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APPLICATION OF PROJECT MANAGEMENT BY CV DUTA JAYA TEHNIC KEDIRI USING CPM-PERT METHOD IN DEEP WELL DRILLING PROJECT

Ade Akbar Mahreza Putra[1], Dyah Ayu Septi Fauji[2]
[1,2] Management Department, Universitas Nusantara PGRI Kediri

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Abstract

This research was conducted at one of the construction companies in Kediri, Indonesia, which faced several issues related to project scheduling. Effective and accurate project scheduling problems are important indicators in the construction industry. Therefore, it is crucial to conduct an analysis so that the company can calculate the effective project duration using the CPM-PERT method to enhance effectiveness in project scheduling. The results of this study indicate that critical activities are located at various points in the project, namely points A, B, C, D, E, F, G, H, and I. This identification is crucial as it provides the company with insights to prioritize critical activities. Consequently, the company can complete the project within a period of 90 (ninety) days, ensuring the effectiveness of project execution in line with the contractual agreement. With this timely completion, the company experiences various positive impacts, including trust from clients and other stakeholders, enhancing the company's good reputation, increasing future business opportunities, and positively influencing company growth. This research highlights the importance of effective project scheduling methods in achieving business goals and maintaining a good reputation in the related industry.

✉ Authors
(*) Corresponden Author

Email:
ademahreza0240@gmail.com[1] , emailnyabudiah[2*]

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Introduction

The development of infrastructure in various sectors in the region has experienced rapid and improved growth, in line with the economic advancement and the community's need for infrastructure facilities. Adequate infrastructure development requires effective planning and management, achievable through careful management practices. Good management implementation can be carried out systematically and comprehensively to address specific projects in the field of infrastructure (Yayat Rahmat Hidayat, 2019). The use of project management aims to plan, execute, and supervise a series of project activities with the intention of minimizing risks related to time and cost. This approach is particularly used to achieve goals in construction projects, such as building construction, establishing new offices, or overseeing research and development activities (Lokajaya, 2019). A common issue in projects is the delay in completion, which can significantly impact the overall project implementation. To anticipate potential delays, planning involving the use of various control tools is necessary (Perdana & Rahman, 2019). Project management implementation is required to prevent failure and reduce risks in the project. Effective management must be able to organize activities such as project scheduling and manage human resources directly involved in project implementation. This will ultimately affect the project cost estimates submitted by the company (Yayat Rahmat Hidayat, 2019).

The success or failure of implementing a construction project is greatly influenced by three main factors: Cost, Quality, and Time. Control over the Time factor, often referred to as project scheduling, is a crucial instrument in completing the project. Effective project scheduling should be based on accurate time estimates, and one approach that can be used to achieve this is by applying the Critical Path Method (CPM). According to Sandyavitri (2008) cited in (Mar'aini & Akbar, 2022) the Critical Path Method is a method for planning and monitoring projects, widely used among all other systems that use network formation principles that seek to optimize the total project cost through reducing or accelerating the total project completion time. Following the application of the CPM method, the Project Evaluation and Review Technique (PERT) are also often used. PERT is a Management Science model for planning and controlling a project, assuming that the duration of activities is probabilistic or stochastic due to the variability of construction activities (Yuwono, W., Kaukab, M. E., & Mahfud, Y., 2021) Scheduling a project has significant benefits in helping a company understand the interdependence of activities in the project and how these activities contribute to the overall smoothness of the project. Companies can identify priority relationships between activities in the project, and by doing so, the company can have a realistic timeline to complete each activity in the project (Mar'aini & Akbar, 2022). So far, companies often estimate project time and cost based solely on experience. Problems often arise when the project completion time does not align with the initial agreement, which can damage the company's image by giving the impression that the company cannot meet the agreed-upon contract. Additionally, the company may face additional costs due to inaccuracies in determining the project completion time. There is a possibility that the project owner expects the project to be completed earlier than scheduled or due to external factors such as holidays, year-end turnover, or inadequate weather conditions. In adverse weather conditions, work progress may be hindered, so project implementation may not align with the initial plan, and progress may be slower than planned.

From the above explanation, an integrated approach is needed to control project time and cost to overcome uncertainties in research implementation. Therefore, the identified problem formulation of this research is the difference between the planned time for project work and its actual implementation. Delays in project work execution occur due to the suboptimal use of time and cost during the work execution process.

