Time Acceleration Analysis of the Kijing Terminal Development Project in Mempawah, West Kalimantan

Ineza N. R. Marpaung, Silvianita, Daniel M. Rosyid and Suntoyo
Department of Ocean Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

Keywords: Precedance Diagramming Method (PDM), Monte Carlo Method, Time Cost Trade off, Project Duration Acceleration.

Abstract: The cargo port is a port that is planned specifically for the purpose of loading and unloading of goods and is equipped with a warehouse for storing goods and cranes to move cargo ship. With the construction of the port, the company needs a good project management design. The mismatch between the schedule design and the reality on the ground still creates problems. This is a challenge for a project manager who must carefully look at existing activities to avoid delays in the project. To overcome this problem, it is necessary to maximize performance by reducing the duration of each activity in the project that still includes safety time. This paper analyzes the acceleration of the duration of the Kijing terminal construction project in Mempawah West Kalimantan using the Precedance Diagramming Method (PDM) method, as well as the Monte Carlo method to find out the project's probability on time, then find the optimal duration with the Time Cost Trade Off (TCTO) method. From the results of the analysis with the PDM method obtained 12 activities that exist on the critical path. Based on the Monte Carlo simulation, the results show that the probability of the project to be completed on time is 55% or 45% chance of being late. The optimum duration and costs on the critical path are obtained at the addition of 1 hour of overtime. The total duration of the project, which was originally 595 days to 513 days with a difference of 82 days, with a total cost of Rp2,740,269,901,670 to Rp2,740,775,765,420 with a difference of Rp505,863,750 and also a cost slope of Rp 6,169,070 per day.

1 INTRODUCTION

The West Kalimantan region is one of the priorities in economic development announced by the Government of the Republic of Indonesia. This region has several potential natural resources such as palm oil, bauxite, rubber, wood, and other agricultural products. In addition, there are many investors (both local and foreign) who are interested in investing in the industrial sector in West Kalimantan.

This potential was realized by one of the oil and gas companiesas a port service provider company is able to develop the potential of ports in Kijing Beach, Mempawah, West Kalimantan. The port development plan is also very likely, given the existing condition of the Pontianak Port which is the closest port to Kijing that has overcapacity and the limited depth of the Kapuas River channel ± 5 meters. It is hoped that the existence of the Kijing Terminal can later reduce the burden on existing ports in West Kalimantan, invite ocean going ships to be able to dock at the Kijing Terminal and reduce overall logistics costs.

Kijing Terminal is located ± 80 km from the North of Pontianak Harbor where there is Temajo Island in front of Kijing Beach with a distance of ± 5 km that can be used to reduce wave energy.Kijing Terminal will be developed in 3 (three) stages, namely: Initial Phase, Phase I and Phase II. Kijing Terminal has offshore and onshore facilities, each of which has 4 (four) zones, namely: container zones, liquid bulk zones, dry bulk zones and multipurpose zones which are expected to accelerate economic growth in the West Kalimantan region and provide benefits to all parties involved.Based on the importance of doing a good scheduling and acceleration on the Kijing Terminal construction project, it is necessary to have a system that makes it easy to analyze the acceleration of the Kijing Terminal construction project in Pontianak Port, Mempawah, West Kalimantan.

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Table 1: General Specification.

SPECIFICATION	
KIJING TERMINAL PROJECT	
INITIAL PHASE	
Length	5434 m
Total Length	5434 m
Depth	-12 sd 15
Area	32.8 Ha
Capacity (per year)	500.000 TEUs
	500.000 tonnes
PHASE I	
Length	2441m
Total Length	4415 m
Depth	-12 sd 15
Area	49.2 Ha
Capacity (per year)	950.000 TEUs
	23.840.000 tonnes
PHASE II	
Length	1747 m
Total Length	6162 m
Depth	-12 sd 15
Area	37.8 Ha
Capacity (per year)	1.950.00 Us

2 LITERATURE STUDIES

This section explains the theory used in this study. Project management for construction have been used by (Hendrickson, 2003). Project scheduling for gas transmission pipe by Silvianita et al (2018).

2.1 Presedence Diagram Method

Network planning analysis is to find out the critical path of the project (Demeulemeester, 2013).

