Volume 4, No. 6 June 2025
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Cost and Time Analysis on the Preservation of Roads and Bridges in Bulu Regency Sukoharjo Regency Boundary Central Java Province – Tuban City Boundary East Java Province

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Abstract

The complexity of construction project implementation often results in time and cost inefficiencies, particularly in large-scale infrastructure developments. This study analyzes the cost and time performance of the Jalan and Jembatan Preservation Project in the Bulu Section, spanning from the Sukoharjo Regency boundary in Central Java Province to the Tuban City boundary in East Java Province. Using a descriptive quantitative method with a case study approach, the research applies Earned Value Management (EVM) methodology. Data were collected through field observations, project documentation (weekly progress/cost reports), and interviews with project personnel. Key EVM indicators—BCWS, BCWP, and ACWP—were used to evaluate performance, alongside metrics including Cost Variance (CV), Cost Performance Index (CPI), Schedule Variance (SV), and Schedule Performance Index (SPI). Findings indicate CV < 0 and CPI < 1, demonstrating actual costs exceeded the planned budget, while SV < 0 and SPI < 1 confirm project delays. The project is projected to incur a financial loss of approximately IDR 1.52 billion and a 25-calendar-day delay beyond the 285-day contractual schedule. These results underscore the need for enhanced project controls to mitigate inefficiencies. The study validates EVM's utility for early deviation detection in pavement preservation and provides strategic insights for optimizing future infrastructure asset management.

Keywords: earned value method; cost and time performance; work performance; project control, construction project

INTRODUCTION

Infrastructure refers to the physical system in providing transportation, water, drainage, buildings and other public facilities such as electricity, telecommunications, clean water and so on that are needed to meet basic human needs in the social and economic sphere. The infrastructure system is the main supporter of the functions of the social system and the economic system in people's lives. Infrastructure is important in improving the social development and economic activities of the region. Realizing the importance of infrastructure in encouraging economic growth, infrastructure experts agree that in encouraging infrastructure development, the government as the main player in the infrastructure sector should maintain the continuity of investment in infrastructure development and prioritize infrastructure in the national development plan, so that infrastructure can be improved both in quantity and quality (Posumah, 2015). Uneven infrastructure development can be a threat to the national economy. Therefore, infrastructure development should ideally be carried out evenly in each region.

Road infrastructure has a positive relationship with economic growth because road infrastructure is part of transportation services that are important to support economic mobility (Banister & Berechman, 2021). The benefits of road infrastructure development for economic growth are that it can increase community productivity, encourage national and regional

economic development, foster economic progress, and contribute positively to various economic growth indicators such as services, transportation, and communication, processing industries, and agriculture (Akinmoladun et al., 2020). Road infrastructure also plays a significant role in boosting trade and investment by facilitating the movement of goods and services (Garcia & Diez, 2021). According to Government Regulation Number 34 of 2006, roads are land transportation infrastructure that includes all parts of the road, including complementary buildings and their equipment intended for traffic, which are on ground level, above resistant surfaces, below ground, and or water surfaces, and above water surfaces, except for railways, truck roads, and cable roads (Rahman & Ali, 2023). Road networks are crucial in the transportation sector for the sustainable distribution of people, goods, and services, with the distribution being the movement or flow of both people, goods, and services between existing economic nodes (Parker et al., 2022). The development of road infrastructure also reduces transportation costs, increases accessibility, and stimulates the expansion of regional markets (Jovanovic & Matovic, 2021). Additionally, infrastructure investments can stimulate economic activities in areas with limited access to transportation networks, thereby reducing regional inequalities (Zhao & Lee, 2020).

The existence of highways is very necessary to support the pace of economic growth in line with the increasing need for transportation facilities that can reach important areas. Whether the road is smooth or not, good or bad road conditions determine the length or speed of a distribution process of both people, goods and services. One example is the Bulu Section, Sukoharjo Regency, Boundary of Central Java Province, which still has a road pavement width of 5.5 m. Meanwhile, the volume of vehicles crossing the inter-provincial connecting line continues to increase every year. In addition, the condition of road damage ranging from moderate to severely damaged conditions is at the location. So that to deal with these existing problems and conditions, it is necessary to improve road infrastructure by holding the Bulu Road and Bridge Preservation project of Sukoharjo Regency Central Java Province – Tuban City Limit, East Java Province so that the rate of economic growth in the area can increase.

The construction or repair of road infrastructure is a type of construction project that has a complex scope of work, a long duration of work implementation, and requires large costs. Construction projects are engineering activities which is complex and dynamic, so that project performance is not always in accordance with the planning (Susanti et al., 2019). The complexity of project implementation during its work causes many projects not to run according to plan. Both in terms of time, cost and labor. Due to these variations, a consistent and integrated control mechanism for project performance is needed. The scale of a project is proportional to the problems that will arise from a project. The larger the scale of a project, the more complex the problems in it, both in the implementation organization, the activities in a project and its processing are highly dependent on the control of each activity in compiling the project organizational structure so that the implementation of a construction project can always be controlled.

The completion time according to the target time in the work contract document is a benchmark for a successful construction project, namely by the alignment between the plan schedule and the realization in the field. The costs used in the implementation of this construction project are minimal and prioritize quality in the implementation of development.

Construction projects must be systematically ensured to be managed properly by service providers so that the project completion time is in accordance with the contract documents or even faster so that it can be profitable and can avoid work fines due to delays in completing construction projects (Heriyanto et al., 2023). The costs incurred and the time spent to complete a job must be measured continuously to detect when deviations from the plan occur. The existence of significant cost and time irregularities gives an indication of poor project control. A project in its implementation is very rare to find a project that runs exactly as planned. Generally have delays than planned, but there are also projects that have accelerated from the original planned schedule. Work delays often occur due to factors in terms of contractor costs, site conditions, labor productivity, materials, design changes and weather influences.

Project management is a method of approach to control a project effectively and efficiently. Construction management is the planning, scheduling and control of project activities to achieve project objectives to the maximum without problems arising that can hinder project activities. Construction management can be planned with available resources, planned as efficiently and effectively as possible to achieve project objectives with cost, quality and time constraints. Cost, quality, and time are important and interrelated components in the world of construction. Cost and time control is part of overall construction project management with the aim of achieving project quality and achievement. Project achievement is defined as the cost and time that needs to be achieved so that the project runs according to plan and avoids construction projects running not as planned (Adriansyah & Prafitasiwi, 2023).

The demand to be able to complete projects effectively and efficiently based on time, quality and cost that has been planned requires a good project management implementation. The project control process plays a very important role in minimizing the possibility of irregularities in project implementation. The construction project cycle requires the right cost, time and resource management role to reduce the risk of failure in implementation. Problems that often occur in construction projects are caused by improper methods of carrying out work. In addition, there is an inaccurate calculation of costs in planning which will cause a lot of costs to be incurred and there is often a discrepancy between the implementation time and the planned time, causing the costs incurred to swell. For this reason, cost and time management activities are needed to control the project so as to achieve *Triple Constrain* of a project, i.e. the right quality, cost and time (Nurafandi et al., 2023).

