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PREFACE

It is my great pleasure to warmly welcome you to the Sixth International Conference on Informatics and Computing (ICIC 2021) held for the second time, ONLINE. The ICIC is a conference series which is conducted annually by APTIKOM, the Indonesian Association of Higher Education in Informatics and Computing. This year the main theme of the conference is ***"Empowering Artificial Intelligence to Accelerate Digital Transformation in the Era of the Industrial Revolution 4.0"***, with an intention to bring up more awareness in our society on the importance of Artificial Intelligence in the current era and beyond.

The ICIC conference series as a flagship conference of APTIKOM serves as an arena for academicians and their students, experts and practitioners from the industry to meet, present, and have fruitful discussions on their research works, ideas, and papers in the wide areas of Computing which covers Computer Science, Information Systems, Information Technology, Software Engineering, and Computer Engineering. The conference is set to provide opportunities for participants from both academia and industry to share and exchange knowledge as well as the cutting-edge development in the computing field. It is expected that the ICIC participants will be able to take away new thinking and horizon from this conferential meeting to further their works in the area.

There are 164 papers submission and only 80 papers are accepted which is around 48% acceptance rate only. The accepted papers will be presented in one of the 8 regular parallel and tracks sessions and will be published in the conference proceedings volume. The diversity of authors come from 6 different countries.

All accepted papers are submitted to IEEE Xplore. IEEE Conference Number: ## 54025. Catalog Number: CFP21G52-ART ISBN: 978-1-6654-2155-3

On behalf of the ICIC 2021 organizers, we wish to extend our warm welcome and would like to thank for all Keynote Speakers, Reviewers, Authors, and Committees, for their effort, guidance, contribution and valuable support. We would like to also extend our gratitude to IEEE Indonesia Section for technically co-sponsored this event.

I wish you all a most wonderful, enjoyable, and productive conference in this ICIC 2021.

Thank you.

Wa billahi taufiq wal hidaayah.
Wallahul muwaffiq ila aqwamit tharieq.

Wasalaamu ‘alaykum warahmatullahi wabarakaatuh.

Yusuf Durachman

Organizing Chair

TABLE OF CONTENT

2021 Sixth International Conference on Informatics and Computing (ICIC) | 978-1-6654-2155-3/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICIC54025.2021.9633013

Implementation of the Program Evaluation and Review Technique (PERT) Method to Determine Estimated Time of Project Completion

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Abstract. One of the causes of failure in a project is the project completion time that exceeds a predetermined time limit. The purpose of this study is to assist the project manager in making a project schedule, when the project starts and when the project is finished and how long it takes to complete the project. In addition, the purpose of this study is to be able to compare the implementation time in the field using existing methods as well as what actions must be taken if there are obstacles in the project. One method that can be used to analyze the time used to complete a project is the Program Evaluation and Review Technique (PERT) method. PERT is a method that has three-time durations, namely optimistic, most likely, and pessimistic time. PERT can also provide information about the project completion period, before the specified date, the critical path that has an impact on the project completion time. The result of this research is to assist the project manager in determining how long it will take to implement the project and to know which work is considered critical (work that cannot be postponed) so that any obstacles can be overcome so that the project can be completed on time.

Keywords: *PERT, program evaluation and review technique, project schedule*

INTRODUCTION

A temporary organization in which there is a combination of labor (human), materials, equipment, facilities, and support services such as capital/costs to achieve predetermined goals and objectives is called a project [1]. Or in other words, a project is a combination of several resources (labor, budget, equipment, facilities, support services within an organization to achieve certain goals [2]. Project activity is said to be successful if all the scope of work can be fulfilled with good quality, the match between the realization of the schedule, the costs incurred, and the time limit that has been determined [3]. To get a successful project, a project manager requires good project management. Project management is an effort to plan, organize, direct, coordinate, and supervise activities in such a project. Such that it is in accordance with the predetermined time schedule and budget [4]. In planning the project schedule and control, one of the methods used is the Project Evaluation and Review Technique (PERT) method [5].

PERT is a method that has three-time durations, namely optimistic, most likely, and pessimistic time which is used to analyze the project completion time. It is done by looking for the critical path, identifying the start and end time of each project activity, and calculating the amount of slack time for each activity so that it is able to minimize project delays [6]. PERT was first used in 1957 on a project owned by the US Navy to create the Polaris project, which is a project to manufacture guided missiles that can be fired from a submarine towards its target on the ground or in the air. Initially, the project was designed to be completed within five years may be shortened by less than five years. Admiral WF Raborn compiled an integrated planning and control system which was later developed in a study and named the PERT method [7].

