JURNAL TEKNIK SIPIL CENDEKIA
e-ISSN : 2723-3375
doi : **10.51988/jtsc.v7i3.607**
pp : **612-621**

Comparative Analysis of Project Completion Forecasting Using Earned Value Management, Earned Schedule, and Program Evaluation and Review Technique

***Kevin Ardian Krisanto[1], Mega Waty[2]**
[1,2]Civil Engineering Master Program, Tarumanagara University, West Jakarta
*)Corresponding Author: kevin.327241020@stu.untar.ac.id

Received : 19 Juni 2026 Revised : 18 Juli 2026 Accepted : 30 Juli 2026

Abstract

This study evaluates schedule performance and forecasts the completion time of a restaurant construction project in the PIK 2 area by integrating Earned Value Management (EVM), Earned Schedule (ES), and the Program Evaluation and Review Technique (PERT). Unlike previous studies that apply these methods separately or through pairwise comparisons, this study integrates deterministic performance evaluation and probabilistic schedule forecasting to provide a comprehensive framework for project control. The project was evaluated at week 13 of a planned 37-week duration. EVM produced a Schedule Variance (SV) of −Rp1,051,310,568 and a Schedule Performance Index (SPI) of 0.774, forecasting completion at week 48. ES generated a Time Variance (SV(t)) of −4.44 weeks and an SPI(t) of 0.659, projecting completion at week 56. PERT estimated an expected project duration of 122.67 days and forecast completion at week 42 without acceleration and week 40 with acceleration at a 95% confidence level. The findings demonstrate that integrating EVM, ES, and PERT provides complementary insights for monitoring project performance, quantifying schedule uncertainty, and improving completion forecasting.

Keywords: *Construction Project, Earned Value Management, Earned Schedule, Program Evaluation and Review Technique, Schedule Performance*

INTRODUCTION

Construction projects in practice frequently struggle to meet predetermined time and cost targets, particularly as work complexity escalates alongside dynamic field conditions, design revisions, and various technical obstacles [1]. Cost overruns and schedule delays are among the most prevalent challenges faced by project stakeholders, and when left unaddressed, they can trigger declining productivity, diminished project value, and even contract termination [2]. To mitigate such risks, implementing a control system capable of objectively measuring project performance and forecasting completion outcomes has become indispensable within the domain of construction project management [3].

Among the most extensively discussed control techniques in the literature is Earned Value Management (EVM), a quantitative approach that simultaneously evaluates cost and schedule performance based on the actual volume of work accomplished [2]. EVM provides key performance indicators including Schedule Variance (SV) and Schedule Performance Index (SPI), which serve to assess whether a project is progressing in alignment with its planned cost and schedule, while also generating early warning signals for any emerging deviations [1]. Numerous empirical studies have demonstrated the effectiveness of EVM in construction project control; notably, research conducted on road reconstruction projects found that integrating EVM with the Critical Path Method (CPM) enabled earlier detection of performance deviations and yielded more accurate completion time forecasts compared to conventional approaches [4]. A separate study on a multi-story building project in Jakarta similarly illustrated that consistent EVM application can deliver a comprehensive performance overview, which proves highly valuable for project managers in making informed control decisions [5]. Furthermore, a systematic review of construction project management literature from 2020 to 2025 identified the integration of cost and schedule methods, such as EVM as one of the most widely recommended strategies for enhancing project management efficiency [6].

Despite offering an integrated performance overview, EVM carries a notable limitation, particularly in its capacity to predict project completion duration in actual time units [7]. Schedule indicators within EVM, such as SPI, remain expressed in monetary value terms, which can render the interpretation of delays or accelerations in real-time context less precise. This shortcoming has been highlighted in comparative analyses between EVM and Earned Schedule (ES) an extension of EVM that converts schedule performance indicators into time-based units, thereby producing completion duration forecasts that are both more intuitive and temporally relevant [7]. A comparative study conducted on a double-track railway project demonstrated that the Earned Schedule method generated completion time predictions that more closely reflected actual field outcomes than those produced by conventional EVM [8]. Analogous findings were confirmed in a study of an apartment construction project in Tangerang, where ES proved to deliver more accurate duration estimates and greater reliability for schedule replanning purposes [9]. This distinction holds significant practical importance, as time-unit predictions allow project managers to formulate more realistic recovery plans and make more targeted decisions in addressing schedule delays.

