# Scheduling Time and Project Costs Using *the Critical Path Method* (CPM) And *the Evolution and Review Technique* (PERT) Program on *The Dust Collector* Machine at Pt. The Glorious Element of Suryamasinka (Elgisa)

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**ABSTRACT**

Scheduling is one of the meters that is a benchmark for the success of a project in addition to cost and quality. Project planning consists of scheduling, controlling, and executing. PT. ELGISA Accepts orders and installation of *dust collector* and *ducting machines.* PT. ELGISA in project management is still poorly structured in arranging the stages of a project activity. So there is a need for a scheduling improvement system with project management using the *Critical Path Method* (CPM) and *Program Evalution and Technique* (PERT) methods. The purpose of this study was to plan the scheduling time and project costs so that they do not exceed the time that has been set. The calculation results use the CPM method, which is for 53 days while using the PERT method, which is 54 days with a normal time of 75 days. In the CPM and PERT methods, they have a critical line network, the installation of *dust collector* and *ducting* machines is the same, namely A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC on the CPM method, the cost on the critical line is Rp. 107,300,000,- while in the PERT method the cost on the critical line is Rp. 108,915,000,-. The influencing factors are human resources (HR), material and implementation.

***Keywords:*** *Scheduling, Cost, Critical Path Method (CPM), and Program Evalution and Technique (PERT).*

## 1. INTRODUCTION

The rapid growth of projects in Indonesia requires companies to execute strategies appropriately. According to Rijaluddin and Ajie (2020) planning project activities is an important problem because as a basis for the project to run and be completed in optimal time. According to Angelin and Ariyanti (2018) schedule is one of the parameters that become a benchmark for the success of a project in addition to cost and quality. According to Proboyo (1998) delays in the project will have a loss impact on the owner and contractor, because the result of the delay is a conflict and debate about what and who is the causative factor, as well as time demands and additional costs.

PT. ELGISA is a company engaged in the sale of machinery and machine installation services in the metal machinery division. PT. ELGISA accepts machine orders and installation of *dust collector* and *ducting* machines, this machine is a machine used by *manufacturing* companies as a sewage suction device. The dust *collector* and *ducting* machine installation project will be completed in 75 days. The problems that occurred in the PT. ELGISA is that there is a violation of the planned scheduling with the actual situation in the field, as for the factor of delay constraints in the implementation of the project that hinders the process of installing the machine can be seen in table 1.1 as follows:

**Table 1. 1 Data on Project Implementation Constraints**

| No | Types of Project Implementation Constraints |
|---|---|
| 1 | Installation of *dust collector* and *ducting* machines that are not sequential |
| 2 | *Miss* communication anatar workers |
| 3 | Teledor workers |
| 4 | Undisciplined workers |
| 5 | Raw materials do not meet specifications |
| 6 | *Ducting* dents |
| 7 | Tidak ada *maintenance* |
| 8 | The number of grinding machines is less |
| 9 | Less structured scheduling methods |
| 10 | Unstructured SOPs |
| 11 | *Ducting size* is not the same |
| 12 | The size of the nut and bolt are not the same |

Based on the table above, the obstacle of delays in the installation of *dust collector* machines and *ducting* is one of the causes of the project being hampered. Therefore, it is necessary to analyze the time of project work to determine the duration of the fast duration of a project being worked on. Based on data from observations in the field scheduling that is not in accordance with the situation in the field, it is necessary to have a scheduling improvement system by paying attention to project management, namely by using the *Critical Path Method* (CPM) method and *the Evalution and Technique* (PERT) Program.

This research was conducted to plan the scheduling time and project costs so that it does not exceed the predetermined time. Based on the description above, researchers will conduct research on "Scheduling Time and Project Costs using *the Critical Path Method* (CPM) and *Program Evaluation and Review Technique* (PERT). Case Study: Raw Material Processing Unit)".

## 2. METHODS

*Critical Path Method* (CPM)

*Critical Path Method* is a system that is often used among several systems that use the principle of network formation. *Critical path* is a series of activities that determine the fastest time a project can be completed. CPM is the amount of time it takes to complete a project assumed to be known with certainty, as well as the relationship between the resources used and the time it takes to complete a project.

The term for calculating project time according to Herjanto (2007) is as follows:

1. ES (*Earliest activity start time*), is the earliest time an activity can start.
2. EF (*Earliest activity finish time*), is the earliest time an activity is completed.
3. LS (*Latest activity start time*), is the slowest time an activity must start.
4. LF (*Latest activity finish time*), is the slowest time an activity must have been completed.