The critical path is a series of activities that require the overall duration of the project and may not delay because it will affect the entire project. There are four constraints in the Presedence Diagram Method schedulling method, namely finish to finish, finish to start, start to finish, and start to start (Taha, 2007).

2.2 Monte Carlo Simulation

The Basics of Monte Carlo Simulation theory, one of which is the Random Variable. According to Bain and Engelhardt (1992) A random variable is a function defined in the sample space S that connects every possible outcome at e with a real number, namely $(e) = x$. If the set of possible outcomes of the random variable X is a calculated set, $\{1, x2, ..xn\}$, or, $\{x1, x2, ..\}$, then X is called a discrete random variable. Random numbers to find the most possible cost (Most Likely Cos) = ML can be generated using the RAND function found in Microsoft Excel.

2.3 Time Cost Trade off

Time Cost Trade Off analysis method is a method to speed up time by making an exchange between time and cost. In this research, the time acceleration analysis used on the critical path of the project is the addition of overtime hours to workers in the field. The addition of overtime hours is carried out in several schemes, namely one hour, two hours, and three houts of additional overtime. Then the optimum additional overtime hours scheme is sought by considering crash cost, crash duration, and cost slope of each scheme.(Hullet & Nosbich, 2012).

3 METHODOLOGY

3.1 Problem Indentification

At the stage of formulating the problem, the problems that occur in the object of research will be obtained and become the focus of the research. The object of this research is multipurpose terminal jetty in Kuala Tanjung. Then, the researcher will determine the objectives that refer to the formulation of the problem that has been set.

3.2 Literature Study

Literatures and references are needed to determine the appropriate method in this research and to facilitate the writing of the steps in this paper.

3.3 Data Collection

Data of the Kijing Terminal project is needed for the completion of this paper. The data needed include: time schedule, draft budget, and manpower.

3.4 Critical Path Analysis using PDM Method

The PDM method was used to analyze the critical path in this study. The use of the PDM method in this study facilitates the description of network planning because of the overlapping activities on the project (Leach, 2000).

3.5 Probability Analysis using Monte Carlo Simulation

Monte Carlo Simulation is used to find out the probability of duration of project completion in this study. The results of using this method are knowing the smallest, largest, and also probability based on the actual contract (McCabe, 2003).

3.6 Acceleration Analysis using TCTO Method

This paper uses the TCTO method to accelerate the duration of the project. TCTO analysis is done by compressing activities that are on the critical path. The alternative used in the TCTO method in this study is to use a one-hour, two-hour, and three-hour overtime scheme (Kezner, 1995). TCTO has been used in many areas such as in loadout process (Silvianita et al., 2016).

3.7 Optimum Costs Determination

To determine the optimum duration of the project, cost analysis must be carried out. The optimum duration of the project is the duration of acceleration by issuing costs as effectively and efficiently as possible. If the amount of costs incurred to accelerate the project is too expensive, then another acceleration alternative will be sought. (PMI. 2013).

4 RESULT AND DISCUSSION

4.1 Project Time Schedule

Project time schedule data consists of the activity name, duration, start date, and completion date. (based on the project)

Table 2: Project Time Schedule.

No	Activity	Duration	Start	Finish
A	**Preparatory Work**			
1	Site office	14 days	Mon 8/13/18	Sun 8/26/18
2	Mobilization & Demobilization	35 days	Mon 8/27/18	Sun 9/30/18
3	Stake out dan Positioning	47 days	Mon 10/8/18	Fri 11/23/18
B	**Work on Pier**			
4	Concrete Pile Work Dia. 1000 mm Bottom Type C0	327 days	Mon 11/26/18	Fri 10/18/19
5	Concrete Pile Work Dia. 600 mm (Wave Screen)	145 days	Mon 2/25/19	Fri 7/19/19
6	Concrete Pile Work Dia. 800 mm (PMA)	327 days	Mon 11/26/18	Fri 10/18/19
7	Concrete Pier Work and PMA	271 days	Mon 2/25/19	Fri 11/22/19
8	PMA Support Buildings	91 days	Mon 11/25/19	Sun 2/23/20
34	Electrical Work	91 days	Sun 11/24/19	Sat 2/22/20
35	Testing and Commissioning	127 days	Sun 11/24/19	Sun 3/29/20

4.2 Activity's Constraint

Activity"s constrain data is to find out which activities can be started earlier than other activities. In this study, the consraint and time schedule data obtained were inputted into Microsoft Project software to obtain the expected network planning.

