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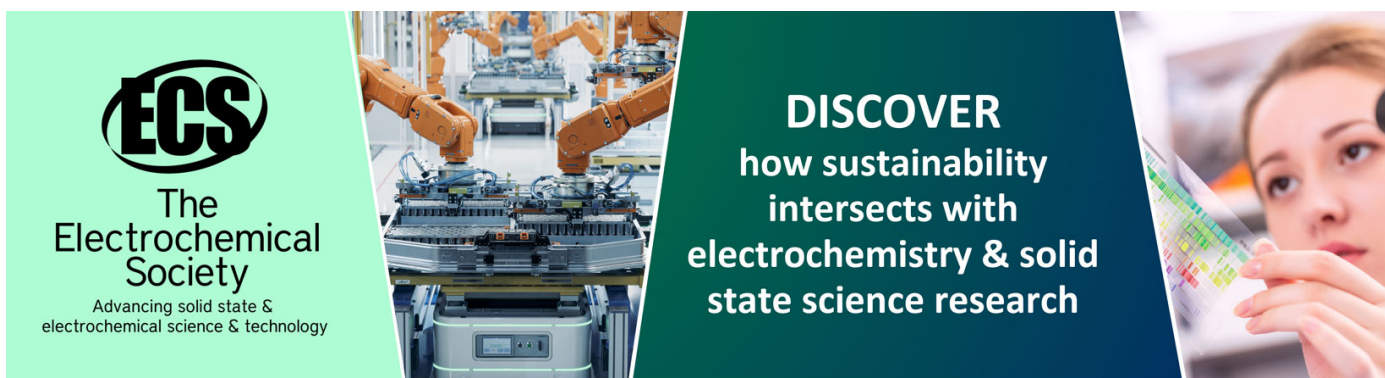
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Project Acceleration of Outside Plant-Fiber Optic (OSP-FO) Project in PT. XYZ Using Time Cost Trade Off (TCTO) Method by Adding Overtime Hours

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Abstract. Various things can occur in the implementation of a construction project that could lead an increase implementation time so that the completion of the project tends to be delayed or not according to plan. The OSP-FO Project was chosen as a case study because of the 3rd license party is not released yet from 5th July 2018 until entered May, 2019. The project is not having production work for more than 6 weeks and the status of the project is become on hold project. Therefore, it is necessary to renew the schedule and accelerate the project when the license is release. Time Cost Trade Off (TCTO) method is a schedule compression to get a project that is more profitable in terms of time (duration), cost, and income. The goal is to compress projects with acceptable duration and minimize the total cost of the project by selecting critical activities with adding optimum working hours for 3 hours per day. From the results of the analysis, the optimum cost is Rp. 22,397,932,645,- and the optimum duration is 292 days, so that the cost efficiency is Rp. 91,596,790 or 0,0041% and the time efficiency is 78 days or 0.2110%.

Keywords: Project Schedule Management, Acceleration, Microsoft Project, Crashing, Critical Path Method, Time Cost Trade Off.

1. Introduction

In practice, the implementation of construction projects in the field has various possibilities causing delays, such as design changes, weather influences, material supply delays, and inappropriate or less specific planning[3]. Besides the project can be said late, the project can also experience on hold. If there has been no production work on a project for more than 6 weeks, the project is officially "on hold"[5]. Besides that, the project can also be said to be on hold if there is a lack of signature with 3rd party on purchase, license, scope of work, or legal document, a bug or issue resolution from a vendor or 3rd party, etc. happen. If the problem occurs, then the contractor as the executor in the field must deftly provide a solution to the delay in the project, for example by accelerating. Acceleration can be done not only to overcome the problem of delay, if the project has no production work more than 6 weeks or usually named the on hold project, the contractor can create a new schedule and accelerate the critical activities that will occur if the project starts later.



In PT. XYZ they have a website to know the information of the project, such as the development of the schedule, official report, and other information about the project or they named it web service on project management office based. The website is called SMILE (Supply Management Information of Logistic Enhancement). The appearance of the website can be seen according to the picture below.

