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Analysis of The Construction Time of The Cilutung Sumedang Bridge – Majalengka

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ABSTRACT

Project management is the process of managing limited resources efficiently, effectively, and within a specified timeframe to complete a project according to a predetermined plan. The three main functions of project management include planning, execution, and control. The control function involves managing various project resources such as manpower, equipment, materials, and methods used. To achieve optimal project performance in the construction of the Cilutung Bridge, various analyses were conducted to ensure the smooth implementation of the project in accordance with the plan. In this study, the applied analysis includes calculating the volume of work, developing implementation plans, and estimating the requirements for labor, materials, and equipment, accompanied by the preparation of an S-curve and the analysis of the critical path using the CPM (Critical Path Method). These analyses were carried out to assess project performance, ensuring that implementation remains on schedule and achieves optimal results. The findings show that the calculated total work volume for the Cilutung Sumedang–Majalengka Bridge Construction Project is 12,257.813 m³. Furthermore, based on the CPM (Critical Path Method) analysis, the project requires 72 days, or approximately 18 weeks, for completion.

Keywords: Work Volume, Needs Analysis (Manpower, Materials and Tools), S Curve and Critical Path Method (CPM)

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INTRODUCTION

Infrastructure development, particularly bridges, plays a vital role in improving regional connectivity and fostering economic growth (McKinsey Global Institute, 2017; World Bank, 2025). Research indicates that global investment in economic infrastructure needs to reach $3.7 trillion annually to support GDP growth and meet sustainable development goals (McKinsey Global Institute, 2017). The Cilutung Bridge, which connects the Sumedang and Majalengka Regencies, is a strategic project designed to facilitate the flow of transportation and the distribution of goods and services in the region. Bridge infrastructure has been recognized as critical for maintaining essential connectivity and protecting communities, particularly in developing regions (World Bank, 2025).

However, in the implementation of construction projects, delays are often a major challenge that can affect project cost, quality, and completion time (Larsen et al., 2015; Yaseen et al., 2020). Studies have identified that lack of staff, financial challenges, insufficient planning, client approval delays, material scarcity, and ineffective site management primarily cause delays in construction projects (Yaseen et al., 2020). Factors such as adverse weather conditions, delays in material delivery, and lack of coordination among stakeholders can lead to deviations from the planned schedule (Emam et al., 2015). Research on bridge construction specifically has revealed that factors including labor shortages, high bid competition, fluctuating fuel prices, and facility inadequacy are significant contributors to project delays (Durdyev & Hosseini, 2020; Fashina et al., 2021; Kamandang & Casita, 2018).

To address delay-related issues, effective time management is essential (Mostafa, 2023). Several methods have been developed to tackle this problem, including the Critical Path Method (CPM), the Program Evaluation and Review Technique (PERT), and the Time Cost Trade Off (TCTO) method, which can be utilized to identify critical paths, evaluate activity durations, and optimize both project time and cost (Hegazy et al., 2015; Carson, 2025). The application of PERT and CPM methods in construction has been shown to eradicate deficiencies in project time management by organizing project activities through network diagrams (Mostafa, 2023). These methodologies enable project managers to identify the critical path, determine minimum completion times, and make informed decisions regarding resource allocation (Carson, 2025). The Time Cost Trade-Off (TCTO) analysis has emerged as an effective technique for optimizing project schedules by reducing completion time at minimum additional cost through activity crashing (Taher, 2017; Jamal et al., 2025). Recent studies demonstrate that TCTO analysis, when combined with project crashing methods, can significantly accelerate project schedules while maintaining cost efficiency (Jamal et al., 2025).

This research is expected to provide added value in developing best practices for bridge construction management. By enhancing the understanding of project dynamics in bridge construction, the study aims to increase the effectiveness of project management, minimize risks, and ensure sustainability in transportation infrastructure development that supports long-term growth and community welfare.

In the study conducted by Pebi Mahar Ramadhan and Saihul Anwar (2022), the analysis focused on determining the estimated project duration, as well as cost requirements for heavy equipment, materials, and labor—including the preparation of the Cost Budget Plan (Rencana Anggaran Biaya or RAB)—and identifying critical paths in the Cikeusal Bridge construction project in Cimahi District, Brass Regency. A descriptive quantitative approach was applied, emphasizing the collection and analysis of numerical and thematic data to generate relevant and actionable information. The research included an analysis of work volume, evaluation of implementation methods, utilization of tools and materials, and cost estimation. The project data comprised a Barchart and S-Curve. Data collection techniques involved field observations, interviews with stakeholders, and a literature review of relevant theories and methods. The

results of the analysis indicated that the work volume significantly affects labor needs, wages, equipment usage, and material consumption for each work item, depending on the volume and coefficients applied. The estimated duration of the Cikeusal Bridge construction project was found to be 36 weeks, or approximately nine months, with a total budget estimated at IDR 3,399,084,563,837. Project scheduling and cost analysis were conducted using Microsoft Excel software.

