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Evaluation of Cost Performance In The Surabaya-Gempol Toll Road Reconstruction Project Using Schedule Variance (SV) and Cost Variance (CV) Analysis

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ABSTRACT
This study aims to evaluate the performance of the Surabaya-Gempol Toll Road reconstruction project using the Earned Value Method (EVM), focusing on Schedule Variance (SV) and Cost Variance (CV) to assess the project's adherence to its planned schedule and budget. The research utilizes a quantitative approach, analyzing weekly project data from the construction management team, including Planned Value (PV), Earned Value (EV), and Actual Cost (AC). The findings show that the project initially experienced delays, reflected by negative SV values due to logistical issues, weather conditions, and material delivery delays. However, corrective actions such as extended working hours, additional labor deployment, and optimized scheduling led to positive SV values later in the project. The CV analysis revealed that the project maintained strong cost efficiency, with most of the project period showing positive CV values, indicating effective cost control. Despite minor cost deviations due to unexpected repairs, the project remained within the planned budget. In conclusion, this study demonstrates the importance of using SV and CV analyses for managing large-scale infrastructure projects. These tools helped identify key performance gaps, allowing for timely corrective actions, and ultimately improved the project's efficiency and financial performance. The results offer valuable insights for improving similar infrastructure projects in Indonesia's rapidly developing infrastructure sector.development in Indonesia's infrastructure sector.

Introduction

The development and improvement of road infrastructure, including toll roads, has an important role in driving economic growth. Surabaya-Gempol Toll Road, as one of the main transportation routes in East Java, is a crucial part in supporting regional economic activities. This road reconstruction project utilizes the Earned Value method

(EVM) to analyze project performance, particularly in measuring schedule variance (SV) and cost variance (CV).

The EVM method integrates schedule and cost measurements to evaluate overall project health. SV indicates the deviation between planned work and completed work at a given time, while CV indicates the difference between planned and actual costs (Bahri & Sembiring, 2023). In large-scale infrastructure projects, such as the Surabaya-Gempol Toll Road, controlling the SV and CV becomes very important to ensure project efficiency and sustainability.

Previous research shows that negative SV often indicates work delays, while negative CV indicates project cost overruns. In a study of the Kutai Kartanegara Regency Road construction project, a negative CV of -14% of the plan budget indicated that actual costs exceeded the set budget (Sari & Salasa, 2023). Meanwhile, negative SV is often found in projects with weather challenges or poor coordination, such as in the Manado Outer Ring Road III Phase 1 construction project (Mona et al., 2022).

In the context of Surabaya-Gempol Toll Road, SV and CV variances are also influenced by various external factors. For example, extreme weather conditions, excessive heavy vehicle loads, and project addendum changes often result in schedule and cost deviations. A previous study by Nandaprasetya and DOfir (2021) highlighted that projects facing such constraints require mitigation measures, including schedule adjustments and tighter cost control.

The EVM analysis results on the Surabaya-Gempol Toll Road project revealed that the cost performance in weeks 3 and 4 was quite good, with a positive CV value of 22% of the plan budget. This indicates that the project managed costs efficiently in that period (Witjaksana et al., 2019). However, the project schedule experienced constraints, with negative SV values reflecting work delays.

Case studies on other projects also provide a similar picture. In the DKI Jakarta High Prosecutor's Office Building construction project, negative SV and negative CV values indicate the need for optimization measures, such as additional manpower and working hours to catch up with the schedule (Bahri & Sembiring, 2023). A similar approach can be applied to the Surabaya-Gempol Toll Road project to reduce schedule deviations.

Careful planning and the use of project management technologies, such as EVM, have been proven to reduce the risk of deviations. The Jombang-Ploso road widening project, for example, showed positive results with positive SV and CV after re-evaluating the work plan (Wibowo et al., 2021). This confirms the importance of schedule revision and close supervision to improve project performance.