While ES addresses several of EVM's shortcomings in schedule interpretation, both methods remain fundamentally deterministic, their completion duration forecasts are derived from historical project progress trends without accounting for potential variability in future activity durations [7]. In construction practice, activity duration variability arises from unpredictable factors such as extreme weather events, sudden design changes, material supply disruptions, and fluctuating labor productivity [1]. Given this inherent uncertainty, deterministic approaches often yield predictions that inadequately reflect the true risks surrounding project completion. This concern has prompted researchers to compare project duration estimates produced by Earned Schedule against those of Earned Duration Management (EDM), with comparative findings indicating that each method carries distinct predictive advantages depending on project characteristics and progress stage [10]. Additionally, a study on a motorcycle parking structure project reinforced the view that time control through EVM must be supplemented with further analytical tools to generate more comprehensive, data-driven recommendations for managing schedule delays [11].

To address these limitations, the Program Evaluation and Review Technique (PERT) was introduced as a probabilistic scheduling approach that incorporates three duration estimates, optimistic, most likely, and pessimistic to explicitly account for activity duration uncertainty within a project [12]. This framework produces a range of plausible completion time estimates along with associated probability values for various scenarios, enabling project managers to assess delay risks far more comprehensively than the single-point forecasts offered by deterministic methods such as EVM or ES [13].

This research is closely aligned with Sustainable Development Goal (SDG) 9: Industry, Innovation and Infrastructure, particularly in its pursuit of enhancing the efficiency and reliability of construction project execution through the adoption of data-driven and quantitatively grounded schedule control methods. In this regard, the implementation of more accurate, evidence-based project control approaches constitutes a tangible form of innovation within the construction industry, one that resonates with SDG 9's vision of building resilient, inclusive, and sustainable infrastructure [14]. The application of Earned Value Management (EVM), Earned Schedule (ES), Time Variance Analysis (TVA), and the Program Evaluation and Review Technique (PERT) is expected to contribute to reducing delay risks, improving resource management effectiveness, and advancing the realization of more productive, innovative, and sustainable infrastructure development. Moreover, the early warning capability of these methods against potential schedule deviations can serve as a sound basis for more timely and well-informed decision-making, thereby enabling project execution to proceed with greater efficiency and deliver optimal benefits to all stakeholders. Indirectly, enhanced project execution efficiency and the reduction of waste resulting from delays also contribute to the goals of SDG 12: Responsible Consumption and Production, by promoting more effective and sustainable utilization of construction resources [15].

Although previous studies have demonstrated the effectiveness of Earned Value Management (EVM), Earned Schedule (ES), and the Program Evaluation and Review Technique (PERT), these methods have largely been investigated independently or through pairwise comparisons. Existing research primarily emphasizes either deterministic monitoring of current project performance (EVM and ES) or probabilistic estimation of project duration (PERT), with limited efforts to integrate both perspectives into a unified framework for schedule evaluation and forecasting. As a result, project managers often rely on separate analyses that provide fragmented information, making it difficult to simultaneously assess current schedule performance, quantify future uncertainty, and formulate appropriate corrective actions. To address this research gap, this study integrates EVM, ES, and PERT within a single analytical framework to evaluate schedule performance and forecast project completion from complementary deterministic and probabilistic perspectives. This integrated approach provides a more comprehensive basis for project control by combining actual performance monitoring, time-based schedule assessment, and risk-informed completion forecasting, thereby supporting more reliable and informed managerial decision-making in construction projects.