Completion time is very important in project implementation. In the implementation of construction projects, the time of completion of work can be influenced in terms of the methods used, the distribution of Human Resources (HR), and the accuracy of the estimation of scheduling material stocks in implementation. If not controlled properly, it will become a problem in the implementation of project completion. Therefore, a control method is needed to solve the problem, one of which can be using the *Earned Value*. Method *Earned Value* It is carried out as a project control to manage the activities of a work to be in accordance with the planned targets, so as to achieve satisfactory results and minimize failures. Method *Earned Value* It is a combination of aspects of schedule, cost and work performance that has been carried out in the field to be able to estimate the amount of cost and time needed to complete the project. This method is used to detect if there is a cost overrun or delay in the implementation

of a project, making it easier to anticipate and take steps so that the project can be completed on time with the remaining costs (Isfandina et al., 2023).

Thus, the use of this method can improve understanding of the relationship between costs, schedules, and the physical progress of the project. Project delays are often a source of disputes and demands between owners and contractors, so delays can incur very high costs. The contractor will be fined according to the contract and will also incur costs *Overhead* as long as the project is still ongoing. From the owner's side, project delays will have an impact on revenue reductions due to delays in facility operations. A project tends to experience delays if planning and control are not done properly. Various things can happen in a construction project that can cause more work time, resulting in delayed project completion (Asmoro, 2023).

Use of the *Earned Value* In evaluating the time performance and cost performance of a project, 3 (three) indicators are used, namely, ACWP (*Actual Cost of Work Performed*), BCWP (*Budgeted Cost of Work Performed*), and BCWS (*Bugeted Cost of Work Scheduled*). ACWP is the actual cost of the work that has been carried out. This cost is obtained from the project's accounting or financial data on the reporting date (e.g. the end of the month), i.e. a record of all actual cost expenditures from the work package or accounting code including overhead calculations and others. So, ACWP is the actual amount of expenses or funds used to carry out work in a certain period of time. BCWP shows the value of the results from the point of view of the value of the work that has been completed against the budget provided to carry out the work. When the ACWP figure is compared with the BCWP, it will be seen that the cost that has been incurred for the work that has been carried out is seen with the cost that should be incurred for that purpose. BCWS is a budget for a work package, but it is compiled and linked to the implementation schedule. So here there is a combination of costs, schedules, and scope of work, where each element of work has been given a cost allocation and schedule that can be a benchmark in the implementation of work. So that the implementation of the construction can be in accordance with the target time and cost target that has been stated in the contract (Maulidi et al., 2021).

Results of the evaluation *earned value* can be used as an *Early warning* If there are performance problems in the completion of the project, prevention can be carried out beforehand. This study will evaluate the implementation of the Road and Bridge Preservation project of the Bulu Section of Sukoharjo Regency, Central Java Province Boundary – Tuban City Boundary, East Java Province by analyzing the project performance in terms of cost and time, so that it can be considered in the implementation of highway construction in the future. Limited costs are a concern in this study, so several construction alternatives are carried out with the aim of achieving cost efficiency and implementation time (Asmoro, 2023). However, there are problems in implementation, namely the delay in the project in weeks 1 to 24. By using the *Earned Value* In the project performance analysis, it is hoped that a solution can be found so that the total project work time is in accordance with the plan, which is 41 (forty-one) weeks. This evaluation is needed as a review material for the project leader to take action in the next week or time to catch up on the delays.

The purpose of the research was to analyze the performance of the Road and Bridge Preservation project on the Bulu Section, Sukoharjo Regency, Central Java Province Boundary, to Tuban City Boundary, East Java Province. This analysis includes the determination of the

value of the project's basic indicators, namely BCWS (Budgeted Cost of Work Scheduled), BCWP (Budgeted Cost of Work Performed), and ACWP (Actual Cost of Work Performed), as well as the assessment of indicators measuring cost and time deviations.

The research gap identified is the lack of comprehensive performance evaluation on large-scale, cross-provincial road preservation projects using EVM, especially when facing real-life constraints such as licensing delays and cost escalation from third-party coordination. This study brings a novelty by applying the EVM method in a detailed analysis of the cost and time performance of the Bulu Road and Bridge Preservation Project located at the administrative boundary between Central Java and East Java provinces. This project is uniquely situated in a high-traffic area with strategic economic significance, where performance deviations have critical implications.

Therefore, the objective of this study is to assess the cost and time performance of the project using the Earned Value Method and provide quantitative indicators such as CV, CPI, SV, SPI, EAC, and TE to evaluate actual project conditions. The benefit of this research is to provide actionable insights and early warnings for project managers and government agencies, enabling more accurate cost forecasting, timely interventions, and better project governance in future infrastructure projects with similar complexities.

RESEARCH METHODS

This study uses a quantitative descriptive method with a case study approach on the *Bulu Road and Bridge Preservation project of Sukoharjo Regency, Central Java Province Boundary – Tuban City Boundary, East Java Province*. The research data includes *the time schedule* of plans and realizations, weekly reports, and actual costs consisting of direct costs (materials, labor, and equipment) and indirect costs (office and field overhead). Data was obtained through interviews with the implementing contractor, supervisors, and logistics, as well as through field observations and checking daily and weekly reports. Data analysis was carried out using *the Earned Value Management (EVM) method*, which involves the calculation of three basic elements (*Budget Cost of Work Scheduled* - BCWS, *Budget Cost of Work Performed* - BCWP, and *Actual Cost of Work Performed* - ACWP), analysis of cost and time deviations through *Cost Variance* (CV), *Cost Performance Index* (CPI), *Schedule Variance* (SV), and *Schedule Performance Index* (SPI), as well as project time and cost estimates through *Estimate to Complete* (ETC), *Estimate at Completion* (EAC), and *Time Estimate* (TE). This approach aims to provide a comprehensive overview of project performance, efficiency levels, and estimated time and costs required to complete the project according to actual conditions in the field.

The sampling technique used was purposive sampling, where data from week 1 to week 33 of the project schedule were selected based on their relevance to cost and time performance indicators.

The data collection techniques included document analysis (project time schedules, weekly and daily reports, RAB documents), interviews with project implementers and supervisory consultants, and field observations.

The data analysis was conducted using the Earned Value Management (EVM) method. Three main components—Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP)—were calculated to analyze

cost and time performance. Supporting indicators such as Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Estimate to Complete (ETC), and Estimate at Completion (EAC) were used to interpret deviations. This method offers a comprehensive assessment of project efficiency, helping to identify risks and formulate corrective actions for better planning and execution in future construction projects.

RESULTS AND DISCUSSION

Research Results

Based on secondary data from the Road and Bridge Preservation project, the Bulu Batas Section of Central Java Province – Tuban City Boundary can determine the value of BCWS, BCWP, and ACWP. These three basic elements can be calculated as cost and time performance indicators to determine the value of the measurement of deviations, which include variance analysis (CV and SV) and performance index analysis (CPI and SPI).

