Analysis of Time Management Implementation Using the Crashing Method on the Rehabilitation Project of the Disdikbudpora Hall Building in Semarang Regency

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Abstract. This study analyzes the application of time management using the crashing method on the Rehabilitation Project of the Disdikbudpora's Hall Building in Semarang Regency. This project has an implementation period of 57 calendar days. To assess whether this duration could be optimized, the crashing method was applied to critical path activities by adding overtime work hours (1 to 3 hours/day). The research utilized a qualitative method with a quantitative approach, using primary data from field observations and secondary data such as schedules and weekly reports. Results showed that by adding 1, 2, and 3 hours of overtime, the project duration could be reduced to 54, 49, and 48 days, respectively. Cost analysis revealed that adding 2 hours of overtime provided the most optimal balance between shortened duration and additional labor costs, totaling IDR 58,556,562.50. This option offered a 5 day acceleration with a relatively small cost difference compared to 1 hour overtime. Therefore, adding 2 hours of overtime is considered the most efficient strategy for project acceleration.

Kata kunci: crash duration, project acceleration, time management

1. Introduction

In every project implementation, proper time management and scheduling are essential. A project is considered successful if it is completed efficiently in terms of time. Time management involves planning, organizing, mobilizing, and controlling productivity within the allocated timeframe. Time is a critical resource that must be managed effectively and efficiently. Effective time management, when carried out with discipline and commitment, can lead to better results [1].

The Rehabilitation Project of the Disdikbudpora's Hall Building in Semarang Regency was

scheduled to be completed in 57 calendar days. This often raises the question of whether the given duration is already optimal or if the project can be accelerated [2]. A suitable method is therefore required to optimize the project schedule. One such method is the crashing method, which shortens project duration by focusing on critical path activities [3]. However, crashing often leads to increased direct costs, such as labor wages [4].

2. Methods

This study uses a qualitative research method with a quantitative approach. The quantitative approach refers to quantities, meaning the number or amount of something. It involves collecting and calculating measurable data [5]. Primary data was obtained through field observation, while secondary data included literature reviews, time schedules (S-curves), weekly reports, and project drawings. The researcher analyzed data from both documents and field surveys and explained the findings in descriptive sentences.

Crashing analysis was performed by identifying tasks on the critical path and calculating the acceleration (crashing) by adding working hours. A cost analysis was then conducted to determine the most optimal crashing duration.

3. Results and Discussion

Based on the available data, several tasks were identified as being on the critical path. These tasks were subjected to crashing by adding working hours. The project operates 7 days a week, Monday through Sunday, with a daily working time of 8 hours, from 08:00 to 12:00 and from 13:00 to 17:00. Additional working hours were introduced to improve daily productivity and shorten project duration. Overtime productivity rates are 90% for 1 hour, 80% for 2 hours, and 70% for 3 hours of overtime per day.

3.1. Crash Duration - 1 Hour Overtime

For example, the task of installing 1 kg of profile steel for the warehouse stairs had the following values:

Volume = 240.05 kg

Normal Duration = 8 days

$$\text{Daily Productivity} = \frac{\text{volume}}{\text{normal duration}} = \frac{240.05}{8} = 30.01 \text{ kg/day}$$

$$\text{Productivity per hour} = \frac{\text{daily productivity}}{\text{normal daily working hours}} = \frac{30.01}{8} = 3.75 \text{ kg/hour}$$

Overtime Productivity = overtime hours x productivity coefficient x productivity per hour

= 1 x 0.9 x 3.75

= 3.38 kg/hour

Daily Productivity after crashing

= daily productivity + overtime productivity

= 30.01 + 3.38

= 33.38 kg/hour

$$Crash\ duration = \frac{\text{volume}}{\text{daily productivity after crashing}} = \frac{240.05}{33.38} = 7.19 \approx 8 \text{ days}$$

A similar calculation was applied to all critical path tasks, presented in the Table 1.

