Improving Construction Project Duration Through Manual Correct-Rising of CPM And PERT with Primavera P6 And MATLAB-Based Optimization

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***Abstract*—This research paper presents an applied scheduling framework for improving construction project duration through manual correct-rising of the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT), supported by Primavera P6 and MATLAB-based optimization. The study is developed from a residential construction scheduling case in Pune, with the Belmont Skyverse project used as the primary case study. The baseline schedule consists of 96 activities distributed across substructure, superstructure, finishing and MEP phases. The research first develops an Excel-based baseline, then applies CPM to identify the deterministic critical path and PERT to account for duration uncertainty using optimistic, most-likely and pessimistic estimates. The correct-rising procedure reviews activity durations, logical dependencies, sequencing, float values and resource constraints to remove unrealistic links and reduce idle time. Primavera P6 is used for schedule validation and resource-leveling, while MATLAB-based Linear Programming and Artificial Neural Network logic supports resource allocation improvement. Results show that the original 789-day baseline duration was reduced to 735 days under the corrected CPM schedule, saving 54 days.**

Resource utilization improved from 63% to 90%, and the Schedule Efficiency Index improved from 0.74 to 0.96. The PERT expected duration was 747 days, reflecting uncertainty in activity execution. The study concludes that manual correct-rising, when combined with professional scheduling software and optimization tools, provides a practical approach for reducing construction duration without compromising feasibility or project control.

***Index Terms*—CPM, PERT, Correct-Rising Method, Primavera P6, MATLAB Optimization, Construction Scheduling, Critical Path, Project Duration, Resource Allocation, Schedule Efficiency.**

I. INTRODUCTION

Construction project scheduling is one of the most important functions of construction management because it converts design intent, procurement constraints, activity sequencing and resource availability into a measurable execution plan. In residential and high-rise construction, even small errors in activity duration, dependency logic or resource allocation can accumulate into substantial time overruns. Delays also increase indirect cost, reduce client confidence, disturb contractor cash flow and create conflicts among stakeholders. CPM and PERT remain two of the most widely used scheduling methods. CPM is suitable when activity durations are reasonably known and the planner needs to identify the critical path, calculate float and compress the schedule. PERT is useful where uncertainty exists because it uses three time estimates to calculate expected activity duration. However, both methods depend heavily on the accuracy of input data. If a schedule contains unrealistic durations, unnecessary finish-to-start links or poorly leveled resources, software output may appear mathematically correct but remain impractical for site execution. This research therefore focuses on manual correct-rising, a planning review process that improves CPM and PERT networks through engineering judgment and practical sequencing correction.

II. LITERATURE REVIEW

The literature establishes CPM and PERT as classical tools for project time management. Bagshaw emphasized that CPM is appropriate for deterministic planning, while PERT is more relevant where activity

durations are uncertain. Karabulut and Hendradewa showed that CPM-PERT analysis can be strengthened through Monte Carlo simulation for schedule risk assessment. Ballesteros-Perez proposed M-PERT to improve manual project-duration estimation, supporting the idea that manual calculation and review remain valuable in scheduling education and practice. Forcael and colleagues compared discrete event simulation with PERT and found that simulation can manage variability in activity durations more realistically.

Recent studies have expanded construction scheduling through fuzzy PERT, Primavera P6, Microsoft Project, variability analysis and high-rise case studies. Salhab et al. observed that activities outside the deterministic critical path can become significant when variability is considered. Desai et al. highlighted the practical value of Primavera P6 and Microsoft Project for schedule control, while Santoso et al. recommended combined use of CPM and PERT in high-rise construction projects. Despite this progress, relatively few studies demonstrate how manual correction of durations, dependencies and sequences can be integrated with Primavera P6 and MATLAB-based resource optimization in a real construction project. The present paper addresses this gap by developing and applying a combined correct-rising CPM-PERT framework.

