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THE ACCELERATING OF DURATION AND CHANGE OF COST ON CONSTRUCTION PROJECT IMPLEMENTATION

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ABSTRACT

Planning is a guideline in implementing the project so that development can be implemented in accordance with the time and cost planned. Control discrepancy between initial plan and realization that exists in implementation project required a project management, therefore required optimization analysis of project duration, so it can be known how long a project is completed and look for the possibility of project acceleration implementation by Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) or critical path method. This research aims to apply Project Evaluation and Review Technique (PERT) and Critical Project Management (CPM) methods to find optimize solutions and control the performance of time and cost in project scheduling. The research method used case study method at hospital project in Bogor District, Indonesia, by collecting data direct observation and interview results at contractor. Based on these data, create a schedule by using PERT and CPM methods, which will be measured performance of time performance and project cost which is expected to overcome the problem of controlling and completion of project. The results of this study, using PERT and CPM methods proved to optimize the project. Based on calculation by PERT method reduce duration of work: 12 days (13, 18%). Based on calculation by CPM method reduce duration of work: 31 days (34, 06%) but direct cost increase 112.208,300, - rupiahs (0, 25%).

Keyword: Project Cost, Crashing, PERT, CPM

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1. INTRODUCTION

The construction industry has an important and strategic role in supporting the growth and development of various fields in development. The development of the construction industry is closely linked to the implementation of development in all fields. Given the role, construction services must continue to develop roles in development. Planning is a very important issue and used as a guide in implementing the project so that development can be implemented in accordance with the time and cost planned. By increasing the complexity of construction projects, proper planning and control, the project activity now shows the key points in construction scheduling management. Where planning and scheduling is a very important stage in determining the success of construction projects. Good planning and scheduling are guidelines for carrying out project work effectively and efficiently. Schedule is one of the parameters that become the benchmark of success of a construction project, in addition to budget and quality. Planning and scheduling is necessary to determine the duration or sequence of project activities, so that logical and realistic scheduling is established. In general, project planning and scheduling uses a definite duration estimate. However, many factors of uncertainty so that the duration of each activity can't be determined with certainty. Factors causing the uncertainty of such duration are the productivity of workers, weather and others. Problems often encountered in the implementation of construction projects is a discrepancy between the initial plan with the realization, so how well the initial planning (budget cost, implementation schedule and quality) that has been done, at the implementation stage is always a change that result in delays in completion and followed by increased costs . To control the discrepancy between the original plan and the realization of the project, project management is required by using Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) methods that manage the synchronization of all available resources, and optimally utilize them maybe. In addition, project management can analyze the acceleration of project duration so that it can be known how long a project can be completed by increasing the cost due to the crash program (TCTO).

2. LITERATURE STUDY

A project is a collection of activities that take place within a certain time with a particular end result. Managing and controlling activities using project management concept is a relatively new step, which began intensively in the mid-20th century. This is characterized by the application of a particular method and technique approach to previously known ideas, with the aim of increasing the human resources available in the company to meet the challenges that arise [1]. Projects in network analysis are a series of activities aimed at producing a unique product and only performed within a certain period (temporary) [2]. Selection of scheduling methods in a construction work may be influenced by the type of construction work whether it is repetitive or not, the size or size of the project, or the nature or characteristics of other projects [3]. Project management is not something new for organizations and managers. The ideas and concepts behind effective project management are the extent to which modifications and improvements can be made. A technician from DuPont, Morgan R. Walker and a computer expert from Remington-Rand, James E. Kelly, Jr., originally understood the Critical Path Method (CPM). They create a unique way of presenting operations within the system. The method used diagrams are filled with arrows or networking methods in 1957 [4]. PERT system uses network to describe the interrelation between project elements. The project plan's network image shows all the activities contained within the project as well as the logic of its dependence on each other [1]. CPM is a way of project management that prioritizes cost as the object being analyzed. CPM is a network analysis that seeks to optimize the total project cost through the reduction of time or acceleration of the total project completion time. CPM method is known to have a characteristic that is the critical path (Critical Path), the path that has a series (group) of activity components with the total amount of time the longest and shows the fastest project completion time [4]. Planning techniques are a good control tool to provide a realistic picture of the time and money needed for each activity and the number of resources available. Also identifies the sequence of activities that must be terminated before any other activity begins [5]. The project of river irrigation maintenance work in the execution time with a critical time of 130 calendar days using the old scheduling obtained optimal time 100 working days by using CPM - PERT method [6].