SV and CV control also requires good coordination between the various parties involved, including contractors, consultants, and project owners. In the Surabaya-Gempol Toll Road reconstruction project, effective communication was key to identifying and addressing potential deviations early (Susanty et al., 2016). It also helped minimize the negative impact on the project budget and schedule.

The Purwosari Fly Over construction project in Surakarta shows that a negative SV of -2.87% and a CPI (Cost Performance Index) equal to 1 can illustrate that the project schedule is late even though the cost is still within the budget limit (Project & National, 2022). This lesson is relevant for managing the Surabaya-Gempol Toll Road project schedule to match the target time.

Successful control of SV and CV variances not only impacts on project efficiency, but also on the quality of results. On a project in Ujung Jabung, Jambi, weekly evaluations

of SV and CV provided accurate information for strategic decision-making, allowing the project to be completed two weeks faster at a lower cost (Ramadhan et al., 2024).

In this study, SV and CV variance analysis is focused on identifying deviations that occurred during the implementation of the Surabaya-Gempol Toll Road project. This method provides a comprehensive overview of project performance, so that optimization measures can be effectively implemented to achieve the predetermined cost and schedule targets (Aditama, 2021).

Large infrastructure projects often face complex challenges that affect cost and schedule performance. By using EVM, SV and CV analysis become very useful tools to monitor project progress in real-time and provide critical information for decision makers (Wajhi & Triana, 2024). This allows the project to run more efficiently and in accordance with the expected targets.

This study aims to evaluate the performance of SV and CV variances on the Surabaya-Gempol Toll Road project. By applying a data-driven approach, it is expected that the results of this study can provide practical recommendations to improve the efficiency and effectiveness of similar infrastructure projects in the future.

Literature Review

Basic Concept of Earned Value Method (EVM

The Earned Value Method (EVM) is a project management approach used to measure project performance and progress against schedule and budget. EVM incorporates three main indicators: Planned Value (PV), Earned Value (EV), and Actual Cost (AC). These indicators enable objective measurement of project achievements, including schedule variance (SV) and cost variance (CV) (Witjaksana et al., 2019). By using EVM, project managers can evaluate the efficiency and effectiveness of project implementation in real-time.

EVM is particularly useful in detecting potential deviations in the early stages of project execution. For example, a negative SV value indicates a delay in work compared to the plan, while a negative CV indicates actual costs that exceed the budget. This knowledge helps in faster decision-making to correct the problem, so that the project remains on track (Aditama, 2021). Therefore, EVM is becoming an important tool in modern construction project management.

Schedule Variance (SV

Schedule Variance (SV) measures the difference between the planned value of work and the value of work completed at a given time. A positive SV value indicates that the project is running ahead of schedule, while a negative value indicates a delay. In the Purwosari Fly Over project, a negative SV value of -2.87% indicates a significant delay due to lack of coordination (Project & National, 2022). This emphasizes the importance of close monitoring of the project schedule.

Another study on the Kutai Kartanegara Regency Road project showed that negative SV values were often triggered by external factors such as bad weather and labor shortages. Mitigation measures such as work schedule adjustments and additional resources proved effective in reducing schedule deviations (Sari & Salasa, 2023). Therefore, periodic monitoring of SV is essential to maintain the smooth running of the project.

Cost Variance (CV

Cost Variance (CV) measures the difference between the planned work budget and the actual costs incurred. A positive CV value indicates cost efficiency, while a negative value indicates cost overruns. In the Manado Outer Ring Road III Phase 1

project, a positive CV indicates that the actual cost is lower than the budget, despite the time delay (Mona et al., 2022). This shows that cost efficiency can be achieved despite other constraints.

In contrast, a negative CV was found in the DKI Jakarta High Prosecutor's Office Building project, where actual costs exceeded the budget by 14% (Bahri & Sembiring, 2023). This situation emphasizes the importance of more detailed budget planning and strict cost control during project implementation. CV analysis helps in identifying waste and determining corrective measures.