III. RESEARCH METHODOLOGY

The research follows a case-study based applied methodology. The primary case is Belmont Skyverse, Lohegaon, Pune, a residential building project represented through 96 scheduled activities. Activities are grouped under substructure, superstructure, finishing work and MEP work.

The methodology begins with work breakdown, duration estimation and dependency identification, followed by CPM analysis, PERT analysis, manual correct-rising, Primavera P6 validation and MATLAB-based optimization support.

- Work Breakdown Structure was prepared to divide the project into manageable phases and activities.
- CPM analysis was used to calculate early start, early finish, late start, late finish, total float and critical path.
- PERT analysis was performed using optimistic, most likely and pessimistic activity durations to account for schedule uncertainty.
- Manual correct-rising was applied to refine unrealistic durations, remove unnecessary dependency links, introduce feasible parallelism and reduce idle periods.
- Primavera P6 was used for schedule validation, resource-leveling, activity sequencing and project control visualization.
- MATLAB-based LP-ANN optimization logic was considered for improving resource allocation and schedule efficiency.

The PERT expected duration was calculated using TE = (O + 4M + P) / 6, and activity variance was calculated using sigma squared = [(P - O) / 6] ^2. CPM compression relied on critical path review, fast tracking, crashing possibilities and lead-lag adjustment.

Performance was evaluated using total project duration, phase-wise time saving, resource utilization, cost saving and Schedule Efficiency Index.

IV. CASE STUDY DESCRIPTION

The Belmont Skyverse project schedule includes substructure, superstructure, finishing and MEP activities. The baseline schedule was prepared in Excel and then converted into Primavera P6 for detailed sequencing and validation. Table 1 summarizes the major section-wise schedule and budget allocation used in the analysis.

Table 1. Section-wise schedule and budget allocation for Belmont Skyverse

Section	Start Date	Finish Date	Activities	Duration (Days)	Budget (INR)
Substructure	2024-01-01	2024-09-18	23	262	69,45,000
Superstructure	2024-09-19	2025-07-31	39	316	1,29,38,000
Finishing Work	2025-08-01	2026-02-28	25	204	60,55,000
MEP Work	2025-10-10	2026-02-28	9	118	25,00,000

The superstructure phase represents the largest duration and budget component because it includes repeated floor-wise columns, beams, slabs, reinforcement, formwork and concrete placement. This phase therefore offered the highest scope for duration improvement through better cycle planning and parallel activity execution.

V. RESULTS AND DISCUSSION

5.1 OVERALL SCHEDULE IMPROVEMENT

The comparison of the original Excel schedule and optimized Primavera P6/CPM schedule shows a clear improvement after correct-rising. The baseline project duration of 789 days was reduced to 735 days, giving a net saving of 54 days. Resource utilization increased from 63% to 90%, while the Schedule Efficiency Index improved from 0.74 to 0.96. Table 2 presents the main before-and-after results.

Table 2. Optimized project results before and after correct-rising

Parameter	Excel Schedule Before Optimization	Primavera P6 / CPM After Optimization
Total Project Duration	789 days	735 days
Total Activities	96	96
Resource Utilization	63%	90%
Schedule Efficiency Index	0.74	0.96

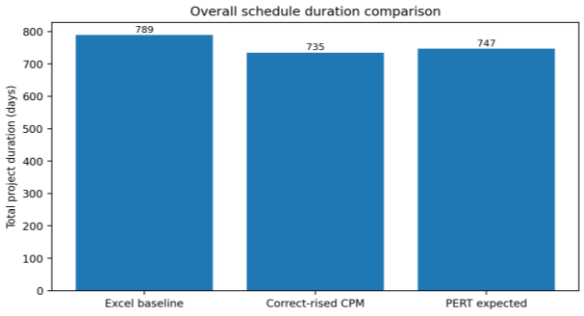

Figure 1. Overall schedule duration comparison

5.2 PHASE-WISE DURATION OPTIMIZATION

The maximum saving was obtained in the superstructure phase, where duration reduced from 316 days to 290 days, saving 26 days.