How to calculate the duration of project completion, namely *forward computation* and *backward computation* as follows:

1. Forward Calculation
   Starting from *the start* (*initial event*) to *the finish* (terminal *event*) to calculate the EF (fastest completion time of an activity), ES (the fastest time for the activity to occur) and E (the fastest time an event starts).

$$EF = ES + t \quad ..... (2.1)$$

2. Countdown

Starting from *finish* to *start* to identify LF (when an activity occurs at the latest), LS (the slowest time an activity occurs) and L (when at the latest an event occurs).

$$LS = LF - t \quad \text{.......................................... . . (2.2)}$$

As for calculating *Slack* is by the formula:

*Slack* = LF – EF atau LS – ES .................. .... . (2.3)

*Program Evaluation And Review Technique* (PERT)

*Program Evaluation and Review Technique* (PERT) is a project management tool used to schedule, organize and coordinate the parts of work in the project. PERT is a method developed by the United States Navy in 1958 to regulate missile programs. Meanwhile, there is a similar method at the same time developed by the private sector called CPM or *Critical Path Method*.

According to Suharto (2002) the approximate time model is as follows:

1. a (Optimistic Time) is the shortest estimated duration for completing an activity.
2. m (Most Likely Estimated Time) is the duration of completion that has the highest probability (in contrast to: the expected time).
3. b (Pessimistic Time) is the longest duration required to complete an activity.

The PERT formula is:

$$Te = \frac{a + 4(m) + b}{6} \quad \text{........................................... .. (2.4)}$$

$$S = \text{...........................................} \left(\frac{a - b}{6}\right)^2 \text{... (2.5)}$$

$$V(te) = S^2 \quad \text{.................. ... ... (2.6)}$$

$$Z = \frac{T(d) - Te}{\sqrt{\sum V(te)}} \text{.................................................... (2.7)}$$

Information:

Te *: expected duration*
a : *minimum* (most optimistic time)
m : *most likely*
b : *maximum* (slowest time)
S: Standard deviation

## 3. RESULTS AND DISCUSSION

The data used in this study such as the schedule of work activities, time (duration) and cost of working on the project. The data is used to create an overall network of work the data obtained by *interviewing supervaisiors* and technicians. Work activity data is used to find out the activities to be carried out next. The duration (time) is used to find out how long the time being done in a activity is being used to find out how much it will cost in completing the project.

Metode *Critical Parth Method* (CPM)

The first step that must be done to create a network of work using the CPM method is to know all activities, then determine the order of relationship between one job and another because every work that will come will be able to be done after the previous activity has been completed. The following is a forward and backward calculation of the CPM method can be seen in the table below:

**Table 3.1 Calculation of Forward and Reverse CPM Methods**

| No | Jenis Pekerjaan | Kode Kegiatan | *Prodecessor* | Durasi (Hari) | Perhitungan Maju | | Perhitungan Mundur | | *Slack* | Keterangan |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Earliest Start* | *Earliest Finish* | *Latest Start* | *Latest Finish* | | |
| | **Persiapan *Project*** | | | | | | | | | |
| 1 | Persiapan instalasi | A | Start | 15 | 0 | 15 | 0 | 15 | 0 | Kritis |

