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Comparison of Additional Working Hours and Additional Manpower as Construction Project Acceleration Based on Earned Value Analysis

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ABSTRACT

Quality, time, and cost are interrelated critical elements in the project. In its implementation, problems that are very likely to occur can arise. One of them is delay. This delay problem also occurs in the Hospital Building Construction Project. This research uses two stages of analysis, namely Earned Value Analysis and Project Crashing on delays experienced by the project in week 17, to find a solution to the problem. The results of calculations using the Earned Value Analysis method obtained the value of Schedule Variance (SV) -Rp 146,450,657.32; Schedule Performance Index (SPI) 0.6688; Estimate Temporary Schedule (ETS) 48 weeks; and Estimate All Schedule (EAS) 65 weeks. So, the project planned to be completed in 49 weeks is predicted to experience a delay of 16 weeks. Furthermore, scheduling adjustments and analysis of the series of activities were carried out with the help of Microsoft Project to determine the critical path. Project Crashing in this study was done by comparing two alternatives: adding four work hours (overtime) and increasing the workforce by 30%. Both alternatives can reduce the duration of work to 26 days. The cost required from the acceleration alternative by adding overtime hours is Rp 30,850,351,655.73, with an efficiency of -0.6%. The alternative of additional labor requires a cost of Rp 30,572,882,563.04 with an efficiency of 0.3%.

Keywords: *Earned Value Analysis; Estimation; Delay; Acceleration; Project Crashing.*

INTRODUCTION

Infrastructure development from various fields is one of the efforts to create prosperity and community welfare. Hospitals are an infrastructure for the community to obtain health facilities and services. To optimize the community's needs in the health sector, the Hospital Building Project Construction was carried out to improve its facilities and capacity.

There are three essential elements in implementing a construction project: cost, quality, and time. These three elements are interrelated, where a project is expected to be completed on time according to the planned schedule, with minimal cost, and has the right quality [1].

In its implementation, problems can arise that are very likely to occur, such as delays. A delay can be explained as a situation where a project is delayed beyond the contract date or the date agreed upon by the parties involved [2]. A delay problem is a problem that is often encountered in project implementation. Various factors can cause delays in a project. These factors can be errors in materials, labor, equipment, finance, environmental conditions, improper management, and incorrect forecasting of the time required to complete a project's entire set of activities [3].

Time control is one of the essential things in project implementation. This can cause problems for project owners and contractors if the schedule and control are not carried out effectively. Problems can arise, such as owners can experience financial problems in the project and contractors can experience losses [4].

One method of analysis that can be used in planning and controlling time and cost is the Earned Value Analysis (EVA) method. Through calculations with Earned Value Analysis (EVA), it can be seen whether or not the project's performance is efficient so that the project can have an Early Warning to take precautions. This prevention is carried out so that the project can avoid cost overruns and be completed at the planned time [5].

Acceleration needs to be done to anticipate delays in project completion. Acceleration must also pay attention to the costs incurred. Several ways can accelerate project implementation time, such as increasing working hours (overtime), increasing labor, effective implementation methods, and using productive equipment [6].

The problem of delays is also experienced in the Hospital construction project, where in week 17, the delay reached 4.73%. This research will calculate the estimated project completion time by earned value analysis. By that estimated date, this research will compare Project Crashing between two alternatives to accelerate the project by increasing working hours and labor at the same duration to accelerate the completion of the project.

MATERIALS AND METHODS

Type of Research

This research uses quantitative research, which is more systematic, structured, specific, and well-planned from start to finish. In its implementation, this research uses data obtained and then processed by emphasizing numbers that make this research more detailed and precise. This research also includes a table of calculation results to make it easier to read and understand.

Research Stages

Below is a series of stages carried out to achieve the objectives of this research.

1. Conduct a study in the field to find out the problems that occur and find answers to these problems through literacy studies. Collecting data related to the problem. The data collected are RAB, Time Schedule, Weekly and Monthly Reports, and AHSP.
2. Calculate the analysis of BCWS, BWCP, SV, and SPI indicators. Then, proceed with the calculation of the estimated completion time or TE.
3. Make scheduling adjustments with the estimated delay time calculation results and analyze the series of activities to determine the critical path with the help of Microsoft Project software.
4. Calculate the acceleration of project implementation using the Crashing Method with two alternatives: the addition of working hours (overtime) and the addition of labor.
5. Comparing the cost requirements between the two acceleration alternatives between additional working hours (overtime) and additional labor.

