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OPTIMIZATION OF CAFE AND SALON DEVELOPMENT PROJECT MANAGEMENT WITH PERT AND CPM METHODS AT PT DTD

Ryan Swastiputro Adinugroho[1], Sugiyono Madelan[2]
[1)] Universitas Mercu Buana, Jakarta, Indonesia, ryanadinugroho7@gmail.com
[2)] Universitas Mercu Buana, Jakarta, Indonesia, sugiyono@mercubuana.ac.id

Corresponding Author: Ryan Swastiputro Adinugroho

Abstract: The construction of cafe and salon by PT DTD has been delayed in terms of time. The purpose of this study is to calculate the best time optimization and determine the critical path of the cafe and salon construction project at PT DTD. This research is an evaluation of a project that has been completed. The methods used are Critical Path Method (CPM) and Project Evaluation Review Technique (PERT). The software used is POM-QM for Windows. The project runs for 15 months or 62 weeks from the initial target of the contractor being 8 months. Using POM-QM, from the PERT method, the optimum time for the project is 50 weeks. Project optimization can be carried out using PERT and CPM methods with POM QM software.

Keywords: Construction Project, PERT, CPM, cafe and salon.

INTRODUCTION

The construction project of a 3-storey cafe & salon building carried out by PT. DTD requires a good scheduling process because in the process it is late from the targeted schedule. The initial target of the contractor for the completion of this project is 8 months.

Table 1 Project Implementation Data

Working days	Working hours	Project building size	Working hours per day	Total manpower	Project target time	Project completion time	Project delay
Monday - Sunday	Normal 08:00 – 17:00 Overtime 18:00 – 23.00	913,4496 meter square	8 hours	Varies, depending on the stage of work.	8 months	15 months	7 months

Source: Contractor Data

From the data obtained from the contractors in table 1 above, the target time for completion of the project targeted by the contractor company is 8 months. Meanwhile, in reality, the project

ran for 15 months or 62 weeks to be exact. The project implementation time can be seen in table 2 below.

Table 2 Project Implementation Time Data

NO	Activity	WORK	Duration (Week)	Week end of activity
I	**I**	**PREPARATORY WORK**		
1	1	DISMANTLING AND DISPOSAL OF MATERIALS	2	**2**
2	2	UITZET / BOUWPLANK	2	**3**
3	3	SOIL EXCAVATION	2	**4**
4	4	WORKSHOP FLOOR	1	**5**
5	5	BACKFILL	2	**6**
II	**II**	**STRUCTURE WORK**		
1	6	FOUNDATION WORK	4	**6**
2	7	SLOOF	8	**15**
3	8	PRACTICAL COLUMN	2	**26**
4	9	BEAM	2	**28**
5	10	REBATE FLOOR	2	**24**
III	**III**	**STEEL WORK**		
1	11	STEEL COLUMN	14	**19**
2	12	STEEL BEAM	12	**20**
3	13	BONDEX PLATE & PLATE CASTING	3	**22**
IV	**IV**	**ARCHITECTURAL WORK**		
1	14	LIGHT BRICK INSTALLATION	9	**31**
2	15	PLASTERING	11	**35**
3	16	GROUTING	10	**37**
4	17	WALL PAINT JOB	2	**52**
4	18	FLOOR JOB	2	**43**
6	19	PALIMANAN STONE INSTALLATION	4	**51**
7	20	PARTITION WORK	9	**53**
8	21	FURNITURE WORK	5	**57**
V	**V**	**CEILING WORK**		
1	22	CEILING FRAME WORK	3	**53**
2	23	GYPSUM INSTALLATION	1	**54**
3	24	PAINTING FINISHING	1	**55**
VI	**VI**	WINDOW DOOR WORK		
1	25	WINDOW DOOR WORK	3	**53**
VII	**VII**	**IRON WORK**		
1	26	IRON LADDER	7	**42**
2	27	ROOF TRUSS	3	**37**
3	28	RAILING	3	**43**
4	29	GALVALUME ROOF COVERING AND GUTTERS	1	**38**
5	30	FENCE WORK	2	**62**
VIII	**VIII**	**UTILITIES WORK**		
1	31	MECHANICAL ELECTRICAL WORK	13	**47**
IX	**IX**	**OTHER WORK**		
1	32	ANDESITE STONE WORK	3	**61**

NO	Activity	WORK	Duration (Week)	Week end of activity
2	33	PAVING WORK	3	**59**

Source: Contractor Data and processed by researcher

Because this project is delayed in terms of time, it is necessary to optimize in terms of time and it is necessary to create a critical path so that the project can run well. Based on this phenomenon, the researcher discusses the scheduling of a project, with this the researcher conducts research with the title: OPTIMIZATION OF CAFE AND SALON DEVELOPMENT PROJECT MANAGEMENT WITH PERT AND CPM METHODS AT PT DTD.