Activity	Total Durasi (Pekerja)	Lag	Actual		Forecast SMILE	
			A-Start	A-Finish	F-Start	F-Finish
1. Preparing	20	5	01/07/2018	05/07/2018	01/07/2018	05/07/2018
[006] 1.1. Kick Off Meeting/Rapat Koordinasi	5	1	01/07/2018	01/07/2018	01/07/2018	01/07/2018
[011] 1.2. Survey	10	2	02/07/2018	03/07/2018	02/07/2018	03/07/2018
[012] 1.3. DRM (Approval Design)	5	2	04/07/2018	05/07/2018	04/07/2018	05/07/2018
2. Material Delivery	30		01/07/2018		01/07/2018	15/05/2019
[006] 2.1. Pemasangan Pipa ke-3	4		01/07/2018		01/07/2018	13/05/2019
[015] 2.2. SITAC (ODC)	4		01/07/2018		01/07/2018	06/05/2019
[016] 2.3. Delivery Material HDPE/Subduct	3		01/07/2018		01/07/2018	11/05/2019
[017] 2.4. Delivery Material Sipil (HH/MH/Pondasi)	3	129	01/07/2018	06/11/2018	01/07/2018	06/11/2018
[018] 2.5. Delivery Material FO	4		01/07/2018		01/07/2018	12/05/2019
[019] 2.6. Delivery Material ODC	3		01/07/2018		01/07/2018	08/05/2019
[025] 2.7. Delivery Material Tiang	3		01/07/2018		01/07/2018	06/05/2019
[026] 2.8. Delivery Material GGP	3		01/07/2018		01/07/2018	11/05/2019
[030] 2.9. Delivery Material Aksesoris	3		01/07/2018		01/07/2018	15/05/2019
3. Instalasi & Test Comm	40				16/05/2019	04/06/2019
[010] 3.1. Pekerjaan Galan (Trenching/Rodding/Crossing/Boring)	3				16/05/2019	25/05/2019
[021] 3.2. Pekerjaan Sipil (HH/MH/Bridge/Pondasi)	4				16/05/2019	26/05/2019
[022] 3.3. Pekerjaan Duct/Subduct/HDPE	5				16/05/2019	22/05/2019
[023] 3.4. Pemasangan FO	3				16/05/2019	04/06/2019
[024] 3.5. Pemasangan ODC	4				16/05/2019	28/05/2019
[025] 3.6. Pemasangan Tiang	4				16/05/2019	03/06/2019
[026] 3.7. Pemasangan GGP	4				16/05/2019	23/05/2019
[027] 3.8. Instalasi/Terminasi	4				16/05/2019	20/05/2019
[028] 3.9. Commissioning Test	5				16/05/2019	25/05/2019
4. Closing	10				05/06/2019	25/06/2019
[005] 4.1. Pelaksanaan UT	5				05/06/2019	11/06/2019
[007] 4.2. Pemasangan BAST-1	5				12/06/2019	25/06/2019

Figure 1. Actual Schedule on website SMILE of OSP-FO Project

Based on Figure 1, it can be seen the actual schedule on website SMILE of OSP-FO Project. The last activity in this project is on 6th November, 2018, the name of the activity is civil material delivery (HH/MH/Foundation), and the other activity that have been done are kick off meeting, survey, and DRM (Design Review Meeting). The last activity on the project makes the status of the project become on hold because there is no production work for more than 6 weeks. This happened because the 3rd license party from city service is not released yet, but there is a material that has been ordered and has arrived at the project location. Then, PT. XYZ moved that material to another OSP-FO Project. So, PT. XYZ has made a Forecast SMILE to forecast the schedule the date if the 3rd license is release.

Therefore, it is necessary to make a new schedule and accelerate the project. In planning construction projects, optimized time and costs are very important to be known[4]. One of alternative form of optimization for overcome time delay the project that can be done is make additional working hours. With limited resources, then the alternative commonly used to support the acceleration of activities is by increasing working hours, so that affect the total cost of the project. To find out this needs to be learned about the existing network, and the relationship between time and cost, this referred to as the Time Cost Trade Off Analysis[2].

The purpose of this method is to accelerate the time of project implementation and analyze the extent to which time can be shortened by adding minimum costs to activities that can accelerate the implementation period so that the maximum acceleration can be known and the minimum costs. TCTO method provides an alternative to the project planner to be able to arrange the best planning so that efforts to optimize the time and cost of completing a project can be done. With the minimum cost increment, the overall project cost due to the acceleration of the settlement can be controlled so that the owner and the implementing contractor can get their own benefits. Based on these considerations, in this final project the author believes this is the right method to solve OSP-FO Project in PT. XYZ and will be discusses in this final project.

2. Literature Review

2.1. Accelerate Project Method

Accelerate the project completion time means making an effort to complete a construction project with a duration that is faster than a predetermined schedule. In this paper, the alternative that is used in

accelerating the project is the addition of working hours. According to the Decree of the Minister of Manpower and Transmigration Number KEP.102 / MEN / VI / 2004, the wages of workers for overtime are 1.5 times an hour's wages for the first 1 hour overtime and 2 times an hour's wages for the next hours of overtime.

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

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

$$\text{Daily Productivity after Crash} = (\text{working hours per day} \times \text{productivity per hour}) + (a \times b \times \text{Productivity per hour})$$

*Where: a = length of overtime, b = coefficient of decline in productivity due to additional working hours (overtime).