Table 1. Crash Duration Analysis Adding 1 Working Hour

NO	JOB DESCRIPTION	Unit	Volume	Normal Duration	Productivity				Crash Duration	
					Daily	Per Hour	Overtime	Crash	Day	Rounding
1	2	3	4	5	6 = (4) / (5)	7 = (6) / 8 jam	8 = 0,9 x (7)	9 = (6) + (8)	10 = (4) / (9)	11
I	**PREPARATORY WORK**									
2	Preparation Work (Demolition, Land Clearing, etc.)	Unit	1,00	1	1,00	0,13	0,11	1,11	0,90	1
A	**REHABILITATION WORK OF THE DEPARTMENT A HALL BUILDING**									
I	**SOIL AND FOUNDATION WORKS**									
1	Excavation of 1 m3 of common soil up to 1 meter deep for a total volume up to 200 m3	m3	2,92	1	2,92	0,37	0,33	3,25	0,90	1
3	Installation of 1 m3 of Split Stone Foundation	m3	0,27	1	0,27	0,03	0,03	0,30	0,90	1
II	**CONCRETE WORKS**									
1	Production of 1 m3 of concrete with compressive strength f'c = 14,5 Mpa (K175)	m3	5,30	3	1,77	0,22	0,20	1,97	2,70	3
2	Reinforcement of 1 kg using plain or deformed steel bars	kg	455,51	2	227,76	28,47	25,62	253,38	1,80	2
4	(K3) Installation of 1 m² formwork for Bondex floor system	m2	24,77	2	12,39	1,55	1,39	13,78	1,80	2
III	**STEEL & ALUMINIUM WORKS**									
1	Installation of 1 kg of steel profiles for warehouse stairs	kg	240,05	8	30,01	3,75	3,38	33,38	7,19	8
IV	**WALL MASONRY WORKS**									
1	Installation of 1 m² of red brick wall (5x11x22)cm half-brick thick, using mortar mix 1SP : 6PP	m2	3,30	1	3,30	0,41	0,37	3,67	0,90	1
3	Application of 1 m² plaster with a mix ratio of 1 Pc : 6 Pp , 15 mm	m2	57,46	9	6,38	0,80	0,72	7,10	8,09	9
4	Application of 1 m² skim coat	m2	57,46	6	9,58	1,20	1,08	10,65	5,39	6
V	**FLOOR AND WALL FINISHING WORKS**									
1	Installation of 1 m² of 40x40 cm ceramic floor tiles for warehouse floor	m2	3,39	2	1,70	0,21	0,19	1,89	1,80	2
2	Dismantling and reinstallation of 1 m² wall sound insulation	m2	73,21	7	10,46	1,31	1,18	11,64	6,29	7
X	**Painting and Finishing Works**									
2	Painting of 1 m² existing wall (1 coat of putty, 2 coats of finish paint)	m3	200,72	5	40,14	5,02	4,52	44,66	4,49	5
3	Repainting of 1 m² exterior existing wall (1 coat of putty, 2 coats of exterior finish paint)	m2	284,53	6	47,42	5,93	5,33	52,76	5,39	6

(Source: Analysis Results)

3.2. Crash Duration - 2 Hour Overtime

For example, the task of installing 1 kg of profile steel for the warehouse stairs had the following values:

Volume = 240.05 kg

Normal Duration = 8 days

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

$$= \frac{240.05}{8} = 30.01 \text{ kg/day}$$

$$\text{Productivity per hour} = \frac{\text{daily productivity}}{\text{normal daily working hours}}$$

$$= \frac{30.01}{8} = 3.75 \text{ kg/hour}$$

Overtime Productivity = overtime hours x productivity coefficient x productivity per hour

= 2 x 0.8 x 3.75

= 6.00 kg/hour

Daily Productivity after crashing

= daily productivity + overtime productivity

= 30.01 + 6.00

= 36.01 kg/hour

$$\textit{Crash duration} = \frac{\text{volume}}{\text{daily productivity after crashing}}$$

$$= \frac{240.05}{36.01}$$

$$= 6.67 \approx 7 \text{ days}$$

A similar calculation was applied to all critical path tasks, presented in the Table 2.