RESEARCH METHODS

The research method applied is a quantitative approach, which generally involves the use of numerical data. From data collection to data interpretation, this method is closely related to research variables that focus on current issues and ongoing phenomena, presenting research results in an appropriate form. (Sugiono, 2013).

The information required for this research involves the duration of activities, project schedules, project costs, and project workforce estimates. The data collection methods in this study include the use of both primary and secondary data:

a. Primary Data

Primary data refers to information that originates directly from the source provided to the researcher. This primary data is obtained directly from the first party, usually through methods such as interviews, observations, and other means. In the context of this research, the collected primary data includes information about the relationships between activities obtained through interview results.

b. Secondary Data

Secondary data refers to information obtained through reading, studying, and understanding other sources, such as literature, books, and other documents. In the context of this research, the collected secondary data comes from internal company information, such as Bill of Quantities (BOQ), building design books, and project schedule timelines..

Data analysis and the application of project scheduling theory will be conducted based on the gathered information. The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) methods will be employed to enhance the effectiveness of project management undertaken by CV DUTA JAYA TEHNIC in the well drilling project..

RESULT

Creating a list of activities or tasks is a method to outline various actions involved in the well drilling project, following the steps below:

a. Table 1 Activity Detail Code

No.	Rincian Kegiatan	Kode
1	Pemberangkatan Alat dan Bahan/Material	A
2	Pembersihan dan Persiapan Lokasi	B
3	Pengeboran	C
4	Pumping Test Sementara	D
5	Pemasangan Pipa Kontruksi	E
6	Pemasangan Gravel Pack	F
7	Pumping Test 12 Jam Non-Stop	G
8	Pengecoran	H
9	Pembersihan Lokasi	I

b. Assigning identification codes to each task aims to facilitate the process of network planning. The details of this arrangement can be accessed through Table 1.

1. Inserting the duration for each well drilling task.

2. Assembling project tasks based on the sequence of dependencies for each task from the beginning to the end of the project. The details can be monitored in Table 2.

Table 2 *Network Planning*

No.	Kode	Durasi (Hari)	Pendahuluan	Lanjutan
1	A	1	A	B
2	B	3	A	C
3	C	40	B	D
4	D	1	C	E
5	E	20	D	F
6	F	14	E	G
7	G	1	F	H
8	H	7	G	I
9	I	3	H	I

Next, a network diagram is created to illustrate the relationships between activities, making it easier to understand the sequence of tasks. This network diagram can be seen in the illustration in Figure 1.

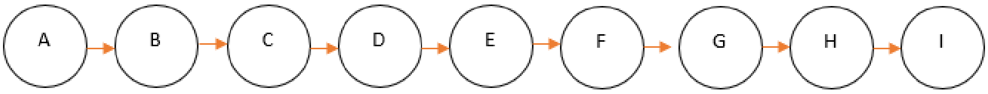


Figure 1 Network Diagram

In the table and diagram above, you can see the relationship between preceding and succeeding tasks, where each task depends on the completion of its predecessor. For example, task B cannot be executed without the completion of task A as its predecessor, and this continues with task C and so on, resulting in the creation of the critical path for each task from the beginning (task A) to the end (task I) as depicted in the network diagram in Figure 1. To streamline the work undertaken by the implementing company, it is crucial to conduct an analysis so that the company can calculate the effective project duration using the CPM-PERT method.

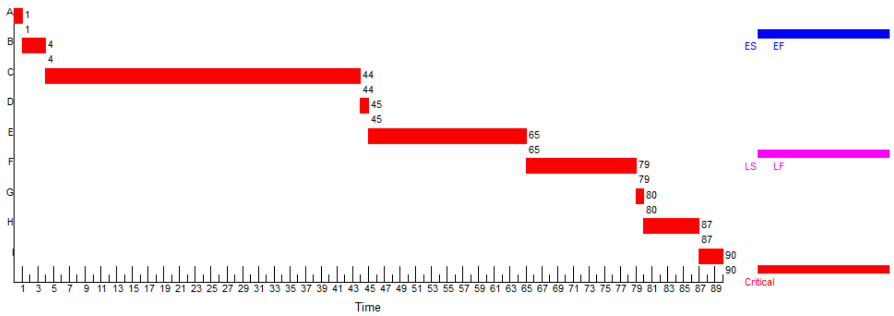
In the Critical Path Method (CPM), we are presented with both the Forward Pass and Backward Pass calculations to measure accuracy in each task of this deep well drilling project. Given the dependencies in each task within the context of this project, and with the identification of the critical path for each task, it results in the forward and backward calculations in this project being closely related to the predetermined durations for each task, as outlined in Table 3..