Several previous studies that used PERT research were conducted by E. Dannyanti in 2010 [8], A. Goksu and S. Catovic in 2012 [9], W. Agyei in 2015 [10], S. Chatwal in 2014 [11], as well as Haga and Marold in 2005 [12].

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PERT is used to speed up the project completion time, and the project can be completed not exceeding the predetermined time limit.

The purpose of this study is to assist the project manager in determining how long it will take for project implementation. In addition, it can help project managers to find out which jobs are included in the critical work path and what actions will be taken in the event of constraints on critical work. In this study, PERT was used to design a project schedule so that a critical work path was obtained in a manufacturing project for making marble floors and kitchen tables. By using PERT, the project time and critical work paths can be identified so that the project can be completed on time.

METHOD

The research methodology in this study uses descriptive methods. The descriptive method is a method used to create descriptions, pictures, or paintings in a systematic, factual, and actual manner regarding the facts, characteristics, and relationships between the phenomena being investigated [13]. The research methodology in this study began with a review of the PERT literature study along with collecting secondary data and determining the details of the work. The next step is to estimate work time into 3 types of time, namely optimistic time (to), most likely (m), and pessimistic time (tp). After that, it calculates the value of the expected time (te), standard deviation (S), and variance (S2). After that, perform forward, backward and slack calculations and finally look for the probability value of the project completion time, which can be used to help the project manager find out when starting the project and when the project is finished, and what actions must be taken if there are obstacles that can hinder project activities [14].

RESULTS AND DISCUSSION

Secondary Data Collection

The data used in this study is the project of making marble floors and kitchen tables for Hotel Nusa Bakti with a project time of 90 days, starting from February 10, 2020, to May 9, 2020. There are eleven steps in determining the time needed to complete the project using the PERT method [14]. This step starts from determining the details of the project work, then continues by calculating the estimated time of work which includes optimistic time (to), most likely (m), pessimistic time (tp), then calculating the value of expected time (te), standard deviation (S), variance (S2). After that, perform forward, backward and slack calculations and finally look for the probability value of the project completion time [15].

Specifying Job Details

A job breakdown structure is work done to organize workers in completing project production work. The structure of the work breakdown in this study is shown in Table 1.

TABLE 1. Job Details.

No.	Job description	Duration	Start	Finish
I	**Cutting Work**			
I.1	Cut out the size pattern	10 Days	10/02/2020	19/02/2020
I.2	Chisel the base and table legs	20 Days	20/02/2020	10/03/2020
I.3	Floor cut	12 Days	11/03/2020	22/03/2020
II	**Calibration Work**			
II.1	Desk calibration	8 Days	23/03/2020	30/03/2020
II.2	Floor calibration	8 Days	31/03/2020	07/04/2020
III	**Caulking work**			
III.1	Floor and Countertop Putty	12 Days	08/04/2020	19/04/2020
IV	**Polishing Work**			
IV.1	Polishing	12 Days	20/04/2020	01/05/2020
V	**Packing Work**			
V.1	Packing	8 Days	02/05/2020	09/05/2020
	Total Job Duration	90		

Calculating the Estimated Work Time

Estimating the time of each work item into 3 types of time, namely time optimistic (to), most likely (m), and time pessimistic (tp) [15], where the most likely (m) value is taken from the time duration of the work in Table 1. The results of this estimate were obtained from interviews with the project manager and are shown in Table 2.

TABLE 2. Job Details and Time Estimates Optimistic, Most Likely and Pessimistic

No.	*Jobs*	*Code*	*Precursor*	*Optimistic*	*Most Likely*	*Pessimistic*
1	*Cut Pattern Size*	*I.1*	-	*8 Days*	*10 Days*	*16 Days*
2	*Foot Chisel and Table Pedestal*	*I.2*	*I.1*	*14 Days*	*20 Days*	*24 Days*
3	*Cut the Floor*	*I.3*	*I.2*	*6 Days*	*12 Days*	*16 Days*
4	*Calibration of Table Legs and Pedestals*	*II.1*	*I.2*	*6 Days*	*8 Days*	*12 Days*
5	*Floor Cut Calibration*	*II.2*	*I.3*	*4 Days*	*8 Days*	*12 Days*
6	*Floor and Countertop Putty*	*III.1*	*II.1, II.2*	*6 Days*	*12 Days*	*16 Days*
7	*Polish the Floor and Countertop*	*IV.1*	*III.I*	*6 Days*	*12 Days*	*16 Days*
8	*Packing*	*V.1*	*IV.I*	*4 Days*	*8 Days*	*14 Days*

Calculating the Value of Expected Time, Standard Deviation, and Variance

At this stage, calculating the value of expected time (te), standard deviation (S), and variance (S2), these values are used to determine the critical path and the likelihood of completion of project production. The values of te, S, and S2 were calculated using Formula 1 [8].

$$te = (to + 4 * m + tp)/6,\ S = (tp - to)/6,\ \text{and}\ S^2 = ((tp - to)/6)^2 \quad (1)$$

The results of the calculation of te, S, and S^2 values are shown in Table 3.

