

TIME AND COST CONTROL ANALYSIS OF DISASTER EMERGENCY RESPONSE HANDLING PROJECT CONSTRUCTION IN MOJOKERTO DISTRICT USING CRITICAL PATH METHOD

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ABSTRACT

Landslides along the Sumber Pasinan River in Mojokerto Regency, East Java, pose significant risks due to soil erosion and increased flooding during the rainy season. This study aims to analyze the acceleration of construction for a disaster emergency response project using the Critical Path Method (CPM) to minimize time and costs. Employing a quantitative research approach, primary data was gathered through direct observations at the project site, complemented by secondary data from relevant literature and project documents. The findings indicate that the implementation period was successfully reduced from 71 working days to 47 days, achieving a time acceleration of 24 days. This required the addition of 11 workers for the critical task of installing river stone masonry, which constituted 70.16% of the project's workload. The application of CPM proved effective in managing time and resources efficiently. The implications of this research highlight the importance of employing structured project management methodologies in disaster response construction projects. By demonstrating the effectiveness of CPM in accelerating project timelines while controlling costs, this study provides a valuable reference for future projects facing similar challenges. It also opens avenues for further research into the long-term impacts of workforce augmentation on project quality and cost-effectiveness in disaster management contexts.

Keywords: Construction Management, Project Management, Critical Path Method (CPM), Microsoft Project

INTRODUCTION

Natural hazards, particularly landslides, are safety-threatening phenomena with significant socioeconomic impacts in many parts of the world. Landslides occur due to the deformation of soil and rock on slopes due to various factors such as rainfall, human activities, topography, geology, and vegetation (Yuliana Yamco, 2022). The movement of soil masses is also influenced by water, wind, and gravity, and often occurs on slopes that lose the balance between thrust and resistance (Anakta Sebayang, 2022). Therefore, slope reinforcement methods are essential, especially around river areas, to anticipate landslides caused by scouring water flow or lateral soil pressure (Rifqi Riftyan Pranaya, 2023; Supratikno, 2023); Darlina Tanjung, 2024;.

In the context of construction projects, the complexity of the work, the amount of costs, the use of equipment, and the number of workers demand an effective management system to maintain the efficiency and effectiveness of implementation (Harris et al., 2020; Parsamehr et al., 2023). Due to the dynamic nature of construction projects that do not always go according to plan, consistent control of time and cost is needed to achieve success (Andi Permana Sidiq, 2022). In addition, the selection of the right labor, materials, and work methods is also the key to the success of construction projects, so that there is no waste or delay (Bajjou & Chafi, 2020, 2022). Unfortunately, construction projects often experience a mismatch between schedule and realization due to various factors, such as weather, design changes, and lack of careful planning (Agenda, 2016; Rifqi Riftyan Pranaya, 2023).

Poor project control can lead to high cost and time deviations, so regular monitoring and evaluation are necessary (Castollani et al., 2020). One commonly used project planning and control method is the Critical Path Method (CPM), which helps estimate project duration and optimize costs through proper scheduling (Saputra et al., 2021). In addition, the *Earned Value* concept is also an important method for measuring project performance on an ongoing basis from the aspects of time and cost, providing important information for project managers to take corrective action (Andi Permana Sidiq, 2022).

Effective time management in construction projects is essential to avoid delays and losses. Delay in project completion is an undesirable condition because it has an impact on cost overruns and losses to various parties (Vidia Pratiwi, 2024).

Accelerating project implementation can be done in various ways, such as increasing working hours, labor, using more efficient tools or work methods, while still paying attention to the amount of costs incurred (Sofia et al., 2021; Yusuf Malif, 2019). The project Budget Plan (RAB) must also be calculated carefully because it is closely related to differences in material prices and labor wages between regions (Wiroso, 2023).

Overall, time and cost are the two main elements that determine the success of the project. *Time* planning is done through the preparation of a *Time Schedule*, which includes an estimate of the overall project duration. Time control aims to ensure the project is completed on time or even earlier (Andi Permana Sidiq, 2022). Project success will be achieved if systematic and efficient management is carried out, with the selection of the right acceleration method, and good time management in order to maintain the quality of work results, cost efficiency, and achievement of planned time targets (Sofia et al., 2021).

Since this project is self-managed, the construction is expected to be carried out effectively at the minimum possible cost. Therefore, this discussion is specific to the approach of accelerating time management which will be analyzed using the CPM (Critical Path Method) method and holding a Cost Comparison and Evaluation of previous projects so that it does not happen again in subsequent projects so that it can provide the best proposal for the relevant agencies as the project owner and the person in charge of the project. Shortening the duration of the project with the minimum possible cost expenditure requires optimization. Therefore, the first thing to do is create a project work network (network), then calculate the project duration, project cost requirements, and the number of resources. In this case, the Microsoft Project application is used as a tool in its processing (Bosu et al., 2016; Shah & Chandragade, 2023). So that later, the progress of a project can be controlled properly and can be achieved on time, on quality, and on budget. In this study, an acceleration plan with the addition of labor will be analyzed in the construction of river stone masonry in Pungging River, Mojokerto Regency.

This study analyzes the acceleration of construction on a river stone masonry project along the Sumber Pasinan River in Mojokerto Regency, aiming to enhance work execution efficiency using the Critical Path Method (CPM) (Prasetya et al., 2025). It seeks to provide strategic recommendations for time and cost management, benefiting contractors by serving as a reference for better project planning and analysis of construction delays applicable to other projects. The research identifies gaps in related studies, including Alfarizi et al. (2024), which examines cost and time management in avalanche handling using BIM, and Nguyen et al. (2023), which assesses offsite construction recoveries post-pandemic. Both studies fail to address the unique challenges of disaster emergency construction, particularly the application of critical path methods in self-managed projects. The novelty of this research lies in its application of CPM to improve time and cost control in disaster response construction, bridging the fields of disaster management and project management to offer valuable insights.