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Earned Value Analysis

Earned Value Analysis is one of the tools used in project management that integrates cost and time or schedule scope[7]. This method is one of the common methods used in monitoring and controlling performance on a project. This method can determine the greater or lesser costs than budgeted and the faster or slower implementation of the specified schedule [8]. In addition, calculations with this method can also predict the cost and time required to complete all work [9].

1. BCWS (Budgeted Cost of Work Schedule)
   BCWS is a budget for work planned within a certain period.
   BCWS = Plan Percentage (%) x Contract Value
2. BCWP (Budgeted Cost of Work Performance)
   BCWP is the value of the cost of work that has been obtained against the planned budget.
   BCWP = Actual Percentage (%) x Contract Value
3. SV (Schedule Varian)
   SV is a deviation from the cost of work achieved with the cost plan's value.
   SV = BCWP – BCWS
4. SPI (Schedule Performance Index)
   SPI is the Schedule efficiency value in using resources in the field. The SPI value > 1 indicates that the activities in that week were carried out ahead of the implemented schedule. Meanwhile, the SPI value < 1 indicates that the activities in that week are slower than the planned schedule.
   SPI = BCWP / BCWS

5. ETS (*Estimate Temporary Schedule*)
   ETS is the calculation of the estimated completion time of the remaining work.
   $$ETS = \frac{Original\ Date\ (OD) - Actual\ Time\ Expended(ATE)}{SPI}$$
6. EAS (*Estimate All Schedule*)
   EAS is the calculation of the estimated time required to complete all work in the project.
   EAS = ATE + ETS

Project Crashing

Project crashing is done to catch up on achievements that need to catch up due to changes or irregularities in the project. This method can also accelerate the project completion time from the planned schedule [10]. Project Crashing is done by reducing the duration of completion of activities on the critical trajectory, which will affect the duration of project completion [11]. Some alternatives that can be done in project crashing are increasing work shifts, working hours or overtime, labor, availability of materials, using more productive equipment, and faster installation methods [12].

Additional Working Hours

Adding working hours or overtime is an alternative often used in projects to accelerate job completion. Generally, workers' working time in one day is 8 hours (08.00 - 17.00) with one Hour of rest. In practice, overtime is done by adding 1 to 4 hours according to the time needed and is done after normal hours. The figure below shows that the greater the overtime hours

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added, the lower the workers' productivity.

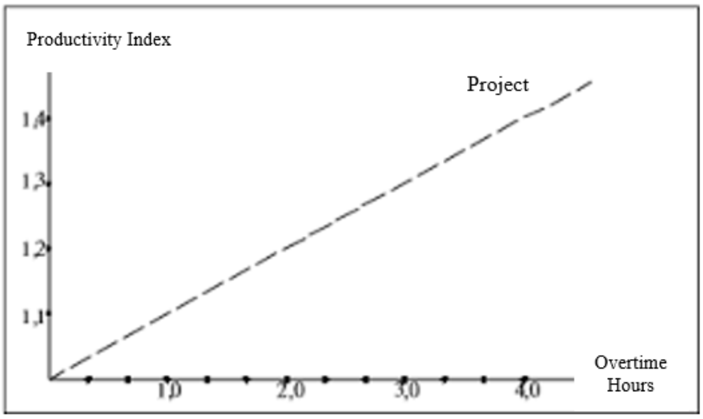

Figure 1: Graph of Indication of Productivity Decline Due to Overtime Hours

Table 1: Productivity Decline Coefficient

Overtime Hours	Decrease in Productivity Index	Work Achievement (%)
1	0,1	90
2	0,2	80
3	0,3	70
4	0,4	60

The calculation of crash analysis and productivity can be formulated as follows.

