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SCHEDULE DEVIATION EVALUATION OF A THREE-STORY BOARDING HOUSE PROJECT USING EARNED VALUE MANAGEMENT

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Abstract: Delays in construction projects affect the achievement of completion targets, so a control method that evaluates schedule performance effectively is required. This study evaluates the schedule performance of a three-story boarding house project at Gg. Menur, Ngropoh, Condongcatur, Depok, Sleman using a schedule-based Earned Value Management (EVM) approach. Because the project Bill of Quantities (BoQ) was not available, Planned Value (PV) and Earned Value (EV) are represented by cumulative percentages of physical progress rather than by budgeted cost values. The approach is therefore a modified, schedule-only application of EVM: it measures schedule performance alone, and cost indicators such as Cost Variance (CV) and Cost Performance Index (CPI) are outside its scope. A quantitative descriptive approach was applied to the project time schedule and weekly progress reports, and performance was analyzed through Schedule Variance (SV) and Schedule Performance Index (SPI), with weeks classified using a predetermined tolerance band of SPI = 1.00 ± 0.05. At the end of week 35 the PV reached 100% while the EV reached only 76.224%, giving an SV of −23.776 percentage points and an SPI of 0.76. Of the 35 weeks, 60% were ahead of schedule, 14.29% within tolerance, and 25.71% delayed, with sustained delay from week 27. The actual progress rate remained almost constant at about 2.2 percentage points per week throughout, whereas the plan required it to double after week 25, indicating that the deviation arose from a back-loaded baseline rather than from a decline in site productivity. An Earned Schedule analysis gives an estimated duration of approximately 42.6 weeks, about 7.6 weeks beyond the plan.

Keywords: Earned Value Management, project schedule performance, Planned Value, Earned Value, project delay

1. INTRODUCTION

Construction development is one of the important sectors in improving infrastructure and driving economic growth in Indonesia. However, project delay remains a classic problem that frequently arises in various types of construction. Delays can cause serious consequences, such as cost overruns, disruption of operational schedules, and reduced trust between project owners and contractors (Assaf & Al-Hejji, 2006). Many studies note that delays occur due to inadequate planning, ineffective time management, and unstable field conditions (Yap et al., 2021). This phenomenon indicates that efficient project management is an urgent need in the construction industry.

Research on construction delay has converged on a consistent set of causes. Yap et al. (2021) attribute delay in developing countries to late payment, shortage of skilled labor, and design change, while field uncertainty, scope change, and logistical constraints dominate internationally. Aldammak et al. (2025) add stakeholder coordination,

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Adhitya Putra et al. (2023) identify labor, material, and planning as dominant, Sogar et al. (2024) single out late payment from owner to contractor, and Mekonen et al. (2025) trace the consequences through to project beneficiaries. Read together, these studies are diagnostic rather than instrumental: they explain why projects fall behind, but they stop short of showing how a delay is measured week by week while the project is still running. That gap is what schedule-control methods are meant to close, and it is the reason Mokoagow et al. (2024) emphasize that time management must be embedded in execution rather than reconstructed afterwards.

To analyze this problem, this study uses the Earned Value Management (EVM) method. Kerzner (2017) states that EVM is an effective management tool for detecting potential project delays from the early stages of implementation. By comparing the value of planned work (Planned Value) with the value of completed work (Earned Value), project managers can determine the efficiency level of implementation against the schedule and identify potential problems early, so that corrective actions can be taken promptly. As part of project management, systematic control is required to ensure the achievement of time, cost, and quality targets (Citeladze, 2023). Several previous studies, such as Auliasari et al. (2023), have applied the Earned Value method to evaluate the time and cost performance of construction projects and have shown that this method is able to detect implementation deviations in a measurable way.