Problem Identification

Based on the above background, the problems that can be identified in this study are:

1. The project was 7 months behind schedule.
2. The project requires optimization of execution time.

Problem Formulation

1. How to calculate the optimum time for a cafe and salon construction project at PT. DTD using PERT method, and CPM?
2. What is the critical path of activity in this project? What activities are included in the critical path?
3. What is the time difference if the project is run normally and if it is run with optimization, based on optimistic, pessimistic, and normal scenarios?
4. What can be suggested after conducting an evaluation of the cafe and salon development project management?

Research Purposes

The purposes of this research are:

1. Analyzing the optimum time of the cafe and salon construction project at PT. DTD.
2. Analyze the critical path of the cafe and salon construction project.
3. Analyze the time difference of this project if it is run normally and if it is run based on optimistic, pessimistic, and normal scenarios.
4. Provide advice on the evaluation results of project management.

LITERATURE REVIEW

Project

According to (Husen, 2009), project is a combination of resources such as human, material, equipment, and capital / costs that are collected in a temporary organization to achieve goals and objectives. A project can be defined as an organized effort or activity to achieve important goals, targets and expectations using available budget funds and resources, which must be completed within a certain period of time (Nurhayati, 2010 in Latifah, 2020).

Project Management

Project management can be defined as an activity process for planning, organizing, directing, and controlling organizational resources owned by the company to achieve certain goals within certain time and resources. (Dimyati & Nurjaman, 2014). The definition of project management according to (Husen, 2009) is the application of knowledge, expertise and skills, the best technical way and with limited resources to achieve the goals and objectives that have been determined in order to get optimal results in terms of cost performance, quality and time and work safety. Meanwhile, according to (Nurhayati, 2010) Project Management is an activity to plan, organize and control the company's organizational resources to achieve certain goals within a certain time with certain resources.

PERT Method

PERT is an acronym for Program Evaluation and Review Technique (a technique for evaluating and reviewing programs), the PERT technique is a method that aims to reduce delays and production disruptions as much as possible, as well as coordinate various parts of a job as a whole and speed up project completion. (Upadi, 2011).

PERT was developed to overcome the uncertainty of the execution time of activities. In PERT, using triple time estimates for each activity, timing can use units of time such as hours, days, weeks, months and years. The explanations for the 3 (three) estimation times are: Optimistic time, which is the shortest possible time for an event to occur. The pessimistic time is the longest time the event will take. Realistic time is the most appropriate time for completion of activities in the PERT network, the most realistic estimate of the time required to complete activities. In the PERT method, the emphasis is directed at trying to get the best timeframe. The PERT method uses the element of probability. Then it is assumed that the approach of the average duration is called expected return (te) with the following formula (Latifah, 2020):

$$te = \frac{to + 4tm + tp}{6} \quad (1)$$

te : expected duration
to : optimistic time
tm : realistic time
tp : pesimistic time

To find out the possibility of achieving the target schedule, it can be done by connecting the expected time (TE) with the target T(d).

CPM Method

CPM (Critical Path Method) is a method by using arrow diagrams in determining the critical path so that it is also known as the critical path diagram. The CPM method helps to get the critical path, namely the path that connects critical activities, or in other words the critical path is the path of activities that should not be late or experience delays in implementation

because the delay will cause delays in the total project completion time (Aulia & Priyo, 2015). The critical path method (CPM) - also called critical path analysis (CPA) - identifies the project's critical path, which is the longest path through the network that contains the project's critical activities. The critical path length measures the time required to complete all activities on the critical path, and provides the shortest time in which the project can be completed. It is possible that the network has more than one critical path. The CPM technique uses the concepts of forward pass and backward pass to identify the project's critical path (Barlow, 2005).

