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## TIME AND COST ANALYSIS ON PROCUREMENT OF SUTET 275 Kv 2CCT QUADRUPLE ZEBRA GUMAWANG – GITET LAMPUNG 1 USING TIME COST TRADE OFF METHOD

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### ABSTRACT

Nowadays, the supply power of electricity in Indonesia has as rapid growth in demands. A serious effort of the government to fulfill this requirement through the PT. PLN (Persero) as Indonesia State Electricity Corporation is accomplish with an estafet procurement in built those structures and infrastructures. Lampung Province, as one of the regions which in a continuation to develop, requires the support of electric power, which at its peak load reaches 1200 MW, while the capacity of existing power plant can only produce 700 MW, therefore the construction of a 275 kV Gumawang-Lampung 1 SUTET interconnection network with a capacity of up to 2000 MW was established to meet these requirements. The typical critical path of tower transmission lines project is in at the foundation concrete curing, before the erection of the lattice tower.

Regarding that matter, here is the problem description in tower number 397, which is the erection of lattice tower already set in December 9<sup>th</sup> 2023, while after analyzed using mircrosoft project, the foundation concrete curing will be reaching in December 13<sup>th</sup> 2023, that is why an accelerate action is need in this situation. As a general information for all that these typical foundation is consist of four similar foundation types and non-connected with the tie beam, and it mean that we can use an accelerate act to achieve the foundation concrete curing in December 8<sup>th</sup> 2023. In this case the time cost trade off method is appropriate to analyze the problems, and the alternative is by adding group of workers and tools of any activities which place on the critical path.

Starting with the preparing a network diagram using the Microsoft Project software, followed by the crashing process by adding groups of workers and tools of any activity on the critical path. The next step is to calculate the crash cost and cost slope values using the time cost trade off (TCTO) method. From the results of the analysis carried out, it was found that the normal project duration was 42 days after the crashing process was carried out to 36 days, with a normal work cost of Rp. 1,774,462,352.84 and after the crashing process was carried out with the alternative of adding labor groups and equipment the cost became Rp. 1,849,762,666.92. It was concluded that with the time cost trade off method there was a reduction in duration and an increase in costs.

**Keywords:** **Keywords:** Time cost trade off, adding groups of workers and tools, tower SUTET 275 kV Gumawang-Lampung.

## **INTRODUCTION**

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The government's equal development program through PT. PLN (Persero) throughout the archipelago in an effort to meet electricity consumption needs continues in line with the demand for this energy supply from customers. The island of Sumatra also requires capacity expansion, apart from being a response to market demand, it is also a preparation for complete infrastructure to support regional development. Lampung, which continues to grow, requires the support of electric power, which at its peak load reaches 1200 MW, while the capacity of the existing power plant can only produce 700 MW, with additional flow support obtained from the interconnection network, so far it is still supplied via the SUTET 275 kV Gumawang-Lampung electricity network interconnection line. 1 with a capacity of up to 2000 MW. The construction of this short circuit will be located in 5 districts and pass through 13 sub-districts and 39 villages, namely: Mesuji Regency, 1 sub-district in 4 villages; West Tulang Bawang Regency, 5 sub-districts, in 13 villages; Tulang Bawang Regency, 1 sub-district in 1 village; Central Lampung Regency, 3 sub-districts, in 19 villages; Pesawaran Regency, 1 District, in 2 villages.

Many things can cause this delay are non-technical factors in the form of land acquisition by the project owner, changes in transmission routes, while other non-technical disturbances that often occur in the field are not mentioned in this research. This means that not all project delays are caused by contractors or consultants, in this case the management and users of electrification services also have an important role in supporting its smooth running. Meanwhile, technical factors at the project location vary, including the

presence of residential areas which limit the size of the tower foundation footprint, thus requiring negotiations for land acquisition, sometimes the tower plans are in valleys or mountains. The road to the location cannot be passed by heavy equipment, so the work is carried out using a manual drill, and casting using a manual molen/site mix. For each tower construction plan, a tower installation/erection schedule is also targeted which depends on achieving a concrete age of 28 days.

In this regard, the project need to conduct a cost and time analysis to simulate the acceleration of implementation using the method Time Cost Trade Off The following is the use of the Microsoft Project software program on tower number 397 which experienced a delay in the tower installation schedule because the concrete age was only reached on December 13 2023, while the tower installation schedule was December 9<sup>th</sup> 2023, so the concrete age to reach 98% compressive strength must be achieved on December 8<sup>th</sup> 2023.

## **PROBLEM DEFINITION**

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Based on the background before, as to simplify the analysis, given here the two problems to discuss ;

How many duration time to execute the project it will change earlier?.

