Optimization of Orifice Metering Station Construction with Time Cost Trade Off Methods

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Abstract. Delay is a common problem in project. In case of building project, the delay in project completion means that the user has to pay penalty corresponding to contractual agreement with the host. The construction of the Seberida Metering Station Engineering Procurement Construction & Commissioning (EPCC) project has been delayed. Based on the project's physical progress scheduling report. The user demanded by the host to complete the project on time. One solution that can be done to overcome the project delay is to accelerate. However, the acceleration of the duration must be carefully calculated so that the project can be completed on time and the additional costs incurred as a consequence of reducing the duration do not swell. This Research uses the Time Cost Trade Off (TCTO) method as a solution to overcome delays, namely the method of scheduling projects by exchanging time and costs. From the results of the analysis with the Time Cost Trade Off method, it was found that the construction of the Metering Station was accelerated for 50 days, from the total duration of the project which normally takes 180 days to 130 days with an additional cost of $ 80,047.01.

Keywords: Optimization, scheduling, Time Cost Trade Off

1. Preliminary

In development, the delay in the completion of a development project means that the user must pay a penalty (penalty) for delay in accordance with the contract agreement with the host whose number is not small. In addition, the delay in the project also results in a decrease in the trust of the host to cooperate again with the user in the future, especially if the host is a government agency. For this reason, it is necessary to have a planning and scheduling for development so that it is received with the host on time. One solution that can be done to overcome the project delay is to accelerate. However, acceleration should not be done haphazardly. By making an acceleration, the project implementation costs will increase. Therefore, acceleration must be calculated carefully so that the project duration is on time and the costs incurred are not inflated. In addition, quality standards must still be considered to maintain good quality.

2. Research Methodology

The topic in this study was to analyze the timing of the implementation of the Seberida Orifice Metering Station EPCC project by using the Time Cost Trade Off method. Based on the project activities, it can be identified that there is a problem in scheduling the construction of the Orifice Metering Station which
must be resolved by optimizing the planned time and cost because the time spent is very large and the length of work done is not short. Therefore the purpose of this study is to optimize the schedule of activities and the estimated time of the project by exchanging time and costs.

2.1 Identification of Problems
Judging from the purpose of the study, this type of research is evaluation research. This study is intended to predict what will or is happening based on the results of an analysis of the current situation. The limitation of this research is that it is only reviewed from the financial and project schedule that was carried out in the period of 2016-2017 with variables that were analyzed by the project finance and project schedule in the planning and actual in the field

2.2. Data Retrieval Procedure
The steps involved in collecting this data are as follows:
- Identifying ongoing projects
- Determine the variables and parameters that play a role in project implementation
- Collecting relevant and detailed data based on the specified variables and parameters.

![Figure 1. Flowchart Penelitian.](image)

Data collected consists of:
- Primary Data is data that is processed directly from its data source by conducting interviews with the relevant companies in the Project Management Office Department of data collection conducted in the interview is about the existing time schedule problems and solutions to existing problems.
- Secondary data is data collected, processed, and presented by other parties. In this study, secondary data is taken from the Work Request Form and project planning schedule and the actual EPCC Seberida Orifice Metering Station project.

3. Data Analysis and Discussion
From the results of this study produce sequences of data that are interrelated with each other, including CPM, PERT, Matrix of Consequences of Delay, Crashing. The following is an analysis of the research.

3.1 CPM
Based on data processing above, then get results like below
Table 1. Recapitulation of Critical Activities.

| Task Name                              | Duration |
|----------------------------------------|----------|
| Entire the project                     | 180 days |
| A. Engineering                         | 29 days  |
| Data Sheet, BOM, Sizing & drawing preparation | 7 days   |
| Customer approval                      | 5 days   |
| B. Procurement                         | 125 days |
| B.1 Order and Processing               | 125 days |
| B.1.1 Ordering Main Equipment          | 5 days   |
| FILTER SEPARATOR                       | 5 days   |
| VALVES (PSDV, VALVE 6", VALVE 4")     | 5 days   |
| UPS                                    | 5 days   |
| GENSET                                 | 5 days   |
| B.1.2 Delivery Equipment               | 123 days |
| Delivery of Filter Separator           | 120 days |
| Delivery for Valves                    | 120 days |
| Delivery for UPS                       | 120 days |
| Delivery for Transmitter               | 120 days |
| Delivery Genset                        | 120 days |
| C. Construction                        | 130 days |
| C.1 Skid Fabrication                  | 125 days |
| Assembly                               | 5 days   |
| D. Test Commissioning                  | 79 days  |
| 1. FAT                                 | 53 days  |
| Metering Skid                          | 3 days   |
| 3. SAT & COMMISSIONING                 | 26 days  |
| 3.1 Delivery To Site                   | 5 days   |
| 3.2 Installasi                         | 10 days  |
| 3.3 Internal Test                      | 7 days   |
| 3.4 SAT & Commissioning                | 4 days   |
| E. Documentation                       | 5 days   |
| Final Document                         | 5 days   |
| F. Training                            | 3 days   |
| Training Metering                      | 3 days   |

3.2. PERT

Based on the data processing above, we get a percentage of the normal duration as below.