Table 3: Activity's Constraint.

No	Activity	Duration	Predecessors	Successors
A	**Preparatory Work**			
1	Site office	14 days	START	4
2	Mobilization & Demobilization	35 days	3	5
3	Stake out dan Positioning	47 days	4	7FS+2 days, 16FS+2 days, 18FS+2 days, 17FS+62 days, 22FS+142 days, 26SS+14 days
B	**Work on Pier**			
4	Concrete Pile Work Dia. 1000 mm Bottom Type C0	327 days	5FS+2 days	8SS+90 days, 9SS,11FS+37 days, 14FS+37 days
5	Concrete Pile Work Dia. 600 mm (Wave Screen)	145 days	7SS+90 days	10SS
34	Electrical Work	91 days	43FF	42SS
35	Testing and Commissioning	127 days	44SS	FINISH

4.3 Critical Path Analysis

The critical path is a path that has a series of activities with the longest total amount of time and shows the fastest project completion time period. In addition to using software, the determination of the critical path was also done by manual calculation by calculating the earliest start, earliest finish, latest start, latest finish and float. Activities that have total float = 0 are activities included in the project's critical path. The formula of float is LS-ES or LF-EF.

Table 4: Critical Path Manual Calculation.

Activity	Activity ID	ES	EF	LS	LF	Float
Preparatory Work						
Site office	A1	1	582	8	575	7
Mobilization & Demobilization	A2	15	547	22	540	7
Stake out dan Positioning	A3	57	493	57	493	0
Work on Pier						
Concrete Pile Work Dia. 1000 mm Bottom Type C0	B1	106	164	135	135	29
Concrete Pile Work Dia. 600 mm (Wave Screen)	B2	197	255	225	227	28
Hoist Crane Work	H3	532	37	532	37	0
Electrical Work	H4	469	37	469	37	0
Testing and Commissioning	H5	469	1	469	1	0

4.4 Critical Path Determination

After determining the total float on the project, activities that are on the critical path can be identified. An activity is said to be critical if the Total Float value is equal to 0. The total float is obtained from LF minus EF or LS minus ES.

Table 5: Critical Path.

No	Activity	Activity ID	Float
1	Stake Out & Positioning	A3	0
2	Land Plant Work	E1	0
3	Rigid Concrete Work	E2	0
4	Rigid Work	F1	0
5	Paving Block Work	F2	0
6	Structure	G1	0
7	Building Support	G2	0
8	Mechanical Work	H1	0
9	Plumbing Work	H2	0
10	Hoist Crane Work	H3	0
11	Electrical Work	H4	0
12	Testing and Commissioning	H5	0

4.5 Project Completion Probability Analysis

The analysis carried out in this study is about the probabilities of the duration of project completion using the Monte Carlo method. There are several steps in using the Monte Carlo method (Hullet & Nosbich, 2012), including:

A. Optimistic Time and Pessimistic Time Data
Other data used for the Monte Carlo simulation are pessimistic time and optimistic time for each activity. This data was obtained from interviews with contractors and staff at one of the oil and gas companies. The following are the results of the interviews summarized in the table below.

Table 6: Optimistic Time and Pessimistic Time Data.

Activity	a	m	b
	Days		
Site office	7	14	20
Mobilization & Demobilization	26	35	42
Stake out dan Positioning	39	47	54
Work Pile Pile Dia. 1000 mm Bottom Type C0	316	327	334
Work Pile Dia 600 mm (Wave Screen)	137	145	154
Work Pile Pile Dia 800 mm (PMA)	316	327	337
Work PMA	262	271	283
Work Mechanical	146	154	162
Work Plumbing	146	154	162
Work Hoist Crane	23	28	45
Work Electrical	84	91	99
Testing And Commissioning	116	127	138

B. Calculate the Standard Deviation

Standard deviation is used as input normal distribution in generating random numbers. Calculation of standard deviation is done using the following formula:

$$\sigma = \frac{b-a}{6} \quad (1)$$

Where:

σ = standard deviation
a = optimistic time
b = pessimistic time

The following table is the result of calculating the value of the standard deviation and the new duration of the project.