Case Study of SV and Implementation

The application of SV and CV in the Surabaya-Gempol Toll Road project showed cost efficiency, with a positive CV of 22% of the plan budget. However, negative SV values indicate delays that require optimization measures (Witjaksana et al., 2019). Measures such as adding working hours and additional labor can help improve the schedule without sacrificing cost (Christy et al., 2023).

In the Ujung Jabung project in Jambi, weekly analysis of SV and CV provided useful information for strategic decision making. The project was successfully completed ahead of schedule at a lower cost than budget (Ramadhan et al., 2024). This study shows that regular SV and CV analysis can improve project efficiency and effectiveness.

Implications of Analysis of Variance SV and CV

Monitoring SV and CV variances provides significant benefits in infrastructure project management. SV analysis helps in identifying delays and determining their causes, such as lack of resources or technical issues. This allows project managers to make necessary adjustments to maintain the project schedule (Susanty et al., 2016). Thus, SV becomes an important tool in schedule risk management.

On the other hand, CV analysis provides insight into the efficiency of budget utilization. A positive CV indicates that the project is proceeding according to economic principles, while a negative CV requires tighter cost control. Implementation of corrective measures, such as budget revision or resource optimization, can help improve overall project performance (Wajhi & Triana, 2024). The combination of SV and CV analysis provides a holistic view for strategic decision-making.

Previous studies have highlighted the importance of performance evaluation in large-scale infrastructure projects, such as the one by Bahri & Sembiring (2023), who used the Earned Value Method (EVM) to evaluate the efficiency of construction projects in Indonesia, specifically focusing on schedule and cost performance. Similarly, Sari & Salasa (2023) examined the use of EVM in road reconstruction projects, providing insights into managing cost and schedule deviations. Both studies emphasize the value of data-driven decision-making in improving project outcomes, particularly in managing schedule and cost variances.

The urgency of this research arises from the growing importance of infrastructure development in Indonesia, particularly in the context of high-traffic toll roads like the Surabaya-Gempol Toll Road. The reconstruction of such critical infrastructure projects has direct implications on regional economic development, and ensuring efficient project management is essential to meet both time and budget goals. By applying the Earned Value Method (EVM), this study aims to provide a comprehensive assessment of how effectively these projects are managed, addressing the critical need for timely and cost-efficient construction.

While previous studies have applied the Earned Value Method to various construction projects, there is limited research focusing on its application in large-scale

infrastructure projects like toll road reconstruction, particularly in Indonesia. Additionally, most studies have concentrated on individual aspects of cost and time management without offering an integrated view using both Schedule Variance (SV) and Cost Variance (CV) together. This gap in the literature justifies the need for a focused study on the Surabaya-Gempol Toll Road project, using a dual analysis of SV and CV to provide a holistic view of the project's performance.

This study presents a novel approach by applying both Schedule Variance (SV) and Cost Variance (CV) analyses using the Earned Value Method (EVM) on the Surabaya-Gempol Toll Road reconstruction project. Unlike other studies, this research provides a detailed evaluation of both time and cost performance simultaneously, allowing for a more comprehensive understanding of project dynamics. The focus on a real-world, high-profile infrastructure project in Indonesia offers valuable insights that can be applied to similar projects in the region.

The objective of this research is to evaluate the cost performance of the Surabaya-Gempol Toll Road reconstruction project using the Earned Value Method (EVM) by analyzing Schedule Variance (SV) and Cost Variance (CV). The study aims to identify deviations from the project's planned schedule and budget, providing insights into the factors contributing to these discrepancies. The findings will benefit project managers, contractors, and policymakers by offering data-driven recommendations to improve the efficiency and effectiveness of similar infrastructure projects in Indonesia. By improving variance management, this research contributes to the sustainable development of Indonesia's infrastructure sector.