Previous research further underscores the importance of these methods. For example, Pebi Mahar Ramadhan and Saihul Anwar (2022) applied descriptive quantitative methods to analyze the Cikeusal Bridge project, identifying critical paths and estimating a 36-week completion timeframe. Similarly, Yuwono et al. (2021) demonstrated the effectiveness of PERT–CPM in managing project time and cost, while Ervianto (2023) emphasized the role of construction management in ensuring project efficiency. Additionally, Sa and Rijanto (2021) employed CPM and crashing techniques to evaluate building construction projects, highlighting the method's utility in accelerating project timelines. The urgency of this research is reinforced by recent data on losses stemming from construction delays in Indonesia. Reports from the Directorate General of Highways (2023) reveal that delays in infrastructure projects, including bridges, have resulted in average cost overruns of 15–25% and extended project timelines by 30–40%, significantly affecting public service delivery and regional economic performance.

Therefore, this study aims to analyze the construction duration of the Cilutung Bridge through work volume calculations and CPM analysis to ensure that project completion aligns with the planned schedule. The findings are expected to offer practical benefits by providing a systematic approach for project managers to optimize resource allocation, mitigate delay risks, and enhance the overall effectiveness of infrastructure project management—thus supporting sustainable growth and community welfare.

METHOD

According to Sugiwanto et al. (2019), research methods are the most important aspect of conducting research because they are used to determine, develop, and test the data or facts being studied in order to verify their validity. In addition, a research method is a scientific approach to obtaining data with specific purposes and applications based on scientific principles that are rational, empirical, and systematic (Sugiyono, 2017:2).

In this study, the method used is a quantitative approach, which presents results in the form of observable and measurable facts. This method focuses on numerical data that can be processed and analyzed to generate the required findings. The purpose of developing this method in the research titled Analysis of the Construction Time of the Cilutung Sumedang–Majalengka Bridge is to ensure that the research outcomes are objective, quantifiable, and aligned with the principles of scientific accuracy:

1. Searching for data – primary data and secondary data (at relevant agencies and agencies needed to complete the data needed in the preparation of research reports).

2. Literature study as a literature review both from books and other media (internet).
3. Manage and analyze the data obtained. Conclusion and suggestions.

Types and Data Sources

A. Primary Data

It is data obtained from the results of directly reviewing the project location, as well as conducting interview sessions. The concept of primary data emphasizes that the data has not been processed and is directly taken from the primary source by the researcher.

B. Secondary Data

Data obtained from previous literature, such as journals, books, lecture notes, the results of discussions with supervisors, and information collected from agencies related to the implementation of the Cilutung Bridge construction project

Research Interships

1. Volume Calculation

Volume calculation is the first step in conducting data analysis. Starting with preparation work, soil excavation work, foundation work, structure work and finishing work.

To calculate volume, the following formula is used:

- Volume length of work item (m)
  = Length or Height
- Volume to calculate the area of the work item (m2)
  = Length x Width
- Volume to calculate work item cubic (m3)
  = Length x Width x Height

2. Duration Calculationg

Each of these activities takes a long time to build a work network. The volume of work, the number of manpower needed and the productivity of the workforce are the basis for calculating the duration of each activity.

To calculate the duration, the following formula is used:

$$\text{Duration} = \frac{Volume\ of\ Work}{Production\ of\ the\ determining\ tool\ per\ day}$$

3. CPM Analysis

CPM (*Critical Path Method*) analysis is a project management technique used to plan, schedule and control the sequence of activities in a project. The main goal is to identify the *Critical Path*, which is a series of activities that determine the total duration of the project. Activities on this critical line do not have a time allowance (*Float/Salck*), so any delay in the activity will directly affect the project completion time.

CPM technical calculation:

a. Forward Counting

The process starts from the *initial event* to the *terminal event* to determine the fastest completion

time (EF), the earliest time of the activity (ES), and the fastest time of the start of an event (E).
b. Countdown
The process starts from the end point *of finish* to *the start* to determine the latest completion time for an activity (LF), the slowest time for an activity to occur (LS) and the latest time for an event to occur (L).

The steps to determine the critical path in the CPM (*Critical Path Method*) are as follows:
1. Identify activities and dependencies between activities.
2. Create a project Schedule.
3. Calculate the longest path.
4. Identify critical activities.
5. Pay attention to *slack.*

RESULTS AND DISCUSSION

4.1 Volume of work

Work volume analysis is conducted to determine the amount of volume required for each work item, making it easier to identify the necessary tools, materials, and labor for each task. Based on the research results, data on the work volume analysis of the Cilutung Bridge construction project were obtained. The total work volume for the Cilutung Bridge is 12,257.813 m^3.

4.2 Duration of work

Each of these activities requires considerable time to establish an effective work sequence. The volume of work, the amount of labor needed, and workforce productivity form the basis for calculating the duration of each task. The total duration for the Cilutung Bridge project activities is 72 days (18 weeks).

4.3 CPM (*Critical Path Method*)

The Critical Path Method (CPM) is a project management technique used to plan, schedule, and control the sequence of activities in a project. Its main objective is to identify the critical path—a series of activities that determine the overall project duration. Tasks on this critical path have no time allowance (float/slack), meaning any delay in these activities will directly affect the total project completion time.