| No | Jenis Pekerjaan | Kode Kegiatan | *Prodecessor* | Durasi (Hari) | Perhitungan Maju | | Perhitungan Mundur | | *Slack* | Keterangan |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Earliest Start* | *Earliest Finish* | *Latest Start* | *Latest Finish* | | |
| | **Pemasangan Mesin *Dust Collector* 1** | | | | | | | | | |
| 2 | Pemasangan *Positioning* kaki | B | A | 1 | 15 | 16 | 15 | 18 | 2 | Tidak kritis |
| 3 | Pemasangan *Strut* kaki | C | B | 1 | 16 | 17 | 18 | 19 | 2 | Tidak kritis |
| 4 | Pemasangan *Hopper* bawah | D | C | 2 | 17 | 19 | 19 | 21 | 2 | Tidak kritis |
| 5 | Pemasangan *Filter* | E | D | 3 | 19 | 22 | 21 | 24 | 2 | Tidak kritis |
| 6 | Pemasangan *Clamp Filter* | F | E | 2 | 22 | 24 | 24 | 26 | 2 | Tidak kritis |
| 7 | Perakitan *Assembling Body* samping | G | F | 2 | 24 | 26 | 26 | 28 | 2 | Tidak kritis |
| 8 | Pemasangan *Assembling Body* samping | H | G | 1 | 26 | 27 | 28 | 29 | 2 | Tidak kritis |
| 9 | Perakitan *Assembling Top Section* | I | H | 2 | 27 | 29 | 29 | 31 | 2 | Tidak kritis |
| 10 | Pemasangan *Top Section* | J | I | 1 | 29 | 30 | 31 | 32 | 2 | Tidak kritis |
| 11 | Pemasangan Tangki | K | J | 1 | 30 | 31 | 32 | 33 | 2 | Tidak kritis |
| 12 | Pemasangan Pipa Angin | L | K | 4 | 31 | 35 | 33 | 37 | 2 | Tidak kritis |
| 13 | Pemasangan Pipa Air | M | K | 4 | 31 | 35 | 33 | 37 | 2 | Tidak kritis |
| 14 | Pemasangan dan perakitan *Ducting DC* 1 | N | L, M | 9 | 35 | 44 | 37 | 46 | 2 | Tidak kritis |
| 15 | *Cleaning Ducting* 1 | O | N | 3 | 44 | 47 | 46 | 49 | 2 | Tidak kritis |
| 16 | *Cleaning Dust Collector* 1 | P | O | 1 | 47 | 48 | 49 | 50 | 2 | Tidak kritis |
| | **Pemasangan Mesin *Dust Collector* 2** | | | | | | | | | |
| 17 | Pemasangan *Positioning* kaki | Q | A | 1 | 15 | 16 | 15 | 18 | 2 | Tidak kritis |
| 18 | Pemasangan *Strut* kaki | R | Q | 1 | 16 | 17 | 18 | 19 | 2 | Tidak kritis |
| 19 | Pemasangan *Hopper* bawah | S | R | 2 | 17 | 19 | 19 | 21 | 2 | Tidak kritis |
| 20 | Pemasangan *Filter* | T | S | 3 | 19 | 22 | 21 | 24 | 2 | Tidak kritis |
| 21 | Pemasangan *Clamp Filter* | U | T | 2 | 22 | 24 | 24 | 26 | 2 | Tidak kritis |
| 22 | Perakitan *Assembling Body* samping | V | U | 2 | 24 | 26 | 26 | 28 | 2 | Tidak kritis |
| 23 | Pemasangan *Assembling Body* samping | W | V | 1 | 26 | 27 | 28 | 29 | 2 | Tidak kritis |
| 24 | Perakitan *Assembling Top Section* | X | W | 2 | 27 | 29 | 29 | 31 | 2 | Tidak kritis |
| 25 | Pemasangan *Top Section* | Y | X | 1 | 29 | 30 | 31 | 32 | 2 | Tidak kritis |
| 26 | Pemasangan Tangki | Z | Y | 1 | 30 | 31 | 32 | 33 | 2 | Tidak kritis |
| 27 | Pemasangan Pipa Angin | AA | Z | 4 | 31 | 35 | 33 | 37 | 2 | Tidak kritis |
| 28 | Pemasangan Pipa Air | AB | Z | 4 | 31 | 35 | 33 | 37 | 2 | Tidak kritis |
| 29 | Pemasangan dan perakitan *Ducting DC* 2 | AC | AA, AB | 9 | 35 | 44 | 37 | 46 | 2 | Tidak kritis |
| 30 | *Cleaning Ducting* 2 | AD | AC | 3 | 44 | 47 | 46 | 49 | 2 | Tidak kritis |
| 31 | *Cleaning Dust Collector* 2 | AE | AD | 1 | 47 | 48 | 49 | 50 | 2 | Tidak kritis |
| | **Pemasangan Mesin *Dust Collector* 3** | | | | | | | | | |
| 32 | Pemasangan *Positioning* kaki | AF | A | 1 | 15 | 16 | 15 | 16 | 0 | Kritis |
| 33 | Pemasangan *Strut* kaki | AG | AF | 1 | 16 | 17 | 16 | 17 | 0 | Kritis |
| 34 | Pemasangan *Hopper* bawah | AH | AG | 2 | 17 | 19 | 17 | 19 | 0 | Kritis |