METHOD

This research analyzes time and cost control in the construction of the Disaster Emergency Response Handling Project at Sumber Pasinan River, Mojokerto Regency, using the Critical Path Method (CPM). It applies project management theories and methods to address practical problems related to project efficiency. Primary data was obtained through direct observation at the project site to understand the workflow, document activity duration, and resource usage. Secondary data included literature studies, project documents, and reports. Data collection involved field observation to record detailed project activities and analyze work data such as S curves, weights, and volumes. A work network analysis was conducted using CPM to identify activities on the critical path, organizing them based on work dependency logic with time estimates. This analysis included calculations of the Latest Event Time (LET) and Earliest Event Time (EET) to determine the critical path based on float time. The study also calculated direct and indirect costs due to project acceleration and determined the optimal project duration by comparing additional overtime with resulting costs. It aims to provide strategic recommendations for improving time and cost efficiency in construction projects using the CPM approach.

RESULTS AND DISCUSSION

Project Data

Project data is all information about the project that includes a planning description of a construction project. Data or information that discusses the project can be divided into two categories, namely general project data and project technical data. General project data is identity data about the project itself, while project technical data is data regarding technical planning in the implementation of the project construction. The following is general project data and technical data for the construction of retaining walls using river stone masonry in Sumber Pasinan, Mojokerto Regency.

Project Profile

The construction project of river masonry in Pungging River, Mojokerto Regency is a disaster emergency response handling project that aims to anticipate the rise of water from the Sumber Pasinan river which often overflows during the rainy season, if not handled immediately, during the rainy season it can erode the river banks which are getting wider so that landslides can occur. The details of the construction project of river stone masonry in Sumber Pasinan River, Mojokerto Regency, can be found as follows:

Package Name: Disaster Emergency Response	
Location Project	: Patung Village, Pungging Sub-district, Mojokerto District
Project Type	: Self-managed
Funding Source	: DIP A Satker OP SDA Brantas
Start of Work	: October 01, 2024
End of Work	: December 21, 2024
Implementation Time	: 3 Months (71 Days)
Project Owner	: OP SDA II BBWS Brantas
Planner	: OP SDA II BBWS Brantas
Supervisor	: OP SDA II BBWS Brantas
Implementing Contractor	: OP SDA II BBWS Brantas
Type of work	: Stone masonry
DPT Length	: 45 m
DPT top width	: 0,40 m
DPT height	: 6,00 m
Distance between columns	: 6,00 m
Distance between scales	: 6 m

Plan Drawing

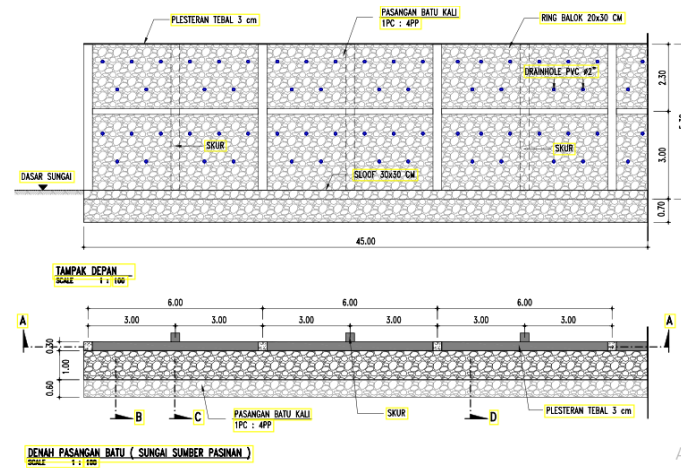


Figure 1. Plan and front view of the stone masonry of Pasinan Source, Mojokerto Regency
Source: Processed by Researcher, 2024

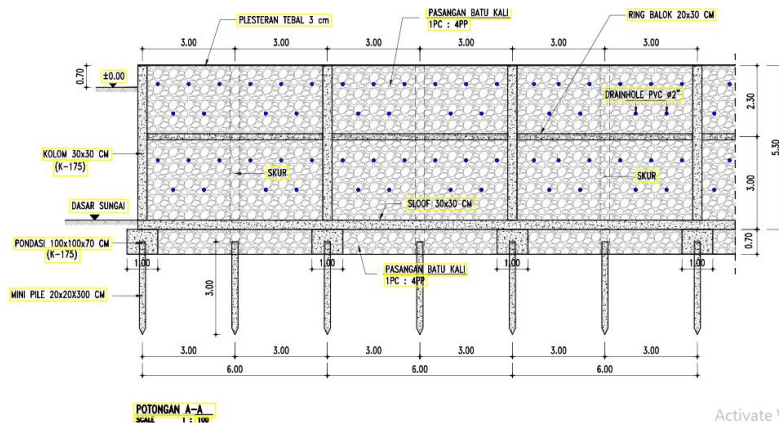


Figure 2. A-A section of the stone masonry of Pasinan Source, Mojokerto Regency
Source: Processed by Researcher, 2024

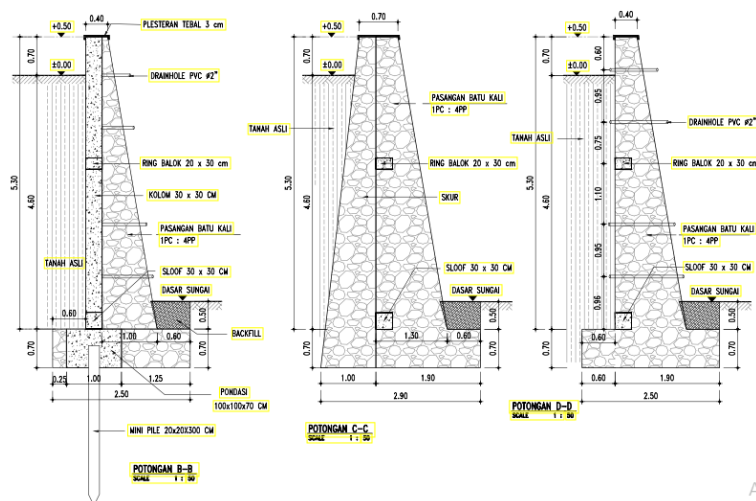


Figure 3. Drawing of Pieces B-B, C-C, and D-D of Stone Masonry Source Pasinan Mojokerto Work Items

Several work items are involved in the Mojokerto Regency Pasinan Stone Pair construction project, which includes preparatory and finishing work. Table 4.1 describes the work items in the construction project of the Kali Stone Pair of Pasinan Source, Mojokerto Regency.