The gap this study addresses is not simply that boarding houses are smaller than the office towers and infrastructure projects to which EVM is usually applied. It is that the constraints of this project class are structurally different. The site at Gg. Menur sits inside a dense settlement reached by a narrow lane, so material cannot be delivered in bulk, stored on site, or staged ahead of need; deliveries are broken into small loads, working space limits the number of trades that can work concurrently, and the labor force cannot simply be enlarged to recover lost time. Under those conditions the usual recovery levers available to large projects, namely resource-loading and parallel working, are largely unavailable, which makes early and quantified detection of schedule slippage more valuable, not less. Yet small and medium projects of this kind rarely operate a formal control system, so slippage is typically recognised only once it is large. Applying EVM here therefore tests the method where its recovery options are most constrained and its diagnostic value is highest.

Accordingly, this study evaluates the schedule performance of the project by determining PV and EV, computing SV to identify schedule deviation, and classifying weekly performance through SPI. Beyond applying EVM to a new project type, the study contributes in two ways: it adopts a declared tolerance band instead of a rounding rule so that the weekly classification is reproducible, and it separates the effect of the planned baseline from the effect of site productivity by comparing planned and actual progress rates, which shows that the two are commonly conflated when a project is reported simply as delayed.

2. METHOD

This study uses a quantitative descriptive method, namely research that describes the condition of a particular project by processing available data to produce measurable conclusions (Creswell, 2014). The Earned Value concept essentially examines the tendency of time variance and cost variance during project execution; however, this study focuses on time variance.

Project Profile

The object of this study is a three-story boarding house construction project functioning as a rental residential building, located at Gg. Menur, Ngropoh, Condongcatur, Depok, Sleman, Special Region of Yogyakarta. The project was carried out by CV. Tirto Rejo with a planned implementation duration of 35 weeks (January–August 2025). The main scope of work includes preparatory work, demolition, earthworks, reinforced-concrete structural work (foundations, tie beams, columns, and beams across the three floors), architectural and wall work, as well as finishing work and mechanical-electrical-plumbing installations. The project contract value is not included in this study due to the limited availability of cost data; therefore, the analysis uses only the physical progress weights of the work and does not involve the contract cost value. The project data used consist of the *time schedule* (planned S-curve) and the *weekly project report*, which contain the realization of physical progress in each period. Secondary data are data obtained indirectly through documents, archives, and reports already available from the project executor (Sugiyono, 2014). The project location is shown in Figure 1.

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Fig 1. Research Location
Source: Google Maps (2026)

Data Analysis Method

The analysis applies EVM in a modified, schedule-only form. In its conventional definition PV and EV are budgeted cost values, and SPI is therefore a cost-denominated proxy for schedule performance (Anbari, 2003; Project Management Institute, 2017). In this study the project BoQ was not available, so PV and EV are instead the cumulative percentages of physical work planned and completed, taken from the weights of the approved S-curve. The substitution keeps the logic of EVM, which compares work scheduled with work performed, but it changes what the indicators denominate: they express progress in units of physical completion rather than money. Two consequences follow and are carried through the rest of this paper. First, no cost conclusion can be drawn, so CV and CPI are outside the scope of the study. Second, the resulting SPI inherits the known limitation that a cost-denominated or progress-denominated schedule index converges towards unity as a project approaches completion and does not, by itself, measure time (Lipke, 2003); this is the same limitation that motivated Earned Schedule and, later, Earned Duration Management (Khamooshi & Golafshani, 2014). The analysis therefore reports SPI for weekly classification and uses Earned Schedule separately when a duration statement is required.