1. Normal Daily Productivity (Pn)
$$Pn = \frac{volume}{normal\ duration}$$
2. Normal Productivity per hour (Pj)
$$Pj = \frac{Pn}{working\ hours\ per\ day}$$
3. Crash Productivity (Pc)
$$Pc = Pn + (Pj\ x\ overtime\ hours\ x\ coef\ of\ work\ achievment)$$
4. *Crash Duration*
$$Crash\ Duration = \frac{volume}{Pc}$$

The addition of working hours will increase the cost of labor. According to the Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Number KEP. 102/MEN/VI/2004 article 11, there are details regarding the wages earned by workers during overtime. The additional wages earned by workers in the first hour of overtime is 1.5 times the normal hour pay rate and two times the normal hour pay rate for the addition of the next overtime hour[13].

The calculation of crash cost with the alternative of adding working hours (overtime) is calculated through the following series of formulas.

1. Normal labor requirements per day
$$labor\ requirements = \ coefficient\ of\ labor\ x\ normal\ daily\ prod$$
2. Normal wage per day
$$normal\ wage\ per\ day = \ labor\ requirement\ x\ wage\ unit\ price$$
3. Total normal wage

$$total\ normal\ wage = normal\ wage\ per\ day\ x\ normal\ duration$$

4. Normal wage per hour

$$normal\ wage\ per\ hour = \frac{normal\ wage\ per\ day}{working\ hours\ per\ day}$$

5. Overtime wage

$$overtime\ wage = \big((1{,}5\ x\ wage\ per\ hour) + (2\ x\ wage\ per\ hour\ x\ (n)\ hours)\big)$$

6. *Crash Cost*

$$Crash\ Cost = normal\ cost + overtime\ cost$$

7. *Total Crash Cost*

$$Crash\ Cost\ Total = Crash\ Cost\ x\ Crash\ Duration$$

8. Cost Slope

$$Cost\ Slope = \frac{Crash\ Cost - Normal\ Cost}{Normal\ duration - Crash\ Duration}$$

9. Total Cost Slope

$$Cost\ Slope\ Total = Cost\ Slope\ x\ (Normal\ Duration - Crash\ Duration)$$

Additional Labor

Another alternative to accelerate project implementation is to increase the workforce. This addition is done in one unit of work without adding working hours. The series of calculations for the additional labor alternative are as follows.

1. Normal Daily Productivity

$$Normal\ Daily\ Productivity = \frac{volume}{normal\ duration}$$

2. Normal labor requirements per day

$$Normal\ labor\ requirements = coef\ of\ labor\ x\ normal\ productivity$$

3. Additional 30% of labor

$$Additional\ Labor = labor\ requirements\ x\ 30\%$$

4. Crash Productivity

$$crash\ productivity = \frac{Pn\ x\ (total\ normal\ labor + total\ additional\ 30\%)}{total\ normal\ labor}$$

5. Crash Duration

$$Crash\ Duration = \frac{Volume}{Crash\ Productivity}$$

The calculation of crash cost in this alternative can be calculated with the following steps.

1. Additional labor wage per day

$$Additional\ labor\ wage = additional\ labor\ x\ wage\ unit\ prive$$

2. *Crash Cost*

$$Crash\ Cost = Normal\ Cost + (\ Total\ additional\ labor\ wage\ x\ Crash\ Duration)$$

3. Cost Slope

$$Cost\ Slope = \frac{Crash\ Cost - Normal\ Cost}{Normal\ Duration - Crash\ Duration}$$

4. Total Cost Slope

$$Cost\ Slope\ Total = Cost\ Slope\ x\ (Normal\ Duration\ - Crash\ Duration)$$

Project Cost

Project costs are required in project implementation and essential to planning. Project costs are divided into two: direct costs and indirect costs.

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1. Direct Costs
Direct costs are costs that are directly tied to the physical progress and final results of a construction. These costs include material costs, labor costs, equipment costs, subcontractor costs, and others [14].
2. Indirect Costs
Indirect costs are calculated for purposes not directly tied to the physical progress and final construction results but are still related to project facilities and infrastructure [14]. Indirect costs can be divided into two: General Overhead costs, such as purchasing utilities, hiring accountants, and employee payroll, and Project Overhead costs, such as field supervision, field utilities, field insurance, and scheduling costs [15].