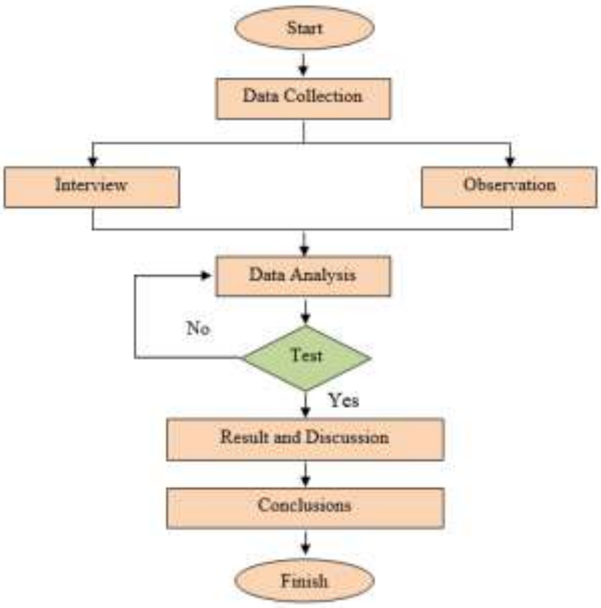
3. METHODOLOGY

3.1. Location of study

This study was conducted on a hospital construction project in Bogor, Indonesia

3.2. Object of study

Identification of the work to be analyzed is the first activity carried out to analyze data using the PERT and CPM methods. This CPM and PERT have problems and the solution to the problems in the case study and the solution uses manual calculation and processing software. Manual calculations are used to complete case study problems using formulas derived from theoretical basis so that the accuracy of manual calculations can be accountable when analyzing. In this study the work to be analyzed is structural work. Processing software is used to solve case study problems using computer program so that it is more efficient. Software used in this study uses WINQSB. This studies is illustrated in the flow chart of the study in Figure 3.1.



Picture 3.1. Flowchart Study

Data in this study are in the form of project planning documents made by the implementing party. The data is collected by searching documents. The data that has been obtained will then be processed so that it is obtained a representative modelling problem. The resulting modelling is then applied to the project scheduling which is a case study to get the optimum proposed solution for the project planning scheme. Then validation takes the form of responses from various parties related to the project to the proposed solution. The last is to conclude the results of the research and provide suggestions and input related to the research that has been carried out. This study data collection on structural work in hospital projects can be seen in the project information table as the following:

Table 3.1. Duration and Cost of Structural Work

Project Activity	Project Duration (Days)	Cost Of Work (Rupiahs)
Lean concrete	21	21.906.816
Base slab	21	20.594.079
Column 30 x 30	14	8.404.942
Column 40 x 40	28	106.572.586
Beam 20x30	21	36.539.172
Beam 25x50	21	59.107.484
Slab	28	86.739.744
Stair	14	110.787.782
Ring Beam 20x30	14	55.214.085

4. RESULTS AND DISCUSSION

4.1. PERT Analysis

After getting the duration and cost of each activity then determine the optimistic duration, realistic duration and pessimistic duration. In this case the author conducted an interview to the contractor handling the project in question. In the interview, the following data are obtained:

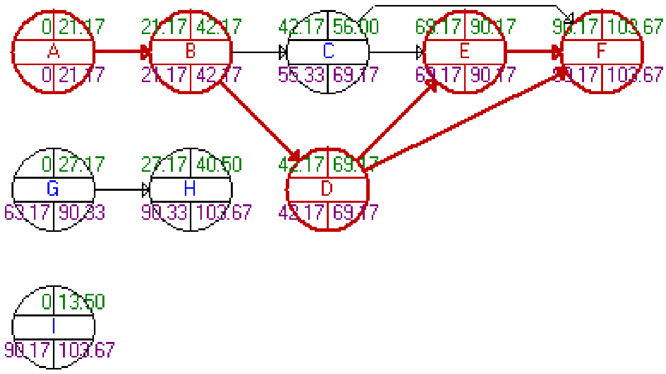
Table 4.1. Optimistic time, Realistic time and Pessimistic time