PV_t = cumulative planned progress in week t (%) (1)

EV_t = cumulative actual progress in week t (%) (2)

Schedule Variance (SV) represents the difference between EV and PV. A positive value (EV > PV) means the work is ahead of schedule, a zero value means on schedule, and a negative value (EV < PV) means delayed. *Schedule Performance Index* (SPI) is the ratio of schedule-time efficiency between EV and PV. Both indicators are calculated as follows:

$$SV_t = EV_t - PV_t \quad (3)$$

$$SPI_t = EV_t / PV_t \quad (4)$$

Weekly performance is classified using a tolerance band declared in advance rather than a rounding rule. A week is classified as ahead of schedule when SPI > 1.05, within tolerance (on schedule) when $0.95 \leq SPI \leq 1.05$, and delayed when SPI < 0.95. Neither the AHSP framework nor the EVM literature prescribes a single universal threshold, since control limits are normally set by the organisation; the band is therefore fixed a priori at ±0.05, which corresponds to a 5% deviation in schedule efficiency, and its influence is tested rather than assumed. Applying no tolerance at all yields 24 weeks ahead, none within tolerance, and 11 delayed, whereas a wider ±0.10 band yields 20, 7, and 8; the adopted ±0.05 band yields 21, 5, and 9. The ranking and the timing of the transition are stable across all three, so the findings do not depend on the choice of band. The SV value in percentage points is reported alongside SPI for every week in Table 1, so that a week classified as within tolerance still discloses the size and sign of its deviation and nothing is concealed by the classification.

The progress data underlying PV and EV were validated before analysis. The work weights that define the S-curve were developed by the contractor from the contract scope, each work item being weighted by its share of the total contract value, and the resulting schedule was approved by the project owner as the baseline for progress reporting; the same approved weights are used unaltered here, so no re-weighting was introduced by the authors. Weekly physical progress was certified by the site supervisor in the weekly report, and the cumulative figures used in this study were checked independently against the sum of the weekly increments, with the closing cumulative value cross-checked against the contractor's own S-curve record; the two agreed, and PV reaching exactly 100.000% in week 35 provides an arithmetic check on the planned series. Data on the causes of delay were not collected through a designed instrument. They were taken from the contractor's weekly report narratives and site

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observations recorded during the same period, and they are therefore reported in this study as descriptive context rather than as tested explanatory variables; no statistical test of their influence is claimed.

3. RESULT

Implementation Schedule and S-Curve

The project *time schedule* was prepared with a duration of 35 weeks and expressed in the form of an S-curve. According to Warsika (2013), the *time schedule* is a plan for allocating time to complete each work item so that implementation runs in an orderly manner and meets the time target. Figure 2 presents the comparison between the cumulative planned progress (PV) and the cumulative actual progress (EV) during project implementation. In the early period, the actual line (EV) lies above the planned line (PV), indicating acceleration; however, from around the middle of implementation, the actual line begins to lag behind the planned line until the end of the project, so that a delay is evident in the final period.

