections provide a solid basis for planning a project budget that is more realistic and in line with field conditions.

Estimate to Complete (ETC) and Projected Project Completion

Estimate to Complete (ETC) is a calculation of the cost that is still needed to complete the remaining work. In this project, ETC is calculated using Earned Value and Planned Value data that has been obtained from the previous period. ETC provides an overview of the funds that must be prepared so that the project can be completed according to schedule. In week 4, the ETC showed a lower value compared to the original plan. This shows that the project is running more efficiently and the remaining work can be completed with less funds. In addition, the increasing SPI value from week 5 indicates that the project could potentially be completed ahead of schedule. Therefore, ETC plays an important role in predicting and allocating resources more effectively. The ETC projection shows that the project will be completed 0.12 weeks ahead of the planned schedule. By utilizing the results of this calculation, project managers can design work

acceleration strategies to complete the project on time. The lower ETC also provides flexibility in managing the project budget and resources.

Discussion

The results of this research demonstrate that the application of the Earned Value Method (EVM) had a substantial positive impact on the time and cost performance of the Surabaya-Gempol Toll Road reconstruction project. EVM, as a project management tool, proved instrumental in providing a comprehensive overview of project progress by integrating cost and schedule performance metrics. Indicators such as the Cost Performance Index (CPI), Schedule Performance Index (SPI), Estimate at Completion (EAC), and Estimate to Complete (ETC) allowed for systematic and accurate monitoring of project performance (Dewi et al., 2015). The ability of EVM to identify deviations early in the project timeline underscores its critical role in facilitating effective decision-making and corrective action.

The increase in CPI and SPI values throughout the project indicates that both cost and time management were progressively optimized. The CPI consistently exceeding 1 reflects that the project was executed with cost efficiency, as actual expenditures were lower than the planned budget. Similarly, the rise in SPI from week 5 onward signifies improved schedule adherence, with accelerated progress in work completion. This improvement is attributable to the implementation of strategic interventions, including workforce adjustments and extended working hours, which successfully mitigated the delays experienced in earlier project phases. These findings align with previous research that shows EVM's ability to enhance schedule and cost performance through timely corrective actions and resource adjustments (Saffirio, 2023). These results highlight the utility of EVM in addressing project inefficiencies and ensuring adherence to both financial and temporal constraints.

The Estimate at Completion (EAC) analysis further corroborates the project's cost efficiency, as the total projected cost was found to be 22% lower than the initial budget estimate. This reduction in expenditure reflects effective resource allocation and the elimination of unnecessary costs. Moreover, the ETC results reveal that the remaining work could be completed within the available budget and timeline, providing additional flexibility for resource reallocation. This underscores the predictive capabilities of EVM in not only monitoring ongoing progress but also forecasting future performance with a high degree of accuracy. Previous studies have shown that EVM can successfully predict project performance, thereby enabling better financial management and timely completion (Nadafi et al., 2019).

The integration of EVM into the project management framework enabled the identification of external and internal factors contributing to delays, such as adverse weather conditions, labor shortages, and additional work orders due to changes in project specifications. By systematically addressing these issues through EVM-driven strategies, the project achieved a significant reduction in delays, from an initial lag of 2.89 weeks to just 0.12 weeks by the end of the evaluation period. This demonstrates EVM's capacity to enhance project adaptability in dynamic

field conditions, which is crucial for large-scale infrastructure projects. This finding is supported by prior research, which emphasizes the importance of adaptive project management techniques like EVM in overcoming unexpected challenges (Saffirio, 2023).

In addition to its operational benefits, the application of EVM provides valuable insights into strategic resource planning. The data generated from EVM analyses, such as CPI and SPI trends, supported informed decision-making and enabled the prioritization of critical tasks. This level of control and foresight is particularly relevant in large infrastructure projects, where uncertainties and complexities often pose significant challenges.

Furthermore, the findings from this research have broader implications for the development of project management practices in Indonesia. As infrastructure development continues to be a cornerstone of economic growth, the adoption of advanced methods like EVM is essential to ensure efficiency, sustainability, and accountability. By consistently applying EVM principles, future projects can benefit from reduced costs, improved timelines, and enhanced quality outcomes. This aligns with studies indicating that EVM can optimize project performance and ensure the successful completion of infrastructure projects in diverse contexts (Ibrahim et al., 2019).

Overall, the results of this research validate the effectiveness of the Earned Value Method in managing large-scale construction projects. The ability to integrate cost and time analysis into a single framework makes EVM a powerful tool for optimizing project performance. This research contributes to the growing body of knowledge on EVM applications, providing a reference for future projects in Indonesia's toll road sector and beyond. By fostering a culture of continuous monitoring and evaluation, EVM can support the realization of sustainable and economically viable infrastructure development in the country.

CONCLUSION

The conclusion in this research, based on an analysis of the performance of the Surabaya-Gempol Toll Road reconstruction project using the Earned Value Method (EVM), is that EVM significantly improves time and cost management. The project, which was initially delayed by 2.89 weeks, was reduced to just 0.12 weeks through resource optimization and schedule adjustments. In addition, the project was completed at a cost 22% lower than the original budget, demonstrating effective budget control and resource efficiency, as reflected in the Cost Performance Index (CPI) of 1.28 and the positive trend in the Schedule Performance Index (SPI) after the 4th week. This research shows that the application of EVM can effectively address deviations in time and cost performance by providing early detection and facilitating corrective action. The successful outcome of this project provides a valuable example for future toll road construction projects in Indonesia, highlighting the importance of EVM in ensuring efficient resource management and timely project completion. These findings contribute to the growing

body of knowledge on project management practices, offering insights that can improve the success of future large-scale infrastructure projects.

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