ANALYSIS OF ADDITIONAL TIME COSTS CONSTRUCTION OF THE RELIGIOUS COURT OFFICE BUILDING OF TRENGGALEK REGENCY, EAST JAVA

Nidya Widyaningsari[1]
Universitas 17 Agustus 1945 Surabaya, Indonesia
Nidya8885@gmail.com

Hanie Teki Tjendani[2]
Universitas 17 Agustus 1945 Surabaya, Indonesia
hanie@untag-sby.ac.id@gmail.com

Sajiyo[3]
Universitas 17 Agustus 1945 Surabaya, Indonesia
sajiyo@untag-sby.ac.id

Abstract

This study discusses several ways to accelerate the building construction process. The study used two methods, namely crashing and overlapping. The crashing method involves adding overtime hours and labor to shorten the project duration. Meanwhile, overlapping is rearranging the relationship between tasks so that they can be done simultaneously without reducing the initial time, thus accelerating completion at a relatively comparable cost. The analysis results show that both methods are effective in accelerating projects, with the overlapping method requiring less cost and providing greater time reductions. The choice of the best method depends on budget constraints and the project's completion time requirements. Thus, this acceleration strategy can help project management in achieving time targets at an optimal cost.

Keywords: Crashing Method, Overlapping Method, Critical Path

INTRODUCTION

The Trenggalek Religious Court is an institution that plays a crucial role in upholding justice for religious communities in Trenggalek Regency. Over the past five years, the number of cases filed with the Trenggalek Religious Court has steadily increased. This situation prompted the decision to construct a new office building with greater capacity. Originally located on Jalan Dr. Sutomo, the new building is now located on Jalan Brigjen Soetran in an effort to address existing problems.

Construction of this building began on May 5, 2025, with a planned completion time of 240 working days, and is expected to be completed by December 30, 2025. Several obstacles were encountered during the project implementation, resulting in a delay of up to -3.5% in progress. This situation necessitates an effective project management strategy to complete the project on time.

Project acceleration is a crucial aspect of construction management, analyzing duration and costs. This study uses the *crashing* and *overlapping methods* .

LITERATURE REVIEW

Project Management

A project is a non-permanent and directed activity undertaken to achieve a specific goal (Abidin and Bihanudin 2021) . Project management itself means a project that requires structured and systematic management to achieve goals that align with predetermined targets, quality, and budget. Project management is a science used to implement, plan, and oversee the completion of a project to ensure it meets predetermined goals (Abidin and Bihanudin 2021) . Project management has several functions, as follows:

- Planning;
- Implementation;
- Control;
- Performance measurement;
- Communication;
- Closing; and
- Risk management.

Project management also has several key objectives that are useful for ensuring that the project runs smoothly and efficiently to achieve the desired results. The primary objectives of project management are as follows:

- Complete projects on time;
- Manage budget efficiently;
- Reach the designated environmental space;
- Produce good quality;
- Manage risks appropriately;
- Coordinating resources;
- Conduct effective communication.

Time and Cost Analysis

Time management is the planning, organization, and control of time productivity. Project management aims to execute projects accurately and achieve predetermined objectives. Time and cost analysis in construction projects is the process of calculating the time and costs required from start to finish. Several factors can influence this process, including:

- Work progress report;
- Completion of work;
- Observation.

Project Scheduling

Project scheduling is a timeline for project implementation that serves as a reference or guideline for project implementation. Project scheduling aims to divide the scope of work by arranging the sequence to determine the project's timely implementation. The benefits of project scheduling include the following:

- Planning and operating work;
- Manage resources well;
- Control time and costs;
- Take into account risk plans;

RESEARCH METHOD

Scheduling Method

Project scheduling involves several methods that can be used to manage time and resources within a project. These methods can be used to achieve desired results, including performance and scheduling. Scheduling methods include the following:

- Barchart Beam Section
  A bar chart is a block-shaped schedule, the length of which can be adjusted to suit the duration of each activity. Bar charts are informative and easy to read, effectively, and simply.
- The S-curve is a curve with a vertical axis representing the cumulative value of costs or activity completion, and a horizontal axis representing the time scale. The S-curve provides information on work progress based on the use of realized funds.

