Journal of Multidisciplinary Research and Innovation
Vol 1 No 2 Februari 2025
ISSN: XXXX-XXXX (Electronic)
Open Access: https://journals.ai-mrc.com/jmri

Improving Renovation Project Timeliness at PT XYZ Using CPM and PERT

Mukhamad Abduh [1], Michaelia Titan Salsabila [2]
[1]Esa Unggul University, Indonesia
[2]Esa Unggul University, Indonesia
[1]mukhamad.abduh@esaunggul.ac.id, [2]michaeliatitan@esaunggul.ac.id

Article Info

Article history:
Received 24-01-2025
Revised 03-02-2025
Accepted 16-02-2025

Keyword:
Project Scheduling; Critical Path Method; Project Evaluation Review Technique; Renovation Projects; Schedule

ABSTRACT

Building renovation projects require efficient labor scheduling to meet project deadlines, involving complex activities that demand good coordination between various departments. Careful planning is essential to ensure the project is completed on time and within budget. This research evaluates project scheduling in terms of activity duration and cost estimation for the renovation project at PT XYZ, using the CPM (Critical Path Method) and PERT (Project Evaluation Review Technique) methods to identify the project's critical path. While CPM follows a deterministic approach, PERT utilizes a probabilistic one.
The research shows that by using CPM and PERT, project scheduling can be optimized for timely completion and cost-effectiveness. Based on calculations, the CPM method was found to be more efficient in scheduling and cost management. The results indicate that the renovation project has an 82% probability of completion within 82 days, saving 6 days compared to the original schedule.

INTRODUCTION

Project scheduling is a critical element in project planning, providing valuable insights into the project's schedule, progress, and resource performance (costs, labor, equipment, and materials), as well as the duration and timeline for project completion (Sriwana, 2020). However, scheduling challenges often arise, particularly when discrepancies occur between planned and actual project timelines. This leads to delays, increased costs, and inefficiencies, especially in large renovation projects.

The Critical Path Method (CPM) is a time-oriented method that identifies the critical path of a project based on activity dependencies, ultimately determining the project's completion time (S. Ulfa et al., 2021). CPM helps in optimizing project costs by reducing or accelerating the total completion time (Tamalika et al., 2022). In contrast, the Project Evaluation and Review Technique (PERT) is an analytical tool used for planning and accelerating construction project timelines by organizing project activities and efficiently managing schedules, thereby providing more accurate predictions of project completion and costs.

At PT XYZ, building renovation projects are conducted annually to enhance the physical and functional aspects of existing buildings, ranging from minor to large-scale renovations. However, scheduling inconsistencies have often been observed, where the actual project timelines diverge from the planned schedules. This mismatch has led to project delays and cost overruns.

Despite the availability of various project scheduling techniques, CPM and PERT were specifically chosen for this research due to their proven effectiveness in handling time and cost management in complex projects. CPM's deterministic approach provides a clear, structured timeline,

`

while PERT's probabilistic approach helps in managing uncertainty, making both methods ideal for the renovation projects at PT XYZ.

Based on data collected from June 2023 to February 2024, this research aims to identify the critical activities in the building renovation projects and calculate both the project completion time and the minimum cost estimates using CPM and PERT analysis.

RESEARCH METHODS

The research was conducted at the Facility Department of Civil Engineering at PT XYZ, located in East Jakarta. The study spanned 8 months, from June 2023 to February 2024. The research employed a descriptive method to provide a detailed account of the renovation project's processes and outcomes. This approach was chosen to systematically describe the activities, challenges, and outcomes observed in the renovation work, as well as to identify key areas for improvement. Descriptive methods are particularly useful in projects where the goal is to analyze existing conditions and make recommendations based on observed patterns and trends.

Problem identification was conducted through interviews with workers involved in the renovation project at PT XYZ, and a recap of labor productivity data for the 8-month period was performed. The data collected from these interviews and observations were subsequently analyzed using CPM and PERT methods for labor scheduling in the renovation projects. These methods were applied quantitatively by calculating the duration and sequencing of critical tasks to identify areas of delay and opportunities for time optimization.