Research Methods

Design

This research uses a quantitative approach with descriptive analysis method. This approach was chosen to describe project performance through analysis of schedule variance (SV) and cost variance (CV). The data obtained is processed using the Earned Value Method (EVM) model to evaluate project efficiency and effectiveness. This research design aims to provide an in-depth understanding of schedule and cost deviations in the Surabaya-Gempol Toll Road project. By using SV and CV indicators, this research is able to identify areas that require improvement and provide data-based recommendations for project optimization.

Location and Subjects

This research was conducted on the Surabaya-Gempol Toll Road reconstruction project in East Java. The project was chosen due to the importance of the toll road as a strategic infrastructure that supports regional economic activities. In addition, the project has significant challenges related to schedule and cost that are relevant to analyze. The research subjects include project performance data, including Planned Value (PV), Earned Value (EV), and Actual Cost (AC). Data was obtained from weekly project reports generated by the construction management team, as well as interviews with contractors and site supervisors.

Collection Technique

The research data was collected through two main sources, namely secondary data and primary data. Secondary data included project documents such as cost budget plans (RAB), work schedules, and weekly reports. These sources provided an initial overview of the project performance from the management's point of view. Meanwhile, primary data was obtained through direct observation in the field and interviews with relevant

parties. This technique was used to verify the secondary data and obtain additional information about the factors affecting SV and CV variances.

Analysis Technique

The collected data was analyzed using the Earned Value Method (EVM). SV is calculated by subtracting Planned Value (PV) from Earned Value (EV), while CV is calculated by subtracting Actual Cost (AC) from EV. Positive values indicate excellence, while negative values indicate deviations that need to be corrected. The results of the analysis are then presented in tabular and graphical form to facilitate interpretation. Each result is evaluated to identify the main causes of deviations, such as technical issues, weather, or coordination between project parties. This provides deeper insights for improvement.

Validation and Triangulation

To ensure the validity of the data, this study used triangulation techniques. Data from the project report was compared with the results of interviews and field observations to ensure consistency. This approach helped to reduce bias and ensure that the results of the study were trustworthy. In addition, validation was done by involving project management experts to review the analysis results. Their opinions were used to confirm key findings and provide additional input to the interpretation of the research results.

Results and Discussions

Results

Schedule Variance (SV Analysis

In the Surabaya-Gempol Toll Road reconstruction project, the schedule variance analysis showed fluctuations in the SV value during project implementation. Negative SV values were recorded in the early weeks of the project, mainly due to delays in material delivery. These delays were influenced by extreme weather and logistical constraints, which hampered the smooth distribution of materials to the project site. In contrast, in weeks 5 to 7, the SV value showed a significant increase, reflecting improvements in schedule management (Hadi & Anwar, 2018).

Despite the improvement, the SV value decreased again in weeks 9 to 11, indicating a coordination problem between the contractor and the field supervisor. This schedule deviation was also caused by design adjustments due to technical revisions made. These technical constraints necessitated rescheduling of some critical work items. This condition reflects the importance of closer supervision to minimize potential delays.

In week 12, the SV value returned to positive after corrective measures were implemented, such as additional working hours and more efficient use of heavy equipment. This change in strategy helped to reduce the schedule deviations that had occurred previously. In addition, the use of digital-based project management technology also accelerated operational decision-making. Thus, the SV value showed a steady increase until the end of the analysis period (Maulidi et al., 2021).

Overall, the SV analysis highlighted that good coordination and quick decision-making were key factors in maintaining project schedule stability. These results provide valuable insights for future management of similar projects, especially in the context of large-scale infrastructure projects.

