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Scheduling Analysis of Oil Tank Maintenance Project System Coil Heater Pipe Factory Using CPM Method (Critical Path Method) and PERT (Project Evaluation and Review Technique)

Analisis Penjadwalan Proyek Perawatan Sistem Tangki Minyak Pabrik Coil Heater Pipe Dengan Menggunakan Metode CPM (*Critical Path Method*) dan PERT (*Project Evaluation and Review Technique*)

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ABSTRACT

Scheduling is a crucial part of every project since it influences so many aspects. In spite of the fact that the project isn't wrapping up when it was supposed to, the corporation is sticking to the provided timetable and running into trouble as a result. In this case, the CPM and PERT methodologies will be used to calculate and schedule the project's crucial trajectory in order to foresee any delays in the project's completion. The findings of the analysis show that the activities A through L make up the critical route for one tank's worth of labor, and that the CPM and PERT approaches provide different conclusions. Which, via the use of the CPM approach, cut down the typical project duration of 24 days to 20 days of actual labor time. Meanwhile, the PERT technique shows that a two-hour reduction in the typical project duration-from 24 days to 23 days and six working hours-is possible in 70% of cases.

Keywords: *Scheduling, CPM, PERT*

ABSTRAK

Penjadwalan adalah bagian penting dari setiap proyek karena hal ini mempengaruhi banyak aspek. Terlepas dari kenyataan bahwa proyek tidak selesai pada waktu yang seharusnya, perusahaan tetap berpegang teguh pada jadwal yang disediakan dan mengalami masalah sebagai akibatnya. Dalam hal ini, metodologi CPM dan PERT akan digunakan untuk menghitung dan menjadwalkan lintasan krusial proyek untuk meramalkan keterlambatan penyelesaian proyek. Temuan analisis menunjukkan bahwa aktivitas A hingga L membentuk rute kritis untuk satu tangki tenaga kerja, dan bahwa pendekatan CPM dan PERT memberikan kesimpulan yang berbeda. Yang mana, melalui penggunaan pendekatan CPM, memangkas durasi proyek yang biasanya 24 hari menjadi 20 hari waktu kerja aktual. Sementara itu, teknik PERT menunjukkan bahwa pengurangan dua jam dalam durasi proyek tipikal - dari 24 hari menjadi 23 hari dan enam jam kerja - dimungkinkan dalam 70% kasus.

Kata Kunci: Penjadwalan, CPM, PERT

1. Introduction

The global trajectory in science and technology is marked by a relentless pursuit of accelerating and automating various processes, transcending industries. As civilizations advance technologically, the imperative to sustain progress grows in tandem with the sophistication of existing infrastructure. A natural consequence of development is the proliferation of buildings and other essential infrastructure, collectively termed construction (Zareei 2018). Contractors, integral to this sector, extend their services beyond mere construction, encompassing diverse fields such as civil engineering, environmental management, mechanical engineering, and electrical engineering (Aulia

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& Cipta 2023). Essentially, contractors represent entities, be they companies or individuals, engaged by property or business owners to execute construction projects as per agreed contractual terms (Suryono & Hasbullah 2020; Ngatilah et al., 2021).

Within the framework of industrial progress and technological evolution, projects emerge as succinct tasks with specific objectives. Central to project management are schedules, serving as the roadmap delineating when and how much work should be accomplished. This timeline exerts significant influence on ongoing projects, guiding future actions and facilitating the potential for process optimization and expediency (Andiyan et al., 2020; Kusumadarma et al., 2020). Consequently, there arises a critical need to scrutinize project durations, employing methodologies like the Critical Path Method (CPM) and the Project Evaluation and Review Technique (PERT) to estimate effective project completion times and explore avenues for time optimization (Handayani & Ganistian 2021).

Despite the proliferation of project management methodologies, a conspicuous research gap persists, particularly concerning the analysis of project scheduling within the realm of maintenance projects in the construction domain, notably oil tank maintenance projects (Jo et al., 2018). This gap underscores the necessity for a comprehensive study aimed at elucidating the intricacies of project scheduling specific to maintenance projects, with a focus on oil tank maintenance.

In response to this research gap, the proposed study endeavors to conduct a meticulous analysis of oil tank maintenance project scheduling utilizing CPM and PERT techniques. By delving into the unique challenges and requisites of maintenance projects within the construction sector, this research seeks to augment the existing body of knowledge. Specifically, the study aims to identify the critical path of the ongoing oil tank maintenance project and explore methodologies to truncate its duration through the strategic application of CPM and PERT techniques.

The significance of this research lies in its potential to enhance the efficiency and efficacy of project management practices within the construction industry, thereby fostering industrial progress and technological advancement. Through meticulous analysis and strategic interventions, this study aspires to contribute valuable insights to the construction sector, facilitating streamlined project execution and optimal resource utilization. Ultimately, the research endeavors to catalyze advancements in project management methodologies, facilitating the seamless integration of technological innovations into construction project workflows.

