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Faculty Information Systems Project Management: A Comparison of *CPM* And *PERT Methods*

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Abstract

This research evaluates the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) to determine the most efficient scheduling method for the development of an information system at the Faculty of Economics and Business, Universitas Pakuan. The system aims to consolidate work unit information and assist faculty leaders in decision-making. Both methods identified the same critical path (A-B-C-E-G-H), ensuring focus on activities critical to project completion. The CPM method estimated a project duration of 50 days, while the PERT method estimated 52 days. The two-day difference reflects CPM's deterministic and optimistic approach, making it suitable for projects with predictable timelines. PERT, with its probabilistic calculations, incorporates activity duration variations and risks, providing more conservative estimates for projects with higher uncertainty. Due to its shorter duration and potential cost savings, the CPM method is recommended for the Faculty's information system development project. This research emphasizes the importance of selecting a scheduling method aligned with project complexity and uncertainty.

Keywords: Information System; CPM; PERT; Project Management; Critical Path

1. Introduction

The rapid advancement of technology has introduced various methods that make tasks more efficient and accessible for people. The ability of technology to process and calculate tasks has improved significantly over time. These advancements are deeply rooted in methods and algorithms that were previously developed. For any project to achieve its optimal objectives and be completed efficiently, proper planning is essential. The time spent executing a project directly impacts the costs incurred. Since most projects have strict deadlines, implementing the right strategy is crucial to reducing time and ensuring completion ahead of schedule [1].

The Faculty of Economics and Business at Universitas Pakuan plans to develop a system that consolidates information from various work units within the faculty. This system is designed to facilitate performance monitoring across units, enabling faculty leaders and deans to make informed decisions more effectively. The system will be developed as a website, ensuring accessibility for all faculty leaders and employees. To complete the website project, the Dean appointed a team of four individuals, including one

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IT head and three IT unit members. The project will be executed in stages, starting with determining the system requirements and concluding with the maintenance phase. The website development follows the SDLC waterfall model, where each stage is completed sequentially and systematically.

This structured approach aligns seamlessly with the use of the Critical Path Method (CPM) that has been conducted on research in optimizing time and cost on a project[2], [3] and the Program Evaluation and Review Technique (PERT) [4], [5]during the project scheduling phase. These methods aim to optimize timelines, ensure adherence to deadlines, and identify critical activities that require priority. By integrating CPM and PERT into the waterfall model, the study seeks to improve project efficiency and enhance decision-making processes. According to the *Project Management Body of Knowledge* (PMBOK), effective project scheduling is essential for achieving desired outcomes, and this study adopts proven methodologies to ensure the successful completion of the project [6].

This research focuses on the field of project scheduling, emphasizing its importance as a critical component of project management. Methods such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) offer systematic approaches to planning and optimizing schedules. These methods play a vital role in implementing effective project scheduling theories. The research aims to compare the CPM and PERT methods in the context of developing a faculty information system. The objective is to determine the most optimal scheduling method that can be effectively applied to the project, ensuring efficiency and timely completion. Research related to the application of the CPM method in information system development projects has been conducted by [7] who apply the CPM (Critical Path Method) method in information system development projects. The result of the study is that the CPM method has succeeded in determining the critical path in the information system development project so that it can be applied by the project team to know important activities that should not be delayed. Then, in the research [8] shows that the application of the PERT and CPM methods in the Knowledge Management System development project has a probability of success in completing the project within 21 weeks of 93.19%. Based on this research, this study will try to apply the CPM and PERT methods to determine the most optimal scheduling method in the faculty information system development project at the Faculty of Economics and Business, Universitas Pakuan.

2. Methods

Project scheduling is planning related to the running time of activities on the project. Each activity in the project is sorted one by one so that it forms a network. Therefore, there is a method of compiling a schedule called network analysis. In scheduling, the time needed to work on an activity on the project is also determined [9].