METHOD

This study employed a descriptive quantitative approach using a case study of a restaurant construction project located in the PIK 2 area. The data analyzed consisted of the Planned Budget Estimate (Rencana Anggaran Biaya/RAB), the baseline project schedule represented by the planned S-Curve, and actual project progress reports. The research methodology was conducted through a systematic sequence of data collection, processing, schedule performance evaluation, completion time forecasting, and comparative analysis using three complementary methods: Earned Value Management (EVM), Earned Schedule (ES), and the Program Evaluation and Review Technique (PERT). The overall research workflow is illustrated in Figure 1.

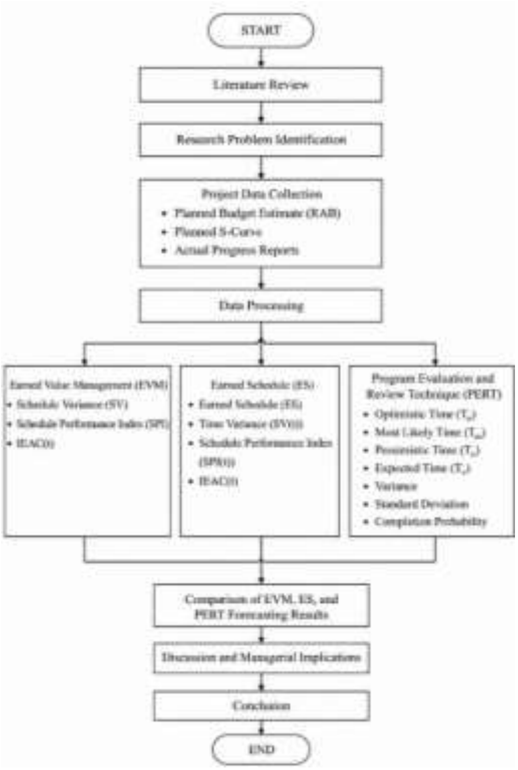


Figure 1. Research Methodology Flowchart

As illustrated in Figure 1, the research began with collecting project planning and progress data, followed by data processing to support schedule performance evaluation and completion time forecasting. The processed data were subsequently analyzed using EVM to assess schedule performance based on cost and progress, ES to evaluate schedule performance from a time-based perspective, and PERT to estimate project duration under uncertainty. Finally, the forecasting results obtained from the three methods were compared to identify their respective characteristics and practical implications for project schedule control. The analytical procedures and mathematical formulations for each method are presented in the following sections.

1. EVM Analysis, encompassing the calculation of Schedule Variance (SV), Schedule Performance Index (SPI), and the projected completion estimate $IEAC_{(t)}$.

$$SV = BCWP - BCWS \quad (1)$$

$$SPI = \frac{BCWP}{BCWS} \quad (2)$$

$$IEAC_{(t)} = \frac{BAC/SPI}{BAC/PD} \quad (3)$$

2. ES Analysis, involving the conversion of earned value (EV) achievements into time-based units (ES), followed by the assessment of time efficiency through $SPI_{(t)}$ and the derivation of the projected completion estimate $IEAC_{(t)}$.

$$SV_{(t)} = ES - AT \quad (4)$$

$$SPI = \frac{ES}{AT} \quad (5)$$

$$IEAC_{(t)} = AT + \frac{(PD-ES)}{SPI_{(t)}} \quad (6)$$

3. PERT Analysis, examining project duration by incorporating temporal uncertainty inherent in activity execution, thereby reflecting the variability of actual field conditions.

$$t_e = \frac{t_o + 4t_m + t_p}{6} \quad (7)$$

$$\sigma e = \frac{t_p - t_o}{6} \quad (8)$$

$$Ve = \left(\frac{t_p - t_o}{6}\right)^2 \quad (9)$$

$$\sigma E = \sqrt{\sum Ve} \quad (10)$$

$$Z = \frac{T_s - T_e}{\sigma E} \quad (11)$$

RESULTS AND DISCUSSION

To evaluate project schedule performance during the observation period, an analysis was conducted using the Earned Value Management (EVM) method. This approach was selected for its ability to integrate work progress information and planned schedule data into quantitative parameters that objectively measure the degree of project deviation. In this study, the evaluation was performed at week 13 by computing the Schedule Variance (SV), Schedule Performance Index (SPI), and Independent Estimate at Completion in Time ($IEAC_{(t)}$). These three parameters were employed to assess the current state of project schedule performance while simultaneously projecting the expected completion time should the prevailing performance trend persist through the remainder of project execution.

