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Analysis of Cost Acceleration Using Time Cost Trade Off Method on Wheat Silo and Pellet Silo Phase III Structure Repair Project in Surabaya

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ABSTRACT

The Wheat Silo and Pellet Silo Structural Repair Project Phase III in Surabaya holds great significance in the wheat flour processing industry in Indonesia. PT Indofood Sukses Makmur Tbk Bogasari Surabaya Division, one of the leading wheat flour producers, required structural repairs on both silos to ensure smooth plant operations and final product quality. The project necessitates proper project management to avoid delays and cost overruns, with a budget of Rp. 28,011,000,000 and an estimated duration of 455 calendar days. This study employs the Time Cost Trade-Off (TCTO) method to analyze options for accelerating the project timeline by considering additional costs that may arise. The results showed that by using TCTO, the project completion time can be accelerated to 359 days from 455 days, reducing the duration by 21.10% at an additional cost of Rp. 739,351,125.00 or 2.64% of the project value. With the addition of 1 hour of overtime per day, the cost of accelerating the project is Rp. 413,445,000.00 or 1.48% of the project value, reducing the work time to 391 days or 14.07% of the original schedule.

Keywords: Acceleration, Wheat Silo, Pellet Silo, Cost Trade Off

1. Introduction

In Indonesia, infrastructure development and the expansion of the construction industry are on the rise. This expansion is largely driven by the rapid expansion of the domestic real estate market, private investment, and government spending on infrastructure projects. In order to improve the lives of its people, the need for development is increasing in all fields, especially in developing countries. There is much progress to be made; this lag must be followed up with development in all sectors. The development consists of the construction of physical projects, such as buildings, bridges, toll roads, large or small companies, and telecommunications networks (Abdilah et al., 2021).

Construction projects are a series of sensitive work mechanisms, because every aspect of the project affects one another. In project implementation, there are often schedule mismatches in the field which result in additional time and cost overruns (Ariesty & Nauval, 2020). The causes of delays that often occur are due to design changes, weather factors, inadequate needs for workers, materials, or equipment, planner errors or specifications. The consequence of this acceleration in development completion is an increase in direct costs (Vebiola & Waskito, 2020).

PT Indofood Sukses Makmur Tbk. Bogasari Surabaya Division began operations on July 10, 1972, located on Jl. Nilam Timur No. 16 Tanjung Perak, Surabaya. Occupies an area of ± 14 Ha. With a milling capacity of 5,900 tons of wheat / day and a total flour production of 1.6 million tons per year. In the procurement and storage of raw materials in the form of wheat grain before being processed into flour, it needs to be stored in a place called silo, and the silo owned by Bogasari is a concrete silo (Hermansyah et al., 2022). Silos owned by

Bogasari are divided into 2 types, namely wheat silos for storing wheat and pellet silos for storing pellets, namely the remaining processed wheat skin that has been wasted which is usually used for animal feed mixture. in Bogasari there are 4 complexes, namely the old pellet silo totaling 18 pieces with a height of 42 m, the new pellet silo totaling 24 pieces with a height of 40 m, the old wheat silo totaling 36 pieces with a height of 50 m, and the new wheat silo totaling 48 pieces with a height of 36.95m. This silo building is needed for the continuity of production, therefore the maintenance of this building is carried out periodically every 20 years (Ashari, 2023).

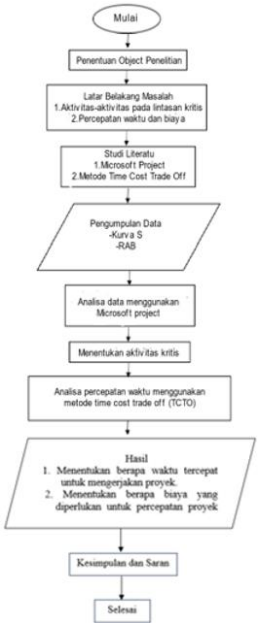
The stage III wheat silo and pellet silo structural repair project in Surabaya faced significant challenges. Based on the project progress report and interviews with the project manager and field team, it was identified that several key activities were delayed. The excavation and foundation installation activities experienced constraints due to unstable soil conditions and bad weather, which caused work delays. In addition, the installation of the steel structure was delayed due to the late delivery of materials from the supplier. Concrete casting work was also hampered by a shortage of skilled labor, while the installation of mechanical and electrical systems was delayed due to sudden design changes. These issues not only disrupted the project schedule but also had the potential to cause significant cost overruns if not addressed with effective management strategies (Pramesti & Listyawan, 2023; Sulistyo et al., 2023; Sulistyo & Al Fikri, 2021).