| No | Jenis Pekerjaan | Kode Kegiatan | *Prodecessor* | Durasi (Hari) | Perhitungan Maju | | Perhitungan Mundur | | *Slack* | Keterangan |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Earliest Start* | *Earliest Finish* | *Latest Start* | *Latest Finish* | | |
| 35 | Pemasangan *Filter* | AI | AH | 3 | 19 | 22 | 19 | 22 | 0 | Kritis |
| 36 | Pemasangan *Clamp Filter* | AJ | AI | 2 | 22 | 24 | 22 | 24 | 0 | Kritis |
| 37 | Perakitan *Assembling Body* samping | AK | AJ | 2 | 24 | 26 | 24 | 26 | 0 | Kritis |
| 38 | Pemasangan *Assembling Body* samping | AL | AK | 1 | 26 | 27 | 26 | 27 | 0 | Kritis |
| 39 | Perakitan *Assembling Top Section* | AM | AL | 2 | 27 | 29 | 27 | 29 | 0 | Kritis |
| 40 | Pemasangan *Top Section* | AN | AM | 1 | 29 | 30 | 29 | 30 | 0 | Kritis |
| 41 | Pemasangan Tangki | AO | AN | 1 | 30 | 31 | 30 | 31 | 0 | Kritis |
| 42 | Pemasangan Pipa Angin | AP | AO | 4 | 31 | 35 | 31 | 35 | 0 | Kritis |
| 43 | Pemasangan Pipa Air | AQ | AO | 4 | 31 | 35 | 31 | 35 | 0 | Kritis |
| 44 | Pemasangan dan perakitan *Ducting DC* 3 | AR | AP, AQ | 11 | 35 | 46 | 35 | 46 | 0 | Kritis |
| 45 | *Cleaning Ducting* 3 | AS | AR | 3 | 46 | 49 | 46 | 49 | 0 | Kritis |
| 46 | *Cleaning Dust Collector* 3 | AT | AS | 1 | 49 | 50 | 49 | 50 | 0 | Kritis |
| | **Pemasangan Mesin *Dust Collector* 4** | | | | | | | | | |
| 47 | Pemasangan *Positioning* kaki | AU | A | 1 | 15 | 16 | 15 | 17 | 1 | Tidak kritis |
| 48 | Pemasangan *Strut* kaki | AV | AU | 1 | 16 | 17 | 17 | 18 | 1 | Tidak kritis |
| 49 | Pemasangan *Hopper* bawah | AW | AV | 2 | 17 | 19 | 18 | 20 | 1 | Tidak kritis |
| 50 | Pemasangan *Filter* | AX | AW | 3 | 19 | 22 | 20 | 23 | 1 | Tidak kritis |
| 51 | Pemasangan *Clamp Filter* | AY | AX | 2 | 22 | 24 | 23 | 25 | 1 | Tidak kritis |
| 52 | Perakitan *Assembling Body* samping | AZ | AY | 2 | 24 | 26 | 25 | 27 | 1 | Tidak kritis |
| 53 | Pemasangan *Assembling Body* samping | BA | AZ | 1 | 26 | 27 | 27 | 28 | 1 | Tidak kritis |
| 54 | Perakitan *Assembling Top Section* | BB | BA | 2 | 27 | 29 | 28 | 30 | 1 | Tidak kritis |
| 55 | Pemasangan *Top Section* | BC | BB | 1 | 29 | 30 | 30 | 31 | 1 | Tidak kritis |
| 56 | Pemasangan Tangki | BD | BC | 1 | 30 | 31 | 31 | 32 | 1 | Tidak kritis |
| 57 | Pemasangan Pipa Angin | BE | BD | 4 | 31 | 35 | 32 | 36 | 1 | Tidak kritis |
| 58 | Pemasangan Pipa Air | BF | BD | 4 | 31 | 35 | 32 | 36 | 1 | Tidak kritis |
| 59 | Pemasangan dan perakitan *Ducting DC* 4 | BG | BE, BF | 10 | 35 | 45 | 36 | 46 | 1 | Tidak kritis |
| 60 | *Cleaning Ducting* 4 | BH | BG | 3 | 45 | 48 | 46 | 49 | 1 | Tidak kritis |
| 61 | *Cleaning Dust Collector* 4 | BI | BH | 1 | 48 | 49 | 49 | 50 | 1 | Tidak kritis |
| | **Pemasangan Mesin *Dust Collector* 5** | | | | | | | | | |
| 62 | Pemasangan *Positioning* kaki | BJ | A | 1 | 15 | 16 | 15 | 19 | 3 | Tidak kritis |
| 63 | Pemasangan *Strut* kaki | BK | BJ | 1 | 16 | 17 | 19 | 20 | 3 | Tidak kritis |
| 64 | Pemasangan *Hopper* bawah | BL | BK | 2 | 17 | 19 | 20 | 22 | 3 | Tidak kritis |
| 65 | Pemasangan *Filter* | BM | BL | 3 | 19 | 22 | 22 | 25 | 3 | Tidak kritis |
| 66 | Pemasangan *Clamp Filter* | BN | BM | 2 | 22 | 24 | 25 | 27 | 3 | Tidak kritis |
| 67 | Perakitan *Assembling Body* samping | BO | BN | 2 | 24 | 26 | 27 | 29 | 3 | Tidak kritis |
| 68 | Pemasangan *Assembling Body* samping | BP | BO | 1 | 26 | 27 | 29 | 30 | 3 | Tidak kritis |