SV = BCWP - BCWS
= Rp. 3.609.124.596,00 - Rp. 4.660.435.164,00
= - Rp. 1.051.310.568,00

The calculation results yielded a Schedule Variance (SV) of −Rp. 1.051.310.568,00. This negative figure indicates that the value of work accomplished through week 13 falls short of what was originally planned to be achieved by that point in the schedule. In practical terms, the project is in a delayed state, as actual progress has not kept pace with the established targets. The magnitude of this deviation suggests that the delay is not trivial in nature; rather, it has already exerted a considerably significant impact on the overall schedule performance of the project.

$$SPI = \frac{BCWP}{BCWS} = \frac{\text{Rp. } 3.609.124.596,00}{\text{Rp. } 4.660.435.164,00} = 0,77441.$$

The computed Schedule Performance Index (SPI) of 0.77441 reveals that the efficiency of project schedule execution remains below the planned benchmark. This value can be interpreted as follows: for 1.00 worth of work that was scheduled to be completed, the project managed to accomplish only 0.77441 worth. Given that the SPI falls below unity, it can be conclusively determined that the project is experiencing execution delays. Beyond indicating schedule deviation, the SPI value also provides insight into the project's time productivity level, which continues to lag behind the ideal condition.

$$IEAC_{(t)} = \frac{\mathrm{BAC/SPI}}{\mathrm{BAC/PD}}$$

$$= \frac{\left(\frac{\mathrm{Rp.\ 7.179.480.000,00}}{0{,}77441}\right)}{\left(\frac{\mathrm{Rp.\ 7.179.480.000,00}}{37}\right)}$$

$$= 47{,}777 \approx \text{Minggu ke-48.}$$

The Independent Estimate at Completion in Time ($IEAC_{(t)}$) calculation produced a projected completion duration of 47.778 weeks, rounded to week 48. This estimate implies that, should the current schedule performance level remain unchanged from the point of measurement, the project is expected to conclude approximately nine weeks beyond the originally planned duration of 37 weeks. This finding carries considerable practical significance, as it offers an early indication of the consequences stemming from the ongoing delay and provides a basis upon which project management may contemplate acceleration measures to minimize completion deviation.

While EVM is capable of signaling project delays through its SV and SPI parameters, schedule performance interpretation remains grounded in a cost-based framework. Accordingly, to obtain a more representative depiction of the delay in actual time units, the analysis was extended using the Earned Schedule (ES) method. This approach converts value-based progress into time-based parameters, enabling the degree of project delay to be interpreted in a more direct and accessible manner for project managers.

$$SV_{(t)} = \mathrm{ES - AT}$$

$$= 8{,}56237 - 13$$

$$= -4{,}43763.$$

The calculation results indicate a Schedule Variance in Time ($SV_{(t)}$), also referred to as Time Variance Analysis (TVA), of −4.43763 weeks. This negative value signifies that the actual project progress position lags approximately 4.44 weeks behind the planned schedule at the time of evaluation. Stated differently, at the point when the project had entered week 13, the actual progress achieved was equivalent to what should have been accomplished around week 8.56 according to the planned schedule. This finding offers a more intuitive representation of the project's delay status compared to the value-based approach employed in EVM.

$$SPI_{(t)} = \frac{\mathrm{ES}}{\mathrm{AT}}$$

$$= \frac{8{,}56237}{13}$$

$$= 0{,}65864.$$

The Schedule Performance Index in Time ($SPI_{(t)}$) of 0.65864 reveals that the time efficiency of project execution reaches only approximately 65.86% of the planned condition. This means that for every one week of execution time utilized, the project generates progress equivalent to only 0.65864 weeks of planned work. The notably lower $SPI_{(t)}$ value relative to the SPI derived from EVM suggests that the Earned Schedule approach tends to be more sensitive in detecting project delays, given that all calculations are conducted directly in time units.