BCWS, BCWP, and ACWP calculations

1. *Budgeted Cost Work Schedule* (BCWS)

The Road and Bridge Preservation Project of the Bulu Batas Section of Central Java Province – Tuban City Boundary has a contract value of addendum 01 without VAT of Rp 49,883,658,519.17 and to calculate this BCWS is obtained from the progress data and the value of the project contract with the following formula:

BCWS = % plan weight x contract value

In week 1 :

BCWS = 0.181% x IDR 49,883,658,519.17

BCWS = IDR 90,441,346.26

The calculation of the next week can be done in the same way as the calculation above, and the results of the calculation from week 1 to week 33 can be seen in the following table 4.3:

No.	Periode	Persentase Rencana per Minggu (%)	Persentase Rencana Kumulatif per Minggu (%)	BCWS per Minggu (Rp)	BCWS Kumulatif per Minggu (Rp)
a	b	c	d	e = c x Nilai Kontrak	f = d x Nilai Kontrak
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	0,181	0,181	90.441.346,26	90.441.346,26
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	0,181	0,363	90.441.346,26	180.882.692,53
3	Minggu ke-3 (1 April s.d. 7 April)	0,000	0,363	-	180.882.692,53
4	Minggu ke-4 (8 April s.d. 14 April)	0,000	0,363	-	180.882.692,53
5	Minggu ke-5 (15 April s.d. 21 April)	0,000	0,363	-	180.882.692,53
6	Minggu ke-6 (22 April s.d. 28 April)	0,266	0,628	132.484.785,19	313.367.477,72
7	Minggu ke-7 (29 April s.d. 5 Mei)	0,313	0,941	156.090.462,69	469.457.940,41
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	0,431	1,372	215.094.784,48	684.552.724,90
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	0,606	1,978	302.107.325,69	986.660.050,58
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	0,617	2,595	307.627.971,79	1.294.288.022,38
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	1,460	4,054	728.190.292,77	2.022.478.315,14
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	1,607	5,661	801.594.387,74	2.824.072.702,88
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1,835	7,496	915.387.800,87	3.739.460.503,75
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	1,845	9,342	920.582.268,95	4.660.042.772,70
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	2,158	11,500	1.076.590.086,58	5.736.632.859,27
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	2,158	13,658	1.076.590.086,58	6.813.222.945,85
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	2,592	16,251	1.293.159.868,87	8.106.382.814,72
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	2,592	18,843	1.293.159.868,87	9.399.542.683,59
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	0,848	19,691	422.928.895,15	9.822.471.578,74
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	0,879	20,570	438.700.942,76	10.261.172.521,50
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	1,255	21,825	625.983.626,06	10.887.156.147,56
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	1,276	23,101	636.592.496,86	11.523.748.644,42
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	3,065	26,167	1.529.144.840,55	13.052.893.484,97

Figure 1. Account *Budgeted Cost Work Schedule* (BCWS)
Source: Processed Researcher, 2024

No.	Periode	Persentase Rencana per Minggu (%)	Persentase Rencana Kumulatif per Minggu (%)	BCWS per Minggu (Rp)	BCWS Kumulatif per Minggu (Rp)
a	b	c	d	e = c x Nilai Kontrak	f = d x Nilai Kontrak
24	Minggu ke-24 (26 Agustus s.d. 1 September)	3,048	29,215	1.520.676.023,09	14.573.569.508,06
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	3,027	32,242	1.509.924.779,26	16.083.494.287,32
26	Minggu ke-26 (9 september s.d. 15 September)	3,027	35,269	1.509.924.779,26	17.593.419.066,58
27	Minggu ke-27 (16 September s.d. 22 September)	4,002	39,271	1.996.269.423,12	19.589.688.489,70
28	Minggu ke-28 (23 September s.d. 29 september)	3,999	43,269	1.994.703.262,34	21.584.391.752,04
29	Minggu ke-29 (30 September s.d. 6 Oktober)	3,999	47,268	1.994.703.262,34	23.579.095.014,37
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	3,941	51,209	1.966.005.272,16	25.545.100.286,53
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	5,430	56,640	2.708.835.115,33	28.253.935.401,86
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	6,270	62,910	3.127.631.122,53	31.381.566.524,39
33	Minggu ke-33 (28 Oktober s.d. 3 November)	6,270	69,179	3.127.631.122,53	34.509.197.646,93

Figure 2. Calculation of *Budgeted Cost Work Schedule* (BCWS) (continued)
Source: Processed Researcher, 2024

2. *Budgeted Cost Work Performed* (BCWP)

Budgeted Cost Work Performed (BCWP) is the budgeted cost for work that has been completed, obtained by multiplying the percentage of progress that has been implemented by the value of the project contract with the following formula:

BCWP = % actual weight x contract value

In week 1 :

BCWP = 0.049% x IDR 49,883,658,519.17
BCWP = IDR 24,650,999.79
The calculation of the next week can be done in the same way as the calculation above, and the results of the calculation from week 1 to week 33 can be seen in the following table 4.4:

No.	Periode	Persentase Realisasi per Minggu (%)	Persentase Realisasi Kumulatif per Minggu (%)	BCWP per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)
a	b	c	d	e = c x Nilai Kontrak	f = d x Nilai Kontrak
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	0,049	0,049	24.650.999,79	24.650.999,79
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	0,049	0,099	24.650.999,79	49.301.999,58
3	Minggu ke-3 (1 April s.d. 7 April)	0,343	0,442	170.934.718,53	220.236.718,11
4	Minggu ke-4 (8 April s.d. 14 April)	0,000	0,442	-	220.236.718,11
5	Minggu ke-5 (15 April s.d. 21 April)	0,000	0,442	-	220.236.718,11
6	Minggu ke-6 (22 April s.d. 28 April)	0,086	0,527	42.729.177,33	262.965.895,44
7	Minggu ke-7 (29 April s.d. 5 Mei)	0,096	0,624	48.135.999,59	311.101.895,03
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	0,005	0,629	2.738.999,98	313.840.895,01
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	0,148	0,777	73.798.999,37	387.639.894,38
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	0,385	1,162	191.985.525,05	579.625.419,43

Figure 3. Account *Budgeted Cost Work Performed* (BCWP)
Source: Processed Researcher, 2024

No.	Periode	Persentase Realisasi per Minggu (%)	Persentase Realisasi Kumulatif per Minggu (%)	BCWP per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)
a	b	c	d	e = c x Nilai Kontrak	f = d x Nilai Kontrak
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	0,410	1,572	204.657.824,67	784.283.244,10
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	0,652	2,225	325.400.085,74	1.109.683.329,84
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1,026	3,251	512.040.088,78	1.621.723.418,62
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	1,573	4,824	784.892.010,19	2.406.615.428,81
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	2,099	6,924	1.047.211.223,91	3.453.826.652,72
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	2,022	8,946	1.008.803.406,75	4.462.630.059,47
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	1,994	10,940	994.640.312,93	5.457.270.372,39
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	2,466	13,406	1.230.193.397,26	6.687.463.769,65
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	0,866	13,077	431.952.256,21	6.523.504.468,09
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	0,419	13,497	209.128.498,10	6.732.632.966,19
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	1,447	14,944	721.911.447,80	7.454.544.414,00
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	1,359	16,303	677.748.956,11	8.132.293.370,11
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	2,743	19,046	1.368.456.433,36	9.500.749.803,47
24	Minggu ke-24 (26 Agustus s.d. 1 September)	3,445	22,491	1.718.535.920,42	11.219.285.723,89
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	6,450	28,941	3.217.738.340,60	14.437.024.064,49
26	Minggu ke-26 (9 september s.d. 15 September)	7,862	36,803	3.921.894.623,31	18.358.918.687,80
27	Minggu ke-27 (16 September s.d. 22 September)	3,437	40,241	1.714.552.100,22	20.073.470.788,02
28	Minggu ke-28 (23 September s.d. 29 september)	4,680	44,920	2.334.339.730,27	22.407.810.518,29
29	Minggu ke-29 (30 September s.d. 6 Oktober)	2,020	46,940	1.007.765.599,30	23.415.576.117,59
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	7,709	54,649	3.845.394.720,96	27.260.970.838,55
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	3,643	58,292	1.817.232.373,86	29.078.203.212,41
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	4,812	63,104	2.400.388.276,45	31.478.591.488,86
33	Minggu ke-33 (28 Oktober s.d. 3 November)	0,735	63,839	366.618.607,10	31.845.210.095,97