RESEARCH METHODOLOGY

This research belongs to the type of descriptive quantitative research, namely research that describes a number of data which is then analyzed using certain methods and then interpreted based on the ongoing reality. Descriptive research is done by focusing on certain aspects and often shows the relationship between various variables.

Operational variables

Table 3 Operational Variables

	VARIABLES	INDICATOR	MEASURING SCALE
PROJECT SCHEDULING	Job Stages (Critical Path)	ES=*Earliest Start* EF=*Earliest Finish* LS=*Latest Start* LF=*Latest Finish* LS-ES=0 LF-EF=0	Ratio
	Crashing Project	Crash Time < Normal Time	Ratio
	Time Scenarios (Optimistics, Pesimistics, Most Likely)	Expected Time (te) $te = \frac{to + 4tm + tp}{6}$	Ratio

Source: Processed by researcher.

Population and Research Sample

The population and sample in this study were the construction of cafe and salon carried out by PT. DTD, starting from the initial stage of the project until the project is completed. The object of this research is located on Jalan Rawa Domba, East Jakarta. This project runs for 15 months, from April 2019 to August 2020. The sampling technique used is purposive sampling at the head office of PT. DTD in Sleman, Yogyakarta Special Region Province.

Data Source

Primary data is the main data needed and obtained directly from PT. DTD as the research target. Primary data obtained by interviewing relevant sources in the company. Secondary data is data that is not obtained directly by researchers, but can be obtained through company documents and other sources related to the research topic.

The source of this research data is from the implementation of the cafe and salon construction project carried out by PT. DTD, based on the project report, schedule and budget-estimate plan of the project.

Data Processing Method

The software used in this research is POM QM for windows. The POM QM software version used is version 5.3 in 2020.

FINDINGS AND DISCUSSION

Table 4 below will explain the activities, their duration in weeks per activity, as well as their predecessor activities as follows:

Table 4 Project Activity Data

NO	Activity	WORK	Duration (Week)	Predecessor 1	Predecessor 2
I		**PREPARATORY WORK**			
1	1	DISMANTLING AND DISPOSAL OF MATERIALS	2		
2	2	UITZET / BOUWPLANK	2	1	
3	3	SOIL EXCAVATION	2	2	
4	4	WORKSHOP FLOOR	1	3	
5	5	BACKFILL	2	6	
II		**STRUCTURE WORK**			
1	6	FOUNDATION WORK	4		
2	7	SLOOF	8	6	
3	8	PRACTICAL COLUMN	2	10	
4	9	BEAM	2	8	14
5	10	REBATE FLOOR	2	13	
III		**STEEL WORK**			
1	11	STEEL COLUMN	14		
2	12	STEEL BEAM	12		
3	13	BONDEX PLATE & PLATE CASTING	3	12	
IV		**ARCHITECTURAL WORK**			
1	14	LIGHT BRICK INSTALLATION	9	13	
2	15	PLASTERING	11	14	
3	16	GROUTING	10	15	
4	17	WALL PAINT JOB	0		
4	18	FLOOR JOB	2		
6	19	PALIMANAN STONE INSTALLATION	4		
7	20	PARTITION WORK	9		
8	21	FURNITURE WORK	5		
V		**CEILING WORK**			
1	22	CEILING FRAME WORK	3		
2	23	GYPSUM INSTALLATION	1	22	
3	24	PAINTING FINISHING	1	23	
VI		WINDOW DOOR WORK			
1	25	WINDOW DOOR WORK	3		
VII		**IRON WORK**			
1	26	IRON LADDER	7	16	
2	27	ROOF TRUSS	3		

NO	Activity	WORK	Duration (Week)	Predecessor 1	Predecessor 2
3	28	RAILING	3		
4	29	GALVALUME ROOF COVERING AND GUTTERS	1	27	
5	30	FENCE WORK	2		
VIII		**UTILITIES WORK**			
1	31	MECHANICAL ELECTRICAL WORK	13		
IX		**OTHER WORK**			
1	32	ANDESITE STONE WORK	3		
2	33	PAVING WORK	3		