In addition to the TCTO method, there are several other methods that can be used to accelerate a project, namely the crashing method involves adding resources to critical path activities to reduce the duration of these activities, although this will usually increase costs (Ariesty & Nauval, 2020). This research aims to produce practical recommendations and optimal solutions for project managers in managing cost acceleration (Mariani & Witjaksana, 2019). The expected results include the identification of critical trajectories, their impact on costs, as well as recommendations for effective acceleration strategies with minimal additional costs (Zanri et al., 2023). Using MS Project, this research also provides practical guidance in project planning and management. Through this comprehensive approach, the research is expected to make a significant contribution in improving the efficiency and effectiveness of construction project management, particularly in the context of silo structure repair in Surabaya (Afrizal, 2018). This research aims to determine how much cost is needed for the acceleration of the wheat silo and pellet silo structure repair project phase III (Waney & Ruitan, 2022).

2. Methodology

2.1. Research Design

An explanation of the flow or stages of the final work can be seen in the flow chart below:



Source: Researcher's Processed Results, 2024

Figure 1. Flowchart of Research Design

The research process begins by identifying the project's background, including critical activities, time, and cost constraints. A literature review is conducted, focusing on Microsoft Project and time-cost trade-off methods. Data is gathered through interviews, observations, and relevant documents. This information is then analyzed using Microsoft Project to determine critical activities. Subsequently, the time-cost trade-off method is applied to calculate the fastest project completion time and the associated cost increase for potential project acceleration. The research concludes by presenting these findings and providing recommendations based on the results.

2.2. Research Subjects

Analysis of the acceleration of construction project work costs using the time cost trade off method (Abdillah & Kurniawan, 2022).

2.3. Research Object

In this study, the object of research on the project repair structure of wheat silo and pellet silo phase III at PT. ISM Bogasari Surabaya.

2.4. Data Collection Procedure

In this study using secondary data taken by the author directly at : PT Ting Tai Konstruksi Indonesia, the data taken is S curve data, namely information about the project schedule which includes a complete list of activities, and the order of dependence between activities. Project cost plan and budget (RAB) data. This data includes cost estimates provided by the project team directly responsible for project implementation. This data is needed to calculate the additional cost of work on alternatives to adding overtime hours on work experiencing a critical trajectory and Normal Labor Wages per month to calculate the cost of acceleration with the addition of working hours (overtime). And Secondary data is supporting data in the form of literature related to the author's research, this literature can be in the form of books, lecture notes, journals related to the author's research.

2.5. Data analysis method to calculate the cost of the wheat silo and pellet silo structure repair project phase III in Surabaya.

Analyze with the Time Cost Trade Off method to calculate the optimal cost of adding working hours (overtime) (Anggraeni et al., 2019).

a. Overtime cost per day (1 hour overtime condition)

B = NTK×1.5×H

(B = Overtime cost per day; NTK = number of workers; H = normal cost per hour.)

b. Overtime cost for 2 hours

B = NTK ×[(1.5×H)+(2×1×H)]

(B = Overtime cost for 2 hours; NTK = number of laborers; H = normal cost per hour.)

3. Results and Discussion

3.1. Labor Wage Cost

The project to repair the structure of wheat silo and pellet silo phase III has a contract value for workers' wages/salaries. The following is a recapitulation of labor wages obtained from the company (secondary data).