Table 1. Work Items

No	Items
1	Preparatory Work
2	Earthwork
3	Structure Work
4	Spouse's Occupation
5	Piling Work
6	Other Occupations

Source: Processed by Researcher, 2024

Work Breakdown Structure

A tool in project management that organizes a list of project activities or objectives according to their scope in a systematic manner. Based on the data from the plan S curve in the appendix, the breakdown results and the code of each activity can be seen in Table 4.2 below.

Table 2. Work Breakdown Structure

No.	Work Breakdown Structure	Code Activities
I	PREPARATORY WORK	
1.1	Site Clearance	A
II	EARTHWORKS	
2.1	Ordinary Land Excavation > 1 m to 2 m deep	B
2.2	Backfilling of soil	C
2.3	50 kg sandbag pairing work	D
2.4	Ordinary Land Excavation > 1 m to 2 m deep (manual)	E
III	STRUCTURAL WORK	
3.1	K175 grade concrete	F
3.2	Fixing with plain iron for fixings foundation, column, and sloof	G
3.3	Installation of foundation and sloof formwork	H
3.4	Erection of column formwork	I
3.5	Beam Formwork Installation	J
IV	PARTNER WORK	
4.1	Masonry Mix 1 SP: 4 PP	K
4.2	Distilled-distilled pipe installation	L
4.4	Plastering 1 SP: 3 PP 15 mm thick	M
4.5	1 m2 Acian Installation	N
5.6	Broadcast with 1PC:2PP	O
V	PILING WORK	
5.1	Penetration of 20 x 20 cm deep square concrete piles 3 meters	P
VI	OTHER WORK - OTHER	
6,1	Demolition Work	Q

Source: Processed by Researcher, 2024

Work Duration Calculation

Calculating duration usually considers several factors, such as the type of work, the volume of tasks, and the amount of labor available. The coefficient of each work item categorizes whether work is done manually or mechanically, using heavy equipment or not.

List of Work Volume (Bill Of Quantity)

The list of work volumes (Bill of Quantity) for the construction project of the Kali Stone Pair Sumber Pasinan Mojokerto Regency includes preparatory work, dewatering work, earthwork, structural work, masonry work, and piling work. The following in Table 4.3 lists the volume of work for the Mojokerto Regency, Pasinan Source Kali Stone Pair.

Table 3. List of work volume (Bill of Quantity)

No.	Job Name	Volume	Sat.
I	PREPARATORY WORK		
1.1	Site Clearance	45,00	m2
II	EARTHWORKS		
2.1	Ordinary Land Excavation > 1 m to 2 m deep	403,50	m3
2.2	Backfilling of soil	252,00	m3
2.3	50 kg sandbag pairing work	599,00	bh
2.4	Ordinary Land Excavation > 1 m to 2 m deep (manual)	40,00	m3
III	STRUCTURAL WORK		
3.1	K175 grade concrete	16,52	m3
3.2	Fixing with plain iron for fixings foundation, column, and sloof	1.152,79	kg
3.3	Installation of foundation and sloof formwork	49,40	m2
3.4	Erection of column formwork	25,44	m2
3.5	Beam Formwork Installation	18,00	m2
IV	PARTNER WORK		
4.1	Masonry Mix 1 SP: 4 PP	291,86	m3
4.2	Distilled-distilled pipe installation	73,04	m1
4.4	Plastering 1 SP: 3 PP 15 mm thick	53,40	m2
4.5	1 m2 Acian Installation	53,90	m2
4.6	Broadcast with 1PC:2PP	273,60	m2
V	PILING WORK		
5.1	Penetration of 20 x 20 cm square concrete piles 3 meters deep	48,00	m1
VI	OTHER WORK - OTHER		
6,1	Demolition Work	180,00	m3

Source: Processed by Researcher, 2024

List of Workers and Tools

Based on observations in the field, the number of workers and craftsmen combined in a job can be identified. Work can also be done manually or mechanically using heavy equipment during implementation, as can be clearly seen in the description below.

A. Site clearance work

1. Preparation of land to be built with river stone masonry
2. Type of work : Manual
3. Number of laborers : 3 people
4. Number of tools : -

B. Ordinary Excavation Work > 1 m to 2 m deep

1. Type of work : Mechanical
2. Number of laborers : 2 people
3. Number of tools : 1 Excavator PC 120

C. Backfill work

1. Type of work : Mechanical
2. Number of laborers : 2 people
3. Number of tools : 1 Excavator PC 120

D. 40 kg sandbag installation work

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : -

E. Ordinary Excavation > 1 m to 2 m deep (manual)

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : -

F. K175 grade concrete

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : 1 molen with a capacity of 1 m³