| No | Jenis Pekerjaan | Kode Kegiatan | *Prodecessor* | Durasi (Hari) | Perhitungan Maju | | Perhitungan Mundur | | *Slack* | Keterangan |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ***Earliest Start*** | ***Earliest Finish*** | ***Latest Start*** | ***Latest Finish*** | | |
| 69 | Perakitan *Assembling Top Section* | BQ | BP | 2 | 27 | 29 | 30 | 32 | 3 | Tidak kritis |
| 70 | Pemasangan *Top Section* | BR | BQ | 1 | 29 | 30 | 32 | 33 | 3 | Tidak kritis |
| 71 | Pemasangan Tangki | BS | BR | 1 | 30 | 31 | 33 | 34 | 3 | Tidak kritis |
| 72 | Pemasangan Pipa Angin | BT | BS | 4 | 31 | 35 | 34 | 38 | 3 | Tidak kritis |
| 73 | Pemasangan Pipa Air | BU | BS | 4 | 31 | 35 | 34 | 38 | 3 | Tidak kritis |
| 74 | Pemasangan dan perakitan *Ducting DC* 5 | BV | BT, BU | 8 | 35 | 43 | 39 | 46 | 3 | Tidak kritis |
| 75 | *Cleaning Ducting* 5 | BW | BV | 3 | 43 | 46 | 46 | 49 | 3 | Tidak kritis |
| 76 | *Cleaning Dust Collector* 5 | BX | BW | 1 | 46 | 47 | 49 | 50 | 3 | Tidak kritis |
| | **Pemasangan Mesin *Dust Collector* 6** | | | | | | | | | |
| 77 | Pemasangan *Positioning* kaki | BY | A | 1 | 15 | 16 | 15 | 20 | 4 | Tidak kritis |
| 78 | Pemasangan *Strut* kaki | BZ | BY | 1 | 16 | 17 | 20 | 21 | 4 | Tidak kritis |
| 79 | Pemasangan *Hopper* bawah | CA | BZ | 2 | 17 | 19 | 21 | 23 | 4 | Tidak kritis |
| 80 | Pemasangan *Filter* | CB | CA | 3 | 19 | 22 | 23 | 26 | 4 | Tidak kritis |
| 81 | Pemasangan *Clamp Filter* | CC | CB | 2 | 22 | 24 | 26 | 28 | 4 | Tidak kritis |
| 82 | Perakitan *Assembling Body* samping | CD | CC | 2 | 24 | 26 | 28 | 30 | 4 | Tidak kritis |
| 83 | Pemasangan *Assembling Body* samping | CE | CD | 1 | 26 | 27 | 30 | 31 | 4 | Tidak kritis |
| 84 | Perakitan *Assembling Top Section* | CF | CE | 2 | 27 | 29 | 31 | 33 | 4 | Tidak kritis |
| 85 | Pemasangan *Top Section* | CG | CF | 1 | 29 | 30 | 33 | 34 | 4 | Tidak kritis |
| 86 | Pemasangan Tangki | CH | CG | 1 | 30 | 31 | 34 | 35 | 4 | Tidak kritis |
| 87 | Pemasangan Pipa Angin | CI | CH | 4 | 31 | 35 | 35 | 39 | 4 | Tidak kritis |
| 88 | Pemasangan Pipa Air | CJ | CH | 4 | 31 | 35 | 35 | 39 | 4 | Tidak kritis |
| 89 | Pemasangan dan perakitan *Ducting DC* 6 | CK | CI, CJ | 7 | 35 | 42 | 39 | 46 | 4 | Tidak kritis |
| 90 | *Cleaning Ducting* 6 | CL | CK | 3 | 42 | 45 | 46 | 49 | 4 | Tidak kritis |
| 91 | *Cleaning Dust Collector* 6 | CM | CL | 1 | 45 | 46 | 49 | 50 | 4 | Tidak kritis |
| | **Pemasangan Mesin *Dust Collector* 7** | | | | | | | | | |
| 92 | Pemasangan *Positioning* kaki | CN | A | 1 | 15 | 16 | 15 | 21 | 5 | Tidak kritis |
| 93 | Pemasangan *Strut* kaki | CO | CN | 1 | 16 | 17 | 21 | 22 | 5 | Tidak kritis |
| 94 | Pemasangan *Hopper* bawah | CP | CO | 2 | 17 | 19 | 22 | 24 | 5 | Tidak kritis |
| 95 | Pemasangan *Filter* | CQ | CP | 3 | 19 | 22 | 24 | 27 | 5 | Tidak kritis |
| 96 | Pemasangan *Clamp Filter* | CR | CQ | 2 | 22 | 24 | 27 | 29 | 5 | Tidak kritis |
| 97 | Perakitan *Assembling Body* samping | CS | CR | 2 | 24 | 26 | 29 | 31 | 5 | Tidak kritis |
| 98 | Pemasangan *Assembling Body* samping | CT | CS | 1 | 26 | 27 | 31 | 32 | 5 | Tidak kritis |
| 99 | Perakitan *Assembling Top Section* | CU | CT | 2 | 27 | 29 | 32 | 34 | 5 | Tidak kritis |
| 100 | Pemasangan *Top Section* | CV | CU | 1 | 29 | 30 | 34 | 35 | 5 | Tidak kritis |
| 101 | Pemasangan Tangki | CW | CV | 1 | 30 | 31 | 35 | 36 | 5 | Tidak kritis |
| 102 | Pemasangan Pipa Angin | CX | CW | 4 | 31 | 35 | 36 | 40 | 5 | Tidak kritis |