2.1 Critical Path Method (CPM)

This study uses the *Critical Path Method* method as the basis for determining the critical path in the faculty information system development project at Universitas Pakuan. The *Critical Path Method* is a method used at the project planning and control stage to determine the relationship between activities in the project. Based on these relationships, it will be possible to determine the critical path to the relationship between activities in the project [10]. The calculation steps using the *Critical Path Method* method are as follows [11], [12].

1. Collect information related to activities on the project, such as the name of the activity, the duration of the activity in units of time, the order of activities from start to finish.
2. Perform forward *pass* calculations, which are calculations to find out the earliest start time (*early start*) and the fastest finish time (*early finish*) on each activity *node*. The formula for forward calculation is as follows:

$$EF_{(i-j)} = ES_{(i-j)} + D_{(i-j)} \quad (1)$$

Information:
$EF_{(i-j)}$ = Fastest completion time
$ES_{(i-j)}$ = Fastest start time
$D_{(i-j)}$ = The duration of an activity

3. Perform a *backward pass*, which is a calculation to find out the longest start time (*latest start*) and the longest finish time (*latest finish*) on each activity *node*. The formula for the countdown calculation is as follows:

$$LF_{(i-j)} = LS_{(i-j)} + D_{(i-j)} \quad (2)$$

Information:
$LF_{(i-j)}$ = Longest completion time
$LS_{(i-j)}$ = Longest start time
$D_{(i-j)}$ = The duration of an activity

4. Identify *float time*, which is the delay in the implementation of an activity that does not affect the overall project delay. The total *float time* with a value of 0 is referred to as the critical path. The float *time formula* is explained as follows:

$$TF = LF_{(i-j)} - EF_{(i-j)} - D_{(i-j)} \quad (3)$$

Information:
TF = time delay in the implementation of an activity
$LF_{(i-j)}$ = Longest completion time
$D_{(i-j)}$ = The duration of an activity

5. Conducting analysis and determination of the critical path produced. The critical path greatly determines the life of the project, if the activities on the critical path are delayed, the duration of the project work will be delayed, but if on the other hand, if the activities on the critical path are carried out faster, the project duration will also be accelerated.

2.2 Program Evaluation and Review Technique (PERT)

PERT is a technique with a probabilistic approach that is used at a high level of uncertainty. PERT originated in the United States Navy in 1958 as a tool for scheduling the development of weapon systems. There are three estimation numbers in the PERT calculation, namely optimistic time (tα), realistic time (tm) and pessimistic time (tβ) [13]. The stages in using the PERT method are as follows [14], [15].

1. Collect information related to activities on the project, such as the name of the activity, the duration of the activity in units of time, optimistic time, realistic time, pessimistic time, and the order of activities from start to finish.
2. Calculate t(mean) with the following formula:
$$t(mean) = \frac{t\alpha+4tm+t\beta}{6} \quad (4)$$
3. Calculate the variant (v) with the following formula:
$$v = (\frac{t\beta-t\alpha}{6})^2 \quad (5)$$
4. Arrange a network diagram using t(mean) as the processing time.
5. Determine the early finish and latest finish using the formula 1 and 2.
6. Determine the critical path on nodes that have a value of 0 from the result of the difference between the early finish and the latest finish.

This study uses the *Critical Path Method* (CPM) and *Program Evaluation and Review Technique* (PERT) [16] as the basis for determining the critical path in the faculty information system development project at the Faculty of Economics and Business, Universitas Pakuan. The two methods will be compared until each method produces a total project duration. The method with the smallest total duration will be selected as the most optimal method to be applied to the faculty's information system development project.

Based on the method used, the stages of this research can be seen in figure 1. The stages start from the collection of research data, continue with the application of *the critical path method* on the research data [17], and end with the feasibility test of the CPM method in the development of the faculty information system project. The feasibility test used is by using a feasibility test questionnaire that will be filled out by the chairman and two IT members of the faculty as parties directly involved in the project.