Table 1. Productivity Decline Coefficient

Overtime Hours	Index Decrease Productivity	Work Performance (%)
1 hour	0.1	90
2 hours	0.2	80
3 hours	0.3	70

$$\text{Crash Duration} = \frac{\text{volume}}{\text{daily productivity after crash}}$$

2.2 Crash Cost and Crash Slope

Crash cost is the cost used to carry out project activities within a period of the duration of the crash. The amount of the crash cost can be calculated using equations below.

$$\text{Total Overtime Wage Costs} = \text{number of workers} \times (3 \text{ hours} \times \text{crashing}) \times \text{overtime / days fees}$$

$$\text{Crash Cost} = \text{normal direct costs} + \text{total overtime wages}$$

Cost slope is an additional direct cost per unit time. The cost slope formula is written in equation below.

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

2.3 Analysis of Time Cost Trade Off (TCTO)

TCTO is a schedule compression to get a project that is more profitable in terms of time (duration), cost, and income, the goal is to compress projects with acceptable duration and minimize the total cost of the project. Specified also the procedure shortens the time begin with calculate project completion time. After that, determine the accelerated costs of each activity. Then, Calculate each cost slope component of activities. After that, Shorten the period of activity, starting from critical activities that have the lowest cost slope, continuing to shorten the activity time until the project point is shortened. Then, tabulate costs versus time. Add direct costs and indirect cost to look for total costs before the desired time period which has the lowest cost slope combination.

3. Research Methodology

Figure below show the conceptual model to calculate TCTO that used in this paper.

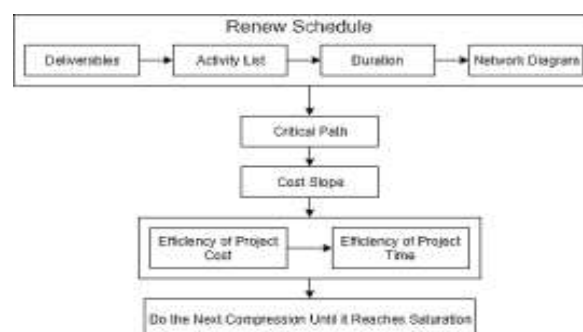


Figure 2. Conceptual Model

Based on Figure 2 shows that the first thing to do this final project is to make a new schedule for the project. Then, calculate the data to define the network diagram. After network diagram created, critical path is defined. Then, analyse the critical path using TCTO method to know find the optimum time and cost for the project. In calculating TCTO stage, the author have to measure the cost slope of each critical activity that appear in the project. After that, calculate the efficiency of the time and cost to know the differences between the normal stage and the compression stage using TCTO method. Last but not least, do this stage until this reaches the saturation or until find the minimum cost with compatible duration.

4. Analysis and Discussion

4.1 Project Schedule

In calculating the duration of the project it is calculated are normal working hours are 8 hours / day and within 1 week is used 7 working days. The normal duration of this project is 304 days. Those are the critical paths in OSP-FO helped by Microsoft Project 2013 are first Procurement of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long, second Procurement of ODP Type Closure Aerial Cap 16 Cores Following Contract Ace 2 Passive Contract (1:8), SC Adapters, and Labelling, third Installation of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long, fourth Single Mode Optical Cable Connection Cap 1 Core by Fusion Splice, fifth Electric Test, sixth Acceptance Test (*Uji Terima*), last Minutes of Handover (BAST).

4.2 Budget Plan

The grand total budget plan for OSP-FO Project is Rp. 22.048.558.269,- with details Rp. 19.843.702.442,- is the total of the budget plan and Rp. 2.204.855.827,- is the value added tax (10%).

4.3 Direct Cost and Indirect Cost

The direct cost for this project is Rp. 19.843.702.442,-. The amount of indirect cost for this project is Rp. 2.645.826.992,-.

4.4 Accelerate Alternative

The assumptions used in the acceleration process of this project are first, normal working hours are 08.00 - 12.00 and then rest for 1 hour and continue at 13.00 - 17.00, so that the effective working hours are 8 hours. Second, the optimum overtime working hours calculated are 3 hours, according to the regulation of the Minister of Manpower and Transmigration Decree Number KEP.102 / MEN / VI / 2004 that the maximum overtime working hours in 1 day is 3 hours. Third, Based on the Decree of the Minister of Manpower and Transmigration Number KEP.102 / MEN / VI / 2004 the price of overtime wages is calculated to be 1.5 times the normal wage for the first hour and for the next working hour is 2 times the normal wage. And the last one is employee productivity due to overtime hours is calculated at 75% of normal productivity.