This improvement was achieved by revising floor-wise cycle planning, aligning formwork and reinforcement teams, avoiding unnecessary waiting time and allowing feasible parallel execution. Finishing work also showed considerable improvement, reducing from 204 days to 185 days.

Table 3. Phase-wise duration reduction using correct-rising method

Phase	Excel Duration	CPM / Primavera Optimized Duration	Time Saving
Substructure	262 days	250 days	12 days
Superstructure	316 days	290 days	26 days
Finishing Work	204 days	185 days	19 days
MEP Work	118 days	113 days	5 days

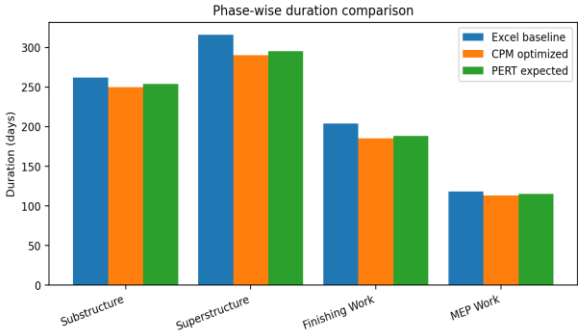

Figure 2. Phase-wise duration comparison

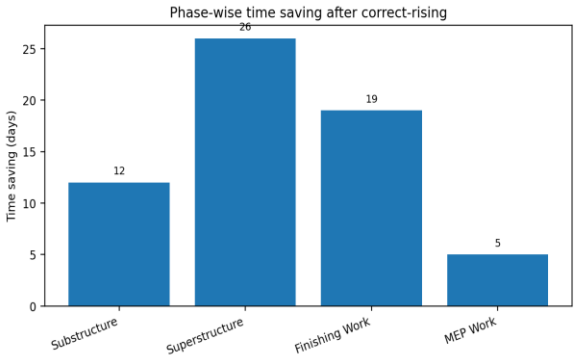

Figure 3. Phase-wise time saving after correct-rising

5.3 COST AND EFFICIENCY PERFORMANCE

The cost comparison indicates that better scheduling and resource allocation reduce indirect losses and improve construction efficiency. Total project cost reduced from INR 2,84,38,000 to INR 2,55,94,200, resulting in a cost saving of INR 28,43,800. The improvement is mainly connected to reduced idle time, better crew deployment and improved sequence reliability.

Table 4. Overall time and cost comparison

Parameter	Excel Before Optimization	Primavera P6 / CPM After Optimization
Total Project Duration	789 days	735 days
Total Project Cost	INR 2,84,38,000	INR 2,55,94,200
Time Saving	-	54 days
Cost Saving	-	INR 28,43,800

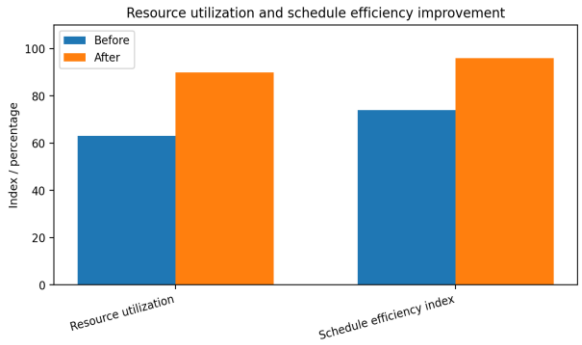

Figure 4. Resource utilization and schedule efficiency improvement

5.4 CPM AND PERT COMPARISON

The CPM durations were shorter because CPM uses deterministic activity durations. PERT produced slightly longer values because it considers uncertainty through optimistic, most likely and pessimistic duration estimates. For the overall project, CPM resulted in 735 days, while PERT estimated 747 days. The PERT schedule therefore provides a more conservative risk-aware estimate, while CPM provides a stronger basis for schedule compression.