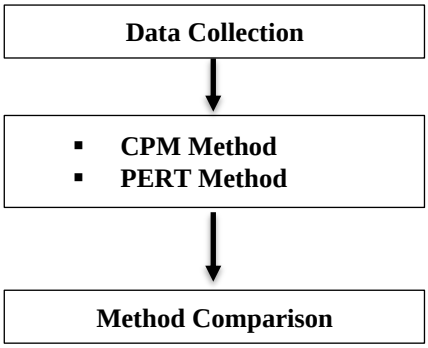

Figure 1. Research Stages

This research uses data related to activities carried out in the information system development project or *dashboard* of the Faculty of Economics and Business, Universitas Pakuan. The data was obtained from the results of observations and interviews with the chairman and two IT members of the faculty as parties involved in the project so that data on activities carried out in the development of the faculty *dashboard* were retrieved.

3. Result and Discussion

The data in this study was obtained from the project manager of the faculty information system development, Faculty of Economics and Business, Universitas Pakuan. The data attributes used as a whole are the name of the activity, the optimistic time of the activity, the realistic time of the activity, and the pessimistic time of the activity. The data will be applied to the CPM method and the PERT method according to the needs of each method.

3.1 CPM Method

The *Critical Path Method* requires several data attributes in its calculation, including the activity code, *predecessor*, and activity duration as seen in table 1. In the duration attribute, *early finish* is carried out using formula 1 and *latest finish* using formula 2. The calculation results can be presented in the format of *a network diagram* as seen in figure 2.

Table 1. Estimated Activity Time

Activity	Code	*Predecessor*	Duration (Days)
Systems *Engineering*	A	-	7
Website *Requirement Analysis*	B	A	3
Website *Design*	C	B	12
Database Preparation	D	C	5
Coding Backend	E	C	20
Coding Frontend	F	C	18
Testing and Verification	G	D, E, F	5
Maintenance	H	G	3

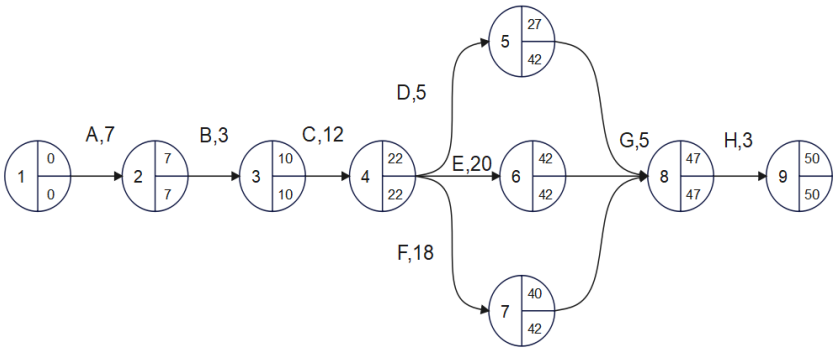

Figure 2. Network Diagram with Early Finish and Latest Finish Values CPM Method

After the duration attribute goes through the early *finish* and *latest finish* calculation stages, the next step can be determined as a critical path. Presenting the results of *the calculation of early finish* and *latest finish* in the form of *a network diagram* can make it easier to determine the critical path. As can be seen in figure 3, the critical path can be determined by selecting each node that has a value of 0 from the difference between formulas 1 and 2. In the CPM method for faculty information system development projects, the critical path is in the A-B-C-E-G-H node or activity.

