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Optimization of Total Project Cost for the Cintapuri Banua Hanyar Road and Bridge Reconstruction Project Using Microsoft Project Through Time-Cost Trade-Off Analysis

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A B S T R A C T

The success of a construction project is strongly influenced by the effectiveness of time and cost management. The Cintapuri Banua Hanyar Road and Bridge Reconstruction Project has a planned duration of 150 calendar days with a contract value of IDR 6,600,822,000.00. This study aims to determine the optimal duration and cost through Time Cost Trade Off (TCTO) analysis assisted by Microsoft Project 2021 software. The study begins by identifying the critical path of the project including mobilization, temporary bridges, traffic management, earthworks, and road pavement works. Acceleration analysis (crashing) was conducted through overtime work scenarios of 1, 2, and 3 hours on critical path activities. Analysis parameters include calculations of crash duration, crash cost, and cost slope. The results showed that project duration acceleration could be achieved to 140.44 days (1-hour overtime), 134.36 days (2-hour overtime), and 132.75 days (3-hour overtime). Additional working hours increased project costs due to overtime wages and equipment operational costs. Based on the Cost-Time Ratio analysis and time-cost equilibrium, the 2-hour overtime alternative is the most optimal choice with the lowest cost-time ratio of IDR 225,040,629.90 per accelerated day and saving 15.64 days of execution time

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INTRODUCTION

Construction projects are complex undertakings because they involve various resources—such as labor, materials, equipment, time, and costs—that are interrelated throughout the implementation process. The success of a project is not only determined by the ability to complete the work according to the planned schedule, but also by how effectively costs are managed to ensure efficient project execution. Therefore, planning and controlling time and costs are crucial aspects of construction project management [Soeharto, 1999].

In the execution of construction projects, changes in the duration of work can affect the total project cost. If a project requires accelerated completion, an appropriate acceleration strategy is necessary because acceleration can lead to increased costs due to the addition of resources or changes in execution methods. Therefore, an analysis of the relationship between time and cost is required to identify the execution alternative that yields the most optimal results [Priyo & Sumanto, 2016].

The Cintapuri Banua Hanyar Road and Bridge Reconstruction Project is a construction project with an implementation plan consisting of a Time Schedule, an S-Curve, and a Cost Estimate (RAB). These documents serve as the basis for determining the planned duration of the work, the scope of work, and the costs required during project implementation. Each task in the project has different characteristics, resource requirements, and cost values, so an analysis of the work activities that affect the project duration is necessary.

Based on the available planning documents, the project schedule only illustrates a single implementation plan based on predetermined durations and costs. However, it is not yet known how accelerating certain activities—particularly those on the critical path—would affect the total project cost. Therefore, an analytical method is needed to identify acceleration alternatives that still prioritize cost efficiency.

The Time-Cost Trade-Off (TCTO) method is used to analyze the trade-off between time and cost by accelerating specific tasks and calculating the resulting cost changes. In this study, acceleration was achieved through the crashing approach, using data from the 2023 Bina Marga Cost Budget Plan and Unit Price Analysis (AHSP) as the basis for calculating cost changes. Using Microsoft Project 2021, a project schedule was modeled, critical activities were identified, and alternative duration and cost analyses were conducted to determine the optimal total project cost for the Cintapuri Banua Hanyar Road and Bridge Reconstruction Project.

Research Questions

Based on the background described above, the research questions in this study are as follows:

1. What are the results of modeling the scheduling for the Cintapuri Banua Hanyar Road and Bridge Reconstruction project using Microsoft Project based on project planning data?
2. Which work activities are on the critical path based on the results of the scheduling analysis using Microsoft Project?

3. How does accelerating critical activities affect changes in project costs based on the Time-Cost Trade-Off (TCTO) method?
4. What are the optimal project duration and total cost based on the results of the Time-Cost Trade-Off analysis?

Research Objectives

The objectives of this study are:

1. To develop a project schedule using Microsoft Project based on planning data.
2. To identify the tasks on the critical path.
3. To determine the cost changes resulting from accelerating tasks using the TCTO method.
4. To determine the most optimal project duration and cost based on the cost-to-time ratio.