Table 7: Calculation of the standard deviation and new duration.

Activity	sd	New Duration
		Days
Site office	0.8	14
Mobilization & Demobilzation	1.3	35
Stake out dan Positioning	1.2	47
Work Pile Pile Dia. 1000 mm Bottom Type C0	1.8	323
Work Pile Pile Dia 600 mm (Wave Screen)	1.5	146
Work Pile Pile Dia 800 mm (PMA)	2.2	325
Work PMA	2.3	273
Work Mechanical	1.5	153
Work Plumbing	1.5	154
Work Hoist Crane	2.8	21
Work Electrical	1.2	92
Testing And Commissioning	2.3	129

C. Determine the Number of Iterations

It is carried out by means of gradual iteration, until there is little or no change in the outcome. In this study iteration is carried out in stages, namely from a range of 10 to 1000 times iteration. We can choose how many time we will do the iteration base on the graph of the standart deviation change and the graph of parameter avarage change (until stable). Following is a graph of the statistical parameters taken to see the difference in results from adding iterations.

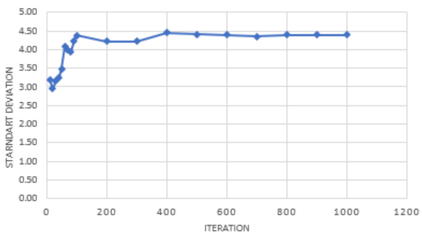

Figure 4: Graph of changes in the standard deviation of the number of iterations.

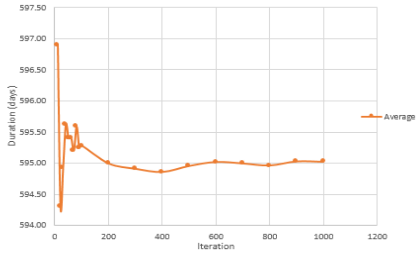

Figure 5: Graph of changes in the results of the parameters Average with the Number of Iterations.

From the graph above it can be concluded that by doing 1000 times the iteration of statistical parameters in the form of standard deviations, the median and the average are already in the stable results. Unstable results occur in iterations carried out between 10 to 500 times. After iterating 1000 times, the results obtained with statistical parameters such as in table 8.

Table 8: Statistical Parameters of Iteration Results.

No	Parameter	Quantity
1	Standart Deviation	4.17
2	Median	595
3	Kurtosis	0.2
4	Skewness	0.023
5	Average	595
6	Maximum	610
7	Minimum	610
8	Varian	17.4011
9	Mode	596

D. Calculate PDF and CDF

Calculating Probability Density Function (PDF) and Cumulative Distribution Function (CDF) is useful to find out the opportunities of project completion.A PDF is specifies the probability, CDF is a direct measure of probability.

The steps in calculating pdf and cfd are as follows:

Table 9: Monte Carlo Simulation Results in 1000 Times Iteration.

Duration	Cum	%cum	Prob	%prob
587	41	4%	41	4%
588	56	6%	15	2%
589	99	10%	43	4%
590	141	14%	42	4%
591	206	21%	65	7%
592	279	28%	73	7%
593	354	36%	75	8%
594	468	47%	114	11%
595	563	56%	95	10%
596	659	66%	96	10%
597	731	73%	72	7%

Table 9: Monte Carlo Simulation Results in 1000 Times Iteration (cont.).

Duration	Cum	%cum	Prob	%prob
598	796	80%	65	7%
599	855	86%	59	6%
600	909	91%	54	5%
601	936	94%	27	3%
602	964	97%	28	3%
603	979	98%	15	2%
604	985	99%	6	1%
605	992	99%	7	1%
606	997	100%	5	1%

Next is to plot the results of pdf and cdf in the table into graphical form, where the cdf results are drawn in scatter form, while the pdf results are in the form of a histogram as shown in Figure 6.

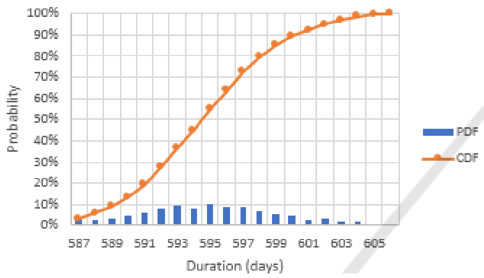

Figure 6: PDF and CDF Graph Results 1000 Times Iteration.