Tabel 3 Forword Pass and Backward Pass

Activity	Start node	End node	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project			90					
A	0	1	1	0	1	0	1	0
B	1	3	3	1	4	1	4	0
C	3	43	40	4	44	4	44	0
D	43	44	1	44	45	44	45	0
E	44	64	20	45	65	45	65	0
F	64	78	14	65	79	65	79	0
G	78	79	1	79	80	79	80	0
H	79	86	7	80	87	80	87	0
I	86	89	3	87	90	87	90	0

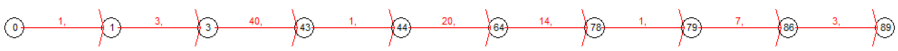
The graph depicting the results of the Forward Pass and Backward Pass calculations from Table 3 can be presented in diagram form in Figure 2.

Figure 2 Early Time and Late Time Graph



After understanding the durations from the Forward Pass and Backward Pass calculations, as outlined in Table 3 and Figure 2, the next step is to represent them in the form of a network diagram, as seen in Figure 3.

Figure 3 CPM Network Diagram



In Figure 3, the CPM network diagram for the deep well drilling project reveals the critical path for each task, namely at points A, B, C, D, E, F, G, H, I, with a project completion time of 90 working days, considering the agreed-upon contract between the contracting company, CV DUTA JAYA TEHNIC, and the client for a 3-month (90 working days) project duration.

In PERT (Project Evaluation Review Technique), we need to estimate task durations by comparing predetermined times with existing historical data. Therefore, past experience data can be used as a reference. The estimated durations, including optimistic, realistic, and pessimistic values, can be identified in Table 4..

Table 4

No.	Kode	Durasi Optimis (a)	Durasi Realistis (m)	Durasi Pesimis (b)
1	A	1	1	1
2	B	1	3	4
3	C	35	40	45
4	D	1	1	1
5	E	14	20	25
6	F	10	14	18
7	G	1	1	1
8	H	5	7	8
9	I	2	3	4

After determining the optimistic, realistic, and pessimistic durations, the next step is to find the expected duration (te), which can be calculated using the following formula:

$$Average\ duration\ (te) = \frac{a + 4m + b}{6}$$

where:
a : *optimis time* (day)
m : *realistis time* (day)
b : *pesimistis time* (day)
Example calculation of task duration (te) is as follows:a : 1 day
m : 3 day
b : 4 day
Therefore:

$$(te) = \frac{a + 4m + b}{6}$$

$$(te) = \frac{1 + (4\ x\ 3\ ) + 4}{6}$$

(te) = 2,83 day

Table 5 Average Durations (*te*)

No.	Kode	Durasi Optimis (a)	Durasi Realistis (m)	Durasi Pesimis (b)	Durasi te = (a+4m+b)/6
1	A	1	1	1	1
2	B	1	3	4	2,83
3	C	35	40	45	40
4	D	1	1	1	1
5	E	14	20	25	19,83
6	F	10	14	18	14
7	G	1	1	1	1
8	H	5	7	8	6,83
9	I	2	3	4	3
TOTAL		70	90	107	89,49

The calculation results for the expected task durations (te) can be observed in the following Table 5:

Table 6 Forward Calculation (te)

No.	Kode	Early Start	Durasi (hari)	Early Finish
1	A	0	1	1
2	B	1	3	3,83
3	C	3,83	40	43,83
4	D	43,83	1	44,83
5	E	44,83	20	64,67
6	F	64,67	14	78,67
7	G	78,67	1	79,67
8	H	79,67	7	86,6
9	I	86,5	3	89,5

By using the te values (expected durations), we can simplify the creation of the PERT network diagram, considering that in project planning, diagram creation is considered a crucial step. The forward calculation results are shown in Table 6, and the backward calculation results are presented in Table 7.