LITERATURE REVIEW

Project Management

Project management is a process that is carried out to plan, organize, direct, and control available resources so that project goals can be achieved in accordance with the time, cost, quality, and scope of work that has been set. According to Soeharto (1999), project management is the process of managing a company's resources to achieve project goals within a certain period of time by paying attention to the aspects of cost, time, and quality (tripple constraints).

Network Planning & Precedence Diagram Method (PDM)

Network Planning or work network is a method of planning and project control that describes the relationship of dependency between activities in the form of a network diagram. The application of network planning helps project implementers in developing a more effective work schedule and simplifying the process of controlling time and resources [Priyo & Sumanto, 2016].

The Precedence Diagram Method (PDM) is a network that includes the Activity on Node (AON) classification. In PDM, activities are represented in the form of nodes and the dependency relationships between activities are indicated by an arrow line. PDM allows for four types of dependency relationships, namely Finish to Start (FS), Start to Start (SS), Finish to Finish (FF), and Start to Finish (SF).

Critical Path Method (CPM)

The Critical Path Method (CPM) is used to determine the critical trajectory based on the dependency relationship between activities. A critical trajectory is a series of activities that have the longest duration in the work network and have a total grace period (Total Float) equal to zero (TF = 0). Delays in critical activities will directly cause delays in the project as a whole [Soeharto, 1999]. CPM calculation parameters include:

$$EF = ES + D \quad (1)$$

$$LS = LF - D \quad (2)$$

$$TF = LS - ES = LF - EF$$

where ES = Early Start, EF = Early Finish, LS = Late Start, LF = Late Finish, D = Duration, and TF = Total Float.

Time Cost Trade Off (TCTO)

The TCTO method analyzes time and cost exchange to obtain a shorter project duration with the least minimum cost increase. Acceleration of duration (crashing) causes direct costs to increase due to the addition of overtime wages or tools, while indirect costs decrease as the total duration of the project decreases [Priyo & Paridi, 2018].

Formulation of Crash Parameters

The calculation of daily productivity after the acceleration of overtime takes into account the coefficient of decrease in work effectiveness (K) due to worker fatigue:

$$P_j = V / (D_n \times H)$$
$$P_h = (P_j \times H) + (P_j \times L \times K)$$
$$\textit{Crash Duration (CD)} = V / P_h$$

Where V = Volume of Work, Dn = Normal Duration (days), H = Normal Working Hours (7 hours/day), L = Overtime Hours (1, 2, or 3 hours), and K = Overtime Effectiveness Coefficient (0.9 for 1 hour; 0.8 for 2 hours; 0.7 for 3 hours).*

Furthermore, the calculation of Crash Cost and Cost Slope is formulated as follows:

$$\textit{Crash Cost} = \textit{Normal Cost} + \textit{Biaya Lembur Tenaga} + \textit{Biaya Lembur Alat}$$
$$\textit{Cost Slope} = (\textit{Crash Cost} - \textit{Normal Cost}) / (\textit{Normal Duration} - \textit{Crash Duration})$$

METHODOLOGY

1. Location and Research Object

This research is located in Cintapuri Darussalam District, Banjar Regency, South Kalimantan, namely in the Cintapuri Banua Hanyar - Galam Rabah Axis Road Reconstruction Project. The object of the research is focused on the analysis of the time schedule, RAB, and AHSP in the road and bridge work package.

Data Types and Sources

The data used is secondary data sourced from CV employment contract documents. SARI ALAM UTAMA and CV Supervision Consultant. WINGS RASTAFARINDO, which includes:

1. Project Cost Budget Plan (RAB).
2. Time Schedule Plan (S Curve).
3. Analysis of Bina Marga's 2023 Work Unit Price (AHSP).
4. Price List of Wage Units, Materials, and Tools of Banjar Regency for

2025/2026.