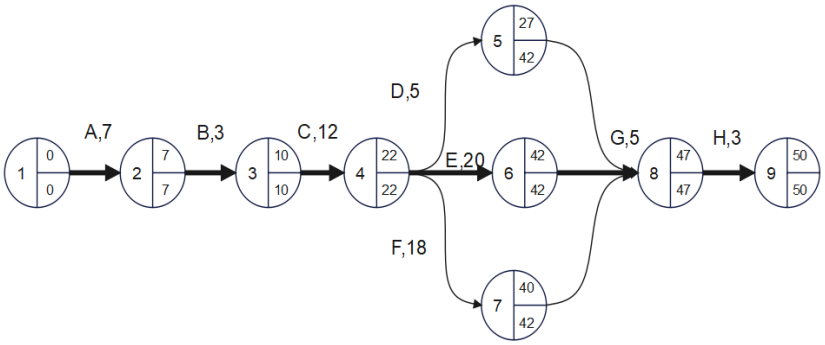

Figure 3. Critical Path of CPM Methods

3.2 PERT Method

Table 2 displays information about the estimated time required by each activity in the faculty information system development project. If the CPM method only requires the duration (days) attribute as the basis for calculation, then the PERT method requires three attributes as the basis for calculation, namely optimistic time, realistic time, and pessimistic time.

Table 2. Estimated Activity Time

Activity	Code	*Predecessor*	Optimistic Times (tα)	Realistic Time (tm)	Pessimistic Times (tβ)
Systems *Engineering*	A	-	5	7	10
Website *Requirement Analysis*	B	A	2	3	5
Website *Design*	C	B	11	12	17
Database Preparation	D	C	4	5	8
Coding Backend	E	C	15	20	22
Coding Frontend	F	C	12	18	20
Testing and Verification	G	D, E, F	4	5	8
Maintenance	H	G	2	3	7

From the data available in table 2, the second and third steps of the PERT method can be determined, namely calculating t(mean) or mean time and variance using formulas 2 and 3. The results of the calculation are presented in table 3.

Table 3. Results of t(mean) and v calculation

Kode	*Predecessor*	tα	tm	tβ	t (mean)	V
A	-	5	7	10	7	0,69
B	A	2	3	5	3	0,25
C	B	11	12	17	13	1,00
D	C	4	5	8	5	0,44
E	C	15	20	22	20	1,36
F	C	12	18	20	17	1,78
G	D, E, F	4	5	8	5	0,44
H	G	2	3	7	4	0,69

The next step is to create *a network diagram* to make it easier to determine the critical point. *The network diagram* prepared in the PERT method has the same concept as the CPM method, namely by calculating *the early finish* time and *latest finish* using the formulas 1 and 2 which are calculated using the t(mean) value. In detail, the results of the preparation of *the network diagram* can be seen in figure 4.

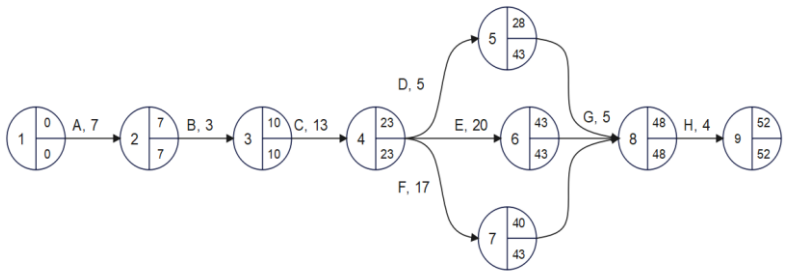

Figure 4. *Network Diagram* with *Early Finish* and *Latest Finish Values* of the PERT Method

The network diagram that has been prepared can facilitate the process of determining critical paths in the PERT method. Critical paths can be arranged based on nodes that have a value of 0 from the difference between *the early finish* and *the latest finish*. As seen in Figure 5, the critical path in the PERT method is located at the node or activity A-B-C-E-G-H.