How many budget cost will change in order to speed up the project.

## **RESEARCH OBJECTIVE**

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The intention of this research are ;To analyze the duration change within the project construction.

To analyze the additional cost that will need in acceleration stage.

## **RESEARCH BOUNDARIES AND SCOPES**

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This research is only discussing the cost and time analysis as an effort in acceleration the foundation work.

This research does not discuss about electromagnetic components.

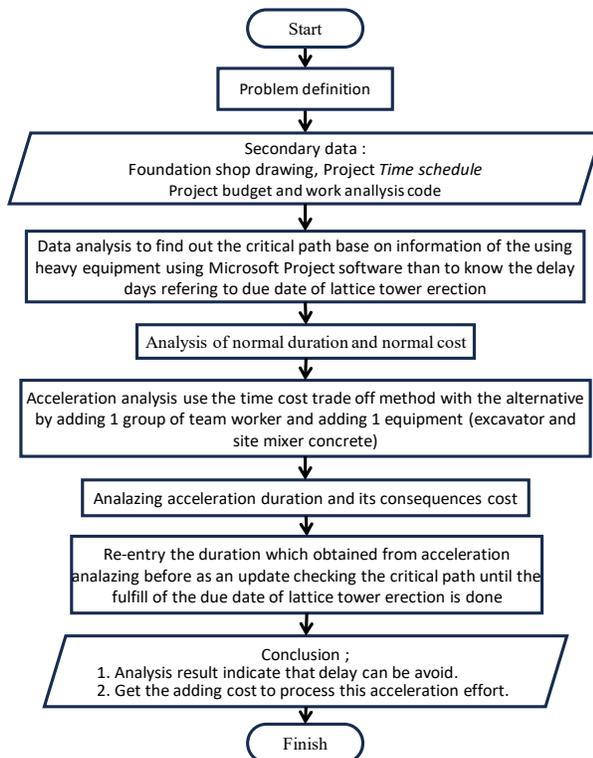
### DECISION VARIABLES AND ASSUMPTIONS

Microsoft Project is use to make easier analysis in finding the initial critical path.

And to modelling it, here is some series of data that need to calculate and give the result of the duration and initial cost refer to activities which is place along the critical path :

Shop drawing, Due date of the lattice tower erection. Project budget and list of those activities.

Below is the step of the research ;



### Normal duration

Normal duration calculation analysis is obtained from the work network diagram by taking into account the time required to complete all remaining work. Normal

duration of 1 type 2AA tower reinforced concrete foundation Quadruple Zebra+3, no. 397 does not include the tower steel structure installation and all cables including accessories.

### Normal cost

Calculation of normal costs is the multiplication of the labor used for the type of work being analyzed and the work tools, all of which are calculated based on the Guidelines for Analysis of Unit Prices for Public Works, Minister of Public Works Code No. 11/PRT/M/2013.

### STANDARD CODE AND FORMULA USED

Overall analysis wheter in normal duration or in crah duration are basically base on Minister for Public Works Code with the I.D No. 11/PRT/M/2013.

Below is some example uses of this code in normal duration.

### Soil excavation

Soil excavation with an excavator.

→ Ref. No. 11/PRT/M/2013, 2.1 Menggali dengan Excavator dan material atau hasil galian dimuat ke DT, page 206.

No.	Item	Unit	Coef.	Unit price
Labour salary				
1	Untrained labor	Hr	0.0414	85,000.00
2	Foreman	Hr	0.0041	150,000.00
Equip. ren				
1	Excavator	Hr	0.0231	168,000.00

In that table the coef. of excavator is 0.0231, and base on standard code is 0,04141, you can modify it with an analysis bucket capacity that used on site first, the result is the value of excavator productivity per/day than a new coef. is with the division of 1/excavator productivity per/day.

*calculating duration and costs by labor salary ;*

Production per day =

$$\frac{1}{(0.0414+0.0041)} \times 7 \times 2 = 43.956 \text{ m}^3/\text{day}$$

$$\text{Duration} = \frac{664.372/4}{43.956} = 3.779 \approx 4 \text{ days}$$

Salary =

$$664.372/4 \times (0.0414 \times 85,000 + 0.0041 \times 150,000) \times 7 \times 4 = \text{Rp. } 19,225,596.94$$

*Calculating duration and costs by equip. rent ;*

→ Ref. No. 11/PRT/M/2013, 6.2.2.3.2

Pekerjaan Mekanis, sub point 3, page 67.