Research Stage Flow

1. The stages of this research were carried out in a structured manner according to the following sequence:
   - Collection of project planning data (Bill of Quantities, Time Schedule, AHSP).
2. Rescheduling and work network modeling (PDM) using Microsoft Project 2021.
3. Identification of activities on the critical path.
4. Calculation of normal productivity and productivity resulting from 1-hour, 2-hour, and 3-hour overtime.

$$\text{Crash Duration (CD)} = V / Ph \quad (6)$$

where V = Volume of Work, Dn = Normal Duration (days), H = Normal Working Hours (7 hours/day), L = Hours

5. Calculate the Crash Duration, Crash Cost, and Cost Slope for each critical task.
6. Simulate crash scheduling in Microsoft Project for each overtime alternative.
7. Evaluate the total cost of the project, duration, and analysis of the cost-time ratio to determine optimal conditions.

RESULTS

Project Overview

The Cintapuri Banua Hanyar - Galam Rabah Axis Road Reconstruction Project in Cintapuri Darussalam District was carried out under the Banjar Regency PUPRP Office with a contract value of IDR 6,600,822,000.00 and an implementation period of 150 calendar days. The service provider that carried out the project was CV. SARI ALAM UTAMA.

AHSP Recapitulation and Critical Trajectory Identification

Based on the preparation of AHSP and PDM work network simulations in Microsoft Project 2021, a critical project trajectory consisting of 10 main activities was obtained. Table 1 presents a recapitulation of AHSP values for critical work items.

Table 1. Recapitulation of the Results of the Preparation of AHSP on Critical Project Work

No.	Payment Currency No.	Critical Job Description	Units	Plan Unit Price (Rp)
1	1.2	Mobilization	Ls	105.741.270,00
2	1.8.(1)	Traffic Management and Safety	Moon	915.829,00
3	1.22	Temporary Bridge	Meters	224.571.919,00
4	3.1.(1)	Ordinary Excavations	m^3	21.297,00
5	3.2.(2a)	Selected Deposits from Excavated Sources	m^3	188.872,00
6	3.5.(2a)	Geotextile Separator Kelas 1	m^2	51.231,00
7	5.1.(1)	Class A Aggregate Foundation Layer	m^3	530.350,00
8	5.1.(2)	Class B Aggregate Foundation Layer	m^3	589.565,00
9	6.1.(1)	Binding Diffuse Coating - Liquid Asphalt	Liters	22.716,00
10	6.3.(4)	Lataston Lapis Fondasi (HRS-Base)	Tone	452.133,00

Crash Duration Calculation

The acceleration duration is calculated using equations (4) through (6). For example, consider the Lataston Foundation Layer (HRS-Base) project with a volume of V = 469.72 metric tons and a normal duration of Dn = 24 days:

• Normal Duration in Hours: 24 × 7 = 168 hours.

• Productivity per Hour (Pj): 469.72 / 168 = 2.796 metric tons/hour.

• 1 Hour of Overtime (K = 0.9):

Ph = (2.796 × 7) + (2.796 × 1 × 0.9) = 22.09 metric tons/day.

Crash Duration = 469.72 / 22.09 = 21.27 days

(Reduction of 2.73 days).

• 2-Hour Overtime (K = 0.8):

Ph = (2.796 × 7) + (2.796 × 2 × 0.8) = 24.05 metric tons/day.

Crash Duration = 469.72 / 24.05 = 19.53 days

(Reduction of 4.47 days).

• 3 Hours of Overtime (K = 0.7):

Ph = (2.796 × 7) + (2.796 × 3 × 0.7) = 25.44 metric tons/day.

Crash Duration = 469.72 / 25.44 = 18.46 days

(Reduction of 5.54 days).

Calculation of Crash Cost and Cost Slope

The increase in acceleration costs is calculated from the addition of labor overtime wages (a factor of 1.5x hourly wages for the first hour) as well as heavy equipment operating costs during overtime. For HRS-Base work, the normal cost of Rp212,376,466.25 has increased as follows:

1 Hour Overtime: Worker/foreman overtime fee IDR 417,263.67 + equipment overtime fee IDR 162,548,735.91

→ Crash Cost = Rp375.342.465,83.