RESULTS AND DISCUSSION

Earned Value Analysis
The following is an example of calculation in week 2.
BCWS
Contract Value = Rp 30,962,084,000.00
Plan Percentage = 0.11%
BCWS = Plan Percentage x Contract Value
= 0.11% x Rp 30,962,084,000.00
= Rp 3,405,829.24
BCWP
Contract Value = Rp 30,962,084,000.00
Actual Percentage = 0.45%
BCWP = Actual Percentage x Contract Value
= 0.45% x Rp 30,962,084,000.00
= Rp 13,932,937.80
SV
BCWS week 2 = Rp 3,405,829.24
BCWP week 2 = Rp 13,932,937.80
SV = BCWP – BCWS
= Rp 13,932,937.80 – Rp 3,405,829.24
= Rp 10,527,108.56
SPI
BCWS week 2 = Rp 3,405,829.24
BCWP week 2 = Rp 13,932,937.80
SPI = BCWP / BCWS
= Rp 13,932,937.80 / Rp 3,405,829.24
= 4.09

Tabel 2: Earned Value Analysis

Week	% Plan	BCWS	% Actual	BCWP	SV	SPI
1		Rp0.00	0.22	Rp6,811,658.48	Rp6,811,658.48	-
2	0.11	Rp3,405,829.24	0.45	Rp13,932,937.80	Rp10,527,108.56	4.0909
3	0.22	Rp6,811,658.48	0.65	Rp20,125,354.60	Rp13,313,696.12	2.9545
4	0.32	Rp9,907,866.88	1.14	Rp35,296,775.76	Rp25,388,908.88	3.5625
5	0.47	Rp14,552,179.48	2.04	Rp63,162,651.36	Rp48,610,471.88	4.3404

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6	0.58	Rp17,958,008.72	3.58	Rp110,844,260.72	Rp92,886,252.00	6.1724
7	1.07	Rp33,129,429.88	4.88	Rp151,094,969.92	Rp117,965,540.04	4.5607
8	2.56	Rp79,262,935.04	6.34	Rp196,299,612.56	Rp117,036,677.52	2.4766
9	4.04	Rp125,086,819.36	7.62	Rp235,931,080.08	Rp110,844,260.72	1.8861
10	5.53	Rp171,220,324.52	7.71	Rp238,717,667.64	Rp67,497,343.12	1.3942
11	7.14	Rp221,069,279.76	7.98	Rp247,077,430.32	Rp26,008,150.56	1.1176
12	9.81	Rp303,738,044.04	8.04	Rp248,935,155.36	-Rp54,802,888.68	0.8196
13	11.22	Rp347,394,582.48	8.39	Rp259,771,884.76	-Rp87,622,697.72	0.7478
14	11.53	Rp356,992,828.52	8.44	Rp261,319,988.96	-Rp95,672,839.56	0.7320
15	12.6	Rp390,122,258.40	8.48	Rp262,558,472.32	-Rp127,563,786.08	0.6730
16	13.13	Rp406,532,162.92	8.67	Rp268,441,268.28	-Rp138,090,894.64	0.6603
17	14.28	Rp442,138,559.52	9.55	Rp295,687,902.20	-Rp146,450,657.32	0.6688

ETS

ATE (*Actual Time Expended*) = 17 weeks
OD (*Original Duration*) = 49 weeks
SPI = 0.669
ETS $= \frac{OD-ATE}{SPI}$
$= \frac{49-17}{0.669}$
= 47.85 weeks ≈ 48 weeks

EAS

ATE (*Actual Time Expended*) = 17 weeks
ETS = 48 weeks
EAS = ATE + ETS
= 17 + 48
= 65 weeks

From the above calculations, it is estimated that the project can be completed in 65 weeks. This calculation means that the project is predicted to be 16 weeks late from the initial plan of 49 weeks. Furthermore, scheduling adjustments are made for 65 weeks using Microsoft Project software to determine the critical trajectory. Then, acceleration is carried out on activities on the critical trajectory in weeks 18 to 65. This research focuses on the acceleration of Concrete Structure Work.

Additional Working Hours

Alternative addition of working hours (overtime) in this study was carried out by adding four working hours. The following is an example of calculations on Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050.