| No | Jenis Pekerjaan | Kode Kegiatan | *Prodecessor* | Durasi (Hari) | Perhitungan Maju | | Perhitungan Mundur | | *Slack* | Keterangan |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Earliest Start* | *Earliest Finish* | *Latest Start* | *Latest Finish* | | |
| 103 | Pemasangan Pipa Air | CY | CW | 4 | 31 | 35 | 40 | 40 | 5 | Tidak kritis |
| 104 | Pemasangan dan perakitan *Ducting DC* 7 | CZ | CX, CY | 6 | 35 | 41 | 40 | 46 | 5 | Tidak kritis |
| 105 | *Cleaning Ducting* 7 | DA | CZ | 3 | 41 | 44 | 46 | 49 | 5 | Tidak kritis |
| 106 | *Cleaning Dust Collector* 7 | DB | DA | 1 | 44 | 45 | 49 | 50 | 5 | Tidak kritis |
| | ***Finishing*** | | | | | | | | | |
| 107 | *Cleaning* area UPBM | DC | P, AE, AT, BI, BX, CM, DB | 3 | 50 | 53 | 50 | 53 | 0 | Kritis |

The following is an advanced calculation of the CPM method
$EF = ES + t$ ............ (2.8)
$EF = 0 + 15 = 15$
Countdown on cpm method
$LS = LF – t$ ………… (2.9)
$EF = 53 – 3 = 50$
Slock calculation to find a critical path on the CPM method
$Slock = LF - EF$ ......... (2.10)
$Slock = 16 - 16 = 0$

From the table above, it can be seen which is included in the critical path on the work activities of A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC. After knowing the critical path of the CPM method, the costs will be calculated on the *dust collector* and *ducting* machine installation project. Based on the calculation of the cost of the critical line in the *dust collector* and *ducting* machine installation project using the CPM method is Rp. 107,300,000, - with a duration of 53 days.

Metode *Program Evaluation and Review Technique* (PERT)

The first step in compiling a network using the PERT method is to determine the approximate duration of the optimistic time (a), the pessimistic time duration (b) and the most likely time duration (m). After knowing the te value (expected duration) then perform the calculation of the completion time using the PERT method with forward and backward counts. In this calculation, it is almost the same as the calculation in the CPM method. Count forward to find out the earliest time of the activity. The results of the advanced calculations are ES and EF. Countdown to find out the time of the most recent activity without delaying the overall completion period.