Project Activity	Predecessor	Optimistic duration (Days)	Realistic duration (Days)	Pessimistic duration (Days)
Lean concrete A	-	15	21	28
Base slab B	Lean concrete	15	21	27
Column 30 x 30 C	Base slab	10	14	17
Column 40 x 40 D	Base slab	21	28	35
Beam 20x30 E	Column	15	21	27
Beam 25x50 F	Column	15	21	27
Slab G	Beam	14	28	37
Stair H	Slab	7	14	17
Ring Beam 20x30 I	Colum	7	14	18

From the results of the analysis using Win QSB software, the following results are obtained:

Table 4.2. Critically Activity Analysis

11-29-2017 11:28:09	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	Yes	21.1667	0	21.1667	0	21.1667	0	3-Time estimate	2.1667
2	B	Yes	21	21.1667	42.1667	21.1667	42.1667	0	3-Time estimate	2
3	C	no	13.8333	42.1667	56	55.3333	69.1667	13.1667	3-Time estimate	1.1667
4	D	Yes	27	42.1667	69.1667	42.1667	69.1667	0	3-Time estimate	3.3333
5	E	Yes	21	69.1667	90.1667	69.1667	90.1667	0	3-Time estimate	2
6	F	Yes	13.5	90.1667	103.6667	90.1667	103.6667	0	3-Time estimate	1.8333
7	G	no	27.1667	0	27.1667	63.1667	90.3333	63.1667	3-Time estimate	3.8333
8	H	no	13.3333	27.1667	40.5	90.3333	103.6667	63.1667	3-Time estimate	1.6667
9	I	no	13.5	0	13.5	90.1667	103.6667	90.1667	3-Time estimate	1.8333
	Project	Completion	Time	=	103.67	HARIs				
	Number of	Critical	Path(s)	=	2					



Picture 4.1. Activity Analysis Chart

From the results of software calculations, the critical paths are A-B-D-E-F and A-B-D-F. Obtained a standard deviation value or the amount of deviation that occurs in each activity is the same. Based on software calculations, it is known that the number of standard deviations or total deviations is 5.21 and 4.81. The time of completion of the building project using software calculations shows a number of 103 days.

4.2. CPM Analysis

After getting the duration and cost of each activity then determine the crash time and crash cost. From the contractor information, the following data are obtained:

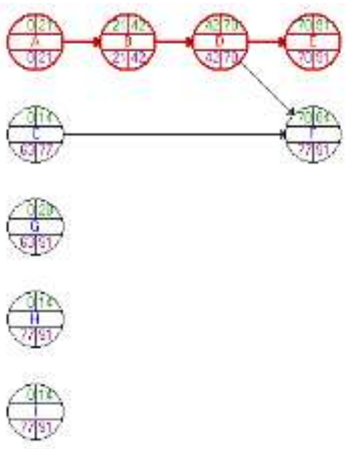
Table 4.3. Crash Time dan Crash Cost

Project Activity	Duration (days)		Cost (Rupiahs)	
	Normal	Crash	Normal	Crash
Lean concrete A	21	15	21.906.816	23.400.000
Base slab B	21	15	20.594.079	25.350.000
Column 30x30 C	14	10	8.404.942	9.400.000
Column 40x40 D	28	21	106.572.586	112.000.000
Beam 20x30 E	21	15	36.539.172	41.003.000
Beam 25x50 F	14	7	59.107.484	62.375.000
Slab G	28	14	86.739.744	90.000.000
Stair H	14	7	110.787.782	128.411.620
Ring Beam 20x30 I	14	7	55.214.085	65.750.000

From the results of the analysis using Win QSB software, the following results are obtained:

Table 4.4. Normal Critically Activity Analysis

11-30-2017 00:05:32	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	21	0	21	0	21	0
2	B	Yes	21	21	42	21	42	0
3	C	no	14	0	14	63	77	63
4	D	Yes	28	42	70	42	70	0
5	E	Yes	21	70	91	70	91	0
6	F	no	14	70	84	77	91	7
7	G	no	28	0	28	63	91	63
8	H	no	14	0	14	77	91	77
9	I	no	14	0	14	77	91	77
	Project	Completion	Time	=	91	HARIs		
	Total	Cost of	Project	=	$452,669,700	(Cost on	CP =	$185,612,600)
	Number of	Critical	Path(s)	=	1			