The data analysis involved applying CPM to identify the critical path of the renovation project and estimate the minimum time required for completion. PERT, on the other hand, was used to model the probabilistic nature of task durations, helping to account for uncertainties in the project timeline. The results of these analyses were then compared with the existing data from the company to evaluate the potential for improving project efficiency and meeting deadlines.

RESULTS AND DISCUSSION

The project schedule at PT XYZ is developed based on the planned stages and time allocations required to complete renovation activities and other projects. Both the company and the manpower vendor share responsibility, having mutually agreed upon start and end dates for each job. The workforce used in renovation projects is skilled and experienced, which helps minimize future obstacles.

Based on interviews with the Person-in-Charge (PIC) and direct observations, several data points were collected, as shown in Table 1.**Table 1. Activity Type Data**

No.	Activities	Code	Duration (in days)
1	Preparation Work	I	16
2	Demolition Work	II	36
3	Toilet Repair	III	14
4	Sanitary Repair	IV	2
5	Repair of plaster	V	17
6	wall	VI	3
	Miscellaneous Work		

(Source: data processed 2024)

From the table above that it can be seen that the actual activities of the project can be described with activity I (preparatory work) takes 16 days to complete, activity II (demolition work) takes 16 days to complete. completion time of 16 days, activity II (demolition work) requires a 36 days, activity III (toilet work) takes 5 days, activity IV (sanitary repair) takes 2 days, activity V (repair

`

of the wall plaster) takes 22 days, and work VI (other work) takes 7 days with a total completion of work of takes 7 days with a total work completion time of 88 days.

Further details of the complete activity are as follows:

Table 2. Renovation activities along with the sequence and timing of activities

No.	Activities	Activity Description	Code	Activities predecessor	Duration (days)
1	Preparation Work	registration documents workers	A	-	3
		Worker files are uploaded	B	A	1
		approval for enrolment	C	B	3
		worker enrolment	D	C	1
		Job order generation	E	D	2
		approval job order by system	F	E	2
		Material submission	G	F	1
		Material Reservation	H	G	2
		Material Retrieval	I	H	1
2	Demolition Work	Floor Demolition Ceramics	J	I	12
		Wall Demolition Ceramics	K	J	12
		Toilet Demolition Squat	L	K	2
		Floor Drain Demolition	M	L	1
		Wall Faucet Demolition	N	M	1
		Plaster Aci Demolition Wall	O	N	8
3	Toilet refurbishment	Floor Installation Ceramics	P	O	4
		Wall Installation Ceramics	Q	P	2
		Exterior and Interior Wall Painting	R	Q	2
		User design changes	S	D, E, F, G	6
4	Jobs sanitary ware	Toilet Seat Installation	T	R	2
5	Workplaster aci wall	Plaster Work	U	T	9
		Acian Work	V	U	8
6	Other work	Wall paint finishing	W	V	2
		Installation of soap dish, tissue holder,and sink mirror	X	W	1

Calculations with the CPM method use a network of work diagrams which contains the trajectory and sequence of activities in the renovation project. With this diagram network diagram, it can be seen which are the critical activities of the toilet renovation project manager's room.

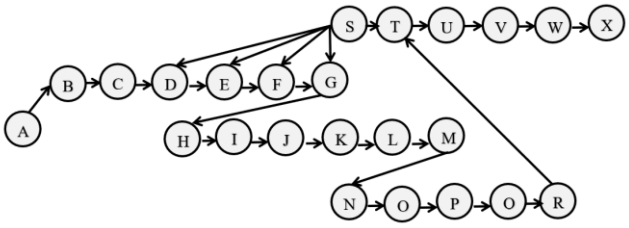

Figure 1. CPM Activity Line Trajectory

From the trajectory of the activity path when viewed from the image, it can be analyzed that Kegiatasn S (Change of design from User) will slow down even the worst possibility of work being

`

delayed until the process of Activities D,E,F,G can be completed again. The critical path can be determined by forward calculation, which calculates the fastest time of activity occurrence and the fastest start and finish time. and the earliest time to start and complete the activities of the renovation project. Backward calculation is the calculation of the slowest occurrence of activities and the time the slowest start of the event and the completion of the activity.