$V$  is bucket capacity = 1.50 m<sup>3</sup>

$F_b$  is bucket factor = 1

$F_a$  is the tool efficiency factor = 0.83

$F_k$  is a factor in soil development

$\frac{\gamma_{\text{sat}}}{\gamma_d}$  → taken 1.1 → from soil test lab.

$T_1$  is the time for digging, loading, etc. = 7 minutes

$T_2$  is turning & swing back and others = 4 minutes

$T_s$  is the cycle time = 7 + 4 = 11 minutes

60 is the multiplication of 1 hour to minutes

So the production capacity is 1 excavator per day =

$$Q = \frac{1.50 \times 1 \times 0.83 \times 60}{11 \times 1.1} = 6.17 \text{ m}^3/\text{hr}$$

Production per day = 6.17 × 7 = 43.215 m<sup>3</sup>/day

★ 7 = working hours per a day

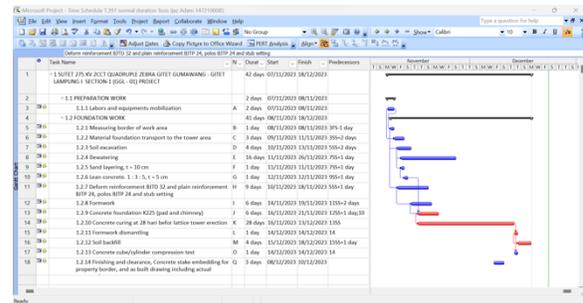
$$\text{Duration} = \frac{664.372/4}{43.215} = 3.843 \approx 4 \text{ day}$$

equip. rent =

$$664.372/4 \times (0.0231 \times 168,000) \times 7 \times 4 = \text{Rp. } 18,079,456.51$$

It will similar way when doing in acceleration duration, just multiply it by 2 times, since the alternative are with the additional 1 group of workers and 1 tool.

Here is the critical path in normal duration ;



The critical path start on concrete work until the curing time. Since the foundation have a four similar types, than it can be speed up/accelerated with working on 2 foundations/leg parallely.

### Calculating crash duration and crash cost

In calculating crash costs, data on work volume, man power or tool coefficient, effective working hours, unit price of labor, materials, equip. rent are required.

Calculation of the acceleration duration is by dividing the volume by the total productivity after crashing to obtain the formula:

Crash duration =

normal duration - duration after crashed

The following is an example of calculating normal costs for activities that are included in the critical path. The acceleration alternative is to add 1 group of workers and add 1 tool each, both for excavators and manual mills. The following is an example of a crashing calculation for earth excavation work ;

### Soil excavation

*calculating duration and costs by labor salary ;*

Production per day => addition of 1 labor group

$$\frac{1}{(0.0414+0.0041)} \times 7 \times 2 \times 2 = 87.912 \text{ m}^3/\text{day}$$

$$\text{Duration} = \frac{664.372/4}{87.912} = 1.889 \approx 2 \text{ days}$$

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$$\text{Salary} = 664.372/4 \times (0.0414 \times 85,000 + 0.0041 \times 15 \times 7 \times 2 = \text{Rp. } 19,225,596.94$$

Calculating duration and costs by equip. rent;

The excavator tool is added by 1 unit with the same bucket capacity

$$\text{Production cap. per/hr, Q} = \left[ \frac{1.50 \times 1 \times 0.83 \times 60}{11 \times 1.1} \right] \times 2 = 12.347 \text{ m}^3/\text{hr}$$

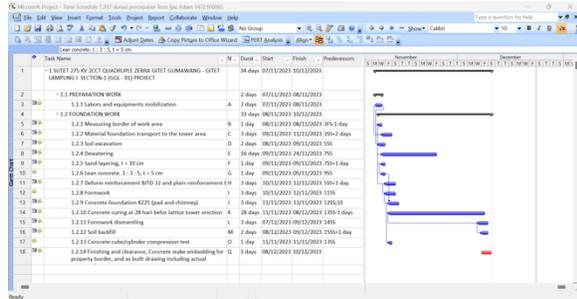
The production formula per day with the addition of 1 tool is as follows;

$$\text{Production per day} = 12.347 \times 7 = 86.430 \text{ m}^3/\text{day}$$

$$\text{Duration} = \frac{664.372/4}{86.430} = 1.922 \approx 2 \text{ day}$$

$$\text{equip. rent} = 664.372/4 \times (0.0231 \times 168,000) \times 7 \times 2 \times 2 = \text{Rp. } 18,079,456.51$$

Here is the critical path in crash duration/accelerated;



The critical path left one, and that is a finishing, end clearing etc, that has no influence with the major activities.