Figure 4. Calculation of *Budgeted Cost Work Performed* (BCWP) (continued)
Source: Processed Researcher, 2024

3. *Actual Cost of Work Performed* (ACWP)

Actual Cost of Work Performed (ACWP) is the real *cost* incurred for work that has been completed according to the work plan weight data in the *time schedule*. Actual costs consist of

direct costs plus indirect costs. Direct costs include the cost of labor, materials, and tools. Indirect costs include office overhead costs (employee salaries, maintenance of office equipment, electrical accounts, office stationery and office operating costs) and field overhead (security, fuel, and field operational costs).

a. Direct Costs

The direct costs in this study refer to the weekly realization weight percentage data on the work schedule and unit price in the East Java Governor's Regulation Number 39 of 2023 concerning Price Standards, AHSP Version 5.0 of the East Java Highway in 2024, as well as contractor bids according to the values stated in the RAB. The direct costs of the Road and Bridge Preservation project for the Central Java Province Boundary Section – Tuban City Boundary in week 1 to week 33 are as follows:

No.	Periode	Bobot Realisiasi (%)	Biaya Langsung (Rp)
a	b	c	d
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	0,049	22.368.240,22
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	0,049	22.368.240,22
3	Minggu ke-3 (1 April s.d. 7 April)	0,343	155.105.629,74
4	Minggu ke-4 (8 April s.d. 14 April)	0,000	-
5	Minggu ke-5 (15 April s.d. 21 April)	0,000	-
6	Minggu ke-6 (22 April s.d. 28 April)	0,086	38.772.322,06
7	Minggu ke-7 (29 April s.d. 5 Mei)	0,096	43.678.455,69
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	0,005	2.485.360,02
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	0,148	66.964.981,54
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	0,385	174.207.065,84
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	0,410	185.705.870,93
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	0,652	295.267.021,53
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1,026	464.623.577,38
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	1,573	712.208.558,72
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	2,099	950.236.193,99
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	2,022	915.385.060,65
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	1,994	902.533.513,55
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	2,466	1.116.273.646,61
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	0,866	391.952.128,24
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	0,419	189.762.546,04
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	1,447	655.060.193,11
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	1,359	614.987.286,07
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	2,743	1.241.733.093,75
24	Minggu ke-24 (26 Agustus s.d. 1 September)	3,445	1.559.394.126,96
25	Minggu ke-25 (2 September s.d. 8 Ssseptember)	6,450	2.919.765.720,82
26	Minggu ke-26 (9 september s.d. 15 September)	7,862	3.558.714.932,57
27	Minggu ke-27 (16 September s.d. 22 September)	3,437	1.555.779.220,96
28	Minggu ke-28 (23 September s.d. 29 september)	4,680	2.118.172.580,78
29	Minggu ke-29 (30 September s.d. 6 Oktober)	2,020	914.443.357,41
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	7,709	3.489.299.160,10
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	3,643	1.648.950.980,58
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	4,812	2.178.104.825,31
33	Minggu ke-33 (28 Oktober s.d. 3 November)	0,735	332.668.579,09
Jumlah			**29.436.972.470,47**

Figure 5. Direct Costs

Source: Processed Researcher, 2024

Based on figure 5 about direct costs, it can be seen that the total direct cost of the Road and Bridge Preservation project for the Bulu Segment of Central Java Province – Tuban City Boundary from week 1 to week 33 is Rp 29,436,972,470.47.

b. Indirect Costs

The calculation of indirect costs in this study uses the reference of project direct costs of 85% of the total construction cost and indirect project costs of 15% of the total construction costs. The details of the calculation of indirect costs are as follows:

Total construction costs = direct costs + indirect costs
Total construction cost = (85% x total construction cost) +
(15% x total construction cost)

The total construction cost is obtained from the following equation formula:

85% x total construction cost = direct costs
85% x total construction cost = IDR 29,436,972,470.47
Total construction cost $= \frac{\text{Rp } 29.436.972.470,47}{0,85}$
Total construction cost = IDR 34,631,732,318.20

Indirect costs are obtained from the following formula:

Indirect costs = 15% x total construction cost
= 15% x IDR 34,631,732,318.20
= IDR 5,194,759,847.73

This project work begins on March 20, 2024, research observations are carried out until November 3, 2024 or equal to 33 weeks. Indirect costs each week are obtained from the following formula:

Indirect costs week 1
= Indirect costs x weight of realization week 1
= IDR 5,194,759,847.73 x 0.049%
= IDR 2,567,093.67

The calculation of the next week can be done in the same way as the calculation above. The recapitulation of direct and indirect costs as well as the calculation of ACWP on the Road and Bridge Preservation project of the Bulu Boundary Section of Central Java Province – Tuban City Boundary in week 1 to week 33 is as follows:

No.	Periode	Bobot Realisiasi (%)	Biaya Langsung (Rp)	Biaya Tak Langsung (Rp)	ACWP (Rp)	ACWP Kumulatif (Rp)
a	b	c	d	e	f = d + e	g
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	0,049	22.368.240,22	2.567.093,67	24.935.333,89	24.935.333,89
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	0,049	22.368.240,22	2.567.093,67	24.935.333,89	49.870.667,77
3	Minggu ke-3 (1 April s.d. 7 April)	0,343	155.105.629,74	17.800.715,48	172.906.345,23	222.777.013,00
4	Minggu ke-4 (8 April s.d. 14 April)	0,000	-	-	-	222.777.013,00
5	Minggu ke-5 (15 April s.d. 21 April)	0,000	-	-	-	222.777.013,00
6	Minggu ke-6 (22 April s.d. 28 April)	0,086	38.772.322,06	4.449.710,01	43.222.032,08	265.999.045,08
7	Minggu ke-7 (29 April s.d. 5 Mei)	0,096	43.678.455,69	5.012.763,00	48.691.218,69	314.690.263,77
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	0,005	2.485.360,02	285.232,63	2.770.592,65	317.460.856,42
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	0,148	66.964.981,54	7.685.243,83	74.650.225,37	392.111.081,79
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	0,385	174.207.065,84	19.992.894,00	194.199.959,83	586.311.041,62
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	0,410	185.705.870,93	21.312.555,69	207.018.426,62	793.329.468,24
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	0,652	295.267.021,53	33.886.353,77	329.153.375,30	1.122.482.843,54
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1,026	464.623.577,38	53.322.578,43	517.946.155,81	1.640.428.999,35
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	1,573	712.208.558,72	81.736.697,35	793.945.256,07	2.434.374.255,43
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	2,099	950.236.193,99	109.053.966,36	1.059.290.160,35	3.493.664.415,78
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	2,022	915.385.060,65	105.054.272,02	1.020.439.332,67	4.514.103.748,45
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	1,994	902.533.513,55	103.579.362,74	1.006.112.876,29	5.520.216.624,74
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	2,466	1.116.273.646,61	128.109.273,75	1.244.382.920,36	6.764.599.545,10
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	0,866	391.952.128,24	44.982.431,19	436.934.559,43	7.201.534.104,53
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	0,419	189.762.546,04	21.778.120,47	211.540.666,51	7.413.074.771,04
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	1,447	655.060.193,11	75.178.058,59	730.238.251,69	8.143.313.022,73
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	1,359	614.987.286,07	70.579.086,79	685.566.372,86	8.828.879.395,59
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	2,743	1.241.733.093,75	142.507.641,67	1.384.240.735,42	10.213.120.131,02
24	Minggu ke-24 (26 Agustus s.d. 1 September)	3,445	1.559.394.126,96	178.964.046,77	1.738.358.173,73	11.951.478.304,74
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	6,450	2.919.765.720,82	335.087.249,58	3.254.852.970,40	15.206.331.275,14
26	Minggu ke-26 (9 september s.d. 15 September)	7,862	3.558.714.932,57	408.416.329,54	3.967.131.262,11	19.173.462.537,25
27	Minggu ke-27 (16 September s.d. 22 September)	3,437	1.555.779.220,96	178.549.181,67	1.734.328.402,62	20.907.790.939,88
28	Minggu ke-28 (23 September s.d. 29 september)	4,680	2.118.172.580,78	243.092.320,45	2.361.264.901,22	23.269.055.841,10
29	Minggu ke-29 (30 September s.d. 6 Oktober)	2,020	914.443.357,41	104.946.197,34	1.019.389.554,76	24.288.445.395,86
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	7,709	3.489.299.160,10	400.449.820,40	3.889.748.980,50	28.178.194.376,36
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	3,643	1.648.950.980,58	189.242.049,40	1.838.193.029,98	30.016.387.406,33
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	4,812	2.178.104.825,31	249.970.451,40	2.428.075.276,70	32.444.462.683,04
33	Minggu ke-33 (28 Oktober s.d. 3 November)	0,735	332.668.579,09	38.178.747,83	370.847.326,92	32.815.310.009,95