Tabel 2. Crash Duration Analysis Adding 2 Working Hour

NO	JOB DESCRIPTION	Unit	Volume	Normal Duration	Productivity				Crash Duration	
					Daily	Per Hour	Overtime	Crash	Day	Rounding
1	2	3	4	5	6 = (4) / (5)	7 = (6) / 8 jam	8 = 2 x 0,8 x (7)	9 = (6) + (8)	10 = (4) / (9)	11
I	**PREPARATORY WORK**									
2	Preparation Work (Demolition, Land Clearing, etc.)	Unit	1,00	1	1,00	0,13	0,20	1,20	0,83	1
A	**REHABILITATION WORK OF THE DEPARTMENT A HALL BUILDING**									
I	**SOIL AND FOUNDATION WORKS**									
1	Excavation of 1 m3 of common soil up to 1 meter deep for a total volume up to 200 m3	m3	2,92	1	2,92	0,37	0,58	3,50	0,83	1
3	Installation of 1 m3 of Split Stone Foundation	m3	0,27	1	0,27	0,03	0,05	0,32	0,83	1
II	**CONCRETE WORKS**									
1	Production of 1 m3 of concrete with compressive strength f'c = 14,5 Mpa (K175)	m3	5,30	3	1,77	0,22	0,35	2,12	2,50	3
2	Reinforcement of 1 kg using plain or deformed steel bars	kg	455,51	2	227,76	28,47	45,55	273,31	1,67	2
4	(K3) Installation of 1 m² formwork for Bondex floor system	m2	24,77	2	12,39	1,55	2,48	14,86	1,67	2
III	**STEEL & ALUMINIUM WORKS**									
1	Installation of 1 kg of steel profiles for warehouse stairs	kg	240,05	8	30,01	3,75	6,00	36,01	6,67	7
IV	**WALL MASONRY WORKS**									
1	Installation of 1 m² of red brick wall (5x11x22)cm half-brick thick, using mortar mix 1SP : 6PP	m2	3,30	1	3,30	0,41	0,66	3,96	0,83	1
3	Application of 1 m² plaster with a mix ratio of 1 Pc : 6 Pp , 15 mm	m2	57,46	9	6,38	0,80	1,28	7,66	7,50	8
4	Application of 1 m² skim coat	m2	57,46	6	9,58	1,20	1,92	11,49	5,00	5
V	**FLOOR AND WALL FINISHING WORKS**									
1	Installation of 1 m² of 40x40 cm ceramic floor tiles for warehouse floor	m2	3,39	2	1,70	0,21	0,34	2,03	1,67	2
2	Dismantling and reinstallation of 1 m² wall sound insulation	m2	73,21	7	10,46	1,31	2,09	12,55	5,83	6
X	**Painting and Finishing Works**									
2	Painting of 1 m² existing wall (1 coat of putty, 2 coats of finish paint)	m3	200,72	5	40,14	5,02	8,03	48,17	4,17	5
3	Repainting of 1 m² exterior existing wall (1 coat of putty, 2 coats of exterior finish paint)	m2	284,53	6	47,42	5,93	9,48	56,91	5,00	5

(Source: Analysis Results)

3.3. Crash Duration - 3 Hour Overtime

For example, the task of installing 1 kg of profile steel for the warehouse stairs had the following values:

Volume = 240.05 kg

Normal Duration = 8 days

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

$$= \frac{240.05}{8} = 30.01 \text{ kg/day}$$

$$\text{Productivity per hour} = \frac{\text{daily productivity}}{\text{normal daily working hours}}$$

$$= \frac{30.01}{8} = 3.75 \text{ kg/hour}$$

Overtime Productivity = overtime hours x productivity coefficient x productivity per hour

= 3 x 0.7 x 3.75

= 7.88 kg/hour

Daily Productivity after crashing

= daily productivity + overtime productivity

= 30.01 + 7.88

= 37.89 kg/hour

$$Crash\ duration = \frac{\text{volume}}{\text{daily productivity after crashing}}$$

$$= \frac{240.05}{37.89}$$

$$= 6.34 \approx 7 \text{ days}$$

A similar calculation was applied to all critical path tasks, presented in the Table 3.