$$IEAC_{(t)} = \mathrm{AT} + \frac{(\mathrm{PD-ES})}{SPI_{(t)}}$$

$$= 13 + \frac{(37 - 8{,}56237)}{0{,}65864}$$

$$= 56{,}1760 \approx \text{Minggu ke-56.}$$

Drawing from the obtained $SPI_{(t)}$ value, the project completion estimate under the Earned Schedule method yields an $IEAC_{(t)}$ of 56.176 weeks, rounded to week 56. This result reflects a substantially longer projected duration compared to the EVM-derived estimate of 47.778 weeks. The discrepancy indicates that the Earned Schedule approach captures the temporal impact of delays more comprehensively, as its calculations are no longer influenced by the characteristics of cost data. Consequently, the completion estimate produced by ES may be regarded as more representative in portraying the true consequences of delays on project completion time.

Unlike EVM and ES, which leverage actual project progress data to forecast completion time based on ongoing performance trends, the Program Evaluation and Review Technique (PERT) adopts a probabilistic framework that explicitly accounts for uncertainty in project activity durations. By combining optimistic, most likely, and pessimistic time estimates for each critical activity, PERT not only generates a project completion duration estimate but also determines the probability of achieving a specified time target. For this reason, PERT analysis in this study serves to evaluate the confidence level of project completion and establish a statistically safe duration based on a predetermined probability threshold.

Following the delay evaluation conducted through EVM and ES, the analysis was further extended using the Program Evaluation and Review Technique (PERT) to examine the probability distribution of project completion time while accounting for activity duration uncertainty. In contrast to the two preceding methods, which rely on actual progress data, PERT employs a probabilistic approach through three duration estimates: the optimistic time (T_o), the most likely time (T_m), and the pessimistic time (T_p). This framework enables project completion to be estimated not solely based on current conditions, but also by incorporating the range of execution variability that may arise throughout the remaining project work. Two PERT calculation scenarios were applied in this study, one without acceleration and one with acceleration, so that the resulting estimates more closely approximate the original planned duration.

$$
\begin{aligned}
T_e &= \frac{(To + 4Tm + Tp)}{6} \\
&= \frac{(100 + 4(110) + 115)}{6} \\
&= 109{,}167 \text{ hari.}
\end{aligned}
$$

Based on the expected duration (Te) calculations, the estimated execution time for each activity along the project's critical path was obtained. The Te value represents a weighted average duration considered the most realistic estimate, as it assigns the greatest weight to the most probable time scenario. Accordingly, the resulting value reflects neither the ideal nor the worst-case condition, but rather a more balanced representation of the likely execution of field activities. The Te values computed for all critical activities were subsequently used as the foundation for determining the overall project expected duration.

$$
\begin{aligned}
\sigma_e &= \frac{(Tp - To)}{6} \\
&= \frac{(115 - 100)}{6} \\
&= 2{,}5 \text{ hari.} \\
V_e &= \sigma e^2 \\
&= 2{,}5^2 \\
&= 6{,}25.
\end{aligned}
$$

In addition to computing the expected duration, the PERT method also quantifies the degree of uncertainty associated with each activity through the standard deviation (σe) and variance (Ve) parameters. These two parameters characterize the potential magnitude of deviation in activity duration from its expected value. The wider the range between the optimistic and pessimistic time estimates, the greater the level of uncertainty attributed to that activity. The variance calculation is therefore of critical importance, as it serves as the basis for measuring the overall time risk along the project's critical path. Table 1 presents all computed parameters derived from each critical activity identified in this study.

Table 1. Calculation T_e, σ_e, dan V_e No Crashing

Code	T_e	σ_e	V_e
A	109.17	2.5	6.25
F1	40.83	2.5	6.25
Ib	39.67	2	4
Ib1	30.5	1.83	3.36
Ja	51	4	16
Jb	10.17	1.17	1.36
Jc	10	1.33	1.78
Jd	10.83	1.5	2.25
Je	4.83	0.5	0.25
Jg	9.17	1.17	1.36
	Total Ve (∑ Ve)		42.87

Once the variances of all critical activities were aggregated, the project standard deviation (σE) was obtained as a measure of overall project duration uncertainty.

$$
\begin{aligned}
\sigma_E &= \sqrt{\sum Ve} \\
&= \sqrt{42{,}861} \\
&= 6{,}5468.
\end{aligned}
$$

This value reflects the degree of spread in the possible completion durations relative to the project's expected duration — the larger the standard deviation, the wider the range of plausible completion times. As such, this parameter constitutes the primary component in the project completion probability analysis conducted through the normal distribution framework.