Productivity

Labor productivity can be defined as the amount of work completed by a single worker or team within a specific timeframe. One approach to measuring labor effectiveness is to use the productivity index. The productivity index is calculated using the following formula:

$$\text{daily productivity} = \frac{\text{Volume}}{\text{normal duration}}$$

$$\text{Productivity/hour} = \frac{\text{Daily Productivity}}{\text{Normal Working Hours}}$$

$$\text{Productivity after crash} = \text{Daily productivity} + (\text{Total Overtime Hours x Productivity/Hour x \%})$$

Crashing Method

Crashing is an effort to shorten the project completion time in a planned and analytical manner by evaluating all activities, especially those on the critical path. The crashing method uses several key terms: normal time, shortened time, normal cost, and acceleration cost. The relationship between time and cost indicates that the shorter the implementation time, the higher the project cost tends to be compared to normal conditions.

$$\text{Cost Slope} = \frac{C_c C_n}{D_n D_c}$$

Information:

C_c : Acceleration cost
C_n : Normal cost
D_n : Normal duration
D_c : Duration of acceleration

Total acceleration cost = normal cost + acceleration cost

Crash duration is determined by considering that the total normal working hours must equal the total effective overtime hours. Effective overtime hours are adjusted work hours due to decreased labor productivity. Therefore, the crash duration reaches its maximum value when work is performed overtime.

$$Dc = \frac{Dn \text{ x } h}{(h + (ho \text{ x } e)}$$

Information:

Dc : Crash duration
Dn : Normal duration
h : Normal amount per day
ho : Overtime hours per day
e : Workforce effectiveness

Crash duration for adding manpower can be calculated using the following formula:

$$Dc = \frac{\text{Volume}}{\text{Productivity after crash}}$$

Overlapping Method

The overlapping method is also known as the overlapping activities method. Overlapping activities can be handled without increasing the network size if the precedence diagram with lead and link implementation is used. This approach provides a more realistic representation of the project and generally results in a shorter project duration.

$$Dbaru = D_A + D_B - (p \text{ x } D_A)$$

Information:

Dbaru : Total project duration after overlapping
D_A : Duration of predecessor activity
D_B : Duration of successor activity

p : Percentage overlapping

When analyzing a network with overlapping activities, a precedence diagram is generally used. In calculations using a precedence diagram, the term lead time is used. Lead time is the time between the completion or start of one activity and the completion or start of another, based on the weight of each activity. Lead time can be expressed as an absolute value (for example, in days) or as a percentage of an activity's duration.

$$LT = p \times D_A$$

Information:

LT : Lead time (overlap time)

p : Proportion of activity A that overlaps

D_A : Duration of activity A

Time efficiency in the overlapping method is measured as the reduction in project duration due to overlap. Mathematically, time efficiency can be calculated using the formula:

$$Ef = \frac{Dnormal - Doverlap}{Dnormal} x100\%$$

Information:

Ef : Project time efficiency

D_{normal} : Total project duration before overlapping

$D_{overlap}$: Total project duration after overlapping

RESULTS AND DISCUSSION

This project began on May 5, 2025, with a planned completion time of 240 working days, and is scheduled to be completed on December 30, 2025. This project was chosen as a case study in this research because its implementation experienced delays, therefore it is necessary to accelerate the project so that it can be completed on time or faster. This research accelerates work on the critical path.

Project Name	:	Construction of the Trenggalek Religious Court Office Building
Project Owner	:	Trenggalek Religious Court
Contractor	:	PT Pratama Citra Parama
Supervising Consultant	:	CV Mahoni
Planning Consultant	:	PT Aretas Wicaksana Consultant
Project Value	:	Rp. 25,418,320,664.06
Execution time	:	240 working days (May 5 to December 30, 2025)
Project Address	:	Jl Brigjen Soetran, Ngantru Village, Trenggalek District, Trenggalek Regency, East Java

Crashing Method

The crashing method is used to speed up project timelines by reducing work duration. The crashing method can be used for activities on the critical path. Determining the critical path using Microsoft Project yields the following results:

Table 1.
Jobs Included in the Critical Path

NO.	JOB NAME	DURATION
I.	**Main Building Works**	
HE	**Preparatory Work**	
IA1	Preparatory Work	240
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	240
IB	**Structural Work**	
IB1	Ground Floor Structural Work	70
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	35
IB3	Floor 1 Structural Work	70
IB4	2nd FLOOR STRUCTURAL WORK	35
IC	**Architectural Work**	
IC3	2nd FLOOR ARCHITECTURAL WORK	140
IC4	Rooftop Floor Architectural Work	119
ID	**Mechanical, Electrical, And Plumbing Work**	
ID1	Lightning Protection Work	35

Source: Researcher Processing (2025)

Table 2.
Crash Duration with Accelerated Work Hours

No	Job Description	Normal Duration (Dn)	Crash Duration (Dc)	Di = Dn-Dc
I.	**Main Building Works**			
HE	**Preparatory Work**			
IA1	Preparatory Work	240	180	60
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	240	180	60
IB	**Structural Work**			
IB1	Ground Floor Structural Work	70	50	20

No	Job Description	Normal Duration (Dn)	Crash Duration (Dc)	Di = Dn-Dc
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	35	28	7
IB3	Floor 1 Structural Work	70	58	12
IB4	2nd FLOOR STRUCTURAL WORK	35	30	5
IC	**Architectural Work**			
IC3	2nd FLOOR ARCHITECTURAL WORK	140	124	16
IC4	Rooftop Floor Architectural Work	119	108	11
ID	**Mechanical, Electrical, And Plumbing Work**			
ID1	Lightning Protection Work	35	30	5

Source: Researcher Processing (2025)

The additional overtime hours are applied for 3 hours, starting at 4:00 PM and ending at 7:30 PM. For the first hour of overtime, wages must be paid at 1.5 times the normal hourly wage. For the second and third hours, workers are paid at double the normal hourly wage. The analysis of increased labor costs due to the acceleration of the project duration by adding 3 hours of overtime per day to work on the critical path is presented in the following table.