Cost Slope = (375,342,465.83 - 212,376,466.25) / (24 - 21.27) = Rp59,603,305.40 / day.
2 Hours Overtime: Crash Cost = Rp538,308,465.41.
Cost Slope = IDR 72,995,187.31 / day.
3-Hour Overtime: Crash Cost = IDR 701,274,464.99.
Cost Slope = Rp88,273,249.77 / day.

Table 2. Recapitulation of Time Cost Trade Off Calculation for 1 Hour Overtime Alternative

No.	Critical Work	Normal Duration (Days)	Crash Duration (Hari)	Normal Cost (Rp)	Crash Cost (Rp)	Cost Slope (Rp/Day)
1	Ordinary Excavations	30	26,58	14.864.000,00	26.617.911,59	4.422.060,89
2	Stack of Options	60	53,16	345.800.000,00	575.747.240,45	33.625.370,97
3	Geotextile Separator	66	58,48	384.000.000,00	384.683.566,81	88.970,27
4	Class A LPA	36	31,90	524.700.000,00	531.651.358,77	1.691.651,72
5	Class B LPA	36	31,90	531.200.000,00	611.630.025,92	19.653.560,11
6	Binding Diffusion Layer	24	21,27	97.270.000,00	102.782.493,04	2.016.041,86
7	HRS-Base	24	21,27	212.376.466,25	375.342.465,83	59.603.305,40
8	Mobilization	150	132,91	105.741.270,00	120.847.166,24	883.974,64
9	Temporary Bridge	150	132,91	224.571.919,00	224.983.817,16	24.103,69
10	Traffic Management	150	132,91	915.829,00	1.213.380,00	17.412,27

Table 3. Recapitulation of Time Cost Trade Off Calculation for 2-Hour Overtime Alternatives

No.	Critical Work	Normal Duration (Days)	Crash Duration (Hari)	Normal Cost (Rp)	Crash Cost (Rp)	Cost Slope (Rp/Day)
1	Ordinary Excavations	30	24,42	14.864.000,00	41.731.284,24	5.415.625,20
2	Stack of Options	60	48,84	345.800.000,00	805.591.548,34	41.180.438,50
3	Geotextile Separator	66	53,72	384.000.000,00	385.352.533,13	108.960,42
4	Class A LPA	36	29,30	524.700.000,00	585.612.907,16	16.113.517,92
5	Class B LPA	36	29,30	531.200.000,00	692.234.500,32	24.069.391,66
6	Binding Diffusion Layer	24	19,53	97.270.000,00	108.294.708,76	2.469.013,29
7	HRS-Base	24	19,53	212.376.466,25	538.308.465,41	72.995.187,31
8	Mobilization	150	122,09	105.741.270,00	135.953.062,02	1.082.589,20

9	Temporary Bridge	150	122,09	224.571.919,00	225.395.715,65	29.519,39
10	Traffic Management	150	122,09	915.829,00	1.160.726,53	8.775,51

1. Acceleration Results Comparison and Cost-Time Ratio Analysis

Each alternative of adding overtime hours has a different effect on the total duration
(2-hour overtime), and 17.25 days (3-hour overtime). To evaluate the most effective and efficient alternatives, the Cost-Time Ratio is calculated:
and project costs. The consecutive reduction in project duration was 9.56 days (1 hour overtime), 15.64 days

Cost-Time Ratio = Total Crash Cost / Duration Reduction

Table 5. Project Acceleration Results Comparison and Cost-Time Ratio Analysis

Ternentiative Scenario	Project Duration (Days)	Duration Reduction (Days)	Normal Project Cost (Rp)	Total Acceleration Costs / Crash Cost (Rp)	Total Crash Project Cost (Rp)	Cost-Time Ratio (Rp/Day)
Normal Conditions	150,00	-	6.600.822.000,00	-	6.600.822.000,00	-
Overtime 1 Hour	140,44	9,56	6.600.822.000,00	2.955.499.425,80	9.556.321.425,80	309.152.660,65
Lamp 2 for me (optimal)	**134,36**	**15,64**	6.600.822.000,00	**3.519.635.451,56**	**10.120.457.451,56**	**225.040.629,90**
Overtime 3 Hours	132,75	17,25	6.600.822.000,00	4.084.471.885,89	10.685.293.885,89	236.780.979,18