TABLE 3. Results of the calculation of te, S, and S^2 values

Kode	Optimistic	Most Likely	Pessimistic	Expected Time	Standard Deviation	Variance
I.1	8	10	16	10,67 ≈ 11 Days	1,33	1,78
I.2	14	20	24	19,67 ≈ 19 Days	1,67	2,78
I.3	6	12	16	11,67 ≈ 12 Days	1,67	2,78
II.1	6	8	12	8,33 ≈ 8 Days	1	1
II.2	4	8	12	8 ≈ 8 Days	1,33	1,78
III.1	6	12	16	11,67 ≈ 12 Days	1,67	2,78
IV.1	6	12	16	11,67 ≈ 12 Days	1,67	2,78
V.1	4	8	14	8,33 ≈ 8 Days	1,67	2,78
		Total		90 Days	12	18,4

Specifying Forward Count and Specifying Backward Count

The next step is to find the critical path in project production scheduling at Hotel Nusa Bakti using the te value in Table 3. To determine the critical path in the PERT method, two calculation phases are needed, namely forward and backward calculations. To perform advanced calculations, the Earliest Finish (EF) value is required. EF can be calculated using Formula 2 [8].

$$EF = ES + te \quad (2)$$

Meanwhile, to do the countdown, the Latest Start (LS) value is required. LS can be calculated using Formula 3 [8].

$$LS = LF - te \quad (3)$$

Calculation of the EF and LS values is shown in Table 4.

TABLE 4. Calculation Results of Forward Value and Backward Value

Job Code	Earliest Start (ES)	Expected Time (te)	Earliest Finish (EF)	Latest Finish (LF)	Latest Start (LS)
I.1	0	11	11	11	0
I.2	11	19	30	30	11
I.3	30	12	42	42	30
II.1	30	8	38	50	42
II.2	42	8	50	50	42
III.1	50	12	62	62	50
IV.1	62	12	74	74	62
V.1	74	8	82	82	74

From the results of the forward calculation recapitulation in table 4, the fastest completion time is 82 days for project production at Hotel Nusa Bakti and can be depicted in the form of a PERT diagram as shown in Figure 1.

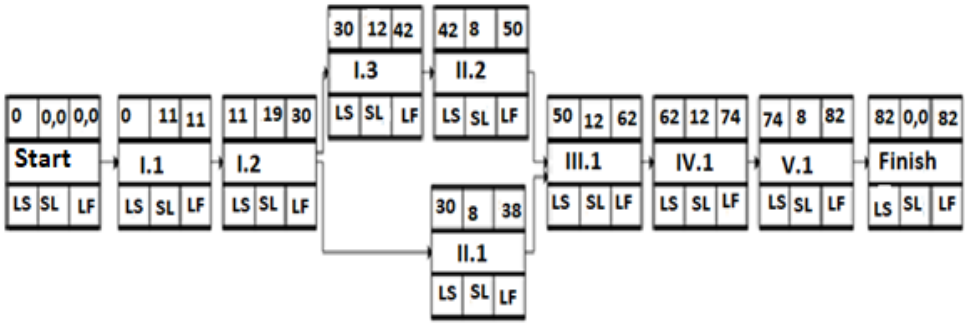

FIGURE 1. Forward Calculation Network Diagram

From the results of the recapitulation of the backward in table 4, the final completion time is 82 days and can be described in the form of a PERT diagram as shown in Figure 2.