Source: Contractor Data and processed by researcher

Table 4 above explains that in this project there are 33 activities, with duration per activity, and predecessor activities per activity. What is meant by the predecessor activity is that the activity can only be carried out after the predecessor activity is completed. For example, for activity number 26, namely the installation of iron stairs, it can only be started after activity number 16, namely grouting, has been completed. Likewise, activity 9, which contains 2 predecessor activities, means that activity number 9 cannot be started if the two predecessor activities have not been completed. Not every activity has a predecessor activity. The list of jobs and the vendors of work are described in table 5. Work carried out by the contractor (PT. DTD) is a job marked with a civil name. Work other than civil means done by a third party. The total cost per job is as follows:

Table 5. List of vendors and total cost of work

NO	Activity	WORK	Duration (Week)	Vendor	Total Cost
I	**I**	**PREPARATORY WORK**			
1	1	DISMANTLING AND DISPOSAL OF MATERIALS	2	**Civil**	**40,585,350**
2	2	UITZET / BOUWPLANK	2		**7,984,598**
3	3	SOIL EXCAVATION	2		**194,599,581**
4	4	WORKSHOP FLOOR	1		**5,659,773**
5	5	BACKFILL	2		**14,149,433**
II	**II**	**STRUCTURE WORK**			
1	6	FOUNDATION WORK	4	**Civil**	**208,749,014**
2	7	SLOOF	8		**129,042,696**
3	8	PRACTICAL COLUMN	2		**21,352,198**
4	9	BEAM	2		**12,972,338**
5	10	REBATE FLOOR	2		**20,949,184**
III	**III**	**STEEL WORK**			
1	11	STEEL COLUMN	14	**Baja**	**145,997,817**
2	12	STEEL BEAM	12		**10,428,415**
3	13	BONDEX PLATE & PLATE CASTING	3		**20,856,831**
IV	**IV**	**ARCHITECTURAL WORK**			
1	14	LIGHT BRICK INSTALLATION	9	**Civil**	**72,816,701**
2	15	PLASTERING	11		**85,505,426**
3	16	GROUTING	10		**102,436,898**

NO	Activity	WORK	Duration (Week)	Vendor	Total Cost
4	17	WALL PAINT JOB	2	**Cat (Januri)**	**22,761,360**
4	18	FLOOR JOB	2	**Sipil**	**33,342,461**
6	19	PALIMANAN STONE INSTALLATION	4	**Palimanan**	**9,300,000**
7	20	PARTITION WORK	9	**Interior**	**422,203,431**
8	21	FURNITURE WORK	5		**187,645,969**
V	**V**	**CEILING WORK**			
1	22	CEILING FRAME WORK	3	**Plafon**	**79,435,556**
2	23	GYPSUM INSTALLATION	1		**26,478,519**
3	24	PAINTING FINISHING	1		**26,478,519**
VI	**VI**	WINDOW DOOR WORK			
1	25	WINDOW DOOR WORK	3	**Alka Alumunium**	**200,000,000**
VII	**VII**	**IRON WORK**			
1	26	IRON LADDER	7	**Sujarno**	**158,621,200**
2	27	ROOF TRUSS	3		**26,436,867**
3	28	RAILING	3		**26,436,867**
4	29	GALVALUME ROOF COVERING AND GUTTERS	1		**26,436,867**
5	30	FENCE WORK	2	**Las (Januri)**	**22,761,360**
VIII	**VIII**	**UTILITIES WORK**			
1	31	MECHANICAL ELECTRICAL WORK	13	**Sound, Listrik, CCTV, Penangkal Petir, AC**	**635,803,808**
IX	**IX**	**OTHER WORK**			
1	32	ANDESITE STONE WORK	3	**Lantai**	**177,930,000**
2	33	PAVING WORK	3	**Civil**	**56,905,253**

Source: Contractor Data and processed by researcher

From the data above, it can be processed using POM QM to find the critical path of the project and optimize the time of the project. To process data using POM QM software, the existing data will be simplified so that it can be processed easily using the software. The following table is a data table that has been made simpler.