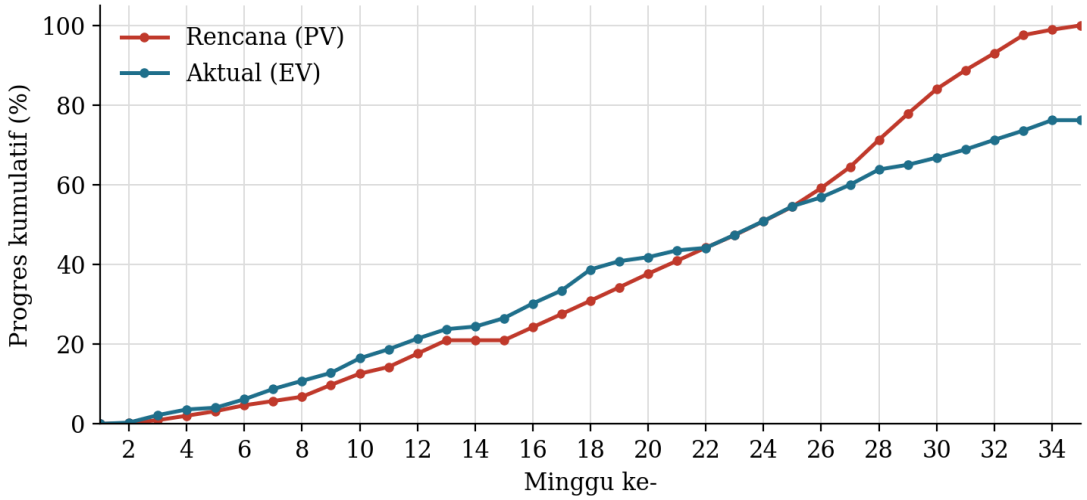


Fig 2. S-Curve Comparison of Planned (PV) and Actual (EV) Progress

Planned Value (PV) and Earned Value (EV) Analysis

Planned Value (PV) describes the target cumulative progress in each week, whereas *Earned Value* (EV) shows the cumulative actual progress achieved in the field. For example, in week 2 the PV was 0.225% with an EV of 0.355%, and in week 7 the PV was 5.763% with an EV of 8.784%, indicating that in the early period the actual progress was higher than the plan. At the end of observation (week 35), the PV reached 100% while the EV was only 76.224%. The growth of the PV and EV values is shown in Figure 3 and Figure 4, while the complete recapitulation for all 35 weeks is presented in Table 1.

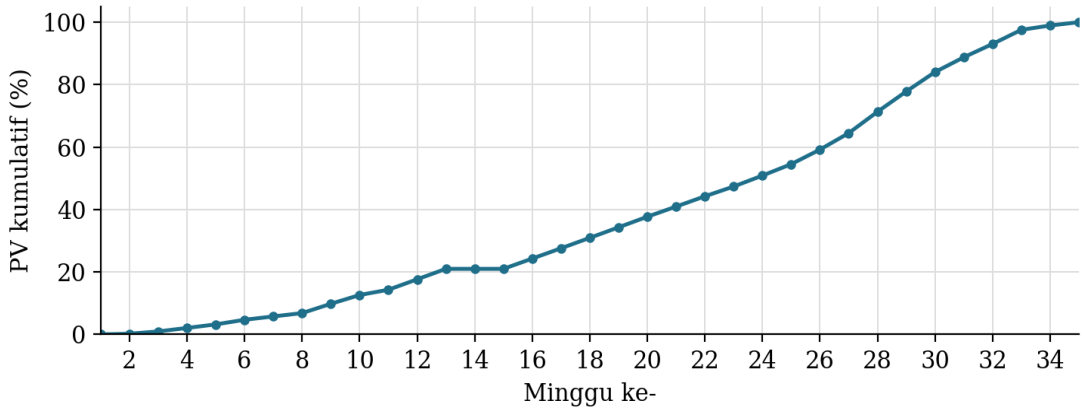


Fig 3. Cumulative Planned Value (PV) Graph

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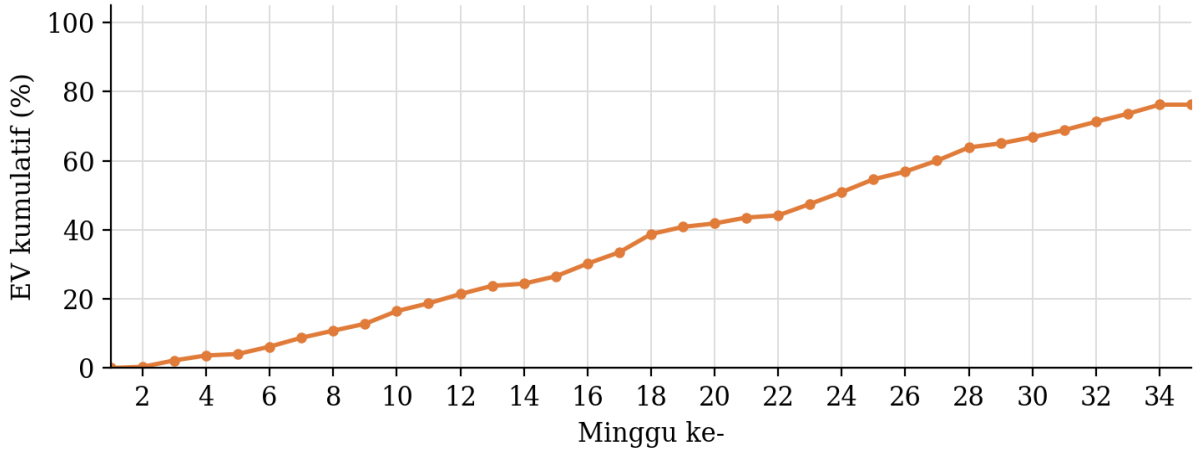