**Calculating cost slope**

Cost slope is a comparison between the increase in costs and the acceleration of project completion time which is calculated from the results of the reduction between crash costs and normal project costs and then divided by the results of the reduction between normal duration and crash duration).

The formula is as follows;

$$\text{Cost slope} = \frac{\text{crash cost} - \text{normal cost}}{\text{normal duration} - \text{crash duration}}$$

The form of the graph is a straight line that has a certain slope.

As an example of cost slope calculations used for earth excavation activities, here are the calculations;

$$\text{Cost slope galian tanah} = \frac{38,451,193.87 - 19,225,596.94}{3.84 - 1.92} = 10,004,416.66$$

Here is the summary result of calculation during normal duration and crash duration ;

Item	Normal cost		
	Salary	Rent equip	Material
Soil excavation	19,225,596.94	18,079,456.51	0.00
Sand layering, t = 10 cm	88,360.00	0.00	397,620.00
Lean concrete 1 : 3 : 5, t = 5 cm	173,130.38	0.00	801,624.42
Deform reinforcement BJTD 32 and plain reinforcement BJTP 24, polos BJTP 24 and stub setting	11,728,752.70	0.00	18,889,464.88
Formwork	12,683,490.00	0.00	1,991,575.90
Concrete foundation K225 (pad and chimney)	12,751,956.00	777,646.30	8,188,631.68
Formwork dismantling	101,600.00	0.00	0.00
Soil backfill	17,586,895.87	16,538,447.16	0.00

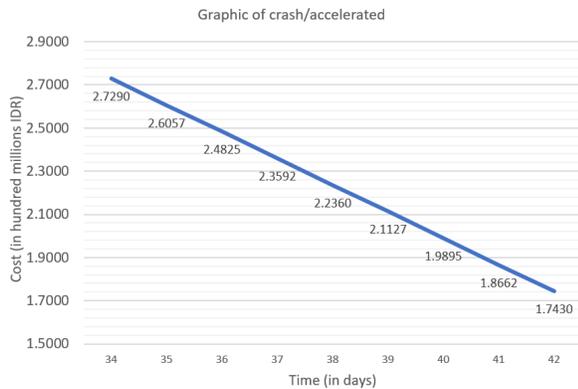
Item	Crash cost		
	Salary	Rent equip	Material
Soil excavation	38,451,193.87	36,158,913.03	0.00
Sand layering, t = 10 cm	176,720.00	0.00	397,620.00
Lean concrete 1 : 3 : 5, t = 5 cm	346,260.75	0.00	801,624.42
Deform reinforcement BJTD 32 and plain reinforcement BJTP 24, polos BJTP 24 and stub setting	23,457,505.41	0.00	18,889,464.88
Formwork	25,366,980.00	0.00	1,991,575.90
Concrete foundation K225 (pad and chimney)	25,503,912.00	1,555,292.60	8,188,631.68
Formwork dismantling	203,200.00	0.00	0.00
Soil backfill	35,173,791.74	33,076,894.33	0.00

Item	Normal duration	Crash duration	Cost slope
Soil excavation	3.84	1.92	10,004,416.66
Sand layering, t = 10 cm	0.49	0.24	363,636.36
Lean concrete 1 : 3 : 5, t = 5 cm	0.47	0.23	740,259.74
Deform reinforcement BJTD 32 and plain reinforcement BJTP 24, polos BJTP 24 and stub setting	4.53	2.26	5,181,818.18
Formwork	5.62	2.81	4,513,898.31
Concrete foundation K225 (pad and chimney)	5.74	2.87	4,441,926.35
Formwork dismantling	0.56	0.28	363,636.36
Soil backfill	3.52	1.76	10,004,416.66

**Cost slope graph**

Correlation between time analysis and costs on normal duration and crash/accelerated duration is displayed in the following linear graph form ;



**Figure 1. Crash/accelerated graph using Microsoft Excel**

## RESULT OF ANALYSIS

Alternative acceleration by adding 1 group of labor and 1 tool results in an acceleration of 9 days, where in the normal duration the concrete reaches 28 days of age on December 13 2023, after crashing the concrete reaches 28 days of age on December 8 2023. So the schedule installing SUTET tower latitice is fulfilled.

## CONCLUSION

Based on the analysis results, the initial duration of foundation work was 42 days, a time acceleration of 9 was obtained so that the days became 34 days. Concrete curing was achieved on December 8, 2023 as planned.

Initial costs for workers' salary and equip. rent Rp. 109,735,331.86, after the crash the cost increased to Rp. 219,470,663.73. Initial total cost budget plan Rp. 1,620,555,230.42 and after acceleration it increased to Rp. 1,730,290,562.28 equivalent to 6.77%.

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