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OPTIMIZING THE SCHEDULING OF THE SURABAYA HEALTH INSPECTION BUILDING CONSTRUCTION PROJECT

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ABSTRACT

Projects can be said to be a success or a failure caused by ineffective planning and control, so project activities fail. so there will be delays, decreased quality, and increased implementation costs. The Critical Path Method abbreviated CPM method and goal programming can be applied to manage project completion time more efficiently and effectively. To be able to reduce the impact of project delays and cost overruns through a crash calculation mechanism with three alternative controls; additional labor or overtime work. In this study, the total project age was 277 calendar days, while the project deadline was 284 calendar days, thus the project was delayed for 7 calendar days with a total fine of Rp 25.242.944.400 and a penalty cost is 1/1.000 for the sum of the contract. Based on the data analysis and discussion that has been carried out in this study, the conclusion that can be drawn from his study is the number of days that can be completed in this project using the CPM scheduling method is 257 days. However, without using this method, the project completion time would take 284 days. In addition, the company can save costs of Rp. 181,682,772 while avoiding penalty fees due to project delays. while using goal programming optimization, the optimal time duration is 250 days with a cost efficiency of Rp. 246.092.991. So that by applying the calculation to the CPM method, the company can perform project efficiency for 27 days while using goal programming optimization have project efficiency for 34 days simultaneously being able to streamline the budget by using network planning

Keywords: *Project Scheduling, CPM, Goal Programming, Critical Path, Time Acceleration*

1. INTRODUCTION

A project activity can be said to be successful if the scope of work is met with good quality, and conformity between the realization of the schedule, the costs incurred, and the agreed time limit according to the contract. Therefore, it is necessary to control time efficiently and effectively. Sufficient knowledge and skills in using tools commonly used in project management such as Microsoft project, excel, primavera, etc. A project manager especially beginners. This capability will be more complete if a project manager is assisted with project management support applications. This capability makes it easier for project managers to manage and document, be it small or large-scale projects, it can also cut monitoring time because it is enough to see from the system.

So far, companies in determining time are only based on experience so several problems often arise in project planning and control, namely the lack of project managers in mapping the critical path of activity. The critical path is critical to project implementation. At PT. XYZ projects often occur due to delays in the completion of critical activities and the impact on project costs is getting bigger. Sometimes found more than one critical path in project work activities.

XYZ Corporate is a company working in the construction of the Indonesian National Construction Implementing Association (GAPENSI) so PT XYZ has standardization and classification to provide national construction services. In addition, PT XYZ's qualifications and classifications have been registered nationally based on the National Business Entity Certification Agency (LSBU) (Ministry of Public Works and Public Housing, 2022). Problems that often arise in there is a difference between the target time and the implementation of building construction by XYZ corporate and the realization of completion so that the impact on the costs incurred is increasing, affecting the company's profits, even the company can suffer losses due to penalties that must be met if the building construction project does not comply with the agreed time.

Inadequate production equipment, procurement of required materials, procurement and quality of human resources, as well as costs are some of the factors that can affect project completion time, delays will impact not only costs but also consumer views on the credibility of the company itself which will have an impact on the survival of the company. In project planning and control, one of the methods used is the CPM method. This method is quite widely used in planning and controlling building construction projects. This method has the advantage of analyzing projects in terms of estimating the project finishing time by finding the critical path, identify the start and end times of each activity to determine the project schedule, and calculating the amount of slack time for each activity so as to minimize project delays.

The shortcoming that exists in previous studies, including those stated in the references review, is that the calculation of the CPM method is not detiled and has not been applied to health care a building construction project especially medical chekup building. In the CPM (Critical Path Method) method there are stages of determining the critical path, where the critical path is the activity in the project that has the longest total execution time and shows the fastest project completion time span compared to other activity paths..

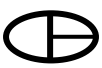
Applying the CPM method to applications, especially in health care building projects, can help and facilitate project managers in mapping problems in project work so that the time and costs needed in project work can be estimated properly and critical paths in project work can be mapped properly. Project managers also easy to find out critical activities in project work so these activities need to be controlled so that related activities do there is no delay in project completion and the project can be completed on time.