G. Reinforcement work with plain iron for foundation, column, and sloof reinforcement

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : -

H. Foundation and sloof formwork work

1. Type of work : Manual

2. Number of laborers : 2 people

3. Number of tools : -

I. Column formwork work

1. Type of work : Manual

2. Number of laborers : 2 people

3. Number of tools : -

J. Ring beam formwork work

1. Type of work : Manual

2. Number of laborers : 2 people

3. Number of tools : -

K. Installation of stone masonry mix 1 PC: 4 PP

1. Type of work : Manual

2. Number of laborers : 6 people

3. Number of tools : -

L. Distilled-distilled pipe installation

1. Type of work : Manual

2. Number of laborers : 3 people

3. Number of tools : -

M. Plastering 1 PC: 3 PP 15 mm thick

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : -

N. Acian

1. Type of work : Manual

2. Number of laborers : 4 people

3. Number of tools : -

O. Broadcast 1 PC: 2 PP

1. Type of work : Manual

2. Number of laborers : 2 people

3. Number of tools : -

P. 20 x 20 cm square concrete pile penetration

1. Type of work : Mechanical

2. Number of laborers : 2 people

3. Number of tools : 1 Excavator PC 120

Q. Demolition Work

1. Type of work : Mechanical
2. Number of laborers : 2
3. Number of tools : 1 Excavator PC 120

List of work coefficients

The coefficient figures for manual and semi-mechanized work are obtained based on Permen PUPR Year 2022, while the tool coefficient figures are calculated based on the productivity calculations in the AHSP Permen PUPR Year 2022. In lump sum (LS) work, the coefficient is not used because the work is followed and adjusted to the project's needs.

Table 4. List of Occupational Coefficients

No.		Job Description	Unit Index Coefficient (OH)	
			Labor	Index
I	Preparatory Work			
1.1	Land preparation	Workers	0.112	
		Carpenter	0.006	
		Total	0.118	
II	Earthwork			
2.1	Ordinary Land Excavation > 1m to 2m deep	Workers	0.188	
		Total	0.188	
2.2	Backfilling	Workers	0.250	
		Total	0.250	
2.3	50 kg sandbag pairing work	Workers	0.040	
		Total	0.040	
2.4	Ordinary Land Excavation > 1m to 2m deep (manual)	Workers	0.900	
		Total	0.900	
III	Structure Work			
3.1	K175 grade concrete	Workers	1.000	
		Stonemason	0.250	
		Total	1.250	
3.2	Reinforcement with plain iron for foundation, column, and sloof reinforcement	Workers	0.002	
		Ironworker	0.002	
		Total	0.004	
3.3	Foundation and sloof formwork work	Workers	0.200	
		Carpenter	0.100	
		Total	0.300	
3.4	Column formwork work	Workers	0.330	
		Carpenter	0.330	
		Total	0.660	
3.5	Ring beam formwork work	Workers	0.360	
		Carpenter	0.360	
		Total	0.720	
IV	Spouse's Occupation			
4.1	Installation of stone masonry mix 1 PC: 4 PP	Workers	1.554	
		Stonemason	0.676	
		Total	2.230	
4.2	Installation of 2" distilled pipe	Workers	0.100	
		Total	0.100	
4.3	Plastering 1 PC: 3 PP 15 mm thick	Workers	0.300	
		Stonemason	0.150	
		Total	0.450	
4.4	Acian	Workers	0.200	
		Stonemason	0.100	
		Total	0.300	
4.5	Broadcast 1 PC: 2 PP	Workers	0.200	
		Stonemason	0.200	

		Total	0.400
V	Piling Work		
5.1	Penetration of 20 x 20 cm square concrete piles	Workers	0.150
		Total	0.150
VI	Other Occupations		
6.1	Demolition Work	Workers	0.400
		Total	0.400

Source: Processed by Researcher, 2024.

Duration of Work

The number of labor coefficients is then multiplied by the volume and divided by 6 (effective hours in 1 day), so the number of days is obtained as follows.

Table 5. List of work duration calculations

No.	Job Description	Unit	Volume	Index (OH)	Number of Days (cxd)/6
	a	b	c	d	
I	PREPARATORY WORK				
1.1	Site Clearance	m2	45,00	0,018	0,89
II	EARTHWORKS				
2.1	Ordinary Land Excavation > 1 m to 2 m deep	m3	403,50	0,188	12,64
2.2	Backfilling of soil	m3	252,00	0,250	10,50
2.3	50 kg sandbag pairing work	bh	599,00	0,040	3,99
2.4	Ordinary Land Excavation > 1 m to 2 m deep (manual)	m3	40,00	0,900	6,00
III	STRUCTURAL WORK				
3.1	K175 grade concrete	m3	16,52	1,250	3,44
3.2	Fixing with plain iron for fixings foundation, column, and sloof	kg	1.152,79	0,004	0,77
3.3	Installation of foundation and sloof formwork	m2	49,40	0,300	2,47
3.4	Erection of column formwork	m2	25,44	0,660	2,80
3.5	Beam Formwork Installation	m2	18,00	0,720	2,16
IV	PARTNER WORK				
4.1	Masonry Mix 1 SP: 4 PP	m3	291,86	2,230	108,47
4.2	Distilled-distilled pipe installation	m1	73,04	0,100	1,22
4.4	Plastering 1 SP: 3 PP 15 mm thick	m2	53,40	0,450	4,01
4.5	1 m2 Acian Installation	m2	53,90	0,300	2,70
4.6	Broadcast with 1PC:2PP	m2	273,60	0,400	18,24
V	PILING WORK				
5.1	Penetration of 20 x 20 cm square concrete piles 3 meters deep	m1	48,00	0,150	1,20
VI	OTHER WORK - OTHER				
6.1	Demolition Work	m3	180,00	0,400	12,00

Source: Processed by Researcher, 2024.

Calculation of Time Acceleration Using the CPM Method (Critical Path Method)

In the calculation of time acceleration using the critical path method (CPM), analyze the time of all work items using the calculation of the fastest time (early start) and the longest time (latest start), and when the time for the longest work must be completed (latest finish). In addition, it also determines the critical path, in this case, activities that require extra attention or need to be prioritized, allocate resources more efficiently, and plan time acceleration using the help of Microsoft Project.