Table 6 Data for POM QM Software

Activity	Duration (Weeks)	Predecessor 1	Predecessor 2	Total Cost
1	2			40,585,351
2	2	1		7,984,599
3	2	2		194,599,582
4	1	3		5,659,774
5	2	6		14,149,434
6	4			208,749,015
7	8	6		129,042,697
8	2	10		21,352,199
9	2	8	14	12,972,339
10	2	13		20,949,185
11	14			145,997,818
12	12			10,428,416

Activity	Duration (Weeks)	Predecessor 1	Predecessor 2	Total Cost
13	3	12		20,856,832
14	9	13		72,816,702
15	11	14		85,505,427
16	10	15		102,436,899
17	2	16		22,761,360
18	2			33,342,462
19	4			9,300,001
20	9			422,203,432
21	5			187,645,970
22	3			79,435,557
23	1	22		26,478,520
24	1	23		26,478,520
25	3			200,000,001
26	7	16		158,621,201
27	3			26,436,868
28	3			26,436,868
29	1	27		26,436,868
30	2			22,761,360
31	13			635,803,809
32	3			177,930,001
33	3			56,905,254

Source: Processed by researcher

Triple Time Estimate Method

Table 7 Processing results of POM QM Triple Time Estimate method

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation	Variance
Project	50						1.68	2.83
1	2	0	2	42.83	44.83	42.83	0.33	0.11
2	2	2	4	44.83	46.83	42.83	0.33	0.11
3	2	4	6	46.83	48.83	42.83	0.33	0.11
4	1.17	6	7.17	48.83	50	42.83	0.17	0.03
5	2	4	6	48	50	44	0.33	0.11
6	4	0	4	38.33	42.33	38.33	0.33	0.11
7	7.67	4	11.67	42.33	50	38.33	1	1
8	2	16.5	18.5	46	48	29.5	0.33	0.11
9	2	23.17	25.17	48	50	24.83	0.33	0.11
10	2	14.5	16.5	44	46	29.5	0.33	0.11
11	13.5	0	13.5	36.5	50	36.5	0.83	0.69
12	11.5	0	11.5	0	11.5	0	0.83	0.69
13	3	11.5	14.5	11.5	14.5	0	0.33	0.11
14	8.67	14.5	23.17	14.5	23.17	0	0.67	0.44
15	10.67	23.17	33.83	23.17	33.83	0	0.67	0.44
16	9.5	33.83	43.33	33.83	43.33	0	0.83	0.69
17	2	43.33	45.33	48	50	4.67	0.33	0.11

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation	Variance
18	2	0	2	48	50	48	0.33	0.11
19	4	0	4	46	50	46	0.33	0.11
20	8.67	0	8.67	41.33	50	41.33	0.67	0.44
21	8	0	8	42	50	42	0.33	0.11
22	3	0	3	44.67	47.67	44.67	0.33	0.11
23	1.17	3	4.17	47.67	48.83	44.67	0.17	0.03
24	1.17	4.17	5.33	48.83	50	44.67	0.17	0.03
25	3	0	3	47	50	47	0.33	0.11
26	6.67	43.33	50	43.33	50	0	0.67	0.44
27	3	0	3	45.83	48.83	45.83	0.33	0.11
28	3	0	3	47	50	47	0.33	0.11
29	1.17	3	4.17	48.83	50	45.83	0.17	0.03
30	2	0	2	48	50	48	0.33	0.11
31	12.5	0	12.5	37.5	50	37.5	0.83	0.69
32	3	0	3	47	50	47	0.33	0.11
33	3	0	3	47	50	47	0.33	0.11

Source: Processed by researcher

Table 7 above is the result of processing the Triple time Estimate method on POM QM. Activities whose slack value = 0 is a critical activity, where the activity should not be too late to start and finish. The total time for completion of all critical activities and the optimum time for completion of the project is 50 weeks. Critical activities resulting from POM QM processing are activities number 12, 13, 14, 15, 16, and 26. These activities are:

- Activity 12: Steel beam
- Activity 13: Bonding plate and plate casting
- Activity 14: Light brick installation
- Activity 15: Plastering
- Activity 16: Grouting
- Activity 26: Iron ladder

From the results of POM QM processing with the Triple time Estimate method above, it was found that the optimum time for completion of the project was 50 weeks.