4.5 Crash Duration

Crash duration is the time needed to complete work after additional working hours (overtime) are carried out. Below is the example of crash duration calculation on Procurement of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long:

Volume: 88 pcs ; Normal Duration: 304 days

Daily Productivity = $88/304 = 0.289$ meters/day; Productivity/hour = $0.289 / 8 = 0.036$ meters/day/hour;

Daily productivity after crash = $0.289 + (3 \text{ hours} \times 0.036 \times 75\%) = 0.37$ meters/day; Crash Duration = $88/0.37 = 237,83 \approx 238$

4.6 Crash Cost

Crash costs are expended after acceleration which is the total direct cost for completing work with the shortest period of time. The down below is the example of crash cost for Procurement of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long for Site Manager:

Overtime expense = Rp. 15.000,- x 1.5 = Rp. 22.500,-

Overtime Cost = $1 \times \text{Rp. 22.500,-} + (2 \times 2 \times \text{Rp. 22.500,-}) = \text{Rp. 112.500,-}$

Crash Cost per day = $(8 \times \text{Rp. 15.000,-}) + (3 \times \text{Rp. 112.500,-}) = \text{Rp. 475.500,-}$

4.7 Cost Slope

Cost slope is an increase in direct costs to accelerate an activity per unit time. The calculation of cost slope for OSP-FO Project is can be seen in the formula below.

$$= \frac{\text{Rp.26.429.524} - \text{Rp.24.994.024}}{304 - 238} = \text{Rp. 21.750,-/day}$$

4.8 Analysis of Time Cost Trade Off (TCTO)

Normal Stage:

Normal Duration = 370 days; Indirect Cost = Rp. 2.645.826.992,-; Direct Cost = Rp. 19.843.702.442,-; Total Cost = Rp. 22.489.529.434,-

Compression Stage 1 for Crashing for Procurement of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long:

Cost Slope/day = Rp. 21.750,- / day ; Normal Duration = 304 days ; Crash Duration = 238 days ; Total Crash = 66 days ; Total Project Duration = 238 days

Additional Cost = Rp. 21.750,- / day x 66 days = Rp. 1.435.500,-

Direct Cost = Rp. 19.843.702.442,- + Rp. 1.435.500,- = Rp. 19.845.137.942,-

Indirect Cost = (Rp. 1.191.814,- x 304 days) + Rp. 2.645.826.992,- = Rp. 2.567.167.271,-

Total Cost = Rp. 19.845.137.942,- + Rp. 2.567.167.271,- = Rp. 22.489.529.434,-

Table 2. Recapitulation of Direct Cost, Indirect Cost, and Total Cost Calculation

No.	Compression Stage	Crash Activity	Project			
			Total Duration (Day)	Direct Cost (Rp)	Indirect Cost (Rp)	Total Cost (Rp)
1	Normal Stage		370	19,843,702,442	2,645,826,992	22,489,529,434
2	Stage 1	Procurement of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long	304	19,845,137,942	2,567,167,271	22,412,305,213
3	Stage 2	Procurement of ODP Type Closure Aerial Cap 16 Cores	300	19,845,155,931	2,562,459,016	22,407,614,946
		Following Contract Ace 2 Passive Contract (1:8), SC Adapters, and Labeling				
4	Stage 3	Installation of Riser Pipe for Optical Cable Safety to ODC Pole/KU Rise Point 2 Inch Diameter 3 Meters Long	299	19,845,137,942	2,560,724,395	22,405,862,337
5	Stage 4	Single Mode Optical Cable Connection Kap 1 Core by Fusion Splice	298	19,845,137,942	2,559,733,184	22,404,871,126
6	Stage 5	Electric Test	296	19,845,137,942	2,557,502,958	22,402,640,900
7	Stage 6	Acceptance Test	295	19,845,137,942	2,556,016,140	22,401,154,082
8	Stage 7	Minutes of Handover (BAST)	292	19,845,137,942	2,552,794,703	22,397,932,645

4.9 Cost and Project Time Efficiency

The percentage of project cost and time efficiency can be calculated as follows:

1. Efficiency Project Cost

= Rp. 22.489.529.434,- – Rp. 22.397.932.645,- = Rp. 91.596.790,-

Or = (Rp. 22.489.529.434,- – Rp. 22.397.932.645,-) / (Rp. 22.489.529.434,-) x 100% = 0.0041 %

2. Efficiency Project Time

= 370 – 292 = 78 days Or = (370-292) / 292 x 100% = 0.2110 %

5. Conclusion

Furthermore, with the result of the calculation that total duration of the project is accelerated 78 days and decreasing Rp. 91,596,790,-, the project got the minimum cost to accelerate the duration, so it will affect to the project completion with a significant benefit to the company.

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