From the graph above shows the results of the Monte Carlo simulation in the form of PDF and CDF graphics, where CDF is the blue line, while the PDF is an orange-colored histogram. The x-axis in the graph above shows the duration of the project completion in days. The y-axis on the graph shows the probability. Percentile is the division of 100 data positions sorted in a distribution. From the graph above it is found that for percentiles / 50% probability, the project can be completed in 594 days or less. Whereas for 80% percentile / probability, the project can be completed in 598 days or less.

After calculating, it is found that completion of the project for less than 595 days has a 56% chance of success, or that the project 44% has a chance to be late. And a 100% chance of success of the project is estimated within 606 days.

4.6 Analysis using the Time Cost Trade off Method

Analysis of the Time Cost Trade Off method is an analysis by exchanging time and costs so that it can speed up the project completion time but result in an increase in costs. In this research, the project time is accelerated in activities that are on the critical path by increasing the worker's overtime hours. In adding workers' melting hours there are government regulations that must be followed by the contractor.

A. Crash Duration Calculation

The following is an example of the calculation of the duration of the crash carried out in this project on Dia Concrete Pile Work. 1000 mm Bottom Type C0 for additional one hour of work:

Normal duration = 316 days

Job Weight = 5.108%

Productivity per hour = 0.00202057% per hour

Daily productivity crashes=0.01798307% per day

Overtime hours will result in a decrease in daily productivity experienced by workers from normal productivity. This is caused by several factors, such as worker fatigue, limited visibility, and cooler temperatures at night.

Table 10: Productivity Coefficient of Overtime Worker.

Extra time	Productivity Decrease Index	Decreased Work Performance (per hour)	Percentage of Decreased Job Performance (%)	Productivity Coefficient
a	**B**	**c = a x b**	**d = c x 100**	**E = 100%-d**
1	0,1	0,1	10	0,9
2	0,1	0,2	20	0,8
3	0,1	0,3	30	0,7

After getting the productivity coefficient, the next step is to calculate the crash duration of each activity. The following tables are the results of crash duration calculations for each activity.

$$\textit{Crash Duration} = \textit{(work weight)} / \textit{(Daily productivity after crash)} \quad (2)$$

Table 11: Crash Duration of One Hour Overtime.

Activity	Duration	Quality	Crash Duration (Days)
	Days	%	1 Hour
Stake out dan Positioning	47	0.0580	42
Work Dump Soil	124	4.1640	111
Work Pile Rigid	28	2.0250	25
Work Rigid	35	0.8560	31
Work Paving Block	35	0.3790	31
Structure	91	2.4610	82
Work Building Support	126	2.6146	113
Work Mechanical	154	0.5201	138
Work Plumbing	154	0.3050	138
Work Hoist Crane	28	0.0290	25
Work Electrical	91	5.2886	82
Testing And Commissioning	127	0.1076	114

Table 12: Crash Duration of Two Hours Overtime.

Activity	Duration	Quality	Crash Duration (Days)
	Days	%	2Hour
Stake out & Positioning	47	0.0580	39
Work Dump Soil	124	4.1640	103
Work Pile Rigid	28	2.0250	23
Work Rigid	35	0.8560	29
Work Paving Block	35	0.3790	29
Structure	91	2.4610	76
Work Building Support	126	2.6146	105
Work Mechanical	154	0.5201	128
Work Plumbing	154	0.3050	128
Work Hoist Crane	28	0.0290	23
Work Electrical	91	5.2886	76
Testing And Commissioning	127	0.1076	106

Table 13: Crash Duration of Three Hours Overtime.