1. Discussion of Optimization Efficiency

Based on the data in Table 5, it can be seen that the alternative of adding 2 hours of overtime per day produces the smallest Cost-Time Ratio value of IDR 225,040,629.90/day, more efficient than the alternative of 1 hour overtime (IDR 309,152,660.65/day) and 3-hour overtime (IDR 236,780,979.18/day).

This condition occurs due to a decrease in the work productivity coefficient (K) at 3-hour overtime (K = 0.7). Excessive worker fatigue causes the cost of 3rd hour overtime is not proportional to the additional results of the duration acceleration obtained. The addition of the 3rd overtime hour only provides an additional acceleration of 1.61 days (from 15.64 days to 17.25 days), but requires a very high additional cost of Rp564,836,434.33. Therefore, the scenario of increasing overtime working hours for 2 hours was chosen as the most optimal project acceleration recommendation financially and operationally.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and discussion that has been carried out on the Road and Bridge Reconstruction Project

Cintapuri Banua Hanyar, the following conclusions were obtained:

1. Scheduling modeling using Microsoft Project 2021 succeeded in compiling a PDM work network with a normal duration of 150 calendar days and a total normal cost of IDR 6,600,822,000.00.
2. Activities on critical trajectories include Mobilization work, Temporary Bridges, Traffic Management and Safety, Ordinary Excavation, Selected Piles, Class 1 Separator Geotextiles, Class B LPA, Class A LPA, Binding Seam Layers, and Foundation Layer Lataston (HRS-Base).
1. 3. The implementation of TCTO with overtime scenarios of 1 hour, 2 hours, and 3 hours resulted in an acceleration of the total project duration to 140.44 days, 134.36 days, and 132.75 days with a total project cost of IDR 9,556,321,425.80, IDR 10,120,457,451.56, and IDR 10,685,293,885.89, respectively.
5. The most optimal acceleration alternative is the addition of 2 hours of overtime work per day because it produces the lowest Cost to Time Ratio (Rp225,040,629.90/day), and is able to save project implementation time of 15.64 days.

Suggestions

a. Further research is suggested to combine the method of increasing overtime hours with the addition of Heavy equipment or the vard/shift work system to suppress the increase in overtime wages.
b. Implementing contractors need to consider the factor of labor fatigue when implementing overtime so that effectiveness and productivity in the field are maintained.
c. The implementation of Microsoft Project software should be combined periodically with updates of actual progress in the field.

REFERENCES

Badan Standardisasi Nasional. (2023). SNI 1725:2023 Pembebanan untuk Jembatan. Jakarta: BSN.

Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2023).

Spesifikasi Umum Bina Marga 2023 untuk Pekerjaan

Konstruksi Jalan dan Jembatan. Jakarta: Direktorat Jenderal Bina Marga.

Luthan, P. L., & Syafriandi. (2019). Aplikasi Microsoft Project untuk Penjadwalan Kerja Proyek Teknik Sipil. Yogyakarta: Andi Offset.

Priyo, M., & Paridi, A. (2018). Analisis Optimasi Waktu dan Biaya Proyek Konstruksi Menggunakan Metode Time Cost Trade Off. Jurnal Teknik Sipil & Perencanaan, 20(2), 85–94.

Priyo, M., & Sumanto, A. (2016). Analisis percepatan waktu dan biaya proyek konstruksi dengan penambahan jam kerja (lembur) menggunakan metode Time Cost Trade Off. Semesta Teknika, 19(1), 1–15.

Soeharto, I. (1999). Manajemen Proyek: Dari Konseptual Sampai Operasional, Jilid 1 (Edisi ke-2). Jakarta: Erlangga.