

Construction Service Project Scheduling Analysis Using Critical Path Method (CPM), Project Evaluation and Review Technique (PERT)

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Abstract:- The success or failure of a project is largely determined by the planning and control of the project. The failure of project implementation was due to lack of planning and lack of ineffective control so that project activities became inefficient. This resulted in delays, reduced quality of work, and unexpected costs of implementation. Problems in this research object is a delay in completing a gondola project because there are several obstacles or problems that occur. Optimization of working time is quite important for companies in working on projects, because in this work time efficiency is needed because the gondola is needed by the client. The implementation of the project requires optimal project planning using the CPM (Critical Path Method) and PERT methods. With the CPM method, 13 critical activities were obtained, with total duration of 55 days was also applied to the Gantt Chart. And with the PERT method (Program Evaluation and Review Technique) obtained 13 critical activities, and a total duration of 53 days with a probability of project completion is 86.65%.

Keywords:- Project Management, CPM, PERT, Activities

I. INTRODUCTION

The construction of a construction project has objective goals that must be in line with strategic goals, thus the performance of a project will affect its achievement [1]. Projects generally have a deadline, which must be completed before or at the agreed time. However, in reality in the field, there are still many project completion times that are delayed or not completed on schedule [2]. Projects are dynamic, non-routine, multi-activity with varying intensity, short cycles, have starting and ending points, and limited funds [3]. According to [4] in a project it is necessary to confirm the relationship between activities to plan a project. CV. KCT collaborates with PT. GKL in working on gondola projects, which is usually when PT. GKL won the project tender, entrusted to CV. KCT. The problem in this company is an internal problem, namely the implementation of the gondola project that was not completed on time. During the implementation of the gondola project in 2019-2020 there were 5 projects that have been completed, but 3 of the 5 projects have experienced delays / delays.

To overcome this problem, the researcher makes a study using the Critical Path Network (CPM) and Project Evaluation and Review Technique (PERT) Methods. By using the CPM and PERT methods, it can be seen in more detail about the time difference between the initial conditions and the repair conditions, when the initial conditions often experience delays in processing time from preparation to completion and result in poor quality [5]. Therefore, it must be noted which work should get more attention because if the work is delayed it will affect the results of other work [6]. This research will answer the question of how to determine the optimal time for project completion and how to determine the critical path to get more attention compared to other activities on the construction service project.

II. METHODS

The situation faced here is that there is a difference between the project implementation time and the predetermined project plan time. The project planning time is usually shorter than the project implementation time [7]. The analysis technique used in this research is the CPM (Critical Path Method) and PERT (Project Evaluation and Review Technique) approaches.

A. Stage 1 : CPM analysis

At this stage a network analysis is carried out using the CPM method. To be able to set up a CPM network, research requires several steps [8]. The steps in compiling a CPM network are:

- Review and identify the project scope, describe it, break it down into activities or groups of activities that are project components.
- Rearrange the components in point 1, into links in the order according to the dependency logic.
- Provide an estimated timeframe for each of the activities resulting from the breakdown of the project scope.
- Identify the critical path (critical path) and float on the network.

Perform forward and backward calculations. From the two calculations, it is identified which activities are on the critical path.

B. Stage 2 : PERT analysis

At this stage, PERT analysis is carried out to determine the duration of each work from the data that has been obtained and to determine the probability of the company reaching the target schedule. To be able to apply the PERT method, research requires the following steps:

- Determine the estimated activity time
- Determine the standard deviation of project activities
- Determine the variety of activities from project activities
- Knowing the probability of reaching the schedule target

III. RESULT

➤ **Description of Activities.** In this step, an assessment and identification of the project scope is carried out by describing and breaking it down into activities or groups of activities that are project components. This arrangement is done based on experience and or data in the project in the past [9]. The details of its activities are as shown in Table 1 below :

Activities code	Type of work	Duration (days)	Delay (days)
A	Create gondola design & spesification	5	-
B	Material selection	2	-
C	Ordering material & negotiating	2	2
D	Purchase & deliveri of material	5	3
E	Material checking	1	2
F	Steel Frame fabrication work	10	-
F1	Cutting steel rods according to the type and dimension of need	8	-
F2	Basic painting for anti-rust	4	-
F3	Making a transportation system	7	-
G	Erection work	13	-
G1	Measurement of setting plate & anchor plate	3	1
G2	Drilling and planting of angkur	9	-
G3	Anchor tensile test	5	1
G4	Gondola frame erection	7	-
G5	Gondola basket assembly	6	-
G6	Instalation of steel slings & gondola basket	3	2
H	Post erection work	8	-
H1	Check of instalation & joints	6	1
H2	Re-painting anti-rust pain	4	-
H3	Gondola test	2	-
I	Finishing	3	-