Normal Daily Productivity

Normal Daily Productivity $= \frac{volume}{normal\ duration}$

Normal Daily Productivity $= \frac{14.38}{7} = 2.0541$ m3/day

Productiviy per Hour

Productivity per hour $= \frac{\text{Normal Daily Productivity}}{8}$

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Productivity per hour = $\frac{2.0541}{8} = 0.2568$ m3/hour

Crash Productivity

Crash Productivity = $prod\ per\ day + (prod\ per\ hour\ x\ overtime\ x\ coef\ of\ work)$

Crash Productivity = $2.0541 + (0.2568\ x\ 4\ x\ 0.6) = 2.67$ m3/day

Crash Duration

Crash Duration = $\frac{volume}{\text{Crash Productivity}}$

Crash Duration = $\frac{14.38}{2.67} = 5.38 \approx 6$ days

With the alternative of adding 4 hours overtime to Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050, the work will finish in six days. The calculation results of all work are then re-entered into Microsoft Project, and it can be concluded that by adding 4 hours overtime can reduce the time by 26 days.

Normal Labor Requirements per Day

Labor requirements = coefficient of labor x normal daily productivity

Pekerja = 5.3 x 2.0541 = 10.89

T. Batu = 0.275 x 2.0541 = 0.56

T. Kayu = 1.3 x 2.0541 = 2.67

T. Besi = 1.05 x 2.0541 = 2.16

Normal Wage per Day

Normal Wage per Day = labor requirements x wage unit price

Pekerja = 10.89 x Rp 100,000.00 = Rp 1,088,695.71

T. Batu = 0.56 x Rp 120,000.00 = Rp 67,786.71

T. Kayu = 2.67 x Rp 120,000.00 = Rp 320,446.29

T. Besi = 2.16 x Rp x 120,000.00 = Rp 258,822.00

Total Normal Wage

Total Normal Wage = (Rp 1,088,695.71 + Rp 67,786.71 + Rp 320,446.29 + Rp 258,822.00) x 7 days

= Rp 12,150,255.00

Normal Wage per Hour

Normal Wage per Hour = Normal Wage per Day / 8 hours

Pekerja = Rp 1,088,695.71 / 8 = Rp 136,086.96

T. Batu = Rp 67,786.71 / 8 = Rp 8,473.34

T. Kayu = Rp 320,446.29 / 8 = Rp 40,055.79

T. Besi = Rp 258,822.00 / 8 = Rp 32,352.75

Overtime Wage

Overtime Wage = ((1.5 x wage per hour) + (2 x wage per hour x 3 hours)

Pekerja = ((1.5 x Rp 136,086.96) + (2 x Rp 136,086.96 x 3) = Rp 1,020,652.23

T. Batu = ((1.5 x Rp 8,473.34) + (2 x Rp 8,473.34 x 3) = Rp 63,550.04

T. Kayu = ((1.5 x Rp 40,055.79) + (2 x Rp 40,055.79 x 3) = Rp 300,418.39

T. Besi = ((1.5 x Rp 32,352.75) + (2 x Rp 32,352.75 x 3) = Rp 242,645.63

Crash Cost

Crash Cost = Normal Wage per Day + Overtime Wage

Pekerja = Rp 136,086.96 + Rp 1,020,652.23 = Rp 2,109,347.95

T. Batu = Rp 8,473.34 + Rp 63,550.04 = Rp 131,336.76

T. Kayu = Rp 40,055.79 + Rp 300,418.39 = Rp 620,864.68

T. Besi = Rp 32,352.75 + Rp 242,645.63 = Rp 501,467.63

Total Crash Cost

Total Crash Cost = (Rp 2,109,347.95 + Rp 131,336.76 + Rp 620,864.68 + 501,467.63) x 6 days
= Rp 20,178,102.05

Cost Slope

Cost Slope = (Crash Cost – Normal Cost) / (Normal Duration – Crash Duration)
Cost Slope = (Rp 20,178,102.05 – Rp 12,150,255.00) / (7 – 6) = Rp 8,027,847.05

Cost Slope Total

Total Cost Slope = Cost Slope x (Normal Duration – Crash Duration)
Total Cost Slope = Rp 8,027,847.05 x (7 – 6) = Rp 8,027,847.05

The work of Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050 by added 4 hours overtime costs Rp 8,027,847.05. The following table recapitulates the cost slope due to adding working hours at each elevation.