Determination of Dependency Logic (Predecessor)

Creating a network diagram requires determining the dependency logic relationship between one activity and another to determine the predecessor. The following table 4.6, based on the field study results, shows the determination of the dependency logic relationship (predecessor) as follows.

Table 6. Determination of Dependency Logic (Predecessor)

Activity code	Job Description	Predecessor	Duration (days)	Number of Workers (people)
I	PREPARATORY WORK			
A	Site Clearance		9	3
II	EARTHWORKS			
B	Ordinary Land Excavation > 1 m to 2 m deep	A	8	2
C	Backfilling of soil	H	6	2
D	50 kg sandbag pairing work	B	5	4
E	Ordinary Land Excavation > 1 m to 2 m deep (manual)	A, B	7	4
III	STRUCTURAL WORK			
F	K175 grade concrete	H, I, J	5	4
G	Fixing with plain iron for fixings foundation, column, and sloof	A	3	4
H	Installation of foundation and sloof formwork	G	8	2
I	Erection of column formwork	H	4	2
J	Beam Formwork Installation	H	6	2
IV	PARTNER WORK			
K	Masonry Mix 1 SP: 4 PP	G	53	6
L	Distilled-distilled pipe installation	K	7	3
M	Plastering 1 SP: 3 PP 15 mm thick	K	5	4
N	1 m2 Acian Installation	M	6	4
O	Broadcast with 1PC:2PP	K	6	2
V	PILING WORK			
P	Penetration of 20 x 20 cm square concrete piles 3 meters deep	B	3	2
VI	OTHER WORK - OTHER			
Q	Demolition Work	B	5	2

Source: Processed by Researcher, 2024.

Project Activities and Time Schedule

The following presents the activities carried out at the project site to construct river stone masonry in Sumber Pasinan, Mojokerto, along with a graphical schedule of the progress plan targeted for every week.

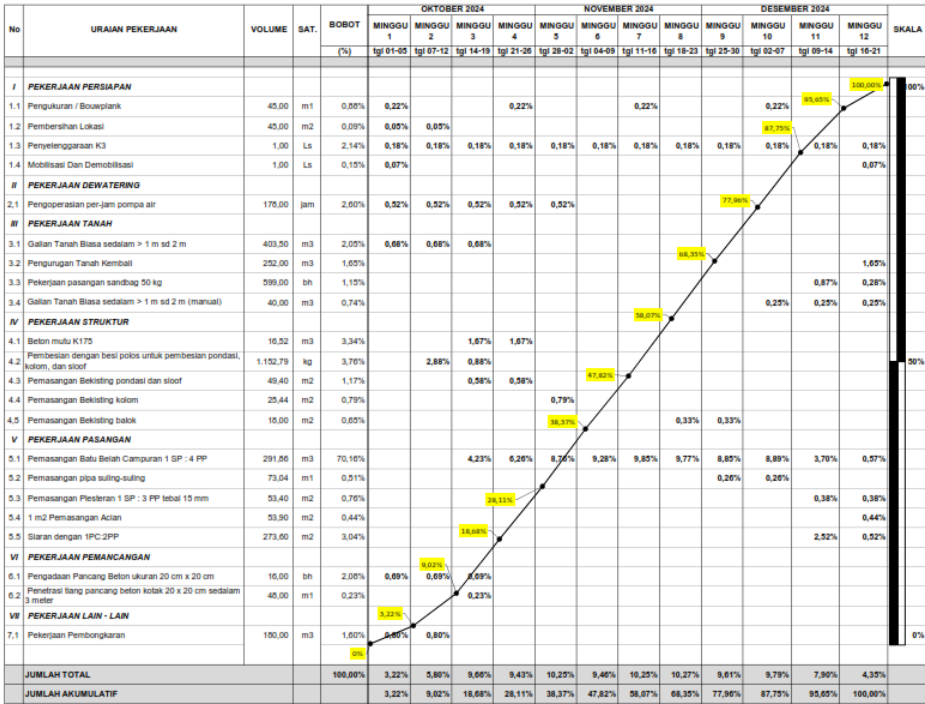


Figure 4. Plan Time Schedule
Source: Processed by Researcher, 2024

Project implementation schedule time planning using Microsoft Project 2016

The project planning schedule, which was planned using Microsoft Project 2016, is presented in the plan schedule bar diagram and plan schedule network diagram.