Table 2. Latest Early Finish No Crashing

Code	Predecessor	Early Start	Early Finish
A		0	109.16
F1	FS C3	0	50.833
Ib	FS+20 F1	70.833	110.5
Ib1	SS-10 Ib	60.833	91.33
Ja	SS-10 Ib	50.833	101.83
Jb	FS-5 Ja	96.833	107
Jc	FS-5 Jb	102	112
Jd	FS-5 Jc	107	117.83
Je	FS Jd	117.83	122.67
Jg	FF Je	113.5	122.67
	Te = Latest EF =		122.67

Based on the cumulative expected durations of all critical path activities, the overall project expected duration (Te) was determined to be 122.67 days. This value represents the most probable project completion time derived from the combined duration estimates of all analyzed activities, and serves as the reference point for calculating the probability of achieving any specified time target through the normal distribution approach.

To determine the likelihood of completing the project within the established target, a Z-value was computed using the target project duration (Ts), the expected project duration (Te), and the project standard deviation (σE). The Z-value functions as a measure of the target time's position relative to the probability distribution of project duration. The greater the gap between the time target and the expected duration, the lower the probability of achieving that target, assuming the level of project uncertainty remains constant.

$$Z = \frac{Ts - Te}{\sigma E}$$

$$= \frac{110 - 122{,}667}{6{,}5468}$$

$$= -1.934.$$

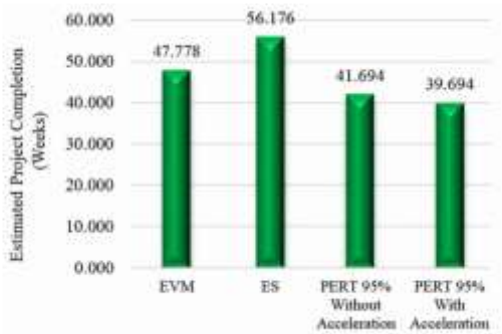
The calculation yielded a Z-value of −1.93, which was subsequently converted using the standard normal distribution table to obtain the probability of project completion within the specified target duration. This Z-value corresponds to a probability of 0.00268, or 0.268%. This result indicates that the likelihood of completing the project in accordance with the original target is extremely low. In other words, the initially planned duration falls considerably below what would be statistically deemed realistic given the level of uncertainty present across the critical path activities.

A time target adjustment is therefore necessary to attain a higher reliability level specifically 95%, which is widely adopted as the safety threshold in project planning. To this end, the target duration (Ts) was computed using the project standard deviation (σE) and the Z-value corresponding to the desired probability level. A Z-value of 1.65, derived from the standard normal distribution table, represents a cumulative probability of 95% on the distribution curve, indicating a 95% chance that the project will be completed on or before that duration.

$$T_s = \sigma_E \times Z + T_e$$
$$= (6{,}5468 \times 1{,}65) + 122{,}667$$
$$= 133{,}47 \text{ hari.}$$

The duration calculation at the 95% confidence level indicates that the project requires 133.47 days to attain a reasonably safe level of completion certainty. Viewed within the context of the overall project, by adding the calculated remaining duration of 133.47 days (27 weeks) to the already-completed duration of 65 days (13 weeks), it can be concluded that the project is projected to finish at week 40 excluding the Eid holiday period, or at week 42 when the holiday is factored in, at a 95% confidence level. This figure implicitly reflects an additional buffer of approximately 5 weeks, or 25 working days, beyond the project's expected duration, a logical consequence of the accumulated uncertainty across each critical path activity.