Fig 4. Cumulative Earned Value (EV) Graph

Schedule Variance (SV) Analysis

Schedule Variance (SV) shows the difference between EV and PV in each week (Figure 5). From week 1 to around week 18 the SV is positive and widening, reaching its maximum in week 18 (SV = +7.837). It first turns marginally negative in week 22 (SV = −0.055), a deviation of a few hundredths of a percentage point that is immaterial at project scale. From week 26 the gap opens decisively: SV falls to −2.334 in week 26 and −4.451 in week 27, and thereafter deteriorates every week to −23.776 percentage points in week 35. The final value follows directly from EV 76.224% less PV 100% (76.224 − 100 = −23.776).

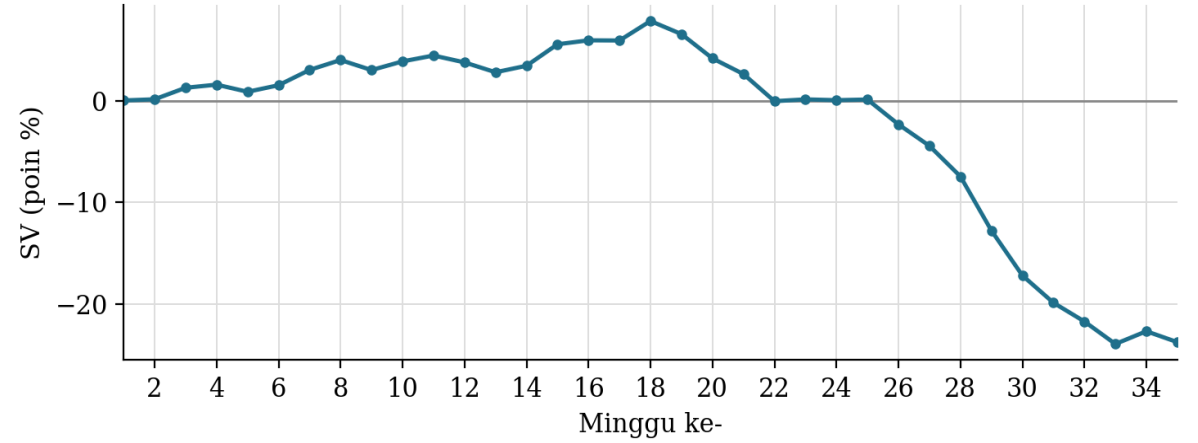


Fig 5. Weekly Schedule Variance (SV) Graph

Schedule Performance Index (SPI) Analysis

Schedule Performance Index (SPI) measures schedule efficiency through the ratio of EV to PV (Figure 6). From week 1 to week 21 the SPI exceeds the upper tolerance limit of 1.05, so those weeks are classified as ahead of schedule; the margin narrows steadily, however, from 2.29 in week 1 to 1.064 in week 21, showing that the early advantage was being eroded well before it disappeared. Weeks 22 to 26 fall within the tolerance band (SPI 0.961 to 1.003) and are classified as on schedule, although the SV reported alongside them shows that week 26 already carries a deviation of −2.334 percentage points at the edge of the band. From week 27 the SPI drops below 0.95 and continues to fall to 0.762 in week 35, so weeks 27 to 35 are classified as delayed. The transition is monotonic: the project is ahead for 21 consecutive weeks, within tolerance for five, and delayed for the final nine, with no alternation between categories.