Table 2. PERT Normal Duration.

| Task ID | Task Name                          | Optimistic (a) |
|---------|------------------------------------|----------------|
|         |                                    | Most Likely (m) | Pesimistic (b) | Expected Duration (A+2m+b)/6 (te) | Variance ((b-a)/6)^2 (v) |
| 2       | Kick Off Meeting                   | 1              | 1              | 1                                    | 0                  |
| 4       | Finalization on P & ID and process parameter | 4              | 5              | 7                                    | 5,2                | 0,25               |
| 5       | Data sheet, BOM, Sizing & drawing preparation | 1              | 2              | 3                                    | 2                  | 0,11111            |
If seen from table z, it can be concluded that the estimated success rate of the project is 77.94% * (Source table z: Wapolle, Statistics)

So it can be concluded that if using a scheduling that has been made by the PMO or Normal Duration then there is a possibility of a delay of 22.08% of 180 contract days so that the EPCC process is likely to be completed up to 220 days if there is a delay in activities that are in a critical trajectory.

After being crashed using the Time Cost Trade Off method it will produce a percentage change as below.

### Table 3. PERT Crashing.

| Task ID | Task Name                                      | Optimistic (a) | Most Likely (m) | Pessimistic (b) | Expected Duration (A+2m+b) /6te | Variance ((b-a)/6)^2 (v) |
|---------|-----------------------------------------------|----------------|-----------------|-----------------|---------------------------------|--------------------------|
| 2       | Kick Off Meeting                              | 1              | 1               | 1               | 1                               | 0                        |
| 4       | Finalization on P & ID and process parameter  | 4              | 5               | 7               | 5.17                            | 0.25                     |
| 5       | Data sheet, BOM, Sizing & drawing preparation | 1              | 2               | 3               | 2                               | 0.1111                  |
| 8       | Customer Approval                             | 3              | 3               | 5               | 3.33                            | 0.1111                  |
| 16      | Valves                                        | 4              | 5               | 6               | 5                               | 0.1111                  |
| 22      | Delivery of Valves                            | 50             | 70              | 70              | 66.67                           | 11.1111                 |
| 45      | Assembly                                      | 4              | 5               | 6               | 5                               | 0.1111                  |
| 91      | Matering Skid                                 | 2              | 3               | 3               | 2.8                             | 0.02778                 |
| 94      | Delivery to Site                              | 4              | 5               | 7               | 5.2                             | 0.25                    |
| 95      | Installasi                                    | 9              | 10              | 12              | 10.2                            | 0.25                    |
| 96      | Internal Test                                 | 6              | 7               | 8               | 8                               | 0.1111                  |
| 98      | SAT & Commissioning                           | 4              | 4               | 4               | 4                               | 0                       |
| 100     | Final Document                                | 5              | 5               | 5               | 5                               | 0                       |
| 101     | Training Matering                             | 3              | 3               | 3               | 3                               | 0                       |
|         | **Total Te**                                  | **124.33**     |                 |                 |                                 |                          |

If seen from table z, it can be concluded that the estimated success rate of the project is 82.89% * (Source table z: Wapolle, Statistics) Work on the EPCC which is targeted to be completed within 180 days can experience a delay of up to 220 working days. After going through a Time Cost Trade Off analysis, the duration of project work that can reach 180 days can be accelerated to 130 days, with the duration of project work after accelerating 50 days.

3.3. **Risk Analysis**

Based on data processing above, then get results like below
### Table 4. Risk Analysis.

| Task Name            | Risk Management          | Response                                                                 |
|----------------------|--------------------------|---------------------------------------------------------------------------|
| **Delivery Equipment** |                          |                                                                           |
| Delivery of Filter Separator | Reducing the possibility | Changed the method of shipping equipment from ocean freight to air freight |
| Delivery for Valves  | Reducing the possibility | Changed the method of shipping equipment from ocean freight to air freight |
| Delivery for UPS     | Reducing the possibility | Changed the method of shipping equipment from ocean freight to air freight |
| Delivery for Transmitter | Reducing the possibility | Changed the method of shipping equipment from ocean freight to air freight |
| Delivery Genset     | Reducing the possibility | Changed the method of shipping equipment from ocean freight to air freight |

#### 3.4. **Crashing**

Based on data processing above, then get results like below.

### Table 5. Crashing.

| Task Name          | Rate $/kg | Total Day | Total Weight | Total Cost      |
|--------------------|-----------|-----------|--------------|-----------------|
| **Delivery Equipment** |           |           |              |                 |
| Delivery of Filter Separator | $5.16 | 60 | 34017 | $175.540,10 |
| Delivery for Valves | $5.16 | 70 | 27900 | $143.964,00 |
| Delivery for UPS   | $5.16 | 60 | 110,40 | $569,66 |
| Delivery for Transmitter | $5.16 | 60 | 99 | $510,84 |
| Delivery Genset    | $5.16 | 35 | 7208 | $37.193,28 |

#### 3.5. **Crashing**

Based on data processing above, then get results like below.