From the results of the project scheduling analysis with the PERT method with the te value as the duration used in the calculation, it is known that the project completion value (te) for 54.35 or if rounded to 54 days. Here is the critical path of the PERT method.

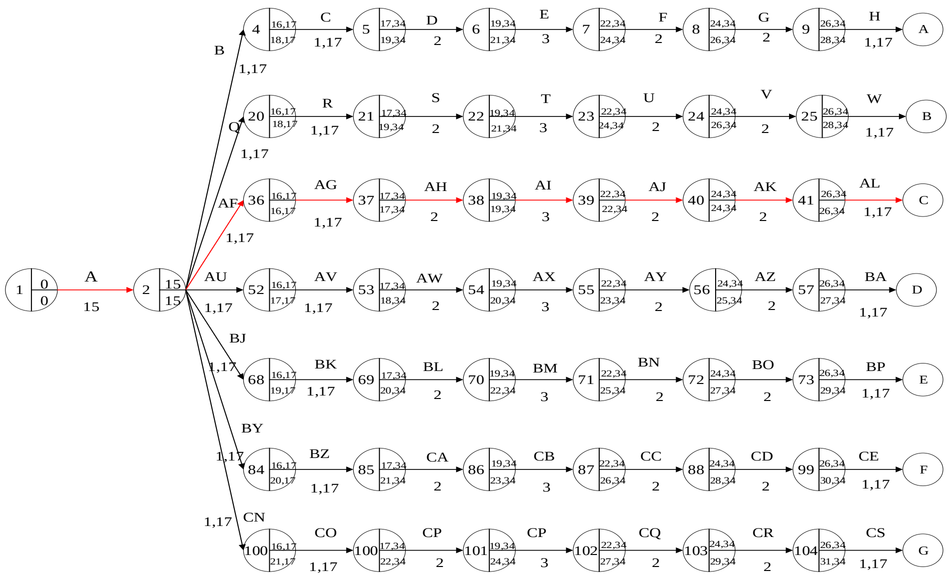

**Figure 3.1 Pert Method Path**

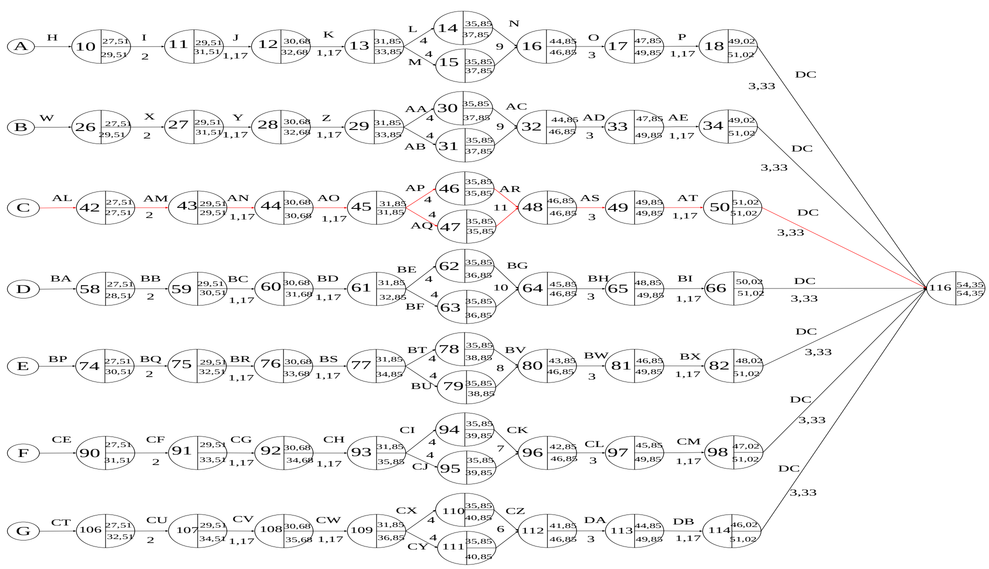

**Figure 3.2 Critical Path of PERT Method (continued)**

Based on the data that has been collected and then processed into the data processing process, the data processing results from the CPM and PERT methods are as follows:

1. The CPM method results in a project work time of 53 days and the critical path is A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC.
2. The PERT method resulted in a project work time of 54.35 or rounded to 54 days and the critical path was A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC.