Table 5. CPM and PERT phase-wise duration comparison

Phase	CPM Duration	PERT Expected Duration	Difference
Substructure	250 days	254 days	+4 days
Superstructure	290 days	295 days	+5 days
Finishing Work	185 days	188 days	+3 days
MEP Work	113 days	115 days	+2 days

Table 6. PERT three-time estimates

Phase	Optimistic Time	Most Likely Time	Pessimistic Time
Substructure	225 days	250 days	300 days
Superstructure	262 days	290 days	348 days
Finishing Work	168 days	185 days	222 days
MEP Work	102 days	113 days	136 days

5.5 VALIDATION THROUGH ADDITIONAL PROJECT CASES

The report also includes comparative observations from Sai Heights Residency, Wakad, and Green Valley Towers, Kharadi. In the Sai Heights case, the original schedule duration of 635 days was reduced to 540 days using correct-rised CPM and to 580 days using correct-rised PERT.

This represents a saving of 95 days under CPM and 67 days under PERT. Green Valley Towers showed additional improvements in resource utilization and planning reliability, with labour efficiency increasing from 70% to 85%, equipment efficiency increasing from 75% to 90%, and Percent Plan Complete improving across all major phases.

Table 7. Schedule saving comparison for Sai Heights Residency

Scheduling Method	Original Duration (Days)	Optimized Duration (Days)	Time Saved (Days)	Saving (%)
CPM	635	540	95	15%
PERT	647	580	67	10%

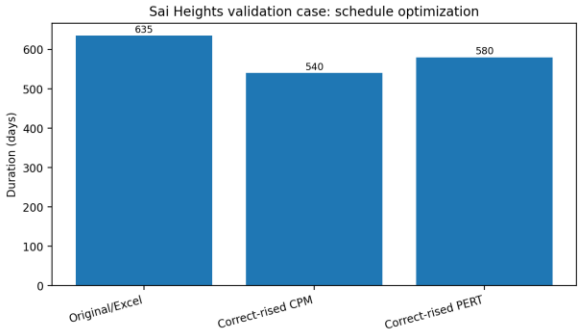

Figure 5. Sai Heights validation case: schedule optimization

Table 8. PPC improvement in Green Valley Towers

Phase	PPC Before (%)	PPC After (%)	PPC Improvement
Substructure	55	80	25%
Superstructure	60	85	25%
Finishing Work	65	90	25%

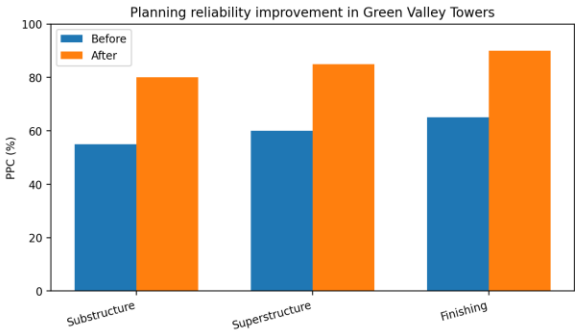

Figure 6. Planning reliability improvement in Green Valley Towers

VI. PROPOSED FRAMEWORK FOR MANUAL CORRECT-RISING CPM-PERT

Based on the case study results, a practical framework is proposed for construction planners. The framework begins with accurate activity identification and proceeds through CPM calculation, PERT risk review, manual correction, Primavera P6 validation and resource optimization.

The key feature of the framework is that it does not depend only on software output; instead, it requires the planner to question whether each duration, dependency and sequence is realistic under actual site conditions.

- Prepare a detailed WBS and activity list with clear predecessor relationships.
- Develop the initial CPM schedule and identify zero-float and near-critical activities.
- Apply PERT for uncertain activities to understand schedule risk and probable duration.
- Review each critical and near-critical activity manually for possible duration correction, dependency correction and feasible overlap.
- Use Primavera P6 to validate sequencing, resource loading and schedule logic.
- Use optimization logic to improve crew deployment, equipment uses and resource balance.
- Monitor the updated schedule regularly and repeat correct-rising whenever actual site progress differs from the planned schedule.