2. MATERIALS AND METHOD

2.1. Project Schedule

Schedule is elaboration of planning project into a sequence of steps for implementing work to achieve goals. The time factor has been included in the schedule. A well-known method of compiling a schedule is network analysis, which depicts in a graph the relationship sequences of project work. Network Planning Notations and Symbols include:

a. ⟶ : Arrows/arrows indicate an activity/activity, namely an activity or work whose completion requires a duration (a certain period of time) and a resort (labor, tools, materials, and costs). The arrows guide the direction of each activity, where length and slope have no effect.



b. Node / Event, which is a round circle which means if an event or event is a meeting of the beginning and end of the activity.

c. - - → Dummy / discontinuous arrows that represent pseudo activities, namely activities that do not require duration and resources.

d. ⟷ Double Arrow / Arrow model that shows the critical path activities (critical path).

The factors that influence Network Planning according to (Siswojo, 2000) include (1) the plan that will be used by the company in implementing the project, determining the activities that must be carried out, and the logic of dependence on each other; (2) The length of time used in the project is usually measured in standard time units: days, hours, minutes, that time. Jobs that must precede or be preceded by other jobs are identified in terms of time. This network is very useful for project planning and control. Scheduling is an activity to determine the time required and arrange the sequence of activities while determining when the project can be completed. Project scheduling is something more specific and becomes part of project planning. Project scheduling includes timing and stages of implementing activities as originally planned.

2.2. Network Planning

Network planning is literally an interrelated dependency relationship between the parts of the work as outlined in the network diagram so that it is known which parts of the work must take precedence and which jobs must wait for the completion of other work (Soeharto, 1997). Overall (Gray and Erik, 2007). The following are some of the terms used to build a project network:

a. Activities are activities within the project that take time to be implemented according to the project plan.

b. A combined activity is an activity or activities that have more than one activity that precedes it (more than one dependency arrow).

c. A path is a sequence of related activities.

d. Predecessor is a predecessor activity.

e. A successor is a substitute activity or activity that follows another activity.

f. The Critical Path is the longest path on the network of a project, if the activity on that path is delayed, the project will experience delays due to the delay at the same time.

2.3. Critical Path Method (CPM)

CPM known as the critical path, was created by (Kelley, Walker, & Sayer, 1989) of the company Remington Rand and M.R Walker of Du Pont in order to develop a management control systemThis system is intended to plan and control a large number of activities that have complex dependencies on a project activity in terms of design and construction. Through the critical path method, implementers can find out which jobs are vulnerable and influential in the overall work process.

If there is a delay and by knowing the location of the delay, in its implementation, anticipatory actions can be taken for the time inefficiency that occurred previously, so that delays in one part do not propagate to other jobs. In the analyzes of identifying the critical path there are several terms or definitions, namely as follows:

a. Earliest Start Time (ES) is the earliest time (fastest) a project activity can start, taking into account the time to be achieved from the activity and the requirements that must be met according to the sequence of work.

b. Latest Start Time (LS) is the longest time to be able to start a project activity without experiencing a delay in the entire project.

c. Early Finish Time (EF) is the earliest time an activity in the project can be completed, or equal to ES + Desired activity time.

d. Latest Finish Time (LF) is the slowest time to be able to complete an activity in a development project without delaying the completion of the entire project, or equal for LS + expected time activity.

2.4. ES, EF, LS, dan LF

According to Heizer and Render (2014: 105-109) in conducting critical path analysis, the use of a two-pass process consisting of a forward pass and a backward pass to determine the time schedule of activities in the project. ES and EF are determined during the feed-forward activity. LS and LF are determined during the back pass activity. ES (earliest start) is the earliest time a project activity can start assuming all its predecessors have been completed. EF (earliest finish) is the earliest time a project activity can be completed. LS (late start) is the last time an activity can be started so as not to delay the completion of the entire project. LF (late finish) is the last time an activity can be completed so as not to delay the completion time of the entire development project..

a. Forward Pass is an Early Start Time rule. Before an activity project could start, all of its predecessors must be completed after any activities. The earliest finish time (EF) of an activity is the calculate of the earliest start time (ES) and the time of the activity itself, that is EF = ES + Activity time.

1) If an activity have only one direct predecessor, ES is the same as the EF of the predecessor activity.