Table 4.
Recapitulation of Acceleration Time and Cost with Additional Working Hours

No	Job Description	Alternative					
		Normal		Crashing			
		Normal Duration (Dn)	Cost (Cn)	Crash Duration (Dc)	Fee (Cc)	Di = Dn-Dc	Cost Slope = (Cc - Cn)/Di
I.	**Main Building Works**						
HE	**Preparatory Work**						
IA1	Preparatory Work	240	134,378,600	180	134,378,600	60	-
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	240	41,948,000	180	41,948,000	60	-
IB	**Structural Work**						
IB1	Ground Floor Structural Work	70	1,355,000,000	50	1,555,700,000	20	10,035,000
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	35	325,400,000	28	443,250,000	7	16,835,714
IB3	Floor 1 Structural Work	70	995,000,000	58	1,123,500,000	12	10,708,333
IB4	2nd FLOOR STRUCTURAL	35	875,300,000	30	987,350,000	5	22,410,000

No	Job Description	Alternative					
		Normal		Crashing			
		Normal Duration (Dn)	Cost (Cn)	Crash Duration (Dc)	Fee (Cc)	Di = Dn-Dc	Cost Slope = (Cc - Cn)/Di
	WORK						
IC	**Architectural Work**						
IC3	2nd Floor Architectural Work	140	723,500,000	124	853,450,000	16	8,121,875
IC4	Rooftop Floor Architectural Work	119	543,500,000	108	653,500,000	11	10,000,000
ID	**Mechanical, Electrical, And Plumbing Work**						
ID1	Lightning Protection Work	35	38,300,000	30	39,250,000	5	190,000
Slope Amount Added 3 Hours of Overtime							78,300,923

Source: Researcher Processing (2025)

In addition to adding three hours of overtime, analysis using the crashing method can also be carried out by adding workers to jobs that are on the critical path.

Table 5.
Crash Duration with Accelerated Workforce Addition

No	Job description	Normal Duration (Dn)	Crash Duration (Dc)	Di = Dn-Dc
I.	**Main Building Works**			
HE	**Preparatory Work**			
IA1	Preparatory Work	240	170	70
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	240	170	70
IB	**Structural Work**			
IB1	Ground Floor Structural Work	70	45	25
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	35	30	5
IB3	Floor 1 Structural Work	70	62	8
IB4	2nd FLOOR STRUCTURAL WORK	35	28	7
IC	**Architectural Work**			
IC3	2nd FLOOR ARCHITECTURAL WORK	140	120	20
IC4	Rooftop Floor Architectural Work	119	100	19
ID	**Mechanical, Electrical, And Plumbing Work**			
ID1	Lightning Protection Work	35	28	7

Source: Researcher Processing (2025)

Table 6.
Recapitulation of Transportation Time and Costs with Additional Labor

No	Job Description	Alternative					
		Normal		Crashing			
		Normal Duration (Dn)	Cost (Cn)	Crash Duration (Dc)	Fee (Cc)	Di = Dn-Dc	Cost Slope = (Cc - Cn)/Di
I.	**Main Building Works**						
HE	**Preparatory Work**						
IA1	Preparatory Work	240	134,378,600	170	134,378,600	70	-
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	240	41,948,000	170	41,948,000	70	-
IB	**Structural Work**						
IB1	Ground Floor Structural Work	70	1,355,000,000	45	1,355,000,000	25	-
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	35	325,400,000	30	325,400,000	5	-
IB3	Floor 1 Structural Work	70	995,000,000	62	995,000,000	8	-
IB4	2nd FLOOR STRUCTURAL WORK	35	875,300,000	28	875,300,000	7	-
IC	**Architectural Work**						
IC3	2nd Floor Architectural Work	140	723,500,000	120	723,500,000	20	-
IC4	Rooftop Floor Architectural Work	119	543,500,000	100	543,500,000	19	-
ID	**Mechanical, Electrical, And Plumbing Work**						
ID1	Lightning Protection Work	35	38,300,000	28	38,300,000	7	-
Number of Additional Slopes of Labor							-

Source: Researcher Processing (2025)

Using the crashing calculation using the added man-hour method, the new project duration was 180 days, 60 days faster than the normal 240-day duration. Meanwhile, the crashing calculation using the added manpower resulted in a project duration of 70 days, a 70-day acceleration from the normal 240-day duration. The difference in duration between the two methods is significant, indicating that project acceleration has the potential to provide greater efficiency than implementation with a normal duration.