Table 3: Recapitulation of Cost Slope for Additional Working Hour

	DESCRIPTION	SLOPE
	CONCRETE STRUCTURE	**Rp492,444,899.62**
3.1	Elevation -4.050 s/d -0.050	Rp47,293,677.70
3.2	Elevation -0.050 s/d +4.810 (1st Floor)	Rp92,679,726.97
3.3	Elevation +4.810 s/d +8.770 (2nd Floor)	Rp92,065,171.27
3.4	Elevation +8.770 s/d +12.730 (3rd Floor)	Rp82,871,148.53
3.5	Elevation +12.730 s/d +17.410 (4th Floor)	Rp90,476,050.56
3.6	Elevation +17.410 s/d +20.960 (5th Floor)	Rp76,314,845.00
3.7	Elevation +20.960 s/d +20.960 (Rooftop)	Rp10,744,279.60

In the alternative of adding 4 hours overtime, the total cost slope of all work is obtained at Rp 492,444,899.62.

Additional Labor

Alternative addition labor in this study was carried out by adding 30% of labor. The following is an example of calculations on Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050.

Normal Daily Productivity

Normal Daily Productivity = $\frac{volume}{normal\ duration}$

Normal Daily Productivity = $\frac{14.38}{7}$ = 2.0541 m3/day

Normal Labor Requirements per Day

Labor requirements = coefficient of labor x normal daily productivity
Worker = 5.3 x 2.0541 = 10.89
Bricklayer = 0.275 x 2.0541 = 0.56
Carpenter = 1.3 x 2.0541 = 2.67
Blacksmith = 1.05 x 2.0541 = 2.16

Additional 30% of Labor

Additional Labor = labor requirements x 30%
Worker = 10.89 x 30% = 3.27

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Bricklayer = 0.56 x 30% = 0.17
Carpenter = 2.67 x 30% = 0.8
Blacksmith = 2.16 x 30% = 0.65

Tabel 4: Labor Rekapitulation

	Requirements Labor	**Additional 30%**
Worker	10.89	3.27
Bricklayer	0.56	0.17
Carpenter	2.67	0.8
Blacksmith	2.16	0.65
Total	**16.28**	**4.88**

Crash Produktivity

Crash Produktivity = $\frac{Pnx\ (total\ normal\ labor + total\ additional\ 30\%)}{total\ normal\ labor}$

Crash Produktivity = $\frac{2.0541\ x\ (16.28+4.88)}{16.28} = 2{,}67$ m3/day

Crash Duration

Crash Duration = $\frac{volume}{Crash\ Productivity}$

Crash Duration = $\frac{14.38}{2.67} = 5.38 \approx 6$ days

With the alternative of adding 30% of the labor to Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050, the work will finish in six days. The calculation results of all work are then re-entered into Microsoft Project, and it can be concluded that by increasing labor by 30% can reduce time by 26 days.

Additional Labor Wage per Day

Additional labor wage = additional labor x wage unit price
Worker = 3.27 x Rp 100,000.00 = Rp 326,608.71
Bricklayer = 0.17 x Rp 120,000.00 = Rp 20,336.01
Carpenter = 0.80 x Rp 120,000.00 = Rp 96,133.89
Blacksmith = 0.65 x Rp x 120,000.00 = Rp 77,646.60
Total = Rp 326,608.71 + Rp 20,336.01 + Rp 96,133.89 + Rp 77,646.60
= Rp 520,725.21

Crash Cost

Crash Cost = Normal Cost + (Total Additional Labor Wage x Crash Cost)
Crash Cost = Rp 12,150,255.00 + (Rp 520,725.21 x 6) = Rp 15,274,606.29

Cost Slope

Cost Slope = (Crash Cost – Normal Cost) / (Normal Duration – Crash Duration)
Cost Slope = (Rp 15,274,606.29 – Rp 12,150,255.00) / (7 – 6) = Rp 3,124,351.29

Total Cost Slope

Total Cost Slope = Cost Slope x (Normal Duration – Crash Duration)
Total Cost Slope = Rp 3,124,351.29 x (7 – 6) = Rp 3,124,351.29

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The work of Dinding Bata t:15 cm at Elevation -4.050 s/d -0.050 by added 30% of labor costs Rp 3,124,351.29. The following table recapitulates the cost slope due to additional labor at each elevation.