An identical set of calculations was subsequently carried out to determine the Ts value under the acceleration scenario. The key distinction lies in the expected duration (Te), which, under the acceleration scenario, was reduced to 112.67 days. As a result, the duration calculation at the 95% confidence level indicates that the project requires 123.47 days to achieve a comparable level of completion certainty. Within the overall project framework, combining the remaining duration of 123.47 days (24 weeks) with the completed duration of 65 days (13 weeks) yields a projected completion at week 38 excluding the Eid holiday, or week 40 inclusive of the holiday, at a 95% confidence level.



Picture 1. Estimated Project Completion

As illustrated in Figure 1, a comparison of project completion duration estimates across the three methods reveals differing outcomes, attributable to the distinct conceptual foundations and analytical objectives underlying each approach. The EVM method projects project completion at week 48, whereas ES forecasts completion at week 56. This discrepancy reflects the greater sensitivity of the Earned Schedule approach in detecting schedule delays, as all its computations are anchored in the time dimension. By contrast, EVM continues to rely on cost-value-based indicators, meaning that delays occurring in the field are not always proportionally captured in its resulting estimates. Consequently, ES tends to produce longer and more realistic duration projections when a project is experiencing significant delays.

The PERT results, on the other hand, at the 95% confidence level, yield a duration of 42 weeks under the no-acceleration scenario and 40 weeks under the acceleration scenario. These figures are not directly comparable to the EVM and ES outputs, as PERT serves a fundamentally different purpose, namely, to analyze activity duration uncertainty and determine the duration required for the project to carry a specified level of confidence in achieving on-time completion. By incorporating three activity duration scenarios (optimistic, most likely, and pessimistic), PERT produces what may be characterized as a confidence-based duration that functions as a safety boundary in project planning. The results further demonstrate that the application of acceleration to critical activities is capable of shortening the project completion duration while maintaining the 95% confidence threshold. In light of these distinctions, EVM and ES are most appropriately utilized as tools for monitoring actual project performance, whereas PERT serves as a risk-informed planning instrument that assists in establishing more reliable and measurable completion targets.

CONCLUSION

This study demonstrates that the combined application of Earned Value Management (EVM), Earned Schedule (ES), and the Program Evaluation and Review Technique (PERT) offers distinct yet mutually complementary perspectives in the evaluation and forecasting of construction project completion. The EVM analysis projected project completion at week 48, while the ES method estimated completion at week 56. This divergence underscores the greater sensitivity of the Earned Schedule approach in identifying schedule delays, given its direct reliance on time-based parameters, which in turn yields more realistic estimates of the project's actual delay condition.

The PERT analysis estimated project completion at 42 weeks under the no-acceleration scenario and 40 weeks under the acceleration scenario, both at a 95% confidence level. These findings indicate that accelerating critical activities effectively shortens the overall project duration while maintaining a high level of confidence in achieving the planned completion time. Overall, EVM and ES are effective tools for monitoring and evaluating schedule performance based on actual project progress, whereas PERT complements them by providing probabilistic completion forecasts that account for schedule uncertainty. Integrating these three methods therefore offers a more comprehensive framework for project schedule control and supports more informed decision-making in construction project management.

ACKNOWLEDGMENT

The authors would like to express their gratitude primarily to the Master of Civil Engineering Program at Universitas Tarumanagara for the academic support extended throughout the course of this research. Sincere appreciation is also directed to Dr. Mega Waty for her guidance, direction, and constructive feedback, which contributed greatly to the successful completion of this study. Acknowledgment is further extended to all parties who supported the data collection process and facilitated the conduct of this research.

REFERENCES

[1] Kerzner, H. (2025). Project Management: A Systems Approach To Planning, Scheduling, And Controlling (14th Edition) (14th ed.). John Wiley & Sons.

[2] Melkisedek, J. & Jin, O, F. (2024). Analisis Prediksi Durasi Akhir Proyek dengan Metode Earned Value dan Earned Schedule. JMTS: Jurnal Mitra Teknik Sipil, 7(4), 1377–1388. https://doi.org/10.24912/jmts.v7i4.30380

[3] Tangtobing, R. F. F., & Waty, M. (2023). Penerapan Metode Earned Value dan Earned Schedule Pelaksanaan Proyek Rumah Sakit X Di Bandung. JMTS: Jurnal Mitra Teknik Sipil, 6(2), 237–248.