This PERT method uses 3 time estimates, namely the optimistic time estimate (a), the most likely time estimate (m), and the pessimistic time estimate (m). optimistic (a), most likely time estimate (m), and pessimistic time estimate (m).The time in this PERT calculation is obtained from the estimated time in the previous period (historical data). (historical data). As for after the activity on the project is known project based on the estimated time, calculations can be made based on the Program Evaluation and Review Technique method.calculation based on the Program Evaluation and Review Technique (PERT) method to determine the expected time (te), standard deviation (s) and variance (s).

Table 3. Network diagram using PERT method

Activities	Times			Preceding activity	Approximate time (te)	Variance	Standard Deviation
	Optimistic (a)	realistic (m)	Pessimistic (b)				
A	1	2	3	-	2	0.1111	0.02
B	1	1	1	A	1	0.0000	0.00
C	1	1	3	B	1	0.1111	0.02
D	1	1	1	C	1	0.0000	0.00
E	1	2	3	D	2	0.1111	0.02
F	1	2	3	E	2	0.1111	0.02
G	1	1	1	F	1	0.0000	0.00
H	1	2	2	G	2	0.0278	0.00
I	1	1	1	H	1	0.0000	0.00
J	8	10	14	I	10	1.0000	0.17
K	8	10	14	J	10	1.0000	0.17
L	1	2	3	K	2	0.1111	0.02
M	1	1	2	L	1	0.0278	0.00
N	1	1	2	M	1	0.0278	0.00
O	5	8	10	N	8	0.6944	0.12
P	2	4	6	O	4	0.4444	0.07
Q	1	2	3	P	2	0.1111	0.02
R	1	2	3	Q	2	0.1111	0.02
S	5	6	10	D,E,F,G	5	1.0000	0.17
T	1	2	3	R	2	0.1111	0.02
U	6	9	12	T	9	1.0000	0.17
V	5	8	10	U	8	0.6944	0.12
W	1	2	3	V	2	0.1111	0.02
X	1	1	3	W	1	0.1111	0.02
		Total			82	7.03	1.17

Source: Data processed

`

Furthermore, the calculation of the normal deviation value of the company's estimated duration is 82 days, so from the results of the normal deviation calculation, the Z value is 0.9938. The company obtained a probability of 0.9938, which means that the company can complete the manager's room toilet renovation project by 99.38%.

Based on data obtained from PT XYZ by interview and direct observation, it was found that the completion of the manager's toilet renovation project took 88 days. The results of the comparison of the 3 project completion methods above are as follows:

Table 3. Duration comparison

No.	Jenis Kegiatan	Eksisting	CPM	PERT
A	registration documents workers	3	3	2
B	Worker files are uploaded	1	1	1
C	approval for enrolment	3	3	1
D	worker enrolment	1	1	1
E	Job order generation	2	2	2
F	approval job order by system	2	2	2
G	Material submission	1	1	1
H	Material Reservation	2	2	2
I	Material Retrieval	1	1	1
J	Floor Demolition Ceramics	12	12	10
K	Wall Demolition Ceramics	12	12	10
L	Toilet Demolition Squat	2	2	2
M	Floor Drain Demolition	1	1	1
N	Wall Faucet Demolition	1	1	1
O	Plaster Aci Demolition Wall	8	8	8
P	Floor Installation Ceramics	4	4	4
Q	Wall Installation Ceramics	2	2	2
R	Exterior and Interior Wall Painting	2	2	2
S	User design changes	6	-	5
T	Toilet Seat Installation	2	2	2
U	Plaster Work	9	9	9
V	Acian Work	8	8	8
W	Wall paint finishing	2	2	2
X	Installation of soap dish,	1	1	1
Total Durasi		88	82	82

Source: Data processed

CONCLUSION

Based on the calculations with CPM and PERT techniques, the CPM method is found to be more efficient in terms of scheduling and project cost optimization. The application of both methods, using the critical path [A - B - C - D - E - F - G - H - I - J - K - L - N - O - P - Q - R - T], indicates a higher probability of successful completion for the renovation project. The critical path analysis suggests that the manager’s room toilet renovation can be completed within 82 days, offering a time savings of 6 days compared to the existing method.

The factors contributing to delays in the renovation project can be categorized into four main causes. The first is the manpower factor, where delays are attributed to incomplete labor enrollment processes. The second factor is materials; pre-ordering and approval processes cause delays,

especially when the warehouse stock is insufficient. The third factor involves method inefficiencies, particularly due to reliance on manual scheduling based on previous experience, which is less optimal. Finally, the environmental factor, including changes in user requests and subsequent revisions, further complicates scheduling and material procurement.