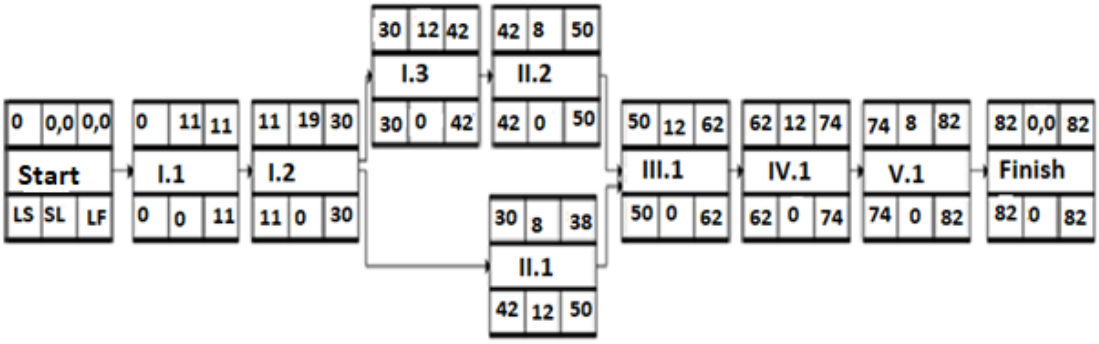

FIGURE 2. Backward Calculation Network Diagram

Determining Slack Calculations

After the forward and backward calculation results are obtained and depicted in the form of the PERT network, the next step is to calculate the total slack value to determine the critical path so that it can be seen which work can be postponed and which cannot be postponed. Slack is a non-critical path where there is a certain amount of time to delay or the time it can be late in implementing an activity without affecting the project production completion time. Slack can be calculated using Formula 4.

$$S = LS\text{-}ES \text{ or } LF\text{-}EF \qquad (4)$$

The calculation of the Slack value is shown in Table 5.

TABLE 5. Recapitulation of Slack Value Calculations

Job Code	Late Start	Early Start	Slack
I.1	0	0	0
I.2	11	11	0
I.3	30	30	0
II.1	42	30	12
II.2	42	42	0
III.1	50	50	0
IV.1	62	62	0
V.1	74	74	0

From the results of the slack calculation in Table 5, it can be seen which jobs are considered critical jobs (jobs that have a slack value equal to 0) and those that are not. From these results, it can be described in the form of a PERT network, as shown in Figure 3.

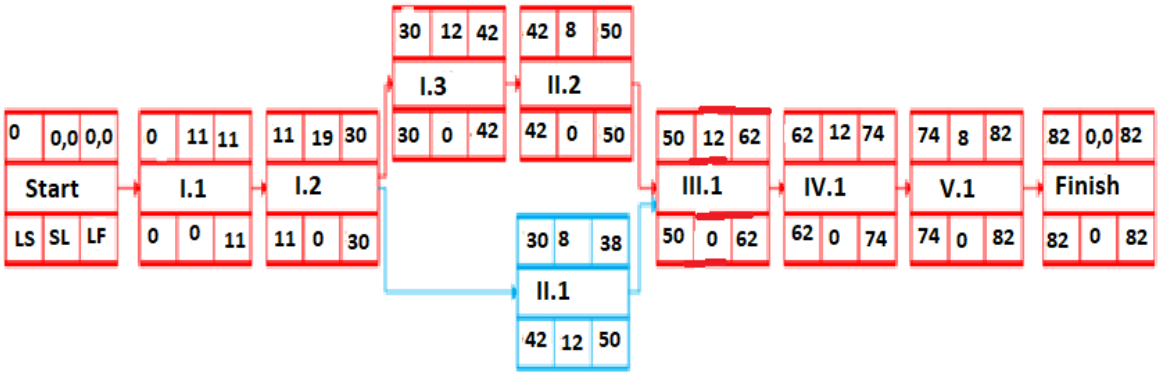

FIGURE 3. Critical Path Network Diagram

From Figure 3, it can be concluded that work activities I.1, I.2, I.3, II.2, III.1, IV.1, and V.1 are traversed by the critical path (the longest path in completing project production for 82 days), which means that the work on this route should not be postponed because it will affect the completion time of the project.

Calculating the Probability of Project Production Completion

The final stage of the PERT model is to find the probability of completion of the project production time at Hotel Nusa Bakti with a total duration (te) of 82 Days, with a total critical path value of 82 Days and a total value of 17.46. The next step is to find the probability value of the project production completion time using Formula 4.

$$\text{Probability (Z)} = \frac{\text{Ts} - \text{Te}}{\sqrt{\sum(S^2)}} \qquad (4)$$

The results of the calculation of the Z value are as follows (based on the Z value table):

$Z = (90 - 82) / \sqrt{17,46} = 8/4,18 = 1,91 = 0,9713$

It means that the Z probability value of 1.91 is 0.9713 ≈ 97.13%. From the results that have been obtained, scheduling planning using the PERT method can be used by the project manager to make a production scheduling for the Hotel Nusa Bakti project without having to make a schedule again [16]-. This can be seen from the estimated working time for 82 days from the planned 90 days. The probability of project production work being successful is 97.13%, with critical work I1, I.2, I.3, II.2, III.1, IV. 1, and V.1.

CONCLUSION

The conclusion in this study is that the PERT method can be used to assist the project manager in analyzing the most effective and efficient time and to obtain the probability of project completion, and to compare the implementation time in the field with calculations with existing methods. In addition, the PERT method can also help project managers to find out which work is critical (work that cannot be postponed). Therefore, if there are obstacles, they can be overcome so that the project can be completed on time.

Acknowledgments

We would like to thank all those who have helped in completing this research.

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