Table 1. Normal Labor Wage/Month

No	Workers	Wage/month (Rp)
1	Construction	7.440.000,00
2	Electricity	6.200.000,00
3	Quality Control	5.890.000,00
4	Planning/Engineering	5.580.000,00
5	Work Safety	5.270.000,00
6	Warehouse	4.960.000,00

No	Workers	Wage/month (Rp)
7	General Affairs	4.650.000,00
8	Gondola Operator	4.340.000,00
9	Helper	3.720.000,00
10	Technician	3.100.000,00

Source: Project Document, 2024

Based on the data of monthly labor wages / salaries of meal workers, the normal labor cost / hour is calculated. Example of calculating normal labor costs / hour for resource name Manager, cost per day (standard cost): Rp. 280,000.00, working hours 8 hours / day, so :

Hourly fee = $\frac{280.000.000}{8}$ = Rp. 35.000,00 /hour.

For other jobs can be seen in table 2 below:

Table 2. Normal Labor Wages

No	Workers	Wage / Day (Rp)	Wage / Hour (Rp)
1	Construction	240.000,00	30.000,00
2	Electricity	200.000,00	25.000,00
3	Quality Control	190.000,00	23.750,00
4	Planning/Engineering	180.000,00	22.500,00
5	Work Safety	170.000,00	21.250,00
6	Warehouse	160.000,00	20.000,00
7	General Affairs	150.000,00	18.750,00
8	Gondola Operator	140.000,00	17.500,00
9	Helper	120.000,00	15.000,00
10	Technician	100.000,00	12.500,00

Source: Researcher's Processed Results, 2024

3.2. Analysis with Time Cost Trade Off Method

Time Cost Trade Off Method Analysis is an analysis by exchanging costs so as to accelerate the project completion time but result in additional costs (Pratiwi et al., 2022). This acceleration cost exists due to the acceleration duration caused by 1 hour of overtime and 2 hours of overtime in a day (Nugroho et al., 2023). The activities to be calculated are activities on the critical path whose acceleration costs are based on the addition of overtime working hours and acceleration duration using the Microsoft Excel program (Akbar, 2022). The following calculation of normal wages for workers is as follows:

a. Normal Conditions

The following is a recapitulation of normal worker wages based on the results of the calculation of normal worker wages on the critical trajectory of the project.

Table 3. Recapitulation of Total Wages of Normal Workers

Code	Number of Workers	Total wage/day (Rp)	Normal Duration (Days)	Total Project Wages (Rp)
2.1	13	1.820.000,00	18	32.760.000,00
2.2	13	1.800.000,00	18	32.400.000,00
2.3	23	3.000.000,00	38	114.000.000,00
2.4	22	2.900.000,00	150	435.000.000,00
2.5	10	1.440.000,00	38	54.720.000,00
2.6	13	1.820.000,00	38	69.160.000,00
2.7	10	1.460.000,00	38	55.480.000,00
2.8	22	2.880.000,00	150	432.000.000,00
2.9	16	2.160.000,00	150	324.000.000,00
2.10	13	1.800.000,00	150	270.000.000,00
2.11	7	1.080.000,00	150	162.000.000,00

Code	Number of Workers	Total wage/day (Rp)	Normal Duration (Days)	Total Project Wages (Rp)
2.12	7	1.100.000,00	150	165.000.000,00
2.13	24	3.120.000,00	150	468.000.000,00
2.14	26	3.360.000,00	135	453.600.000,00
2.15	17	2.280.000,00	135	307.800.000,00
2.16	9	1.320.000,00	135	178.200.000,00
2.17	10	1.440.000,00	135	194.400.000,00
2.18	9	1.320.000,00	135	178.200.000,00
2.19	19	2.520.000,00	135	340.200.000,00
2.20	17	2.280.000,00	135	307.800.000,00
2.21	25	3.240.000,00	135	437.400.000,00
2.22	23	3.000.000,00	135	405.000.000,00
2.23	32	4.100.000,00	135	553.500.000,00