These findings emphasize that improving project scheduling through methods like CPM and PERT can not only save time and reduce costs at PT XYZ, but also provide valuable insights for the broader construction industry. By adopting these methodologies, construction projects—especially renovations—can be better planned, executed more efficiently, and completed on time. Additionally, these techniques offer a more systematic approach to project management, reducing dependency on manual calculations and mitigating delays due to unforeseen changes in project scope or material availability. The broader implication for the construction industry is clear: implementing advanced scheduling methods like CPM and PERT can enhance productivity and contribute to the overall success of construction projects.

CONFLICT OF INTEREST

In this research, the authors declare no conflict of interest

REFERENCES

Alaghbari W, A. S. (2019). Factors Affecting construction labour productivity in Yemen. International Journal of Construction Management, 19(1), 79–91. https://doi.org/10.1080/15623599.2017.1382091.

Alcaesar M R, E. S. (2022). Analisis waktu pelaksanaan proyek menggunakan simulasi monte carlo (Studi kasus : Proyek Rehabilitasi Jalan Sentul – Teras Bendung-Tirtayaa Kabupaten Serang – Banten TA. Teknika: Jurnal Teknik, 10(1), 79-89.

Alejandro Prieto, e. (2024). Renovation process challenges and barriers: addressing the communication and coordination bottlenecks in the zero-energy building renovation workflow in European residential buildings. VOL. 67, NO. 3, 205–217. https://doi.org/10.1080/00038628.2023.2214520.

Berthier, A. A. (2022). Unrelated Parallel MachinesScheduling with Dependent Setup Times in TextileIndustry. Computers & Industrial Engineering, 174 (108):736. 108736. https://doi.org/10.1016/j.cie.2022.

Ervianto, W. I. (2017). Tantangan Pembangunan Infrastruktur dalam Proyek Strategis Nasional Indonesia. Simp. II UNIID 2017, vol. 2, no. 1, 2017.

Yusuf, M. A. (2021). Pengertian Tenaga Kerja . Retrieved from Gramedia.com: https://www.gramedia.com/literasi/pengertian-tenaga-kerja/

Ginting, R. (2009). Penjadwalan Mesin. Graha Ilmu.

Ismael, I. (2013). Keterlambatan Proyek Konstruksi Gedung Faktor Penyebab dan Tindakan Pencegahannya. Jurnal Momentum, ISSN: 1693-752X 14.

Kerzner, H. (2009). Project management: A systems approach to planning, scheduling, and con-rolling. Hoboken: NJ: John Wiley & Sons.

Le N H, et. at. (2019). Effects of foreign direct investment and human capital on labor productivity: Evidence from Vietnam. Journal ofAsian Finance, Economics & Business, 16(3), 123–130. https://doi.org/10.13106/jafeb.2019.vol6.no3.123.

Marzieh Aghileh, et. al. (2024). Multi-project scheduling under uncertainty and resourceflexibility: a systematic literature review. Journal of PRODUCTION & MANUFACTURING RESEARCH, VOL. 12, NO. 1, 2319574.

Nurhayati. (2010). Manajemen Proyek. Yogyakarta: Graha Ilmu.

.

SA. (2022). Renovasi Gedung Kantor: Pengertian & Pra Rencana. Retrieved from Solusi Bangunan: https://solusibangunan.id/renovasi-gedung-kantor- pengertian-pra-rencana

Syahrur Romadhona, et. al. (2021). Project Scheduling Analysis Using the Precedence Diagram Method (PDM) Case Study: Surabaya's City Outer East Ring Road Construction Project (Segment 1). International Journal of Engineering, Science & InformationTechnology (IJESTY). , Volume 1, No. 2 (2021) pp. 53-61.

.Suhendar, S. U. (2021). Implementasi Metode Critical Path Method Pada Proyek Synthesis. Jurnal Optimasi Teknik Industri, vol. 3, no. 1.

Tantyonimpuno, S. (2001). Manajemen Proyek. Surabaya: Institut Teknologi Sepuluh Nopember