Table 7 Backward Calculation (*te*)

No.	Kode	Late Start	Durasi (hari)	Late Finish
1	I	86,5	3	89,5
2	H	79,67	7	86,5
3	G	78,67	1	79,67
4	F	64,87	14	78,67
5	E	44,83	20	64,87
6	D	43,83	1	44,83
7	C	3,83	40	43,83
8	B	1	3	3,83
9	A	0	1	1

As in the CPM approach, after forward and backward calculations based on time in the PERT method, a network diagram is then created, as depicted in Figure 4.

Image 4 PERT Network Diagram

In the PERT network diagram in Figure 4, the critical path of the deep well drilling project is identified at each stage, namely points A, B, C, D, E, F, G, H, I, with a project completion duration of 89.5 working days. After calculating the average time for each task, the next step involves calculating the standard deviation and variance, as outlined below:

Standard deviation (se)
The formula for standard deviation is:

$$(se) = \frac{b-a}{6}$$

where:
a = *optimis time* (day)
b = *pesimis time* (day)
6 = standard diviation
Example calculation of standard deviation (se) is as follows:
Site Cleaning and Preparation
a = 1 day
b = 4 day
6
Therefore:

$(se) = \frac{b-a}{6}$

$(se) = \frac{4-1}{6}$

$(se) = 0{,}5 \text{ day}$

Variance (ve)
The formula for variance is:

$$(ve) = \{\frac{b-a}{6}\}^2$$

Where:
a = *optimis time* (day)
b = *time* (day)
6 = standard diviation
Example calculation of variance (ve) is as follows:
Site Cleaning and Preparation
a = 1 day
b = 4 day
6
Therefore:

$(ve) = \{\frac{b-a}{6}\}^2$

$(ve) = \{\frac{4-1}{6}\}^2$

$(ve) = 0{,}25 \text{ day}$

By applying the standard deviation (sd) and variance (var) formulas presented above, the results obtained can be seen in Table 8.

DISCUSSION

Table 8 Deviation and Variance

No.	Kode	Durasi Optimis (a)	Durasi Realistis (m)	Durasi Pesimis (b)	Deviasi (se) s = 1/6(b-a)	Varians (ve) $V = S^2$
1	A	1	1	1	0	0
2	B	1	3	4	0,5	0,25
3	C	35	40	45	1,67	2,78
4	D	1	1	1	0	0
5	E	14	20	25	1,83	3,36
6	F	10	14	18	1,33	1,78
7	G	1	1	1	0	0
8	H	5	7	8	0,5	25
9	I	2	3	4	0,33	11

The results of data analysis using the CPM method for the deep well drilling project identify the critical path for each stage of work, including:

A = Departure of Equipment and Materials
B = Site Cleaning and Preparation
C = Drilling
D = Temporary Pumping Test
E = Construction Pipe Installation
F = Gravel Pack Installation
G = 12-Hour Non-Stop Pumping Test
H = Casting
I = Site Cleaning

The project completion time for tasks involving the critical path is 90 days. However, in the PERT method, despite having the same critical path as the CPM method, the project completion time is different. In the PERT method, the critical path includes:

A = Departure of Equipment and Materials
B = Site Cleaning and Preparation
C = Drilling
D = Temporary Pumping Test
E = Construction Pipe Installation
F = Gravel Pack Installation
G = 12-Hour Non-Stop Pumping Test
H = Casting
I = Site Cleaning

The project duration in the PERT method is 89.5 days, which is then simplified to 89 and a half days.

CONCLUSION

Based on the results of data processing in the deep well drilling project carried out by CV DUTA JAYA TEHNIC KEDIRI, the following conclusions can be drawn:

a. In the deep well drilling project, whether using the CPM or PERT method, critical paths were identified for each type of work. These tasks include equipment and material departure, site cleaning and preparation, drilling, temporary pumping test, construction pipe installation, gravel pack installation, 12-hour non-stop pumping test, casting, and site cleaning.

b. The duration of the project, as determined by the CPM analysis, is 90 days. This duration needs to be strictly adhered to in order to prevent negative impacts at each stage of the work and to achieve effective work in accordance with the agreed-upon contract between the company and the client.
c. The data processing difference between the CPM and PERT methods resulted in a half-day working difference.
d. To avoid interference between types of work and to prevent delays and ensure timeliness, strict supervision and control are necessary since each task is a critical path

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