Activity	Duration	Quality	Crash Duration (Days)
	Days	%	3Hour
Stake out dan Positioning	47	0.0580	37
Work Dump Soil	124	4.1640	98
Work Pile Rigid	28	2.0250	22
Work Rigid	35	0.8560	28
Work Paving Block	35	0.3790	28
Structure	91	2.4610	72
Work Building Support	126	2.6146	100
Work Mechanical	154	0.5201	122
Work Plumbing	154	0.3050	122
Work Hoist Crane	28	0.0290	22
Work Electrical	91	5.2886	72
Testing And Commissioning	127	0.1076	101

B. Crash Cost Calculation

Addition to the cost of acceleration (crash cost) made on the crash program carried out at the direct cost (direct cost), which is done in addition to labor costs due to overtime. Indirect costs can be assumed to be the same as the budget plan (RAB) obtained. The wages for workers on the Kijing terminal construction project in Mempawah, West Kalimantan are as follows:

Salary per day (normal) = Rp140,000.00
Hourly salary (normal) = Rp. 17,500.00
Salary per day (1 hour crash) = Rp166,250.00
Salary per day (2 hour crash) `= Rp.201,250.00
Salary per day (3 hour crash) = Rp236,250.00

After calculating workers' salaries by adding overtime hours, we can find the total cost of manpower due to the addition of overtime hours with the following calculation: Total crash cost = Subcontract & material costs + total manpower wages. Here is a table of the results of the calculation of the crash cost for each activity on the critical path with each additional overtime hours.

Table 14, 15, and 16 show the crash cost calculation results for each activity on the critical path with each additional overtime.

C. Cost Slope Calculation

In accelerating using the time cost trade off method, it is necessary to find the lowest cost slope to find out the optimum overtime clock scheme. The following is a cost slope calculation performed on the acceleration of the critical path with the addition of overtime hours.

$$\textit{Cost slope} = \textit{(Crash Cost-Normal Cost) / (Normal Duration-Crash Duration)} \quad (3)$$

After calculating the cost slope for each scheme to add overtime hours, a cost slope of Rp 6,169,070 per day is obtained for the addition of 1hour overtime, Rp 6,822,825 per day for the addition of 2 hours overtime, and Rp 8,587,193 per day for addition of 3 hours overtime. So, the addition of 1 hour overtime is the most optimum scheme obtained in this study. A comparison can be seen in the table 17 and figure 7.

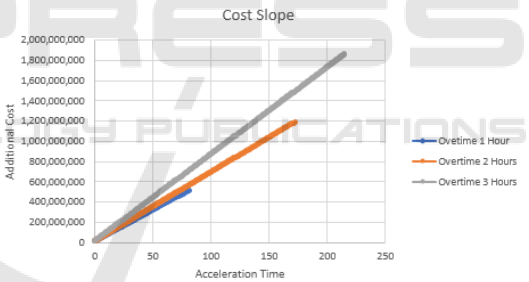

Figure 7: Cost Slope graph for each additional overtime hours.

5 CONCLUSION

From the results of the analysis of the acceleration of the duration of the Kijing sea terminal development project in Mempawah, West Kalimantan using the PDM method, Monte Carlo and the Time Cost Trade Off method, the following conclusions are obtained:

1. Activities that are on the critical path are activities that have a total float = 0. And activities that have a total float = 0 are as follows: Stake Out And Positioning (A3) - Landfill Work (E1) - Rigid Concrete Work (E2) - Rigid (F1) Work - Paving Block (F2) Work - Structure (G1) –
2. Supporting Buildings (G2) - Mechanical Work

(H1) - Plumbing Work (H2) - Hoist Crane Work (H3) - Electrical Work (H4) - Testing and Commissioning (H5).

3. The probability of the Kijing sea terminal development project in Mempawah, West Kalimantan being completed on time with a duration of 595 days based on the project contract is 55%, or the project has a 45% chance of being late. Based on the results of the Monte Carlo method, the Kijing sea terminal development project in Mempawah, West Kalimantan can be completed on time with a duration of 606 days.
4. The optimum duration and costs on the critical path are obtained by adding 1 hour of overtime. The total duration of the project which was originally 595 days to 513 days with a difference of 82 days, with a minimum total cost of Rp2,740,269,901,670 to Rp 2,740,775,765,420 with a difference of Rp505,863,750 and also The smallest cost slope of the other overtime hours scheme is IDR 6,169,070 per day.

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APPENDIX

Table 14: Crash Cost of One Hour Overtime.