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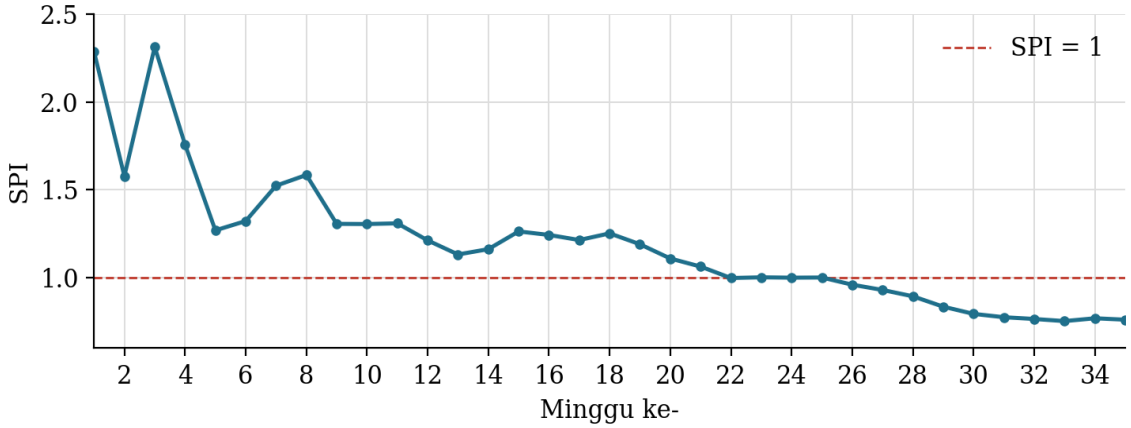


Fig 6. Weekly Schedule Performance Index (SPI) Graph

Over the 35 weeks, 21 weeks were ahead of schedule, five were within the tolerance band, and nine were delayed. Expressed as proportions of the observation period, this gives 60% ahead of schedule, 14.29% on schedule, and 25.71% delayed. The complete recapitulation of PV, EV, SV, SPI, and the resulting category for every week is presented in Table 1.

Table 1. Recapitulation of PV, EV, SV, and SPI Calculations for the Entire Period (35 Weeks)

Week	PV (%)	EV (%)	SV (pts %)	SPI	Category
1	0.014	0.032	0.018	2.29	Ahead of schedule
2	0.225	0.355	0.130	1.58	Ahead of schedule
3	0.962	2.225	1.263	2.31	Ahead of schedule
4	2.074	3.646	1.572	1.76	Ahead of schedule
5	3.216	4.085	0.869	1.27	Ahead of schedule
6	4.695	6.210	1.515	1.32	Ahead of schedule
7	5.763	8.784	3.021	1.52	Ahead of schedule
8	6.830	10.827	3.997	1.59	Ahead of schedule
9	9.806	12.813	3.007	1.31	Ahead of schedule
10	12.626	16.488	3.862	1.31	Ahead of schedule
11	14.308	18.747	4.439	1.31	Ahead of schedule
12	17.657	21.420	3.763	1.21	Ahead of schedule
13	21.004	23.796	2.792	1.13	Ahead of schedule

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Week	PV (%)	EV (%)	SV (pts %)	SPI	Category
14	21.004	24.435	3.431	1.16	Ahead of schedule
15	21.004	26.550	5.546	1.26	Ahead of schedule
16	24.296	30.231	5.935	1.24	Ahead of schedule
17	27.589	33.507	5.918	1.21	Ahead of schedule
18	30.935	38.772	7.837	1.25	Ahead of schedule
19	34.303	40.851	6.548	1.19	Ahead of schedule
20	37.698	41.858	4.160	1.11	Ahead of schedule
21	40.945	43.560	2.615	1.06	Ahead of schedule
22	44.238	44.183	−0.055	1.00	On schedule
23	47.365	47.489	0.124	1.00	On schedule
24	50.871	50.913	0.042	1.00	On schedule
25	54.528	54.637	0.109	1.00	On schedule
26	59.196	56.862	−2.334	0.96	On schedule
27	64.481	60.030	−4.451	0.93	Delayed
28	71.311	63.848	−7.463	0.90	Delayed
29	77.818	65.025	−12.793	0.84	Delayed
30	84.030	66.816	−17.214	0.80	Delayed
31	88.764	68.868	−19.896	0.78	Delayed
32	93.024	71.282	−21.742	0.77	Delayed
33	97.550	73.593	−23.957	0.75	Delayed
34	98.929	76.224	−22.705	0.77	Delayed
35	100.000	76.224	−23.776	0.76	Delayed