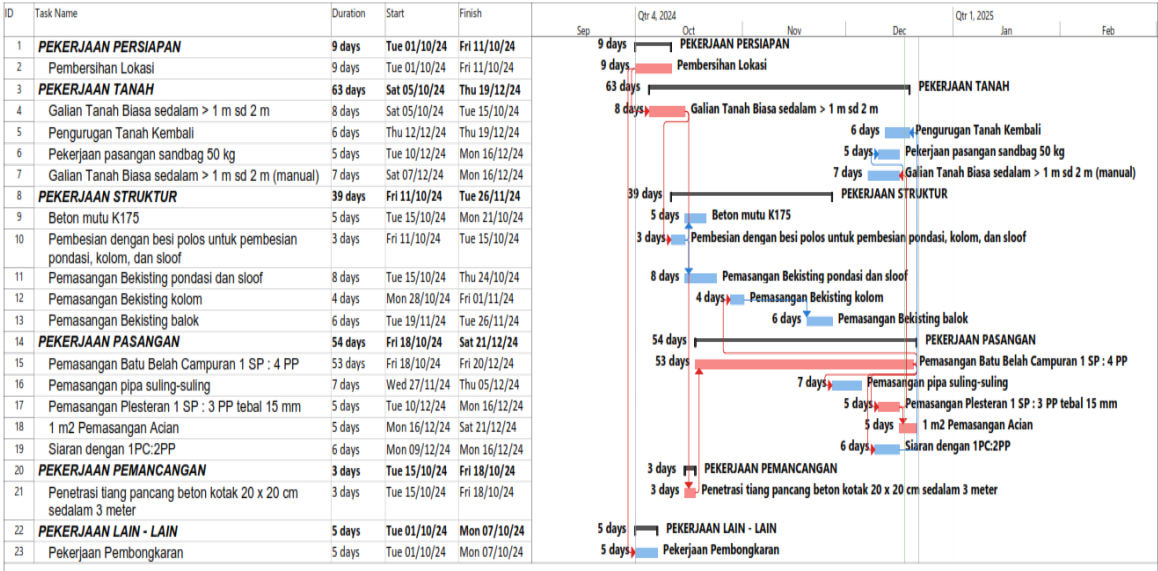


Figure 5. Bar Diagram of Microsoft Project 2016 Plan
Source: Author's Report, 2024.



Source: Author's Report, 2024.

Planning the acceleration of the project implementation schedule time using the S-curve

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No.	Job Name
I	Preparatory Work
1.1	Site Clearance
II	Earthwork
2.1	Ordinary Land Excavation > 1 m to 2 m deep
IV	Spouse's Occupation
4.1	Installation of stone masonry mix 1 PC: 4 PP
4.2	Plastering 1 SP: 3 PP 15 mm thick
4.3	1 m2 Acian Installation
V	Piling Work
5.1	Penetration of 20 x 20 cm square concrete piles 3 meters deep

Source: Processed by Researcher, 2024.

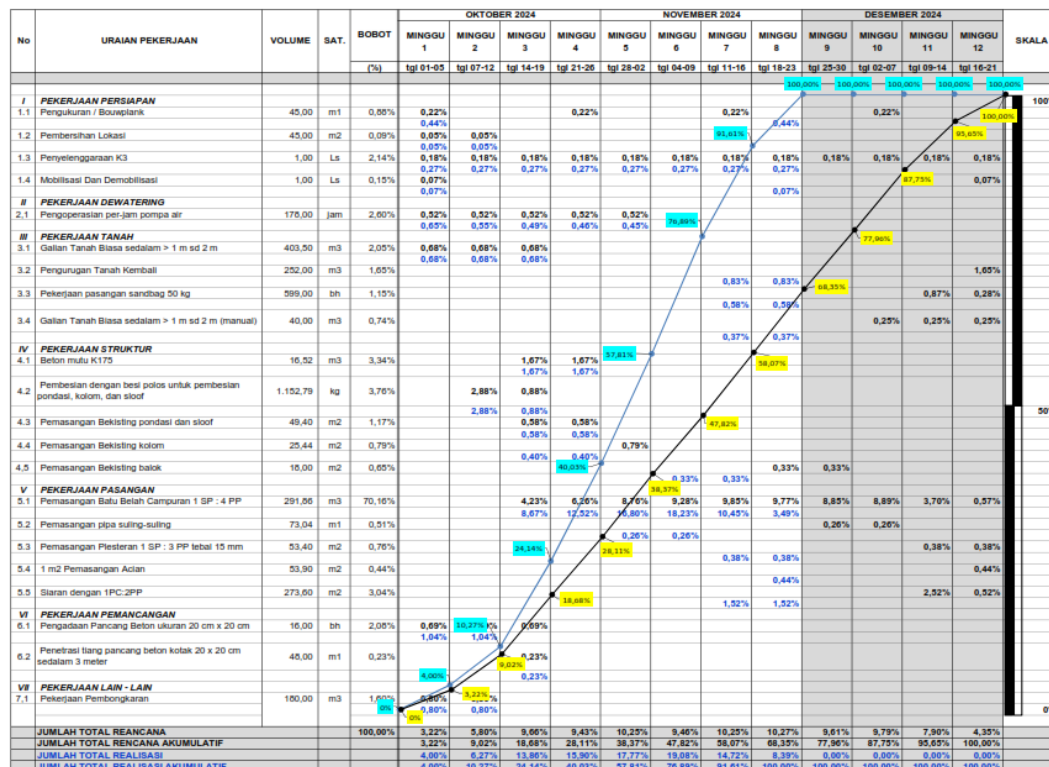


Figure 7. Realization Time Schedule

Source: Processed by Researcher, 2024.

Based on Table 4.8, the project is planned to start in October 2024 and finish in December 2024. However, due to acceleration, the project that should be completed on December 21, 2024, is accelerated to completion on November 23, 2024, or the project that is planned to take 71 working days is accelerated to 47 working days, with a difference in acceleration time of 24 days.

Calculation of the acceleration of the project implementation schedule time using Microsoft Project 2016

The acceleration of this river stone masonry construction project was accelerated by 24 days from the initial planning, so it is necessary to anticipate the addition of workers in the project, namely, in the work with the most considerable weight. The most significant work weight in the construction of this river stone masonry is installing river stone masonry, which is 70.16%. The addition of workers is calculated as follows:

Number of workers on river stone masonry work

Workers = six people
Duration of work = 53 days
Duration of work to be achieved = 30 days

Therefore, the addition of workers is :

53 days x 6 people = 30 days x n

$$n = \frac{53 \times 6}{30} = 10.6 \text{ people rounded up to 11 people}$$

Based on the acceleration S curve in the discussion of table 4.8 and a brief calculation of the addition of workers in the installation of river stone masonry work, the following is a schedule bar chart and network diagram of the acceleration of river stone masonry work at Sumber Pasinan Mojokerto River using micrososft project, shown in figures 4.8 and 4.9 below.