Tabel 3. Crash Duration Analysis Adding 3 Working Hours

NO	JOB DESCRIPTION	Unit	Volume	Normal Duration	Productivity				Crash Duration	
					Daily	Per Hour	Overtime	Crash	Day	Rounding
1	2	3	4	5	6 = (4) / (5)	7 = (6) / 8 jam	8 = 3 x 0,7 x (7)	9 = (6) + (8)	10 = (4) / (9)	11
I	**PREPARATORY WORK**									
2	Preparation Work (Demolition, Land Clearing, etc.)	Unit	1,00	1	1,00	0,13	0,26	1,26	0,79	1
A	**REHABILITATION WORK OF THE DEPARTMENT A HALL BUILDING**									
I	**SOIL AND FOUNDATION WORKS**									
1	Excavation of 1 m3 of common soil up to 1 meter deep for a total volume up to 200 m3	m3	2,92	1	2,92	0,37	0,77	3,69	0,79	1
3	Installation of 1 m3 of Split Stone Foundation	m3	0,27	1	0,27	0,03	0,07	0,34	0,79	1
II	**CONCRETE WORKS**									
1	Production of 1 m3 of concrete with compressive strength f'c = 14,5 Mpa (K175)	m3	5,30	3	1,77	0,22	0,46	2,23	2,38	3
2	Reinforcement of 1 kg using plain or deformed steel bars	kg	455,51	2	227,76	28,47	59,79	287,54	1,58	2
4	(K3) Installation of 1 m² formwork for Bondex floor system	m2	24,77	2	12,39	1,55	3,25	15,64	1,58	2
III	**STEEL & ALUMINIUM WORKS**									
1	Installation of 1 kg of steel profiles for warehouse stairs	kg	240,05	8	30,01	3,75	7,88	37,88	6,34	7
IV	**WALL MASONRY WORKS**									
1	Installation of 1 m² of red brick wall (5x11x22)cm half-brick thick, using mortar mix 1SP : 6PP	m2	3,30	1	3,30	0,41	0,87	4,17	0,79	1
3	Application of 1 m² plaster with a mix ratio of 1 Pc : 6 Pp , 15 mm	m2	57,46	9	6,38	0,80	1,68	8,06	7,13	8
4	Application of 1 m² skim coat	m2	57,46	6	9,58	1,20	2,51	12,09	4,75	5
V	**FLOOR AND WALL FINISHING WORKS**									
1	Installation of 1 m² of 40x40 cm ceramic floor tiles for warehouse floor	m2	3,39	2	1,70	0,21	0,44	2,14	1,58	2
2	Dismantling and reinstallation of 1 m² wall sound insulation	m2	73,21	7	10,46	1,31	2,75	13,20	5,54	6
X	**Painting and Finishing Works**									
2	Painting of 1 m² existing wall (1 coat of putty, 2 coats of finish paint)	m3	200,72	5	40,14	5,02	10,54	50,68	3,96	4
3	Repainting of 1 m² exterior existing wall (1 coat of putty, 2 coats of exterior finish paint)	m2	284,53	6	47,42	5,93	12,45	59,87	4,75	5

(Source: Analysis Results)

After projecting overtime onto the CPM diagram, the total durations were:

- 1 hour overtime = 54 days
- 2 hours overtime = 49 days
- 3 hours overtime = 48 days

3.4. Acceleration Cost Analysis

The cost analysis includes calculating overtime wages for 1, 2, and 3 hours.

a. Normal Hourly Wages
   - Foreman = (Rp130,000) / (8 hours/day) = Rp16,250
   - Chief Craftsman = (Rp125,000) / (8 hours/day) = Rp15,625
   - Craftsman = (Rp120,000) / (8 hours/day) = Rp15,000
   - Laborer = (Rp100,000) / (8 hours/day) = Rp12,500

b. 1 Hour Overtime Wages
   - Foreman = Rp16,250 x 1.5 = Rp24,375
   - Chief Craftsman = Rp15,625 x 1.5 = Rp23,437.5
   - Craftsman = Rp15,000 x 1.5 = Rp22,500
   - Laborer = Rp12,500 x 1.5 = Rp18,750

c. 2 Hour Overtime Wages
   - Foreman = Rp16,250 x 1.5 + (2 x 1 x Rp16,250) = Rp56,875
   - Chief Craftsman = Rp15,625 x 1.5 + (2 x 1 x Rp15,625) = Rp54,687.5
   - Craftsman = Rp15,000 x 1.5 + (2 x 1 x Rp15,000) = Rp52,500
   - Laborer = Rp12,500 x 1.5 + (2 x 1 x Rp12,500) = Rp43,750

d. 3 Hour Overtime Wages
   - Foreman = Rp16,250 x 1.5 + (2 x 2 x Rp16,250) = Rp89,375
   - Chief Craftsman = Rp15,625 x 1.5 + (2 x 2 x Rp15,625) = Rp85,937,5
   - Craftsman = Rp15,000 x 1.5 + (2 x 2 x Rp15,000) = Rp82,500
   - Laborer = Rp12,500 x 1.5 + (2 x 2 x Rp12,500) = Rp68,750

e. Calculation of Overtime Wages

   Example Calculation of 2 Hours Overtime for Profile Steel Installation

   Normal Duration= 8 days

   Crash duration = 7 days

   Overtime = 2 hours

   1) Total daily cost (Normal Hourly Wages + 2 Hour Overtime Wages)
      - Foreman = Rp130,000 + Rp56,875 = Rp186,875
      - Chief Craftsman = Rp125,000 + Rp54,687.5 = Rp179,687.5
      - Craftsman = Rp120,000 + Rp52,500 = Rp172,500