[4] Agus Winarto, D., Ratnaningsih, A., & Soetjipto, W. (2023). Analysis of Project Performance and Completion Time Using EVM and CPM-PERT Methods (Case Study of Road Reconstruction Project). International Journal of Sciences: Basic and Applied Research (IJSBAR), 70(1), 269–280. https://gssrr.org/index.php/JournalOfBasicAndApplied/index

[5] Andreas, A., Tinumbia, N., & Anggraini, E. (2023). Construction Project Control Analysis Using Earned Value Management, Earned Schedule Management, Earned Duration Management (Case Study: Highrise Building Project in Jakarta). Jurnal Infrastruktur, 9(2), 87–98.

[6] Karlina, D., Rahmawati, S., Hutagalung, R. A., & Amin, M. (2025). Model dan Metode Integrasi Biaya dan Jadwal Dalam Manajemen Proyek: Sebuah Systematic Literature Review Periode 2020–2025. *Jurnal IPTEK*, 9(22).

[7] Lipke, W. (2014). Introduction to Earned Schedule. In PM World Journal Introduction to Earned Schedule: III. www.pmworldlibrary.net

[8] Widowati, E. D., & Resita, A. M. (2025). Project Duration Forecasting Methods Using EVM and ESM For A Double-Track Railway Project in Comparison. Jurnal PenSil, 14(3), 456–472. https://doi.org/10.21009/jpensil.v14i3.59154

[9] Wilanata, C., & Waty, M. (2024). Analisis Metode Earned Value Untuk Prediksi Penyelesaian Proyek Konstruksi Apartemen X Di Tangerang. JMTS: Jurnal Mitra Teknik Sipil, 7(3), 873–884.

[10] Lim, W. H., & Gondokusumo, O. (2025). Perbandingan estimasi durasi proyek dengan metode earned schedule dan metode earned duration management. JMTS: Jurnal Mitra Teknik Sipil, 8(3), 635–644.

[11] Rifqi, M., Shiddiq, F., Maskur, A., & Hartati, G. (2025). Evaluasi Pengendalian Waktu Menggunakan Metode Earned Value Management (EVM) (Studi Kasus: Konstruksi Fisik Pembangunan Gedung Parkir Sepeda Motor). Media Ilmiah Teknik Sipil, 19(1), 22–29.

[12] Fadjar, A., Ali, A., & Setiawan, A. (2023). Estimating House Construction Completion Time With Probabilistic Activities Duration Using The Program Evaluation and Review Technique (Pert) Method. Jurnal Sains dan Teknologi Tadulako, 9(1), 1–9.

[13] Nanda, M. P., Kurniawati, M., & Riswanto, S. (2023). Penggunaan Metode Project Evaluation Review Technique (PERT) Dalam Evaluasi Perencanaan Penjadwalan Proyek. Jurnal Teknik Sipil, 17(3), 163–173. https://doi.org/10.24002/jts.v17i3.7181

[14] Mayo-Alvarez, L., Alvarez-Risco, A., Del-Aguila-Arcentales, S., Sekar, M. C., & Yáñez, J. A. (2022). A Systematic Review of Earned Value Management Methods for Monitoring and Control of Project Schedule Performance: An AHP Approach. Sustainability, 14(22), 15259. https://doi.org/10.3390/su142215259

[15] Pratiwi, A., Prihadi, W. R., & Al-Pashya, M. D. R. (2025). Cost and Time Performance Evaluation of a Sports Hall Construction Project Using the Earned Value Method: A Case Study at Gunung Kidul Campus, Universitas Negeri Yogyakarta. INERSIA: Informasi Dan Ekspose Hasil Riset Teknik Sipil Dan Arsitektur, 21(1), 91–101. https://doi.org/10.21831/inersia.v21i1.84089