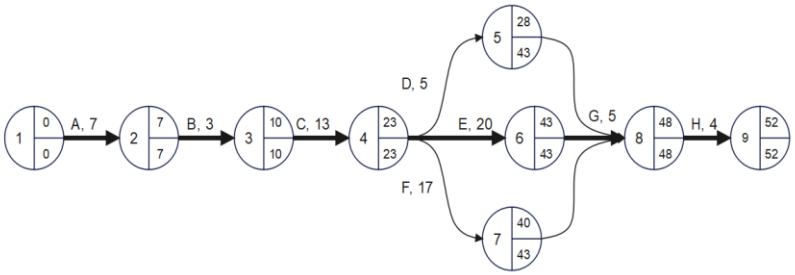

Figure 5. Critical Path of the PERT Method

3.3 Method Comparison

After calculating using the CPM and PERT methods and determining the critical path, the next stage is to compare the two methods. In figure 3 the calculation of the time required to complete the project using the CPM method is 50 days. Meanwhile, by using the PERT method, the time required to complete the project is 52 days. Both methods have critical pathways in A-B-C-E-G-H activity. The results of the study provide a comparison between two project management methods, namely CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique), to determine the project completion time and its critical path. The results of this comparison provide a clearer picture of the efficiency and accuracy of the two methods in managing project time.

3.3.1 CPM and PERT Method Analysis

a) CPM (Critical Path Method):
   a. Objective: CPM is designed to calculate project completion time by identifying the longest path of activity called the critical path. This method uses a definite or deterministic time of activity.
   b. Results: Based on calculations, the CPM method shows that the time required to complete the project is 50 days. This reflects a more assertive time estimate and does not consider possible time variations.
   c. Advantage: CPM is simpler to use because it focuses on a single time estimate for each activity and is especially useful in situations where project activities have low time uncertainty.

b) PERT (Program Evaluation and Review Technique):
   a. Objective: PERT is more suitable for use when there is uncertainty in the duration of project activities. This method uses a probabilistic approach by considering three time estimates: optimistic (fastest time), most likely (normal time), and pessimistic (longest time).
   b. Results: Calculations using the PERT method show that the time required to complete the project is 52 days. This estimate tends to be more conservative because it takes into account the risk of delays in activities.
   c. Advantage: PERT is able to provide greater flexibility in scheduling by taking into account uncertainty and variation in the duration of each activity, making it suitable for

use in more complex projects.

3.3.2 Comparison of the Two Methods

a. Duration Difference: The CPM method provides a shorter project completion time of 50 days, compared to the PERT method which takes 52 days. This two-day difference indicates that the CPM method is more optimistic in its estimates because it does not take into account variations or possible delays.
b. Risk Assessment: The PERT method is more realistic in scheduling because it incorporates risk factors and uncertainties that are not considered in the CPM. This makes PERT more suitable for projects that have a high level of uncertainty or that require more careful planning.
c. Suitability of Use: CPM is more efficient to use for projects that have activities with a definite duration and little uncertainty, while PERT is more suitable for projects with a high level of uncertainty where variations in the duration of activities are significant.

3.3.3 Critical Path Similarity

a. Critical Path Identification: Despite differences in the total duration of the project, both CPM and PERT identify the same critical path, which is in the A-B-C-E-G-H activity. This critical path includes a sequence of activities that must not be delayed in order for the project to be completed on time.
b. Implications of the Critical Path: Focusing on activities within the critical path is crucial because any delay in these activities will directly affect the total duration of the project. Therefore, activities on critical paths must be managed properly to minimize the risk of delays.

3.3.4 Conclusion of CPM and PERT Comparison

a. The main difference between CPM and PERT methods lies in their approach to project timing uncertainty. CPM provides a more direct and optimistic approach with a shorter time, while PERT offers a more realistic and conservative approach with a longer time.
b. Both are equally effective in determining the critical path of a project, but the use of the right method depends largely on the complexity and level of uncertainty of the project being undertaken. CPM is better suited for definite and predictable situations, while PERT excels in the face of uncertainty.

4. Conclusion

The calculation process of the PERT and CPM methods results in the same critical path, namely at nodes A-B-C-E-G-H. However, the PERT method has a longer scheduling duration compared to the CPM method in the Faculty, information system development project at the Faculty of Economics and Business, Universitas Pakuan. The difference in duration between the PERT method and the CPM method is 2 days and this can affect the cost of the Faculty of Economics and Business, Universitas Pakuan. So that the CPM method is more suitable to be applied as a scheduling method in the Faculty, information system development project at the Faculty of Economics and Business, Universitas Pakuan.

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