Laborer = Rp100,000 + Rp43,750 = Rp143,750

2) Total Cost (total workers x total daily cost)

Foreman = 1 orang x Rp186,875 = Rp186,875
Chief Craftsman = 1 orang x Rp179,687,5 = Rp179,687.5
Craftsman = 2 orang x Rp172,500 = Rp345,000
Laborer = 4 Orang x Rp143,750 = Rp575,000
Total overtime cost = Rp1,286,562.5

3) Total overtime wages (Total overtime cost x crash duration)

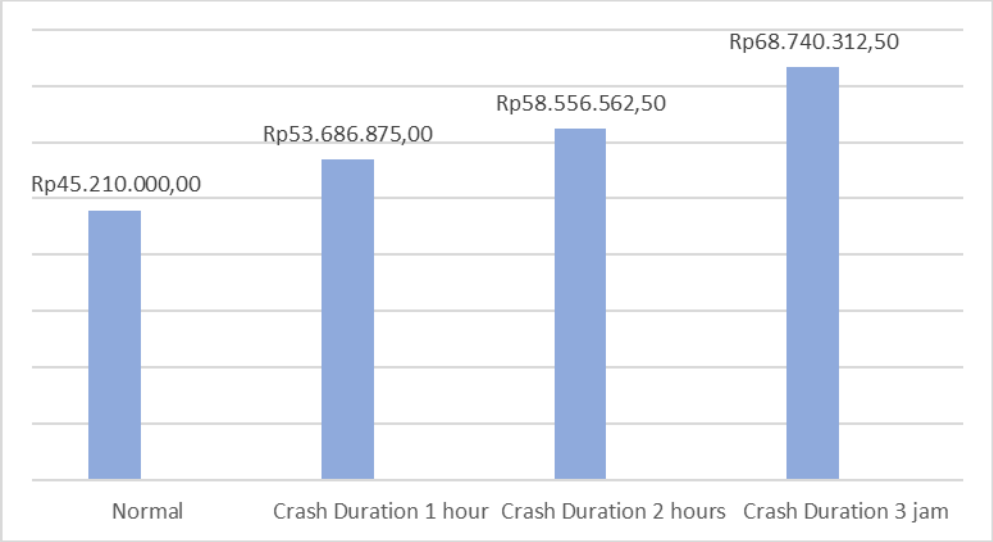
Total overtime wages = Rp1,286,562,5 x 7 hari = Rp9,005,937,5

So the total cost of 2 hours of overtime for 7 days for the work of installing Profile Steel Installation is IDR 9,005,937.50. Using the same approach, costs were calculated for all critical path tasks.

Summary of Labor Costs:

- 1-hour overtime (54 days): IDR 53,686,875.00
- 2-hour overtime (49 days): IDR 58,556,562.50
- 3-hour overtime (48 days): IDR 68,740,312.50

A comparison of durations and labor costs is presented in Figure 1.



Gambar 1. Comparison of Normal and Acceleration Work Duration
(Source: Analysis Results)

Based on the CPM network, 1 hour overtime results in 54 days at Rp53,686,875.00; 2 hours results in 49 days at Rp58,556,562.50; and 3 hours results in 48 days at Rp68,740,312.50.

4. Conclusion

Based on the calculations in Tables 1, 2, and 3, also projections onto the CPM diagram, 1 hour of overtime results in a 54 days duration, 2 hours of overtime results in 49 days, 3hours of overtime results in 48 days. According to the comparison, the most optimal scenario is 2 hours of overtime per day, which achieves a 5 days acceleration with a labor cost of Rp58,556,562.50. This cost difference is relatively small compared to 1 hour overtime (Rp53,686,875.00), while 3 hours overtime only saves one additional day with significantly higher costs (Rp68,740,312.50).

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