### Table 6. Result of Time Cost Trade Off Analysis.

| Task Name | Crash Duration (Days) | Normal Cost | Crash Cost |
|-----------|------------------------|-------------|------------|
| **Delivery Equipment** |                      |             |            |
| Delivery of Filter Separator | 60 | $67.556,16 | $175.540,10 |
| Delivery for Valves | 50 | $202.668,48 | $143.964,00 |
| Delivery for UPS  | 60 | $1,072,32 | $569,66 |
| Delivery for Transmitter | 60 | $1,072,32 | $510,84 |
| Delivery Genset     | 85 | $5,361,60 | $37.193,28 |

#### 4. Conclusion and Proposition

a. From the result of FMEA analysis and pareto diagrams, priority critical components that have been damaged more than twice in a period of 7 months and have the highest RPN value are Collector components in the 1 Ton Hoist electric subsystem with an RPN in the amount of 280, Pendant in the Hoist 1 electric subsystem Ton with RPN in the amount of 168, Hoisting Inverter on 1 Ton Hoist electricity subsystem with RPN in the amount of 98, MC Traversing on Hoist 1 Ton electricity subsystem with RPN in the amount of 98, and Pendant on Hoist 2 Ton electric subsystem with RPN in the amount of 112.

b. Recommended action and appropriate treatment time intervals based on the results of the analysis using RCM Decision Worksheet II and the calculation of maintenance intervals that have been carried out are as follows:
1. The Pendant Component in the 1 Ton Hoist electric subsystem currently has a reliability in the amount of 50%. Recommendations for appropriate maintenance measures to minimize lost time are scheduled on-condition tasks with maintenance time intervals of 94 hours (12 days) and reliability after treatment in the amount of 51%.

2. The Hoisting Inverter component of the 1 Ton Hoist electric subsystem currently has a reliability in the amount of 24%. Recommendations for appropriate maintenance measures to minimize lost time are scheduled on-condition tasks with maintenance time intervals of 494 hours (62 days) and reliability after treatment in the amount of 33%.

3. The MC Traversing component of the 1 Ton Hoist electric subsystem currently has a reliability in the amount of 28%. Recommendations for appropriate maintenance measures to minimize lost time are scheduled on-condition tasks with maintenance time intervals of 146 hours (18 days) and reliability after treatment in the amount of 32%.

4. Pendant component in Hoist’s 2 Ton electric subsystem currently have a reliability in the amount of 37%. Recommendations for appropriate maintenance measures to minimize lost time are scheduled on-condition tasks with maintenance time intervals of 241 hours (30 days) and reliability after treatment in the amount of 66%.

References

[1] Djatmiko, B. (2017). Modelling of Project Cash Flow on Construction Project in Malang City. AIP Conference Proceedings 1887,020014.

[2] Fauzan, R. (2016). Analisis Optimasi Waktu dan Biaya dengan Metode Time Cost Trade Off pada Proyek Pembangkit Listrik Tenaga Panas Bumi (PLTP) Ulabelu Unit 3&4 Lampung. Surabaya: Institut Teknologi Sepuluh Nopember

[3] Hughes, Bob & Cotterell, M. 2002. Software Project Management. Edisi Ke-3. McGraw-Hill. London.

[4] Darmawi, H. 2008. Manajemen Risiko. Jakarta : Bumi Aksara.

[5] Herjanto, Eddy. 2003. Manajemen Produksi dan Operasi. Cetakan ketiga, Jakarta PT. Grasindo.

[6] Institute. PMBOK – A Guide to the Project Management Body of Knowledge”. 6th edition. PA: Project Management Institute. Newtown Square.

[7] Luthan, P. L., & Syafriandi (2006), Aplikasi Microsoft Project Untuk Penjadwalan Teknik Sipil. Yogyakarta: Andi.

[8] Olson, David L. 2004. Introduction to Information System Project Management. Edisi Ke-2. McGraw-Hill. Boston.

[9] Santosa, B. (2009). Manajemen Proyek Konsep dan Implementasi. Yogyakarta: ANDI.

[10] Schwalbe, Kathy. 2004. Information Technology Project Management. Edisi Ke-4. Course Technology, Inc. Boston.

[11] Soeharto, I. (1995). Manajemen Proyek dari Konseptual Sampai Operasional. Jakarta: Penerbit Erlangga.

[12] Tjaturono. 2004. Penerapan Produktivitas Tenaga Kerja Aktual dan Modifikasi Penjadwalan dengan Metode Fast Track untuk Mereduksi Biaya dan Waktu Pembangunan Rumah. Makalah Seminar REI Jatim, 16 Desember 2004, Hotel Sangri-La, Surabaya.

[13] Maddepungeng, A., Suryani,I., Hermawan, D. (2015)., Analisis Optimasi Biaya dan Waktu dengan Metode TCTO (Time Cost Trade Off). Jurnal FONDASI, Volume 4 No 1.