Picture 4.2. Normal Critically Activity Analysis Chart

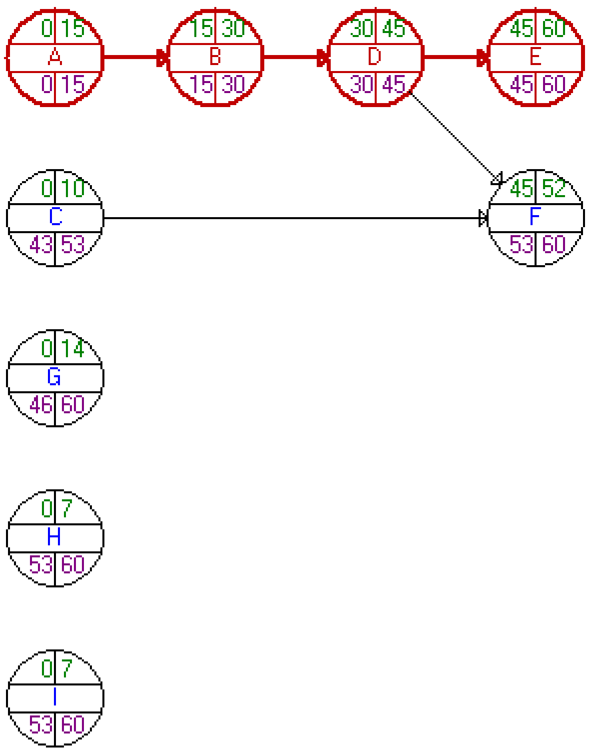
Table 4.5. Critical Path Analysis

11-30-2017	Critical Path 1
1	A
2	B
3	D
4	E
Completion Time	91

From the results of crashing analysis, it can be known the recommended time, added costs, normal costs and suggested costs.

Table 4.6. Crash Time Critically Activity Analysis

11-30-2017 00:07:52	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	15	0	15	0	15	0
2	B	Yes	15	15	30	15	30	0
3	C	no	10	0	10	43	53	43
4	D	Yes	15	30	45	30	45	0
5	E	Yes	15	45	60	45	60	0
6	F	no	7	45	52	53	60	8
7	G	no	14	0	14	46	60	46
8	H	no	7	0	7	53	60	53
9	I	no	7	0	7	53	60	53
	Project	Completion	Time	=	60	HARIs		
	Total	Cost of	Project	=	$564,978,000	(Cost on	CP =	$201,753,000)
	Number of	Critical	Path(s)	=	1			



Picture 4.3. Crash Time Critically Activity Analysis Chart

Table 4.7. Critical Path Crash TimeAnalysis

11-30-2017	Critical Path 1
1	A
2	B
3	D
4	E
Completion Time	60

Based on the results of software calculations that have been done using the Win QSB program, we know Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), and Latest Finish (LF). The slack value is obtained from the reduction of LS with ES. The settlement time is 91 days with a project cost of Rp. 452,669,700, -, the cost on the critical track is Rp.

185,612,600, - with the number of critical paths as much as 1 path, this results from normal time. The crashing analysis table shows the same critical path as showing normal time, acceleration time, suggested time, additional costs, normal costs and suggested costs. From the results of software calculations, the critical path is A-B-C-D-F because this track is the best path for research carried out from the initial operation to the end. Normal fee of Rp. 452,669,700, - with a completion time of 91 days. The accelerated cost of the project is Rp. 564,978,000, - with a completion time of 60 days. There are differences in costs because to speed up the processing time of a project there must be additional workers who need additional costs.

5. CONCLUSIONS

The calculation results for CPM-PERT problems are obtained:

a) From the results of the PERT analysis there is a considerable acceleration, that is : 12 days or 13,18 %;
b) From the results of the CPM analysis obtained a greater acceleration, that is: 31 days (34, 06%), and additional costs due to the crash program of 112.208,300 rupiahs or (0.25%), resulting in a Time Cost Trade off (TCTO).

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