Activity	Sub-cont&material cost	*Man power*	*Manpower* Total (*Crash*)	Total *Crash Cost*
	Rp		Rp	Rp
Stake out & Positioning	1.530.136.543	9	70.323.750	1.589.356.543
Work Dump Soil	113.740.278.706	21	432.915.000	114.104.838.706
Work Pile Rigid	55.470.865.509	5	23.275.000	55.490.465.509
Work Rigid	23.422.410.358	7	40.731.250	23.456.710.358
Work Paving Block	10.351.322.927	7	40.731.250	10.385.622.927
Structure	67.234.202.280	16	242.060.000	67.438.042.280
Work Building Support	71.329.576.849	18	377.055.000	71.647.096.849
Work Mechanical	13.691.583.759	26	665.665.000	14.252.143.759
Work Plumbing	7.797.263.200	26	665.665.000	8.357.823.200
Work Hoist Crane	775.078.271	5	23.275.000	794.678.271
Work Electrical	144.718.074.020	16	242.060.000	144.921.914.020
Testing And Commissioning	2.628.490.414	18	380.047.500	2.948.530.414

Table 15: Crash Cost of Two Hours Overtime.

Activity	Sub-cont&material cost	*Manpower*	*Manpower* Total (*Crash*)	Total *Crash Cost*
	Rp		Rp	Rp
Stake out & Positioning	1.530.136.543	9	85,128,750	1,615,265,293
Work Dump Soil	113.740.278.706	21	524,055,000	114,264,333,706
Work Pile Rigid	55.470.865.509	5	28,175,000	55,499,040,509
Work Rigid	23.422.410.358	7	49,306,250	23,471,716,608
Work Paving Block	10.351.322.927	7	49,306,250	10,400,629,177
Structure	67.234.202.280	16	293,020,000	67,527,222,280
Work Building Support	71.329.576.849	18	456,435,000	71,786,011,849
Work Mechanical	13.691.583.759	26	805,805,000	14,497,388,759
Work Plumbing	7.797.263.200	26	805,805,000	8,603,068,200
Work Hoist Crane	775.078.271	5	28,175,000	803,253,271
Work Electrical	144.718.074.020	16	293,020,000	145,011,094,020
Testing And Commissioning	2.628.490.414	18	460,057,500	3,088,547,914

Table 16: Crash Cost of Three Hours Overtime.

Activity	Sub-cont&material cost	*Manpower*	*Manpower Total (Crash)*	Total *Crash Cost*
	Rp		Rp	Rp
Stake out & Positioning	1.530.136.543	9	99,933,750	1,630,070,293
Work Dump Soil	113.740.278.706	21	615,195,000	114,355,473,706
Work Pile Rigid	55.470.865.509	5	33,075,000	55,503,940,509
Work Rigid	23.422.410.358	7	57,881,250	23,480,291,608
Work Paving Block	10.351.322.927	7	57,881,250	10,409,204,177
Structure	67.234.202.280	16	343,980,000	67,578,182,280
Work Building Support	71.329.576.849	18	535,815,000	71,865,391,849
Work Mechanical	13.691.583.759	26	945,945,000	14,637,528,759
Work Plumbing	7.797.263.200	26	945,945,000	8,743,208,200
Work Hoist Crane	775.078.271	5	33,075,000	808,153,271
Work Electrical	144.718.074.020	16	343,980,000	145,062,054,020
Testing And Commissioning	2.628.490.414	18	540,067,500	3,168,557,914

Table 17: Calculation of Cost Slope.

Activity	Sub-cont&material cost	*Manpower*	*Manpower* Total (*Crash*)	Total *Crash Cost*
	Rp		Rp	Rp
Stake out & Positioning	1.530.136.543	9	85,128,750	1,615,265,293
Work Dump Soil	113.740.278.706	21	524,055,000	114,264,333,706
Work Pile Rigid	55.470.865.509	5	28,175,000	55,499,040,509
Work Rigid	23.422.410.358	7	49,306,250	23,471,716,608
Work Paving Block	10.351.322.927	7	49,306,250	10,400,629,177
Structure	67.234.202.280	16	293,020,000	67,527,222,280
Work Building Support	71.329.576.849	18	456,435,000	71,786,011,849
Work Mechanical	13.691.583.759	26	805,805,000	14,497,388,759
Work Plumbing	7.797.263.200	26	805,805,000	8,603,068,200
Work Hoist Crane	775.078.271	5	28,175,000	803,253,271
Work Electrical	144.718.074.020	16	293,020,000	145,011,094,020
Testing And Commissioning	2.628.490.414	18	460,057,500	3,088,547,914