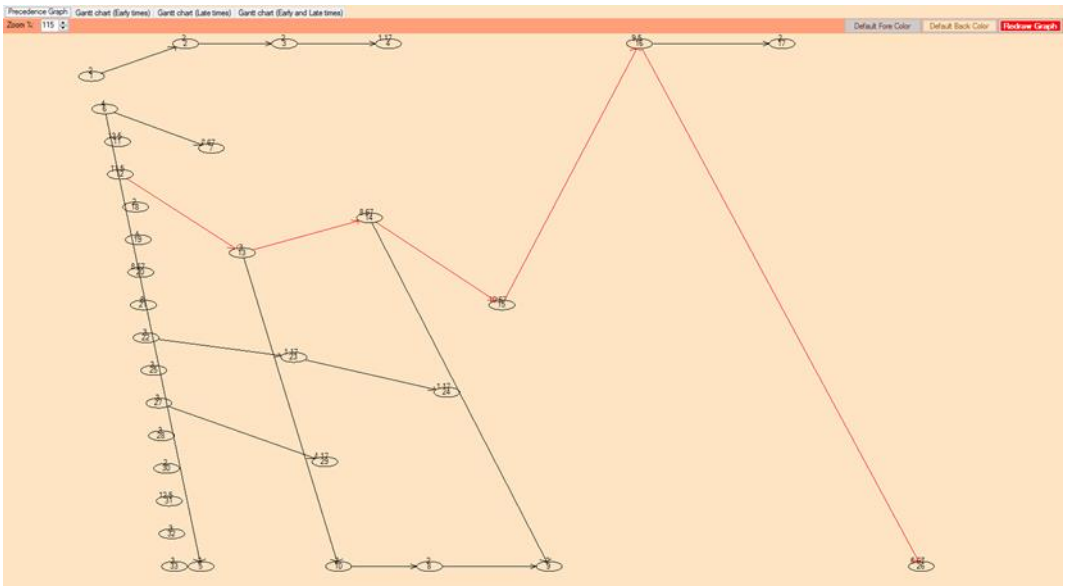

Figure 1. The critical path of the project using Triple Time Estimate method
Source: Processed by researcher

Figure 1 is the critical path of the project resulting from data processing POM QM software with the Triple Time Estimate method. The critical path of the project is the red path. The critical path is found in activities number 12, 13, 14, 15, 16, and 26. A number of these activities means that it should not be too late in starting and completing the project so that the project can run according to plan. If the activities on the critical path are disrupted or their implementation is delayed, the entire project will be delayed as well.

Cost Budgeting Method

Table 8 Processing results of POM QM Cost Budgeting method

Activity	Activity time	Activity Cost	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	52						
1	2	40,585,530	0	2	45	47	45
2	2	7,984,599	2	4	47	49	45
3	2	194,599,600	4	6	49	51	45
4	1	5,659,774	6	7	51	52	45
5	2	14,149,430	4	6	50	52	46
6	4	208,749,000	0	4	40	44	40
7	8	129,042,700	4	12	44	52	40
8	2	21,352,200	17	19	48	50	31
9	2	12,972,340	24	26	50	52	26
10	2	20,949,180	15	17	46	48	31
11	14	145,997,800	0	14	38	52	38
12	12	10,428,420	0	12	0	12	0
13	3	20,856,830	12	15	12	15	0
14	9	72,816,700	15	24	15	24	0
15	11	85,505,420	24	35	24	35	0
16	10	102,436,900	35	45	35	45	0

Activity	Activity time	Activity Cost	Early Start	Early Finish	Late Start	Late Finish	Slack
17	2	22,761,360	45	47	50	52	5
18	2	33,342,460	0	2	50	52	50
19	4	9,300,001	0	4	48	52	48
20	9	422,203,400	0	9	43	52	43
21	5	187,646,000	0	5	47	52	47
22	3	79,435,560	0	3	47	50	47
23	1	26,478,520	3	4	50	51	47
24	1	26,478,520	4	5	51	52	47
25	3	200,000,000	0	3	49	52	49
26	7	158,621,200	45	52	45	52	0
27	3	26,436,870	0	3	48	51	48
28	3	26,436,870	0	3	49	52	49
29	1	26,436,870	3	4	51	52	48
30	2	22,761,360	0	2	50	52	50
31	13	635,803,800	0	13	39	52	39
32	3	177,930,000	0	3	49	52	49
33	3	56,905,260	0	3	49	52	49

Source: Processed by researcher

Table 8 above is the result of data processing using the Cost Budgeting method. Activities whose slack value = 0 are critical activities. The critical activities resulting from POM QM processing are activities number 12, 13, 14, 15, 16, and 26. From the results of POM QM processing using the Cost Budgeting method above, it is found that the optimum time for completion of the project is 52 weeks.