Figure 6. Recapitulation of ACWP Calculation Results
Source: Processed Researcher, 2024

Based on the results of the calculation of BCWS, BCWP, and ACWP, a recapitulation of the calculation can be made as follows.

Recapitulation of the calculation of BCWS, BCWP, and ACWP, it can be seen that in week 33 the BCWS value was obtained of IDR 34,509,197,646.93 then for the BCWP value of IDR 31,845,210,095.97 and the ACWP value of IDR 32,815,310,009.95. The BCWS, BCWP, and ACWP values when made in the form of a graph will be as follows:

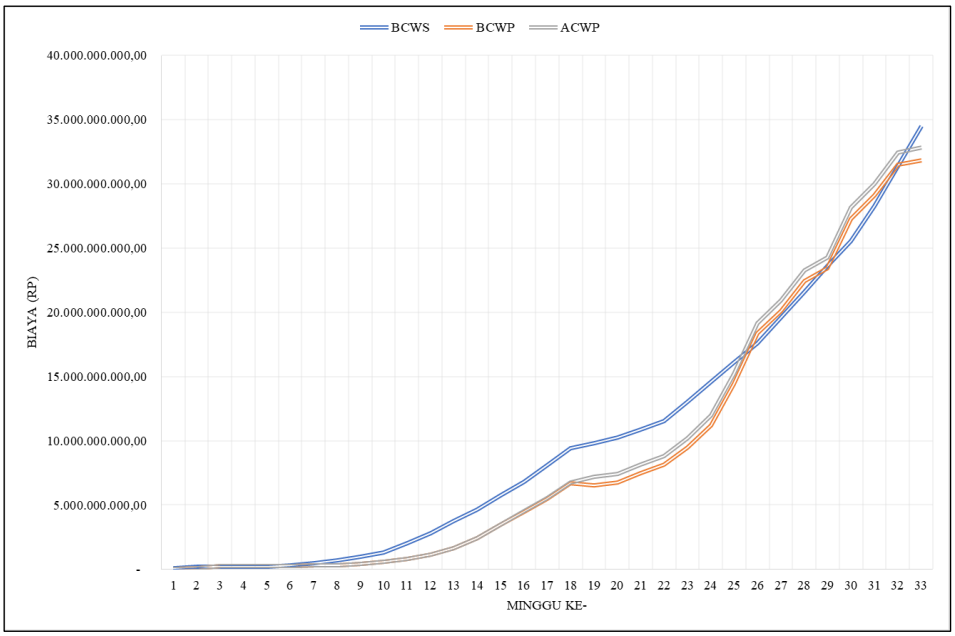

Figure 7. Graph of the BCWS, BCWP, and ACWP Relationship
Source: Processed Researcher, 2024

Based on figure 7, the graph shows the comparison of BCWS and BCWP values. Weeks 1 to 25 and weeks 29 and 33 weeks show that BCWP values are smaller than those of BCWS. This shows that the work has not been carried out according to the planned schedule. The actual cost or ACWP in week 1 to week 33 of the expense is greater than the plan with the ACWP graph marked higher than the BCWP.

Calculation of Cost and Time Deviation

The calculation of BCWS, BCWP, and ACWP in the Road and Bridge Preservation project of the Bulu Boundary Section of Central Java Province – Tuban City Boundary can then be calculated as a cost and time performance indicator to determine the measurement value of the deviation. The parameters for measuring deviations in cost performance indicators consist of *Cost Variance* (CV) and *Cost Performance Index* (CPI). The deviation measurement parameters in the time performance indicator consist of *Schedule Variance* (SV) and *Schedule Performance Index* (SPI). The details of the calculation of these parameters are as follows:

1. Measurement of Cost Deviation

The measurement of cost deviation consists of *Cost Variance* (CV) and *Cost Performance Index* (CPI), the calculation is as follows:

a. *Cost Variance* (CV)

The calculation of the CPI value in week 33 is as follows:

CV = BCWP – ACWP
= IDR 31,845,210,095.97 – IDR 32,815,310,009.95
= (-) IDR 970,099,913.99

The calculation in each week can be done in the same way as the calculation above and the results of the calculation from week 1 to week 33 can be seen in table 4.8 below:

No.	Periode	BCWP Kumulatif per Minggu (Rp)	ACWP Kumulatif per Minggu (Rp)	CV Kumulatif per Minggu (Rp)
a	b	c	d	e = c - d
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	24.650.999,79	24.935.333,89	- 284.334,10
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	49.301.999,58	49.870.667,77	- 568.668,20
3	Minggu ke-3 (1 April s.d. 7 April)	220.236.718,11	222.777.013,00	- 2.540.294,89
4	Minggu ke-4 (8 April s.d. 14 April)	220.236.718,11	222.777.013,00	- 2.540.294,89
5	Minggu ke-5 (15 April s.d. 21 April)	220.236.718,11	222.777.013,00	- 2.540.294,89
6	Minggu ke-6 (22 April s.d. 28 April)	262.965.895,44	265.999.045,08	- 3.033.149,63
7	Minggu ke-7 (29 April s.d. 5 Mei)	311.101.895,03	314.690.263,77	- 3.588.368,74
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	313.840.895,01	317.460.856,42	- 3.619.961,41
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	387.639.894,38	392.111.081,79	- 4.471.187,42
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	579.625.419,43	586.311.041,62	- 6.685.622,19
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	784.283.244,10	793.329.468,24	- 9.046.224,14
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	1.109.683.329,84	1.122.482.843,54	- 12.799.513,70
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1.621.723.418,62	1.640.428.999,35	- 18.705.580,74
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	2.406.615.428,81	2.434.374.255,43	- 27.758.826,62
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	3.453.826.652,72	3.493.664.415,78	- 39.837.763,06
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	4.462.630.059,47	4.514.103.748,45	- 51.473.688,99
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	5.457.270.372,39	5.520.216.624,74	- 62.946.252,35
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	6.687.463.769,65	6.764.599.545,10	- 77.135.775,45
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	6.523.504.468,09	7.201.534.104,53	- 678.029.636,43
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	6.732.632.966,19	7.413.074.771,04	- 680.441.804,85
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	7.454.544.414,00	8.143.313.022,73	- 688.768.608,74
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	8.132.293.370,11	8.828.879.395,59	- 696.586.025,49
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	9.500.749.803,47	10.213.120.131,02	- 712.370.327,55
24	Minggu ke-24 (26 Agustus s.d. 1 September)	11.219.285.723,89	11.951.478.304,74	- 732.192.580,86
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	14.437.024.064,49	15.206.331.275,14	- 769.307.210,66