Table 1. Calculation Results

ACTIVITY	DURATION	FORWARD CALCULATION		BACKWARD CALCULATED		FF	TF	DESCRIPTION
		ES	EF	LS	LF			
	0	0	0	18	18	0	18	Bukan Critical path
A	1	0	0	18	18	0	18	Bukan Critical path
B	4	1	4	18	17	1	13	Bukan Critical path
C	1	4	4	15	15	0	11	Bukan Critical path
D	1	5	5	15	15	0	10	Bukan Critical path
E	2	5	6	14	14	0	8	Bukan Critical path
F	4	7	10	15	14	1	4	Bukan Critical path

G	2	10	11	14	13	1	2	Bukan Critical path
H	1	12	12	12	12	0	0	Critical path
I	1	12	12	12	12	0	0	Critical path
J	2	12	13	11	11	1	2	Bukan Critical path
K	2	13	14	10	10	3	4	Bukan Critical path
L	1	14	14	6	6	1	8	Bukan Critical path
M	1	15	15	5	5	0	10	Bukan Critical path
N	1	15	15	4	4	0	11	Bukan Critical path
O	2	16	17	4	4	3	13	Bukan Critical path
P	1	18	18	1	1	0	17	Bukan Critical path
Q	1	18	18	0	0	0	18	Bukan Critical path

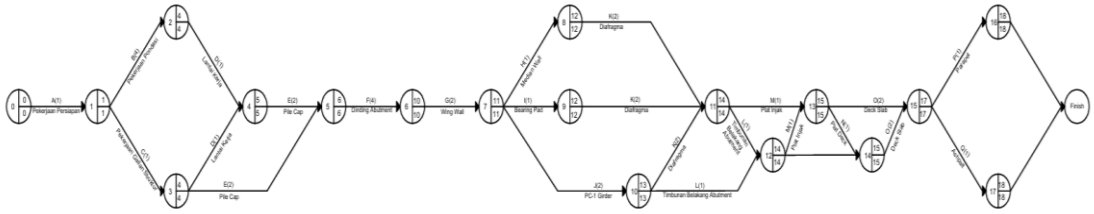

Figure 1 CPM Chart

It can be concluded in the table above for the critical path obtained from the total float and free float 0, the critical path obtained is H-I.

NO	URAIAN	BOBOT(%)	SEPTEMBER					OKTOBER				NOVEMBER				DESEMBER				
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			1-7	8-14	15-21	22-28	29-5	6-12	13-19	20-26	27-2	3-9	10-16	17-23	24-30	1-7	8-14	15-21	22-28	29-5
I	**PEKERJAAN PERSIAPAN**																			
2	Pembersihan Lahan	0.0280	0.028																	
II	**PEKERJAAN PONDASI**																			
1	Bore Pile	32.6945	8.174	8.174	8.174	8.174														
III	**PEKERJAAN GALIAN**																			
1	Galian	2.5856				2.586														
IV	**PEKERJAAN STRUKTUR**																			
1	Lantai Kerja	0.0401					0.04													
2	Pile Cap	8.4498					4.225	4.225												
3	Dinding Abutment	14.1867							3.547	3.547	3.547	3.547								
4	Wing Wall	3.2837										1.642	1.642							
5	Median Wall	0.2676												0.2676						
6	Bearing Pad	0.0600												0.06						
7	PC-I Girder	8.7596												4.3798	4.38					
8	Diafragma	1.2871													0.644	0.644				
9	Timbunan Belakang Abutment	19.0888														19.0888				
10	Plat Injak	1.4955															1.4955			
V	**PEKERJAAN FINISHING**																			
1	Plat Deck	0.8907															0.8907			
2	Deck Slab	5.0766																2.538	2.538	
3	Parapet	1.4013																		1.4013
4	Ashpalt	0.4042																		0.4042
	TOTAL BOBOT	100																		
	PROGRES RENCANA		8.202	8.174	8.174	10.76	4.265	4.225	3.547	3.547	3.547	5.189	1.642	4.7074	5.024	19.7328	2.3862	2.538	2.538	1.8055
	KUMULATIF	0	8.202	16.376	24.55	35.31	39.575	43.8	47.347	50.894	54.441	59.63	61.27	65.979	71.003	90.736	93.122	95.66	98.198	100

Figure 2. Curve – S

CONCLUSION

From the series of discussions in this study, the following conclusions were drawn: the Cilutung Bridge project is projected to be completed within a period of 72 days, or approximately 18 weeks, based on the calculated project duration. Based on the work volume analysis of the Cilutung Bridge project, the following results were obtained: total work volume of 12,257.813

m³, total formwork volume of 3,524.587 m³, and total reinforcement (ironing) volume of 591,341.446 kg. The analysis results using the Critical Path Method (CPM) indicate that this bridge construction project consists of 18 types of work, of which 2 items fall under the critical path and 16 items are categorized as non-critical paths.

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