Tabel 5: Recapitulation of Cost Slope for Additional Labor

	DESCRIPTION	**SLOPE**
	CONCRETE STRUCTURE	**Rp214,975,806.94**
3.1	Elevation -4.050 s/d -0.050	Rp18,406,188.08
3.2	Elevation -0.050 s/d +4.810 (1st Floor)	Rp39,720,364.10
3.3	Elevation +4.810 s/d +8.770 (2nd Floor)	Rp39,332,554.85
3.4	Elevation +8.770 s/d +12.730 (3rd Floor)	Rp37,398,261.90
3.5	Elevation +12.730 s/d +17.410 (4th Floor)	Rp40,830,217.69
3.6	Elevation +17.410 s/d +20.960 (5th Floor)	Rp34,439,519.79
3.7	Elevation +20.960 s/d +20.960 (Rooftop)	Rp4,848,700.54

In the alternative of increasing labor by 30%, the total cost slope of all work is obtained at Rp 214,975,806.94.

Cost Analysis

This project has a nominal cost of Rp. 30,962,084,000.00 excluding VAT and with a profit value of 13%. The calculation of normal costs is done by reducing the Total Project Cost by the value of the cost of work that has been done (BCWP) in week 17 of Rp. 295,687,902.20.

Direct Cost

Direct Cost = Direct Cost + Slope Cost

Indirect Cost

Indirect Cost = (Indirect Cost / Normal Duration) x Crash Duration

Total Cost

Total Cost = Direct Cost + Indirect Cost

Tabel 6: Cost Analysis Recapitulation

	Normal	**Additional Working Hours**	**Additional Labor**
Duration	336	310	310
Cost Slope Total		Rp 492,444,899.62	Rp 214,975,806.94
Direct Cost	Rp 26,679,764,605.09	Rp 27,172,209,504.71	Rp 26,894,740,412.03
Indirect Cost	Rp 3,986,631,492.71	Rp 3,678,142,151.02	Rp 3,678,142,151.02
Total Cost	Rp 30,666,396,097.80	Rp 30,850,351,655.73	Rp 30,572,882,563.04
Efficiency		-Rp 183,955,557.93	Rp 93,513,534.76
Effisiency (%)		-0.6	0.3

At week 17, with a delay of 4.73%, it had an SPI value of 0.6688. Earned Value Analysis estimated that the project can be completed in 65 weeks. This calculation means that the project is predicted to be 16 weeks late from the initial plan of 49 weeks. Furthermore, scheduling adjustments are made for 65 weeks using Microsoft Project software to determine the critical trajectory. Then, acceleration is carried out on activities on the critical trajectory in weeks 18 to 65. This research focuses on the acceleration of Concrete Structure Work.

An acceleration comparison is done between adding 4 hours of work and 30% of labor. Both of these alternatives can reduce the duration of work by 26 days. In other words, the remaining project time, which was first anticipated would be finished in 336 days, can now be finished in 310 days.

Normal costs are calculated by reducing the Total Project Cost of Rp 30,962,084,000.00 with the value of work completed (BCWP) in the 17th week of Rp 295,687,902.20. Then, the normal cost of the rest of the project is Rp 30,666,396,097.80.

Acceleration causes direct costs to increase and indirect costs to decrease. With the same duration, the indirect costs for the two acceleration alternatives have the same value but not the direct costs. Direct costs will increase due to the slope value obtained from each alternative.

The alternative is to add working hours for 4 hours, with a slope value of Rp 492,444,899.62. So, the project's total cost obtained with the alternative of additional working hours is Rp 30,850,351,655.73. This fee is higher than the normal IDR 183,955,557.93, with the efficiency value is -0.6%.

For additional labor, a slope value of Rp. 214,975,806.94 is obtained, so the total cost obtained is Rp 30,572,882,563.04. This fee is Rp 93,513,534.76, lower than the normal fee. The efficiency value of this alternative is 0.3%.

CONCLUSION

Based on the results of this study, several conclusions can be drawn, namely as follows. The estimated project results can be completed within 65 weeks through the earned value analysis. This estimate indicated that the project would be delayed by 16 weeks from the initial planned 49 weeks. Both alternative acceleration by adding 4 hours of work (overtime) and 30% of labor to the work structure can reduce the project's duration by 26 days. The alternative of adding 4 hours of overtime has a cost efficiency value of -0.6%. At the same time, the alternative of adding 30% labor development has an efficiency value of 0.3%.

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