To provide a clearer picture of the time-cost comparison, the analysis results are presented by comparing two acceleration methods: acceleration by adding three hours of overtime per day and acceleration by adding additional workers. This comparison aims to

demonstrate the differences in effectiveness of the two methods in reducing project duration and their impact on total implementation costs.

Table 7.
Comparison of Normal and Crashing Time and Cost

Activity	Duration (Days)	Direction Cost	Indirect Cost	Profit	Total Cost	Ratio
Normal	240	20,609,441,087	2,060,944,109	2,289,937,899	25,418,320,664	1
Add 3 hours of overtime	180	20,697,246,966	1,545,708,082	2,289,937,899	24,532,892,947	0.97
Add workforce	170	20,609,441,087	1,459,835,410	2,289,937,899	24,359,214,396	0.96

Source: Researcher Processing (2025)

Overlapping Method

The overlapping method is used to accelerate a project without changing its initial duration, but rather by changing relationships and lags. Based on the processed data, several tasks fall into the critical work path, as shown in Table 8 below:

Table 8.
Jobs That Are on the Critical Path

No.	Job Name	Code	Duration	Predecessor	Relationship
I.	**Main Building Works**				
HE	**Preparatory Work**	A			
IA1	Preparatory Work	A1	240	-	
IA2	Smk3 Work (Pupr Ministerial Regulation No. 10 Of 2021)	A2	240	A1	SS
IB	**Structural Work**	B			
IB1	Ground Floor Structural Work	B1	70	B2	FS
IB2	Wall Work / Retaining Wall (Under The Main Building Front & Left+Right Ram)	B2	35	B1	FS
IB3	Floor 1 Structural Work	B3	70	B3	FS
IB4	2nd FLOOR STRUCTURAL WORK	B4	35	B4	FS
IC	**Architectural Work**	C			
IC3	2nd FLOOR ARCHITECTURAL WORK	C1	140	C1	SS
IC4	Rooftop Floor Architectural Work	C2	119	C1	SS+14
ID	**Mechanical, Electrical, And Plumbing Work**	D			
ID1	Lightning Protection Work	D1	35	C1	SS+7

Source: Researcher Processing (2025)

To explain the comparison of time and costs, the results of the time and cost analysis carried out using the overlapping method can be seen in Table 9 as follows:

Table 9.
Comparison of Normal and Overlapping Time and Cost

Activity	Duration (Days)	Direction Cost	Indirect Cost	Profit	Total Cost	Ratio
Normal	240	20,609,441,087	2,060,944,109	2,289,937,899	25,418,320,664	1.00
Overlapping	142	20,697,246,966	1,219,391,931	2,289,937,899	24,118,770,917	0.95

Source: Researcher Processing (2025)

CONCLUSION

The cost required for additional time, labor and work tools using the crashing method by adding overtime for 3 hours is Rp 24,532,892,947.00 with a reduction in duration of 60 days from the normal time of 240 days to 180 days. The results of the cost analysis required using the crashing method by adding labor are Rp 24,359,214,396.00 with a reduction in duration of 70 days from the normal time of 240 days to 170 days. While the cost required for additional time, labor and tools using the overlapping method is Rp 24,118,770,917.00 with a reduction in work duration of 98 days from the normal time of 240 days to 142 days;

REFERENCES

Abidin, M. 2025. *Integration of Crashing and Six Sigma Methods on Time and Quality Performance in LRT Bridge Structures* . Repository.Mercubuana.ac.id.

Abidin, Yakub, and Bihanudin. 2021. *Project Management Project Management* .

Abrar, Husein. 2009. *Project Management: Planning, Scheduling, and Project Control* . Andi Yogyakarta.

Isbahi, M. B., Zuana, M. M. M., & Toha, M. (2024). The Multi-Social Relation of the Cattle Industry in the Plaosan Subdistrict Animal Market of Magetan Regency. *Malacca: Journal of Management and Business Development* , *1*(1), 31–46. https://doi.org/10.69965/malacca.v1i1.51

Istimawan Dipohusodo. 1967. *Project and Construction Management* .

Koten, OA, and HT Tjendani. 2023. "Cost and Time Analysis Using the Crashing Method in the Improvement of the Naibonat–Nunkurus Road, Kupang Regency." *Scientific Journal of Engineering and…* .

Mahyuddin, Mahyuddin. 2023. *Professional Construction Project Management* .

Soeharto, Iman. 1995. *Project Management From Conceptual to Operational* . Erlangga.

Wulfarm, Ervianto. 2005. *Andi Yogyakarta Publisher* .