2. Methods

There are two main types of studies in this field: descriptive and quantitative. The Oil Tank Project is currently being studied as a research object. This research requires information such as activity time, project implementation schedule, project activities, project expenditures, and similar information. Primary and secondary sources were used to compile the information presented here. Information was collected in real time during fieldwork by direct observation and interviews with employees, to be used in subsequent data processing. The secondary data collected serves as additional information to process the primary data collected through field observations and employee interviews. In this study, CPM and PERT were used to process the data .

CPM Method

The first step to making this happen is to write down everything that needs to be done for the project and how long it will take. The next step is to select work that is interdependent on each

other. Identifying which activities can be completed in parallel requires an understanding of the interdependencies between them. Once the framework has been established and the dependent activities have been identified, the diagram will be converted into a network diagram, a kind of flow chart that shows the sequence of events (Ihendeson et al., 2019). Critical routes are identified during the process of creating a network diagram. It is important to determine the timing of each activity to calculate the critical route, the longest chain of crucial tasks. The next step is to determine the critical route. Time constraints for the nodes in the network diagram can be set after the critical routes have been identified. Project adaptability can be measured by the calculation of time buffers. Allowances are resources that should be used to reduce potential risks and unforeseen difficulties in a project.

PERT method

The PERT technique is similar to the CPM method in its implementation. The first step is to list the tasks and figure out which ones are interdependent. After listing the tasks and determining their interdependencies, a flow chart will be created that represents the relationship between the tasks (Soni et al., 2022). There are arrows (representing jobs) and nodes (representing milestones) in this network. Next, plan how long you think the project will take. The quickest way to calculate the total time the project will take is to identify the longest route that leads to it. Task progress management is the last phase of the PERT implementation. This can be achieved by resolving all pending dependencies and addressing any issues that arise.

3. Results and Discussion

Job Description and Duration

To meet project objectives, it is important to think about how those resources will be used. Time is an important consideration in planning, but planners must also maintain some level of adaptability given economic, social and other considerations. The following is a summary of the work to be done and the time frame in which it must be completed for the Haeter Coil Pipe Oil Tank System project:

Table 1. Job Description and Duration

No.	Work Activities	Work Duration (Minutes)
I	MT-261 tank pipe thickness check	1440
II	MT-262 tank pipe thickness check	1440
III	MT-263 tank pipe thickness check	1440
IV	MT-266 tank pipe thickness check	1440
V	AT-045 tank pipe thickness check	1440
VI	AT-046 tank pipe thickness check	1440
VII	AT-047 tank pipe thickness check	1440
VIII	AT-048 tank pipe thickness check	1440
	TABLE 1 (continued)	
	Total Working Time	11520 Minutes

Data Processing

CPM and PERT techniques are used to process the data. Estimating the completion time of

the Factory Coil Heater Pipe Oil Tank System using CPM or PERT is the purpose of data processing. And in its application, the activity description only describes the work of one tank. For a thorough explanation and calculation, it is attached to the report.

Work Network with CPM Method (*Critical Path Method*)

By identifying which tasks are on the critical path, CPM analysis can be used to keep the project on schedule. Before applying forward and backward calculations to the CPM method, the details of the activities carried out on the project must first be known, as well as knowing the order of dependence between activities so that the work network that will be made does not experience errors in its application. The following is a description of the flow diagram of the activities of working on one tank according to the sequence of activities with a duration of 1440 minutes or the same as 3 working days:

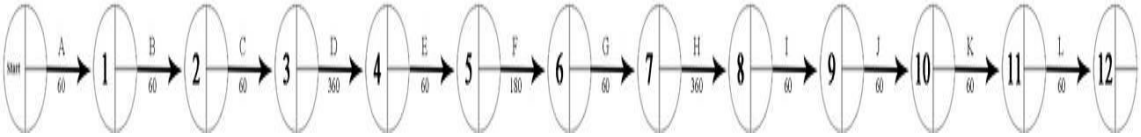

Figure 1. Flowchart of One Tank Work

Forward Calculation

The early finish time and early start time are determined using advanced calculation, which is a calculation approach that starts from the beginning (initial event) to the end (terminal event). In this case, EF is calculated by summing ES and the length of time.

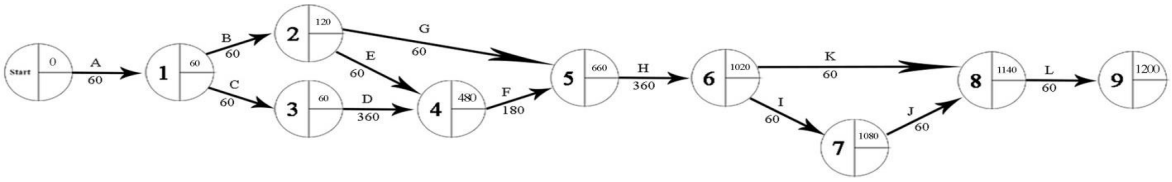

Figure 2. Forward Calculation CPM Work Network Diagram

Backward Calculation

The slowest time (LS) is determined by subtracting the longest time (OF) from the total length of the event (which is the reverse direction of the countdown). Take a look at the CPM rating:

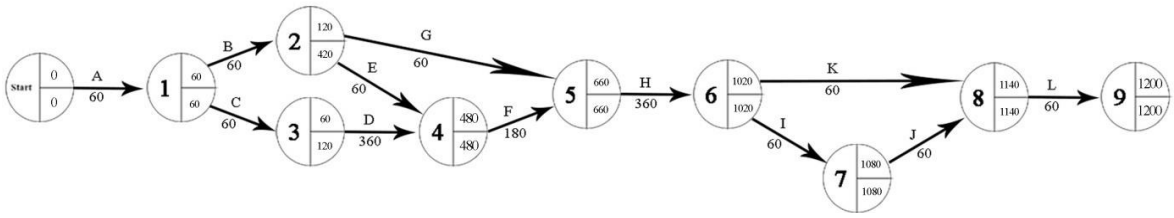

Figure 3. Diagram of CPM Work Network Backward Calculation

Slack or *Float* Calculation

The length of time a task may be delayed without significantly extending the project timeline is known as total float. Subtracting LS from ES or LF from EF yields the entire float. If the Total Float

value for a task is zero, then the task is critical.

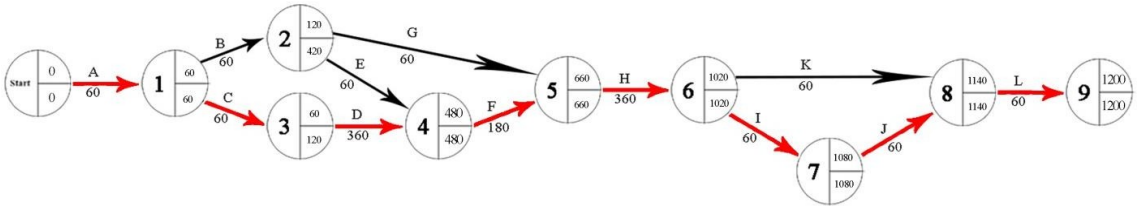

Figure 4. CPM Critical Path

Steps A, C, D, F, H, I, and J, as well as L, are important routes. The results obtained are faster than the initial duration of 1440 minutes to 1200 minutes for one tank. Where the acceleration is obtained is because there are activities that can be done simultaneously and make it more efficient.

***Project Evaluation and Review Tachnique* (PERT) method.**

The likelihood of the project being completed on schedule is analyzed using PERT. Unlike the CPM fixed time, the PERT approach provides three estimates for the duration of each task: an optimistic estimate (a), a most likely estimate (m), and a pessimistic estimate (b). In applying the PERT method to produce clearer calculation results, the time listed on the job description is converted into minutes. Which in 1 working day, the duration of work remains the same, namely 8 hours of work duration. And in its application, the applied duration is converted into minutes to make it clearer in the calculation of standard deviation and variation and probability calculations. When totaled at the most likely duration of 11,520 minutes or equal to 192 working hours which is equivalent to 24 days. In the description described, only one tank is worked on due to the same workmanship in each tank work.

Comparison of CPM and PERT Methods

The time taken to process data varies between the CPM and PERT approaches. Each procedure has a unique critical path. In most cases, the critical route will take the longest. A journey that does not take into account downtime between different parts of the overall process. The defining characteristic of the critical path is the lack of buffer time. This implies that these tasks need to start at the right time to keep the project from running over schedule. Although PERT and CPM are very different from each other in terms of vocabulary and network structure, they both aim to achieve the same thing. These two methods have many similarities in their analysis. The main difference is that PERT calculates three different durations for each activity. Using these estimates, we can determine the task average and standard deviation. Since CPM assumes that the execution time is fixed, it only requires one time factor per task.

Results and Discussion is a section that contains all scientific findings obtained as research data. This section is expected to provide a scientific explanation that can logically explain the reason for obtaining those results that are clearly described, complete, detailed, integrated, systematic, and continuous.

4. Conclusions

The following can be concluded from the data collected and analyzed for the Oil Tank project using CPM and PERT. Using the CPM technique, we found that when all tasks related to a single tank

are performed in the same order (A, C, D, F, H, I, J, and L), we get the critical path. The findings of the study can be broken down into two categories: those caused by the CPM approach and those caused by the PERT method. The result of using the CPM technique shows a reduction of 4 days of working time, from an average of 24 days to 20 working days. The extent to which activities outside the critical route can be performed in parallel with activities on the critical path affects the acceleration that can be achieved. However, when the PERT approach was used, the processing time was reduced from the standard 24 days to just 23 days and 6 hours. Each result of using the strategy is an improvement over the typical duration of project completion. Since the role of engineering, equipment, and worker management is very significant in project work, these aspects must be taken into account to minimize delays and setbacks in project execution from start to finish

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