Table 1:- Types of Project Activities

IV. DISCUSSION

1. Critical Path Method. The initial step in creating a network using the CPM method is to detail each activity then proceed with the stage of determining the sequence of dependence between one activity and another, because in the formation of a network using the CPM method, it is necessary to know what preceded activities because future activities can be carried out after activities beforehand or in other words can be done in parallel [10].
 - a. Relationship Between Project Activities. The relationship between activities is arranged into a chain or network diagram for the Activity On Node (AON) in the following order as shown in figure 1:

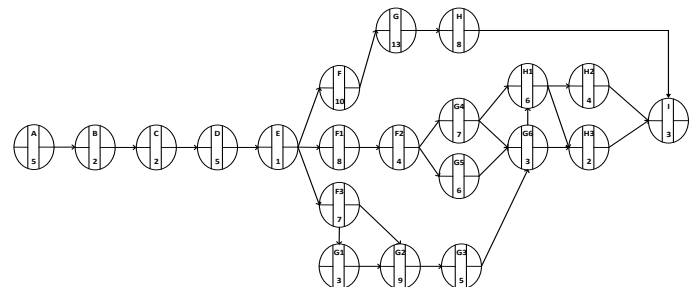


Fig 1:- AON Network Diagram

- b. Critical Path Method. The critical path in this packaging packaging project is a path that consists of a series of activities which in case of delay will result in overall delay [11]. This step is preceded by performing forward and backward calculations. The forward calculation is done to determine the Early Start (ES) and Early Finish (EF), while the backward calculation is to determine the Latest Start (LS) and Latest Finish (LF). From these two calculations, it can be identified the critical path that can be calculated float / slack, which is the allowance for the completion time of an activity.
 - Forward Calculation. For advanced calculations in the table above, the Activity On Node (AON) network diagram is as shown in figure 2 below :

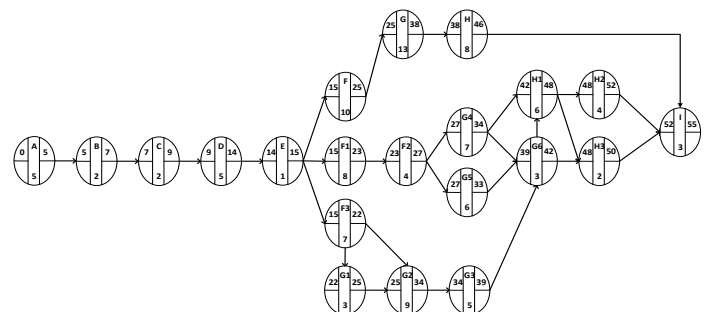


Fig 2:- Advanced Calculation AON Network Diagram

- Backward Count. In the countdown, the calculation moves from the event terminal to the event core. In the backward calculation, this project is intended to find out the time or date of the most recent project end in order to be able to start and end each activity without delaying the entire project completion period. Here is the equation for the countdown. The countdown network diagram Activity On Node (AON) is shown in Figure 3

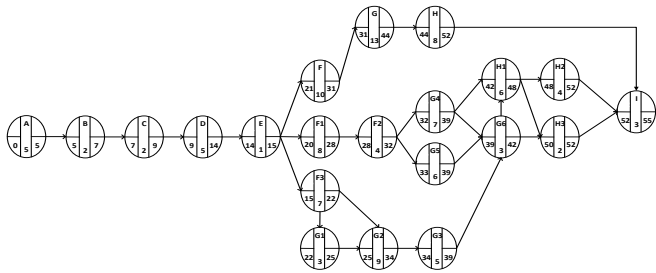


Fig 3:- The countdown network diagram Activity On Node (AON)

- Total Float Calculation. Total Float is the amount of time that the completion time of an activity can be postponed without affecting the quickest time of completion of the overall project. This stage is the stage of determining the critical path, which is the longest implementation path, which determines the project completion time.
- Critical Path. The critical path is the path with the longest amount of time compared to all other possible passes. The duration of the overall Project completion time is 55 days. Therefore, another way that can also be used to find the critical path is by calculating the length of each existing path. The critical path can be seen in Figure 4 below:

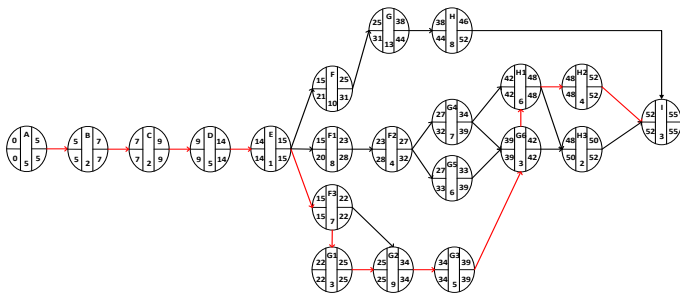


Fig 4:- AON Critical Path Network Diagram

2. PERT (Project Evaluation Review Technique) Method. Like the CPM method, PERT also uses an arrow chart to illustrate the project trajectory. In terms of understanding and calculation, critical activity is the same, the critical path or float in PERT is known as slack. The difference between CPM and PERT which is clearly visible is in the estimation of activity duration [12]. If in CPM the time is estimated with certainty (deterministically), then in PERT there are 3 time estimates, namely:
 - a. Optimistic time (To), namely the possibility that activities can be completed in a shorter time.
 - b. The most frequent occurrence (Tm), namely the estimated time that usually occurs under normal conditions.
 - c. Time pessimistic (Tp), which is the possibility that the activity can be completed in a longer time.

Referring to the information above, time estimation data for optimistic time and pessimistic time are needed. This data was obtained through interviews and discussions with field parties. Based on the calculation of slack using the PERT method, 13 critical trajectories were found, namely: A, B, C, D, E, F3, G1, G2, G3, G6, H1, H2, and I. day. The

following is the Activity On Node (AON) network diagram for the project's critical path in Figure 5:

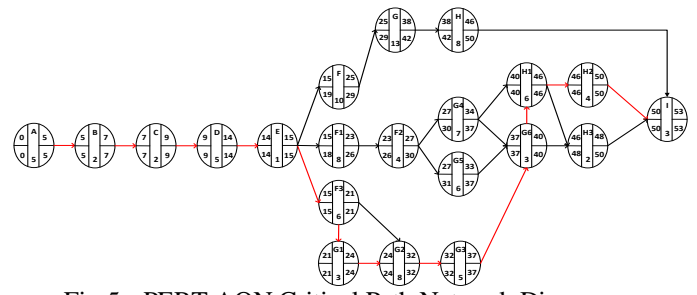


Fig 5:- PERT AON Critical Path Network Diagram

Based on the calculation of variance and standard deviation, the time to complete activities that pass through the critical path is 1,802 days. By using a normal curve of the probability of the project completion time using the following formula:

$$z = \frac{T(d) - \sum T_e kritis}{S}$$

$$z = \frac{55 - 53}{1.802}$$

$$z = 1.11 \sim 0.8665$$

From the figures above, the figure is 0.8665 in table Z normal distribution, then the possibility of completing the project in 53 days is 86.65%. This means that the completion of the project analyzed using the CPM method has a great chance of being completed with the duration given by the company.

3. Results of Comparative Analysis of CPM and PERT.

In this research, the methods used for scheduling are CPM and PERT. The comparison of the working time of the gondola project with these two methods can be seen in the table 2 and figure 6 below:

Description	CPM	PERT	Difference
Time (days)	55	53	2

Table 2:- Comparison of Time Using the CPM and PERT Methods

By using PERT network planning to improve the project work system, each related section can understand the process flow in detail, know which activities can be carried out in parallel / concurrently, and prioritize activities that are considered critical so that they do not affect the overall project delay. When compared with the results of the completion of this gondola project, which was completed in 113 days, with the improvement of the work system and the use of the PERT method, this time efficiency was 60 days faster. By using the PERT method, a Gantt Chart for project implementation can be made.

V. CONCLUSION

The conclusions of this study are:

1. Project completion using the CPM scheduling method is 55 days. The PERT project method can be completed in 53 days. Meanwhile, without using these two methods, the project completion time will take 113 days. From both the CPM and PERT methods by considering the actual ideal conditions, the PERT method produces a shorter duration of completion of the entire project compared to the CPM method.
2. Activities that are considered critical in the gondola project are activities A (making gondola designs), B (material selection), C (ordering materials and negotiating), D (purchasing and delivering materials), E (checking materials), F3 (manufacture of anchoring system), G1 (measurement of setting plate & anchor plate), G2 (drilling and planting of anchors), G3 (tensile anchor test), G6 (mounting steel slings on gondola baskets), H1 (checking all installations and joints), H2 (repainting anti-rust paint), and I (finishing). From the calculation of the PERT method, the probability value or probability of completing the gondola project is 86.65%. This means the possibility of completion of the gondola project by CV. KAT on time is quite high.

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