VII. CONCLUSIONS

The study demonstrates that construction project duration can be reduced effectively through systematic manual correction of CPM and PERT schedules. The Belmont Skyverse baseline schedule of 789 days was reduced to 735 days after applying correct-rising and Primavera P6-based optimization, resulting in a saving of 54 days. The most significant improvement occurred in the superstructure phase, which saved 26 days due to better floor-cycle planning and coordination.

The CPM method proved useful for deterministic compression of the schedule, while PERT provided a more risk-aware estimate by considering duration uncertainty. Resource utilization increased from 63% to 90%, and the Schedule Efficiency Index improved from 0.74 to 0.96. The cost comparison also showed a saving of INR 28,43,800, indicating that better scheduling can improve both time and cost performance.

Overall, manual correct-rising of CPM and PERT is a practical and effective method for improving construction project periods. When supported by Primavera P6 and MATLAB-based resource optimization, it provides a stronger planning framework than spreadsheet-based scheduling alone. The approach can be adopted by construction planners, project managers and contractors for residential and high-rise projects where repeated activities create opportunities for cycle improvement.

VIII. LIMITATIONS AND FUTURE SCOPE

The study is primarily based on residential construction project data from Pune and therefore may require calibration before application to infrastructure, industrial or heavy civil projects. Some optimization assumptions depend on expert judgment and available project records.

Future research can extend the framework through real-time site data, IoT-based progress tracking, BIM-4D integration, Monte Carlo simulation and automated schedule-learning systems. Further work may also include detailed time-cost trade-off optimization and validation across multiple projects with different structural systems.

REFERENCES

[1] K. B. Bagshaw, “PERT and CPM in project management with practical examples,” *American Journal of Operations Research*, vol. 11, no. 4, pp. 215–226, 2021.

[2] P. Ballesteros-Perez, "M-PERT: Manual project-duration estimation technique for teaching scheduling basics," Journal of Construction Engineering and Management, vol. 143, no. 9, Art. no. 04017063, 2017.
[3] M. Karabulut, "Application of Monte Carlo simulation and PERT/CPM techniques in planning of construction projects: A case study," Periodicals of Engineering and Natural Sciences, vol. 5, no. 3, pp. 408–420, 2017.
[4] E. Forcael, M. Gonzalez, J. Soto, F. Ramis, and C. Rodriguez, "Simplified scheduling of a building construction process using discrete event simulation," in Proc. LACCEI International Multi-Conference for Engineering, Education and Technology, 2018.
[5] A. P. Hendradewa, "Schedule risk analysis by different phases of construction project using CPM-PERT and Monte Carlo simulation," IOP Conference Series: Materials Science and Engineering, vol. 528, Art. no. 012035, 2019.
[6] A. M. Nemaa and G. K. Aswed, "Forecasting construction time for road projects and infrastructure using the fuzzy PERT method," IOP Conference Series: Materials Science and Engineering, vol. 1076, Art. no. 012001, 2021.
[7] H. Raghuwanshi and K. Paliwal, "Planning and scheduling construction projects using Primavera software: A case study," International Journal of Trend in Scientific Research and Development, vol. 5, no. 2, 2021.
[8] D. Salhab, D. E. Moller, S. M. Lindhard, F. Hamzeh, M. Randrup, and A. Pilgaard, "Accounting for variability: Identifying critical activities as a supplement to the critical path," Journal of Construction Engineering and Management, vol. 148, no. 5, Art. no. 04022019, 2022.
[9] N. V. Desai, N. B. Yadav, and N. N. Malaviya, "Increasing the potential application of Microsoft Project and Primavera P6 for project management: A comparative analysis of a residential project," Materials Today: Proceedings, vol. 77, pp. 794–804, 2023.
[10] F. W. Santoso, F. S. Handayani, and Setiono, "A comparative analysis of the CPM and PERT methods in project time management for a high-rise building construction project," *Sustainable Civil Building Management and Engineering Journal*, vol. 2, no. 2, Art. no. 13, 2025.