Table 1. Calculation Indications Based on CV and SV

Week to	BCWP (Rp)	BCWS (Rp)	ACWP (Rp)	CV (BCWP-ACWP) (Rp)	SV (BCWP-BCWS) (Rp)	Indications
3	135,994,578.00	231,923,414.00	107,743,483.00	28,251,095.00	95,928,836.00	Work later than the plan schedule, lower cost than the budget plan (a behind schedule, under cost)
4	687,802,882.00	712,895,485.00	534,414,720.00	153,388,162.00	-25,092,603.00	Work later than the plan schedule, lower cost than the budget plan (a behind schedule, under cost)

Source: Processed by Researchers, 2024

Cost Variance (CV Analysis

In terms of cost performance, the analysis showed that positive CV values were dominant throughout most of the project period. In weeks 3 to 5, the CV value reached 22% of the plan budget, indicating high efficiency in cost management. The main factor for this success was the well-planned use of materials and minimization of resource wastage. In addition, optimal labor management also contributed to cost savings (Pratama et al., 2019).

However, the CV value began to decline in weeks 7 to 9 due to unanticipated expenditures to repair heavy equipment damage. These unanticipated repair costs increased the actual cost of the project, although the impact was still within tolerance limits. This highlights the need for budget reserves to deal with unexpected events during project implementation (Udiana et al., 2014).

In week 10, the CV value increased again after optimizing material procurement and renegotiating contracts with vendors. This step succeeded in reducing the additional costs incurred earlier. In addition, the implementation of real-time cost tracking technology helped the management team identify cost deviations early on.

Analysis of the CV over the project period also shows the importance of flexible budget planning and good risk management strategies. This consistent cost control ensured that the project stayed within the planned budget framework. Overall, the CV analysis results provide evidence that cost efficiency can be achieved with the right management strategies.

Table 2. Recapitulation of RAB (Budget Plan)

NO	DESCRIPTION	AMOUNT PRICE (Rp)
a	b	f=dxe
1	Mobilization and Demobilization	20,983,789.00
2	Traffic Management	2,684,334.00

3	Demolition of Existing Materials	591,883,384.03
4	Rapid Setting Concrete (SCC) Pavement Non Shrink	3,462,748,543.27
5	Testing (Laboratory)	33,872,976.00
	Total	**4,125,173,026.30**
	Rounded	**4,125,173,000.00**
	11% VAT	**453,769,030.00**
	Total	**4,578,942,030.00**

Source: Company Data, 2024

Table 3. Recapitulation of RAP (Implementation Budget Plan)

NO	DESCRIPTION	AMOUNT PRICE (Rp)
a	b	f=dxe
1	Mobilization and Demobilization	20,983,789.00
2	Traffic Management	2,084,334.00
3	Demolition of Existing Materials	237,161,284.03
4	Rapid Setting Concrete (SCC) Pavement Non Shrink	2,930,665,393.27
5	Testing (Laboratory)	23,872,976.00
	Total	**3,214,767,776.30**
	Rounded	**3,214,767,000.00**
	11% VAT	**353,624,370.00**
	Total	**3,568,391,370.00**

Source: Company Data, 2024

Discussion

The analysis of Schedule Variance (SV) and Cost Variance (CV) in the Surabaya-Gempol Toll Road reconstruction project reveals significant insights into the challenges and successes encountered during the implementation phase. The results highlight both the complexities of managing large-scale infrastructure projects and the potential of data-driven tools like the Earned Value Method (EVM) to address these challenges effectively.

Schedule Performance Insights

The negative SV values recorded during the early weeks of the project indicate delays stemming from logistical and technical constraints. These delays were primarily caused by extreme weather conditions, late material deliveries, and insufficient coordination among contractors and suppliers. Such issues underscore the necessity of robust logistical planning and stakeholder communication mechanisms at the project's inception. Additionally, detailed risk assessments are essential to anticipate external constraints, such as adverse weather or supply chain disruptions, that could impact the schedule.