So to speed up scheduling, which was previously estimated to be completed in 75 days using the CPM method, the project can be completed in 53 days. From the calculation hail, the cost of the CPM method is Rp. 107,300,000, - while the result of calculating the PERT method is Rp. 108,915,000,-. Below is a table of the comparison of CPM and PERT methods as follows:

**Table 3.3 Comparison of CPM and PERT Methods**

| Method | Day | Critical Path | Cost |
|---|---|---|---|
| CPM | 53 | A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC | IDR 107,300,000.00 |
| LAWSUIT | 54 | A-AF-AG-AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC | IDR 108,915,000,00 |

1. UPBM Project Cause and Effect Diagram

Causal diagrams are used to help identify the causal factors of the project becoming backwards. The causal diagram on the UPBM project in figure 3.3 is as follows:

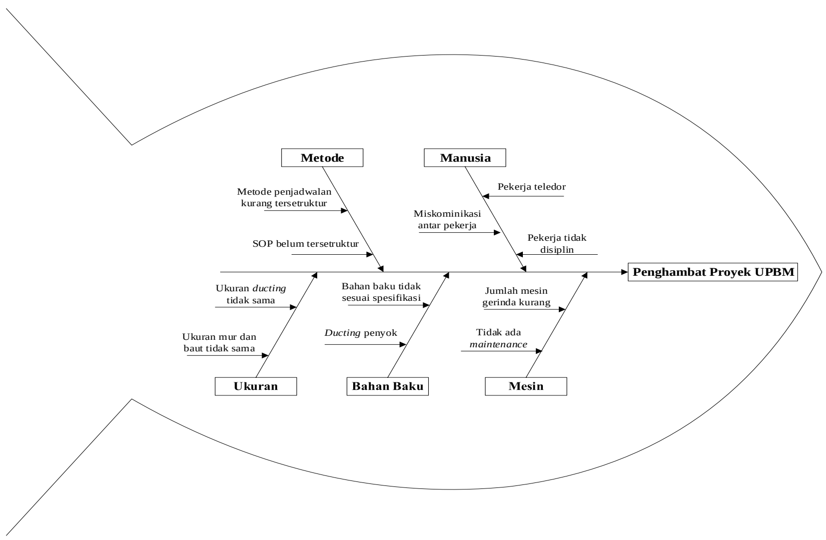


**Figure 3.3 UPBM Project Causal Diagram**

Based on the above gamabar on the inhibition of the UPBM project is due to human factors, methods, machines, raw materials, size. The human factor is the workers who are teledor, the existence of miscommunication between workers so that and the lack of discipline in work. The method factor is that the method used is still dabbling in using the previous project work method and the SOPs used are still not structured on scheduling and project activities are still not properly structured. The raw material factor is that the raw material *dacting* is dented and also the raw material is not in accordance with the required specifications. The engine factor is the lack of grinding machines and no *maintenance* so that the machines used in working on the project must alternate. The size factor is that the size of the nuts and bolts is not the same, *the size of the ducting* is not the same.

## 4. CONCLUSION

Based on the results of data processing and analysis that has been carried out, it can be concluded as follows:

1. Based on calculations using two methods of CPM and PERT, it was found that the results used the CPM method, namely for 53 days with a critical path while using the PERT method, which was 54 days with a normal time of 75 days. A comparison of the two methods found that the CPM method was more effective and efficient than using the PERT method. In the CPM and PERT methods, the critical line work network in the installation of *dust collector* and *ducting* machines is the same, namely A-AF-AG-

AH-AI-AJ-AK-AL-AM-AN-AO-AP, AQ-AR-AS-AT-DC on the CPM method, the cost on the critical line is Rp. 107,300,000, - while in the PERT method the cost on the critical line is Rp. 108,915,000,-.

2. Factors that affect the duration of the installation of *dust collector* and *ducting* machines in the UPBM area are the source of labor (HR), *materials* and implementation.

## SUGGESTION

The advice that companies can give in this study are:

1. Advice for companies
   a. Every project work should use methods so that all scheduling and financing can be detailed correctly, if one day something goes wrong, it can be found where the problem is and corrected.
   b. During the ongoing project work, technicians should check both the *material* and the ongoing project, if there is a shortage of *materials*, the technician can immediately buy a stock of material and if the worker makes a mistake in installing the machine, it can be repaired immediately.
2. Suggestions for future research
   a. The next research on project management can use the CPM method combined with PDM and *Crashing*.

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