4. DISCUSSIONS

The EVM indicators turn the time schedule into measurable performance data, but their most informative feature in this project is not the size of the final deviation; it is where the deviation came from. The conventional reading of Figure 6, that the project ran ahead of schedule and then lost momentum from week 26, is incomplete. Decomposing the two curves into rates shows that the actual work rate barely moved: the project earned 54.637% in the first 25 weeks, an average of 2.185 percentage points per week, and 21.587% in the last ten weeks, an average of 2.159 percentage points per week, a change of just 1%. The planned rate, by contrast, is not constant at all. The baseline schedules 54.528% for the first 25 weeks (2.181 points per week) and the remaining 45.472% for the final ten (4.547 points per week), requiring the site to more than double its output for the last 29% of the duration. The site never accelerated, but neither did it slow down. The deviation therefore originates in a back-loaded baseline that site delivery was never structured to meet, rather than in a collapse of productivity after week 26, and the early positive SV was in part an artefact of the same back-loading: progress looked good while it was being compared against an undemanding early plan.

This reading is consistent with the composition of the work scheduled in each period. The first half of the programme is dominated by substructure and structural frame activities, which are repetitive, need few trades working at once, and suit the narrow access of the site because material arrives in discrete batches. The final third concentrates the architectural and finishing packages, namely floor finishes, doors and windows, ceilings, painting

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and facade work, which carry a large combined weight and, unlike the frame, must run concurrently to achieve the planned rate. Concurrency is precisely what this site cannot supply: limited working space caps the number of trades that can be deployed at once, and the narrow lane prevents the bulk delivery and on-site storage that finishing packages require. The high-weight finishing activities are therefore the proximate contributors to the SPI decline, but the underlying cause is the mismatch between a baseline that assumed concurrency and a site that could not physically deliver it. Field records for the period report late material distribution, restricted access, weather, and limited working space, which is consistent with this interpretation, although as stated in the method these factors were recorded descriptively and were not tested quantitatively.

These findings share similarities with the study by Septiyanto (2018) on a school dormitory building project that experienced delays due to late material procurement, delays in preceding work, and suboptimal labor, with an SPI of 0.828. In line with this, Junaidi et al. (2022) also used the Earned Value method to control the cost and time of a flyover project that experienced schedule deviation, and Johari and Islami (2022) applied the Earned Value concept to analyze project cost and time so that performance deviations could be identified earlier. These similarities reinforce that project delays are generally influenced by field implementation obstacles that cause the actual progress to be lower than planned.

Compared with other reported projects, the final SPI of 0.76 is low. Septiyanto (2018) recorded 0.828 on a school dormitory project delayed by late material procurement, predecessor delays, and suboptimal labor, so the present project ends further behind despite being smaller and simpler; scale is evidently no protection when recovery levers are unavailable. Junaidi et al. (2022) and Johari and Islami (2022) applied Earned Value to a flyover and to a well hook-up project and, in both, deviation was identified while the work was still running, which allowed corrective action. The comparison should be read with care, since these projects differ in type, scale, and measurement basis, and the present index is denominated in physical progress rather than cost. What they share is the pattern reported by Ervianto (2007), in which delay emerges from the interaction of management, resources, and field conditions rather than from any single cause.