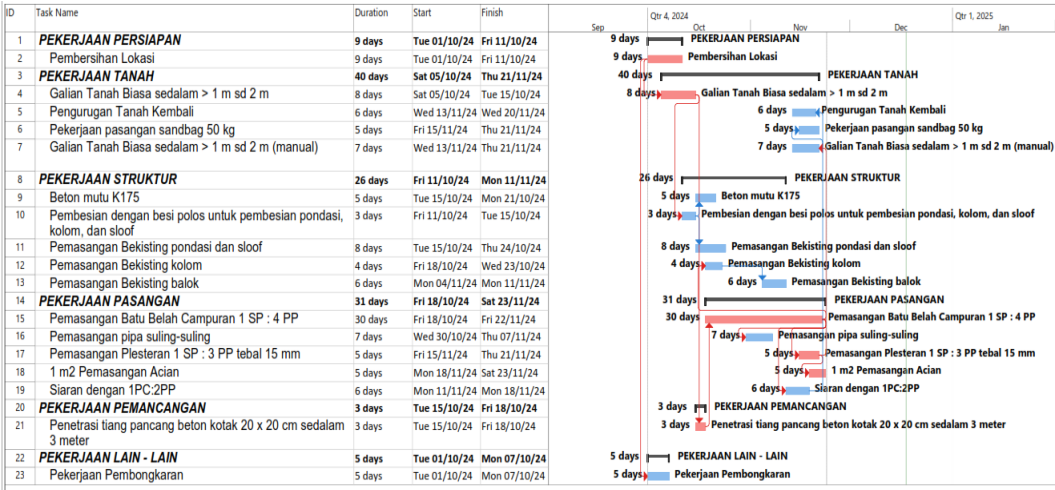


Figure 8. Microsoft Project 2016 Realization Bar Diagram
Source: Author's Report, 2024.

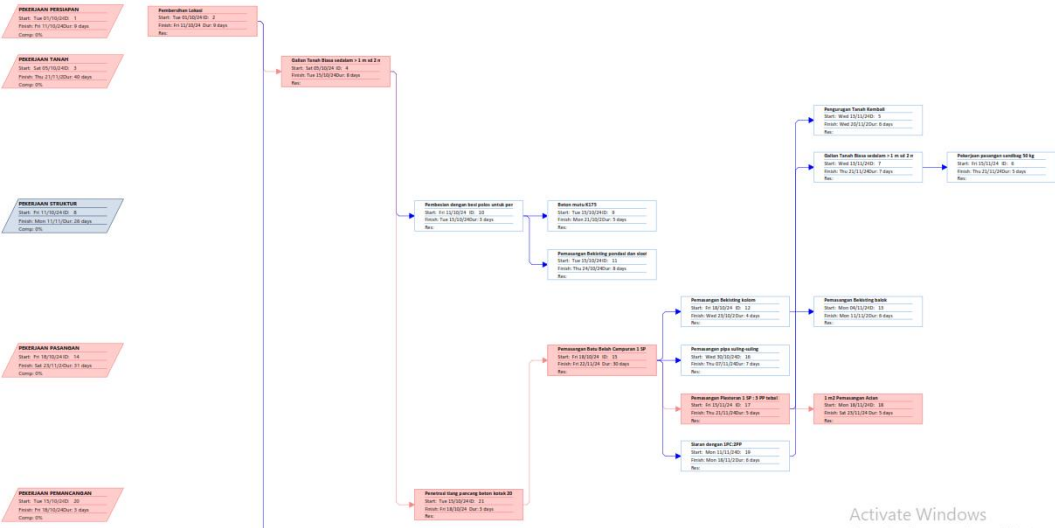


Figure 9. Network Diagram Realization of Microsoft Project 2016
Source: Author's Report, 2024

Then, after time accelerates, the current work duration can be relabeled by adding workers to the work of installing river stone pairs.

Table 8. Duration of Work After Acceleration with CPM

Activity code	Job Description	Duration (days)	Number of Workers (people)
I PREPARATORY WORK			
A	Site Clearance	9	3
II EARTHWORKS			
B	Ordinary Land Excavation > 1 m to 2 m deep	8	2
C	Backfilling of soil	6	2
D	50 kg sandbag pairing work	5	4
E	Ordinary Land Excavation > 1 m to 2 m deep (manual)	7	4
III STRUCTURAL WORK			
F	K175 grade concrete	5	4
G	Fixing with plain iron for fixings foundation, column, and sloof	3	4
H	Installation of foundation and sloof formwork	8	2
I	Erection of column formwork	4	2
J	Beam Formwork Installation	6	2

IV	PARTNER WORK		
K	Masonry Mix 1 SP: 4 PP	30	6
L	Distilled-distilled pipe installation	7	3
M	Plastering 1 SP: 3 PP 15 mm thick	5	4
N	1 m2 Acian Installation	6	4
O	Broadcast with 1PC:2PP	6	2
V	PILING WORK		
P	Penetration of 20 x 20 cm square concrete piles 3 meters deep	3	2
VI	OTHER WORK - OTHER		
Q	Demolition Work	5	2

Source: Processed by Researcher, 2024.

Calculation of Cost Differences Due to Acceleration of Construction Work

The following compares the number of workers before and after the acceleration of construction work.

Table 9: Number of workers before and after work acceleration

Activity code	Job Description	Number of Workers Before Acceleration (people)	Number of Workers After Acceleration (people)
I	PREPARATORY WORK		
A	Site Clearance	3	3
II	EARTHWORKS		
B	Ordinary Land Excavation > 1 m to 2 m deep	2	2
C	Backfilling of soil	2	2
D	50 kg sandbag pairing work	4	4
E	Ordinary Land Excavation > 1 m to 2 m deep (manual)	4	4
III	STRUCTURAL WORK		
F	K175 grade concrete	4	4
G	Fixing with plain iron for fixings foundation, column, and sloof	4	4
H	Installation of foundation and sloof formwork	2	2
I	Erection of column formwork	2	2
J	Beam Formwork Installation	2	2
IV	PARTNER WORK		
K	Masonry Mix 1 SP: 4 PP	6	11
L	Distilled-distilled pipe installation	3	3
M	Plastering 1 SP: 3 PP 15 mm thick	4	4
N	1 m2 Acian Installation	4	4
O	Broadcast with 1PC:2PP	2	2
V	PILING WORK		
P	Penetration of 20 x 20 cm square concrete piles 3 meters deep	2	2
VI	OTHER WORK - OTHER		
Q	Demolition Work	2	2

Source: Processed by Researcher, 2024.