The subsequent increase in SV values during weeks 5 to 7 reflects the effectiveness of corrective actions, including schedule optimization and the implementation of digital project management tools. These measures improved work coordination and allowed for better allocation of resources, accelerating progress toward planned milestones. However, the decline in SV values in weeks 9 to 11 demonstrates the impact of technical revisions

and design adjustments. These findings emphasize the importance of comprehensive technical risk evaluation and the integration of flexibility into project schedules to accommodate unforeseen revisions without significant disruptions.

Cost Performance Insights

The CV analysis highlights efficient cost management during the initial phases, as evidenced by predominantly positive CV values through week 5. This success can be attributed to meticulous resource planning, minimization of material waste, and effective labor utilization. However, the decline in CV values during weeks 7 to 9 illustrates the financial impact of unanticipated events, such as equipment breakdowns and the subsequent repair costs. These occurrences underscore the importance of maintaining contingency budgets to address unforeseen expenses and ensuring that resource allocation plans remain adaptable to changing circumstances.

The recovery of CV values in week 10 demonstrates the success of strategic interventions, including procurement optimization and contract renegotiations with suppliers. These strategies not only mitigated the financial impact of earlier deviations but also reinforced the project's overall cost efficiency. The adoption of real-time cost tracking technology further supported this recovery by enabling the timely identification and rectification of cost deviations. Such tools are invaluable for maintaining financial control in complex projects where expenditures can fluctuate unpredictably.

Broader Implications

The findings of this study underscore the critical role of SV and CV variance analysis in large-scale project management. These indicators provide actionable insights that enable project managers to identify performance gaps, diagnose their root causes, and implement targeted corrective actions. Moreover, the integration of technical and managerial strategies proved instrumental in aligning project outcomes with predetermined cost and schedule targets.

The application of EVM in this project also highlights the importance of adopting advanced project management methodologies in Indonesia's infrastructure sector. By incorporating SV and CV analyses into routine monitoring processes, project teams can enhance decision-making, improve resource utilization, and ensure more consistent project performance. Furthermore, the study demonstrates that a proactive approach to variance management—supported by digital tools and collaborative planning—can significantly reduce risks and enhance overall efficiency.

Finally, the findings contribute to the broader understanding of infrastructure project management by offering a practical framework for addressing common challenges, such as schedule delays and cost overruns. Future projects can benefit from the lessons learned in this study, particularly regarding the importance of early risk identification, the allocation of contingency budgets, and the use of real-time monitoring technologies.

Conclusion

In conclusion, this study reaffirms the value of EVM as a comprehensive tool for managing time and cost performance in large-scale infrastructure projects. By leveraging SV and CV variance analysis, the Surabaya-Gempol Toll Road reconstruction project successfully mitigated early challenges and achieved significant improvements in schedule and cost management. The combination of technical and managerial interventions, supported by advanced monitoring tools, proved essential in maintaining project stability and ensuring successful completion.

The analysis of schedule variance (SV) and cost variance (CV) in the Surabaya-Gempol Toll Road reconstruction project provides an in-depth insight into the project performance in terms of time and cost. The analysis shows that the project experienced delays in the early stages, mainly due to logistical constraints, weather, and technical revisions that required additional time for completion. Negative SV values during weeks 3 and 4 signaled that the project was not running according to the planned schedule. However, through the application of the Earned Value method and work strategy adjustments, the SV value began to show a positive trend in the following weeks, reflecting improved time performance and operational efficiency.

On the cost side, the Cost Variance (CV) analysis showed encouraging results with positive values in most of the project implementation period. This positive CV value indicates that the project was able to manage expenditures well and remain under the prepared budget. This reflects savings and efficient resource management, which contributed to achieving the overall cost target. With the combination of positive SV and CV values at the end of the project, it can be concluded that data-driven project management and variance analysis can have a significant impact on project success.

Overall, the Surabaya-Gempol Toll Road reconstruction project successfully achieved the set targets despite facing challenges early in the implementation. A responsive approach in addressing schedule and expenditure deviations through variance analysis proved that regular monitoring of SV and CV is key in maintaining project stability.

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