Source: Researcher's Processed Results, 2024

So the implementation of the Phase III wheat silo and pellet silo structure repair project requires labor costs of Rp. 5,970,620,000.00.

b. Cost Calculation

The following is a recapitulation of the calculation results of adding 1 working hour:

Table 4. Recapitulation of Wages for Addition of 1 Working Hour

Code	Normal Duration	Duration after adding 1 hour of overtime	Wages Addition of 1 hour of overtime (Rp)
2.1	18	16	34.160.000,00
2.2	18	16	34.200.000,00
2.3	38	34	121.125.000,00
2.4	150	135	464.906.250,00
2.5	38	34	58.140.000,00
2.6	38	34	73.482.500,00
2.7	38	34	68.892.500,00
2.8	150	135	462.206.250,00
2.9	150	135	346.275.000,00
2.10	150	135	288.562.500,00
2.11	150	135	176.175.000,00
2.12	150	135	182.418.750,00
2.13	150	135	503.718.750,00
2.14	135	121	485.966.250,00
2.15	135	121	330.783.750,00
2.16	135	121	189.667.500,00
2.17	135	121	206.910.000,00
2.18	135	121	184.222.500,00
2.19	135	121	362.092.500,00
2.20	135	121	327.607.500,00
2.21	135	121	465.547.500,00
2.22	135	121	431.062.500,00
2.23	135	121	585.942.500,00
Total wage in addition to 1 hour of work			Rp.6.384.065.000,00

Source: Processed Results of Researchers, 2024

So in the table above, it is obtained that the wages on this critical path activity increase due to the wages of 1 hour of additional working hours (overtime), to Rp.6,384,065,000.00 with a normal condition wage of Rp.5,970,620,000.00 so that it takes an additional wage of 1 hour of overtime of Rp.413,445,000.00.

c. 2 Hours Overtime Condition

The following is a recapitulation of the calculation results of adding 2 working hours:

Table 5. Recapitulation of Wages for Addition of 2 Working Hours

Code	Normal Duration	Duration after adding 2 hours of overtime	Wages for adding 2 hours of overtime (Rp)
2.1	18	15	37.625.000,00
2.2	18	15	39.725.000,00
2.3	18	15	141.877.500,00
2.4	38	31	476.785.000,00
2.1	18	15	37.625.000,00
2.5	150	124	60.450.000,00
2.6	38	31	74.438.750,00
2.7	38	31	70.253.750,00
2.8	38	31	48.551.875,00
2.9	150	124	674.305.000,00
2.10	150	124	201.422.500,00
2.11	150	124	54.782.000,00
2.12	150	124	294.125.000,00
2.13	150	124	609.453.000,00
2.14	150	124	592.443.000,00
2.15	135	111	445.086.250,00
2.16	135	111	200.632.500,00
2.17	135	111	216.450.000,00
2.18	135	111	195.637.500,00
2.19	135	111	378.807.500,00
2.20	135	111	327.172.500,00
2.21	135	111	453.712.500,00
2.22	135	111	522.077.500,00
Total wage for additional 2 hours of overtime			6.709.971.125,00

Source: Researcher's Processed Results, 2024

So in the table above, it is obtained that the wages on this critical path activity increase due to the wages of additional working hours (overtime) 2 hours, to Rp. 6,709,971,125.00 with a normal condition wage of Rp. 5,970,620,000.00 so that it takes an additional wage of 2 hours of overtime of Rp. 739,351,125.00.

4. Conclusion

Based on the analysis that has been done, several conclusions can be drawn from this research. First, the priority order value of the road surface based on the Bina Marga method is 5.5. Second, the handling of the Bina Marga method with a road surface priority order value of 5.5 is included in the periodic handling category. Third, the cost of handling road maintenance using the Bina Marga method, which includes periodic maintenance and routine maintenance, is Rp. 9,479,663.46. Based on the analysis results of the research obtained, for better results, several suggestions can be proposed. First, further research needs to be done on the comparison with the Geographic Information System (GIS) method. Second, further research is needed on rigid pavement.

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