CONCLUSION

The analysis of the split stone masonry construction project in Sungai Sumber Pasinan revealed that using the Critical Path Method (CPM) reduced the project duration from 71 to 47 working days,

achieving a 24-day acceleration by adding 11 workers for masonry installation. This demonstrates the effectiveness of CPM in enhancing project timelines. Future research could examine the long-term effects of adding workforce on project quality and cost-effectiveness, investigate CPM's applicability in various disaster response projects, analyze the link between acceleration techniques and worker productivity, and compare CPM with other project management methodologies to identify optimal strategies for time and cost management in emergency scenarios.

REFERENCES

- Agenda, I. (2016). Shaping the future of construction: a breakthrough in mindset and technology. *World Economic Forum*, 11–16.
- Alfarizi, M. R., Rifai, A. I., Indrastuti, I., & Prasetyo, J. (2024). Bibliometric Analysis of Cost and Time Management In Handling Avalanches on National Roads In Mountainous Areas Using BIM. *Asian Journal of Social and Humanities*, 2(9), 1941–1955.
- Andi Permana Sidiq, G. J. J. (2022). Analysis of the Application of Earned Value to Time and Cost Management on the Cibuni Bridge Project. *Jurnal ITG*. <https://jurnal.itg.ac.id/>
- Bajjou, M. S., & Chafi, A. (2020). Identifying and managing critical waste factors for lean construction projects. *Engineering management journal*, 32(1), 2–13.
- Bajjou, M. S., & Chafi, A. (2022). Exploring the critical waste factors affecting construction projects. *Engineering, Construction and Architectural Management*, 29(6), 2268–2299.
- Bosu, A., Carver, J. C., Bird, C., Orbeck, J., & Chockley, C. (2016). Process aspects and social dynamics of contemporary code review: Insights from open source development and industrial practice at Microsoft. *IEEE Transactions on Software Engineering*, 43(1), 56–75.
- Castollani, A., Puro, S., Maiko, *, & Dewa, L. (2020). Cost and Time Analysis on Apartment Project with Earned Value Concept Method. *Journal of Project Management*, 3(1).
- Harris, F., McCaffer, R., Baldwin, A., & Edum-Fotwe, F. (2020). *Modern construction management*. John Wiley & Sons.
- Nguyen, Q. C., Perera, S., Ginigaddara, B., Nguyen, D. T. M., Rahmawati, R., Operio, J. H., & Nguyen, D. H. T. (2023). An Evaluation of Offsite Construction Recoveries after the Pandemic: The Case of the Southeast Asian Region. *Buildings*, 13(1), 50.
- Parsamehr, M., Perera, U. S., Dodanwala, T. C., Perera, P., & Ruparathna, R. (2023). A review of construction management challenges and BIM-based solutions: perspectives from the schedule, cost, quality, and safety management. *Asian Journal of Civil Engineering*, 24(1), 353–389.
- Prasetya, K. B., Patriadi, A., & Saiyo, S. (2025). Analysis of Time Control Strategies Using The Critical Path Method (CPM) In The Development of The Java Residence Cluster For Mass-Product. *Devotion: Journal of Research and Community Service*, 6(1), 30–42.
- Rifqi Riftyan Pranaya, M. Z. (2023). Comparative Analysis of Slope Stability with Soil Nailing and Kali Stone Methods on the Lot 6a South Cross Road Project. *Journal of Statik Civil*, 4. <http://jos-mrk.polinema.ac.id/>
- Saputra, N., Handayani, E., & Dwiretnani, A. (2021). Analysis of Project Scheduling with the Critical Path Method (CPM) Case Study of the Construction of the Inpatient Building of Abdul Manap Hospital, Jambi City. *Journal of Civil Talent*, 4(1), 44. <https://doi.org/https://doi.org/10.33087/talentsipil.v4i1.48>
- Shah, P., & Chandragade, A. A. (2023). Application of project management tool in construction for Planning, Scheduling and Optimization. *Materials Today: Proceedings*, 77, 773–779.
- Sofia, D. A., Aulia, A., & Putri, E. (2021). *Comparative Analysis of the Addition of Working Hours and Labor on Project Time and Cost with the Time Cost Trade Off Method*.
- Supratikno, S. A. M. A. G. (2023). *Comparative Study of the Price of Renovation of 200-meter-long Talud with Face Stone and Concrete Slab with Wiremesh Reinforcement*. 11(1), 77–82. <https://doi.org/https://doi.org/10.21063/JTS.2024.V1101.077-82>
- Vidia Pratiwi, A. A. (2024). *Comparative Analysis of Plan Time Management with Actual Conditions of XYZ Campus Building Construction Project*.
- Wiroso, L. H. (2023). *Comparison of Kali Stone Foundation Installation Index by Using Unit Price Analysis and Actual Conditions (Case Study of the Construction of Gladagsari District Office, Boyolali Regency)*.
- Yuliana Yamco, M. A. L. S. L. (2022). *Analysis of Land Landslide Vulnerability Level Based on Geographic Information System in Ambon City*. 1.

Yusuf Malif, A. K. T. D. Y. M. (2019). Analysis of Time and Cost Acceleration of Construction Projects Using the Crashing Method (Case Study: Construction of Iain Manado Flats). *Journal of Statik Civil*, 7(6), 681–688.