A duration statement requires a different indicator. The SPI used above is denominated in physical progress, and dividing the planned duration by it (35 / 0.762 = 45.9 weeks) implicitly assumes that the remaining 23.776% will be earned at the same efficiency, which the rate analysis has already shown to be the wrong assumption. Earned Schedule avoids this by measuring progress on the time axis (Lipke, 2003; Lipke et al., 2009). At week 35 the EV of 76.224% corresponds to the point on the baseline lying between weeks 28 and 29, giving an Earned Schedule of 28.755 weeks and a time-based index SPI(t) = 28.755 / 35 = 0.822. The resulting forecast, IEAC(t) = 35 / 0.822, is approximately 42.6 weeks, about 7.6 weeks beyond plan, some three weeks shorter than the estimate implied by the progress-based SPI. The two figures differ because they measure different things, and the divergence is itself the finding: an SPI of 0.76 does not translate into a 24% time overrun. Comparative evaluations of duration forecasting methods report the same pattern, that schedule indices denominated on the cost or progress axis are weaker predictors of final duration than time-based measures, especially in the later stages of a project (Vandevoorde & Vanhoucke, 2006). This forecast assumes that the remaining work is earned at the observed time-based efficiency, that the baseline sequence holds, and that no acceleration is applied; because the analysis stops at week 35 and no post-week-35 records were available, the estimate could not be validated against the actual completion date and should be treated as indicative.

The study is bounded in three respects. The absence of a complete BoQ confines the analysis to schedule performance, so CV and CPI, and therefore any statement about cost efficiency or about cost-schedule trade-offs, lie outside its scope. The causes of delay are descriptive, drawn from weekly report narratives rather than from a designed instrument, and are not statistically tested. The evaluation is also retrospective, ending at the last planned week, so while the indicators would have been available week by week during execution, this study does not demonstrate that they were used, or would have been acted upon, in real time. Future work could combine EVM with the Critical Path Method or the Precedence Diagram Method, as compared by Sudjatmiko et al. (2026), to link the aggregate index to the specific activities that govern the completion date, and could incorporate the cost dimension once a BoQ is available so that schedule and cost performance can be evaluated together.

5. CONCLUSION

At the end of the 35-week baseline the project had earned 76.224% of its planned scope against a planned 100%, giving a Schedule Variance of −23.776 percentage points and a Schedule Performance Index of 0.76. Of the 35 weeks, 60% were ahead of schedule, 14.29% within the ±0.05 tolerance band, and 25.71% delayed, the

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project moving from ahead to within tolerance at week 22 and into sustained delay from week 27. The principal finding, however, is not the deviation itself but its origin: the actual progress rate held almost constant at about 2.2 percentage points per week across the whole project, while the baseline required that rate to double after week 25. The delay was produced by a back-loaded plan that the site was never structured to deliver, not by a fall in productivity.

Two implications follow. First, an SPI of 0.76 should not be read as a 24% time overrun; the Earned Schedule analysis places the likely duration at about 42.6 weeks, roughly 7.6 weeks beyond plan, and the gap between the two figures shows that a progress-denominated index does not measure time. Second, because this evaluation is retrospective, it demonstrates that EVM can quantify and locate a deviation, not that it delivered early warning on this project; the indicators would have been available from week 22, but the study cannot show they were acted upon. For practice, the recommendation is accordingly twofold. During execution, PV and EV should be compared weekly and the tolerance band treated as a trigger, so that a breach initiates review rather than observation. Where the site cannot absorb additional concurrent trades, as here, recovery should be sought through procurement and sequencing rather than resource loading: securing material deliveries ahead of the finishing packages, reallocating labor to the activities that govern the completion date, and rescheduling the back-loaded finishing work across a longer window at planning stage. Most usefully, a baseline that demands a doubling of output in its final third should be challenged before it is approved, since the analysis here indicates that this is where the delay was created.

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