Figure 8. Value *Cost Variance* (CV) Cumulative Per Week
Source: Processed Researcher, 2024

No.	Periode	BCWP Kumulatif per Minggu (Rp)	ACWP Kumulatif per Minggu (Rp)	CV Kumulatif per Minggu (Rp)
a	b	c	d	e = c - d
26	Minggu ke-26 (9 september s.d. 15 September)	18.358.918.687,80	19.173.462.537,25	- 814.543.849,45
27	Minggu ke-27 (16 September s.d. 22 September)	20.073.470.788,02	20.907.790.939,88	- 834.320.151,85
28	Minggu ke-28 (23 September s.d. 29 september)	22.407.810.518,29	23.269.055.841,10	- 861.245.322,81
29	Minggu ke-29 (30 September s.d. 6 Oktober)	23.415.576.117,59	24.288.445.395,86	- 872.869.278,27
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	27.260.970.838,55	28.178.194.376,36	- 917.223.537,81
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	29.078.203.212,41	30.016.387.406,33	- 938.184.193,92
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	31.478.591.488,86	32.444.462.683,04	- 965.871.194,17
33	Minggu ke-33 (28 Oktober s.d. 3 November)	31.845.210.095,97	32.815.310.009,95	- 970.099.913,99

Figure 9. Cumulative *Cost Variance* (CV) Values Each Week (continued)
Source: Processed Researcher, 2024

Based on table 4.8 about the cumulative *Cost Variance* (CV) value for each week, it is known that the calculation of CV in week 1 to week 33 obtained a negative value, which means

that CV is less than zero (CV < 0) indicating that the cost incurred is greater than the planned budget (*cost overrun*).

b. *Cost Performance Index* (CPI)

The calculation of the CPI value in week 33 is as follows:

CPI = BCWP / ACWP
= IDR 31,845,210,095.97 / IDR 32,815,310,009.95
= 0.97

The calculation in each week can be done in the same way as the calculation above and the calculation results from week 1 to week 33 can be seen in the following table 4.9:

No.	Periode	BCWP Kumulatif per Minggu (Rp)	ACWP Kumulatif per Minggu (Rp)	CPI Kumulatif per Minggu
a	b	c	d	e = c / d
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	24.650.999,79	24.935.333,89	0,99
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	49.301.999,58	49.870.667,77	0,99
3	Minggu ke-3 (1 April s.d. 7 April)	220.236.718,11	222.777.013,00	0,99
4	Minggu ke-4 (8 April s.d. 14 April)	220.236.718,11	222.777.013,00	0,99
5	Minggu ke-5 (15 April s.d. 21 April)	220.236.718,11	222.777.013,00	0,99

Figure 10. Value *Cost Performance Index* (CPI) Cumulative Weekly
Source: Processed Researcher, 2024

No.	Periode	BCWP Kumulatif per Minggu (Rp)	ACWP Kumulatif per Minggu (Rp)	CPI Kumulatif per Minggu
a	b	c	d	e = c / d
6	Minggu ke-6 (22 April s.d. 28 April)	262.965.895,44	265.999.045,08	0,99
7	Minggu ke-7 (29 April s.d. 5 Mei)	311.101.895,03	314.690.263,77	0,99
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	313.840.895,01	317.460.856,42	0,99
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	387.639.894,38	392.111.081,79	0,99
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	579.625.419,43	586.311.041,62	0,99
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	784.283.244,10	793.329.468,24	0,99
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	1.109.683.329,84	1.122.482.843,54	0,99
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	1.621.723.418,62	1.640.428.999,35	0,99
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	2.406.615.428,81	2.434.374.255,43	0,99
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	3.453.826.652,72	3.493.664.415,78	0,99
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	4.462.630.059,47	4.514.103.748,45	0,99
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	5.457.270.372,39	5.520.216.624,74	0,99
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	6.687.463.769,65	6.764.599.545,10	0,99
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	6.523.504.468,09	7.201.534.104,53	0,91
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	6.732.632.966,19	7.413.074.771,04	0,91
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	7.454.544.414,00	8.143.313.022,73	0,92
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	8.132.293.370,11	8.828.879.395,59	0,92
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	9.500.749.803,47	10.213.120.131,02	0,93
24	Minggu ke-24 (26 Agustus s.d. 1 September)	11.219.285.723,89	11.951.478.304,74	0,94
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	14.437.024.064,49	15.206.331.275,14	0,95
26	Minggu ke-26 (9 september s.d. 15 September)	18.358.918.687,80	19.173.462.537,25	0,96
27	Minggu ke-27 (16 September s.d. 22 September)	20.073.470.788,02	20.907.790.939,88	0,96
28	Minggu ke-28 (23 September s.d. 29 september)	22.407.810.518,29	23.269.055.841,10	0,96
29	Minggu ke-29 (30 September s.d. 6 Oktober)	23.415.576.117,59	24.288.445.395,86	0,96
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	27.260.970.838,55	28.178.194.376,36	0,97
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	29.078.203.212,41	30.016.387.406,33	0,97
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	31.478.591.488,86	32.444.462.683,04	0,97
33	Minggu ke-33 (28 Oktober s.d. 3 November)	31.845.210.095,97	32.815.310.009,95	0,97

Figure 11. Cumulative *Cost Performance Index* (CPI) Values Each Week (continued)
Source: Processed Researcher, 2024

Based on table 4.9 on the cumulative *Cost Performance Index* (CPI) value for each week, it is known that the CPI calculation in week 1 to week 33 obtained a value of less than one (CPI < 1) indicating that the cost *overrun* performance is due to the cost incurred (ACWP) greater than the value obtained (BCWP).