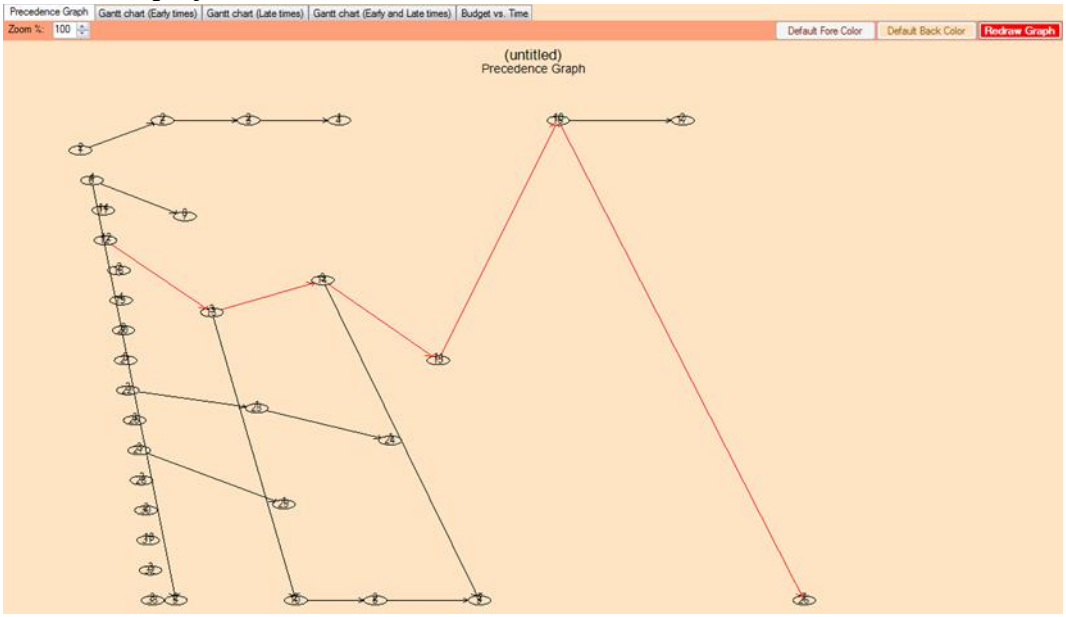

Figure 2. The critical path of the project using Cost Budgeting method
Source: Processed by researcher

Figure 2 is the critical path of the project resulting from the POM QM software data processing with the Cost Budgeting method. The critical path of the project is the red path. Similar to the interpretation of table 8, the critical path is found in activities number 12, 13, 14, 15, 16, and 26. The critical path of the two methods above has the same results.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The conclusions from the results of data processing in this study are:

1. The optimum time for the construction of cafe and salon using PERT and CPM is:
   - Triple Time Estimates method, the optimum time for the construction of cafe and salon is 50 weeks.
   - As for the Cost Budgeting method, after including the cost factor, the optimum time for the construction of cafe and salon becomes 52 weeks.
2. The project's critical path after being processed with the two methods above the results are the same, namely the critical activities are found in activities number 12, 13, 14, 15, 16, and 26. These activities are:
   - Activity 12: Steel beam
   - Activity 13: Bonding plate and plate casting
   - Activity 14: Light brick installation
   - Activity 15: Plastering
   - Activity 16: Grouting
   - Activity 26: Iron ladder

   The implementation of these six activities should not be delayed or disrupted so that the entire project is not disrupted. If the activities on the critical path are disrupted or their implementation is delayed, the entire project will be delayed as well.
3. The difference in the normal time of project development, which is 62 weeks, with the time after running with optimization, based on optimistic, pessimistic, and normal scenarios (Triple Time Estimates) is 12 weeks.

Recommendations

1. The delay in the cafe and salon construction process for future improvements can be optimized by 10 weeks and 12 weeks using time optimization and cost budgeting.
2. The stages of project activities that must be considered carefully are those activities on the critical path. Activities included in the critical path are activities number 12, 13, 14, 15, 16, and 26 as follows:
   - Activity 12: Steel beam
   - Activity 13: Bonding plate and plate casting
   - Activity 14: Light brick installation
   - Activity 15: Plastering
   - Activity 16: Grouting

– Activity 26: Iron ladder

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