2. Measurement of Time Deviation

a. *Schedule Variance* (SV)

The calculation of SV values in week 33 is as follows:

SV = BCWP – BCWS

= IDR 31,845,210,095.97 – IDR 34,509,197,646.93

= (-) IDR 2,663,987,550.96

The calculation in each week can be done in the same way as the calculation above and the results of the calculation from week 1 to week 33 can be seen in table 4.10 below:

No.	Periode	BCWS Kumulatif per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)	SV Kumulatif per Minggu (Rp)
a	b	c	d	e = d - c
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	90.441.346,26	24.650.999,79	- 65.790.346,48
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	180.882.692,53	49.301.999,58	- 131.580.692,95
3	Minggu ke-3 (1 April s.d. 7 April)	180.882.692,53	220.236.718,11	39.354.025,58
4	Minggu ke-4 (8 April s.d. 14 April)	180.882.692,53	220.236.718,11	39.354.025,58
5	Minggu ke-5 (15 April s.d. 21 April)	180.882.692,53	220.236.718,11	39.354.025,58
6	Minggu ke-6 (22 April s.d. 28 April)	313.367.477,72	262.965.895,44	- 50.401.582,28
7	Minggu ke-7 (29 April s.d. 5 Mei)	469.457.940,41	311.101.895,03	- 158.356.045,38
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	684.552.724,90	313.840.895,01	- 370.711.829,89
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	986.660.050,58	387.639.894,38	- 599.020.156,21
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	1.294.288.022,38	579.625.419,43	- 714.662.602,95
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	2.022.478.315,14	784.283.244,10	- 1.238.195.071,04
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	2.824.072.702,88	1.109.683.329,84	- 1.714.389.373,04
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	3.739.460.503,75	1.621.723.418,62	- 2.117.737.085,13
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	4.660.042.772,70	2.406.615.428,81	- 2.253.427.343,89
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	5.736.632.859,27	3.453.826.652,72	- 2.282.806.206,56
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	6.813.222.945,85	4.462.630.059,47	- 2.350.592.886,38
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	8.106.382.814,72	5.457.270.372,39	- 2.649.112.442,33
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	9.399.542.683,59	6.687.463.769,65	- 2.712.078.913,94
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	9.822.471.578,74	6.523.504.468,09	- 3.298.967.110,64
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	10.261.172.521,50	6.732.632.966,19	- 3.528.539.555,31
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	10.887.156.147,56	7.454.544.414,00	- 3.432.611.733,56
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	11.523.748.644,42	8.132.293.370,11	- 3.391.455.274,31
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	13.052.893.484,97	9.500.749.803,47	- 3.552.143.681,50
24	Minggu ke-24 (26 Agustus s.d. 1 September)	14.573.569.508,06	11.219.285.723,89	- 3.354.283.784,17
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	16.083.494.287,32	14.437.024.064,49	- 1.646.470.222,83
26	Minggu ke-26 (9 september s.d. 15 September)	17.593.419.066,58	18.358.918.687,80	765.499.621,22
27	Minggu ke-27 (16 September s.d. 22 September)	19.589.688.489,70	20.073.470.788,02	483.782.298,32
28	Minggu ke-28 (23 September s.d. 29 september)	21.584.391.752,04	22.407.810.518,29	823.418.766,25
29	Minggu ke-29 (30 September s.d. 6 Oktober)	23.579.095.014,37	23.415.576.117,59	- 163.518.896,78
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	25.545.100.286,53	27.260.970.838,55	1.715.870.552,02

Figure 12. Value *Schedule Variance* (SV) Cumulative Weekly

Source: Processed Researcher, 2024

No.	Periode	BCWS Kumulatif per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)	SV Kumulatif per Minggu (Rp)
a	b	c	d	e = d - c
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	28.253.935.401,86	29.078.203.212,41	824.267.810,55
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	31.381.566.524,39	31.478.591.488,86	97.024.964,47
33	Minggu ke-33 (28 Oktober s.d. 3 November)	34.509.197.646,93	31.845.210.095,97	- 2.663.987.550,96

Figure 13. Cumulative Schedule Variance *(SV) Values Each Week (continued)*
Source: Processed Researcher, 2024

Based on table 4.10 on the cumulative *Schedule Variance* (SV) value for each week, it is known that the calculation of SV in weeks 1 to week 25, week 29, and week 33 obtained a negative value which means that SV is less than zero (SV < 0) indicating that the project is behind schedule. In contrast to weeks 26 to 28 and 30 to 32 weeks, a positive value was obtained, which means that SV is more than zero (SV > 0) indicating that the project is accelerating the plan (*Schedule Underrun*).

b. *Schedule Performance Index* (SPI)

The calculation of the SPI value in week 33 is as follows:

SPI = BCWP / BCWS
= IDR 31,845,210,095.97 / IDR 34,509,197,646.93
= 0.92

The calculation in each week can be done in the same way as the calculation above and the results of the calculation from week 1 to week 33 can be seen in table 4.11 below:

No.	Periode	BCWS Kumulatif per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)	SPI Kumulatif per Minggu
a	b	c	d	e = d / c
1	Minggu ke-1 (20 Maret s.d. 24 Maret)	90.441.346,26	24.650.999,79	0,27
2	Minggu ke-2 (25 Maret s.d. 31 Maret)	180.882.692,53	49.301.999,58	0,27
3	Minggu ke-3 (1 April s.d. 7 April)	180.882.692,53	220.236.718,11	1,22
4	Minggu ke-4 (8 April s.d. 14 April)	180.882.692,53	220.236.718,11	1,22
5	Minggu ke-5 (15 April s.d. 21 April)	180.882.692,53	220.236.718,11	1,22
6	Minggu ke-6 (22 April s.d. 28 April)	313.367.477,72	262.965.895,44	0,84
7	Minggu ke-7 (29 April s.d. 5 Mei)	469.457.940,41	311.101.895,03	0,66

Figure 14. Value *Schedule Performance Index* (SPI) Cumulative Weekly
Source: Processed Researcher, 2024

No.	Periode	BCWS Kumulatif per Minggu (Rp)	BCWP Kumulatif per Minggu (Rp)	SPI Kumulatif per Minggu
a	b	c	d	e = d / c
8	Minggu ke-8 (6 Mei s.d. 12 Mei)	684.552.724,90	313.840.895,01	0,46
9	Minggu ke-9 (13 Mei s.d. 19 Mei)	986.660.050,58	387.639.894,38	0,39
10	Minggu ke-10 (20 Mei s.d. 26 Mei)	1.294.288.022,38	579.625.419,43	0,45
11	Minggu ke-11 (27 Mei s.d. 2 Juni)	2.022.478.315,14	784.283.244,10	0,39
12	Minggu ke-12 (3 Juni s.d. 9 Juni)	2.824.072.702,88	1.109.683.329,84	0,39
13	Minggu ke-13 (10 Juni s.d. 16 Juni)	3.739.460.503,75	1.621.723.418,62	0,43
14	Minggu ke-14 (17 Juni s.d. 23 Juni)	4.660.042.772,70	2.406.615.428,81	0,52
15	Minggu ke-15 (24 Juni s.d. 30 Juni)	5.736.632.859,27	3.453.826.652,72	0,60
16	Minggu ke-16 (1 Juli s.d. 7 Juli)	6.813.222.945,85	4.462.630.059,47	0,65
17	Minggu ke-17 (8 Juli s.d. 14 Juli)	8.106.382.814,72	5.457.270.372,39	0,67
18	Minggu ke-18 (15 Juli s.d. 21 Juli)	9.399.542.683,59	6.687.463.769,65	0,71
19	Minggu ke-19 (22 Juli s.d. 28 Juli)	9.822.471.578,74	6.523.504.468,09	0,66
20	Minggu ke-20 (29 Juli s.d. 4 Agustus)	10.261.172.521,50	6.732.632.966,19	0,66
21	Minggu ke-21 (5 Agustus s.d. 11 Agustus)	10.887.156.147,56	7.454.544.414,00	0,68
22	Minggu ke-22 (12 Agustus s.d. 18 Agustus)	11.523.748.644,42	8.132.293.370,11	0,71
23	Minggu ke-23 (19 Agustus s.d. 25 Agustus)	13.052.893.484,97	9.500.749.803,47	0,73
24	Minggu ke-24 (26 Agustus s.d. 1 September)	14.573.569.508,06	11.219.285.723,89	0,77
25	Minggu ke-25 (2 September s.d. 8 Sseptember)	16.083.494.287,32	14.437.024.064,49	0,90
26	Minggu ke-26 (9 september s.d. 15 September)	17.593.419.066,58	18.358.918.687,80	1,04
27	Minggu ke-27 (16 September s.d. 22 September)	19.589.688.489,70	20.073.470.788,02	1,02
28	Minggu ke-28 (23 September s.d. 29 september)	21.584.391.752,04	22.407.810.518,29	1,04
29	Minggu ke-29 (30 September s.d. 6 Oktober)	23.579.095.014,37	23.415.576.117,59	0,99
30	Minggu ke-30 (7 Oktober s.d. 13 Oktober)	25.545.100.286,53	27.260.970.838,55	1,07
31	Minggu ke-31 (14 Oktober s.d. 20 Oktober)	28.253.935.401,86	29.078.203.212,41	1,03
32	Minggu ke-32 (21 Oktober s.d. 27 Oktober)	31.381.566.524,39	31.478.591.488,86	1,00
33	Minggu ke-33 (28 Oktober s.d. 3 November)	34.509.197.646,93	31.845.210.095,97	0,92

Figure 15. Cumulative *Schedule Performance Index* (SPI) Values Each Week (continued)
Source: Processed Researcher, 2024

Based on table 4.11 on the cumulative *Schedule Performance Index* (SPI) value for each week, it is known that the calculation of SPI in weeks 1 to 25, 29, and 33 weeks obtained a value of less than one (SPI < 1) indicating that the project schedule performance is not good. In contrast to the 26th to 28th week and the 30th to 32nd week, a score of more than one (SPI > 1) showed that the project schedule performance was good (*Schedule Underrun*).

Project Cost and Completion Time Calculation

After calculating the cost and time performance indicators in the previous subchapter which show that the project has been delayed and accelerated and the costs incurred exceed the budget, then the progress of the project for the future time can be estimated in the following way:

1. Estimated Cost of Residual Work (*Estimate to Complete* / ETC)

ETC = ((Total budget – BCWP))/CPI
= ((IDR 49,883,658,519.17 – IDR 31,845,210,095.97)) / 0.97
= IDR 18,587,953,269.02

The estimated cost for the remaining work is Rp 18,587,953,269.02 assuming that the project's capacity trend will stabilize until the project is completed.

2. Estimated *at Completion* (EAC)

EAC = (Remaining budget) + ACWP
= (Total budget - BCWP) / CPI) + ACWP
= IDR 18,587,953,269.02 + IDR 32,815,310,009.95
= IDR 51,403,263,278.97

The EAC value indicates that the cost required for the completion of the project is greater than the planned budget, then:

Rest of the budget = Total budget – EAC
= IDR 49,883,658,519.17 – IDR 51,403,263,278.97
= (-) IDR 1,519,604,759.80

3. Project Time Estimate (TE)

The total project implementation time is planned for 285 (two hundred and eighty-five) days or 41 (forty-one) weeks. Reporting is carried out on day 231 or week 33. So, the estimated project completion time is as follows:

TE = ATE + (OD - (ATE x SPI)) / SPI
= 231 + (285 – (231 x 0.92)) / 0.92
= 310 days

It can be known that the time required for project completion is greater than the planned time. The results of the analysis using the *earned value method* showed that it took 310 days to complete the Bulu Provincial Road and Bridge Preservation project in Central Java Province – Tuban City Boundary or 25 days late from the contract time.

Interpretation of Results

Based on the results of the calculation of project performance analysis using *the earned value method* on the Preservation of Bulu Roads and Bridges, Sukoharjo Regency, Central Java Provincial Boundary – Tuban City Boundary, East Java Province in sub chapter 4.2, the following summary was obtained:

1) The three basic elements of calculating project performance analysis using *the earned value* method:
   a) BCWS (*Budgeted Cost of Work Scheduled)*
      = IDR 34,509,197,646.93
   b) BCWP (*Budgeted Cost of Work Performed*)
      = IDR 31,845,210,095.97
   c) ACWP (*Actual Cost of Work Performed*)
      = IDR 32,815,310,009.95
2) Cost and time irregularities
   a) Cost deviation :
      - CV (*Cost Variance*)
        = (-) IDR 970,099,913.99 or CV < 0
        This means that the costs incurred are greater than the planned budget (*cost overrun*).
      - CPI (*Cost Performance Index*)

= 0.97 or CPI < 1

The reason is poor cost *overrun*.

b) Time deviation :

- SV (*Schedule Variance*)
  = (-) IDR 2,663,987,550.96 or SV < 0
  This means that the project is delayed in the plan, but in the 26th to the 28th week and the 30th to the 32nd week the SV > 0 was obtained, which means that the project was accelerated.
- SPI (*Schedule Performance Index*)
  = 0.92 or SPI < 1
  This means that the performance of the project schedule is not good, but in the 26th to the 28th week and the 30th to the 32nd week, the SPI > 1 was obtained, which means that the project schedule performance is good.

3) Estimated cost and time of work in the future:

a) Estimated Cost of Residual Work (*Estimate to Complete* / ETC)
= IDR 18,587,953,269.02

b) Estimated *at Completion* (EAC)
= IDR 51,403,263,278.97
This means a loss (-) of Rp 1,519,604,759.80 against the existing budget.

c) Project Time Estimate (TE)
= 310 days
This means that it is 25 days late from the contract time, which is 285 days.

A summary of the results of the calculation of the project performance analysis above can be concluded that the Bulu Road and Bridge Preservation project of Sukoharjo Regency, Central Java Province Boundary – Tuban City Limit, East Java Province, experienced delays in implementation progress and the total cost incurred for the completion of the project was greater than the budget. Based on the results of the interview with the supervisory consultant, the delay in the progress of the project was due to obstacles in Perhutani's licensing for tree cutting, Pertamina's pipeline protection, and waiting for a hotmix overlay permit. The actions taken to accelerate the progress of the implementation were the increase in working time (overtime) and the implementation of an acceleration meeting whose results were agreed to be the production of hotmix material as much as 270 tons per day.

CONCLUSION

Performance analysis of the road and bridge Preservation Project revealed a BCWS of *IDR* 41.16 billion, BCWP of *IDR* 45.36 billion, and ACWP of *IDR* 48.48 billion. Cost deviations (*CV* = -*IDR* 970 million, *CPI* = 0.97) confirmed budget overruns, while schedule variances (*SV* = -*IDR* 2.66 billion, *SPI* = 0.92) indicated delays despite sporadic acceleration (weeks 26–28 and 30–32). The project requires *IDR* 51.40 billion and 310 days for completion, resulting in an *IDR* 1.52 billion loss and 25-day delay against the 285-day contract. To mitigate such inefficiencies, stakeholders should enhance risk assessments (particularly for permits and third-party dependencies), accelerate material procurement, and implement real-time digital

monitoring alongside EVM. Future research should explore integrating EVM with BIM or AI-driven forecasting to optimize predictive cost-time control in infrastructure preservation.

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