2) If an activity have more than one of direct predecessors, it's ES is the maximum value of all predecessor EFs, i.e.: ES = Maximum {EF all direct predecessors }.

b. Backward Pass is the Slowest Finish Time Rule activity project. Again, This rule is based on the fact that before a project activity can be started, all its predecessors must be completed within the given activity time. The rule for the slowest start time or also known as the slowest start time (LS) of a project activity is the difference between the latest completion time (LF) and the existing project activity time, namely: LS = LF - Activity time.

After calculating the earliest time and the slowest time of all activities, it becomes easy to find the amount of float time each activity project has. Slack is the free time that activity has so that its implementation can be postponed without causing delays in the overall project.

1) If an activity is a direct predecessor of only one activity, its LF equals the LS of the activity project that has immediately follows it.

2) If an activity project has a directing predecessor of more than one activity, then LF is the min of all LS values of the activity. activities that directly follow it, namely: LF = Min {LS of all activity that immediately follow it}.

c. Slack or Float is a critical activity with an activity value of zero which is on the critical path, namely Float = LS – ES or Float = LF – EF.

2.5. Goal Programming

Goal Programming (GP) is a development of Linear Programming (LP), so GP has differences from LP, has elements, and meets the requirements as LP has, Algorithms used in GP, as well as Models and formulations in GP. Elements in linier programming include :

a. Decision Variables

The decision variable is the variable whose value you want to find from the model created. The value of this variable will then determine the optimality of the resulting solution. In the form of a series of numbers X1, X2, X3,...Xn.

b. Objective Function

The objective function is the function that you want to optimize in finding a solution. Optimization of the objective function can be done by maximizing or minimizing the value of the function depending on the problem at hand. The general form of the objective function is as follows.

Minimize : Min Z(x) $= \sum_{i=1}^{n} C_i X_i$

Maximize: Max Z(x) = $\sum_{i=1}^{n} C_i X_i$

c. Constraints/Constraints

Constraints are equations or inequalities that limit the value of a variable. The general form of the constraint is as follows:

$g_i(x) = b_i$;
$g_i(x) \geq b_i$;
$g_i(x) \leq b_i$

d. Model Goal Programming

To create a goal programming (GP) model, the targets to be achieved are first determined. Furthermore, for each target, an objective function formula is made, and a solution is sought that minimizes the deviation of each objective function

from the original target. Mathematically, this will be easier to understand.
Target yang dicapai adalah gk (k=1,2,...k)

$$\sum_{j=1}^{n} = C_{j1} X_j = G_1 \quad \text{(Target 1)}$$

$$\sum_{j=1}^{n} = C_{j2} X_j = G_2 \quad \text{(Target 2)}$$

$$\sum_{j=1}^{n} = C_{jk} X_j = G_k \quad \text{(Target k)}$$

This form can be simplified to :

$$Minimize\ Z: \sum_{j=1}^{n} \left| \left(\sum_{j=1}^{n} C_{j1} X_j - G_1 \right) \right|$$

Other Forms |yk| can be written as yk- + yk+ with the following conditions:

$yk^{+} = 0$ If $yk \leq 0$ and $yk^{+} = yk$ If $yk \geq 0$

$yk^{-} = -yk$ If $yk \leq 0$ and $yk^{-} = yk$ If $yk \geq 0$

2.6. Research Methodology

The methodology used in this research is to do the work in a directed and systematic way so that there are clear sequences in the implementation of this research, by using a clear method, the research plan is carried out until the completion of the final stage of the research. The stages in this research begin with initial observation of the problem, identification and problem formulation through literature review and direct field observation through interviews, determining research objectives, collecting data through project identification and determining project duration, data processing through preparing activities, and linking activities and determining critical path.

3. Result and Discussion

This research initially describes the activities, namely the assessment and identification of the project scope by describing and breaking it down into activities or groups of activities that are project components. This preparation is based on experience and/or data in past projects. Each activity has an estimated time in the process or duration which is arranged in the master schedule.

Determine the relationship between activities, that is, activities are rearranged into a chain, where the sequence of activities is in accordance with the logic of dependency in network planning so that the sequence of activities can be known from the beginning of the development process of a project until the completion of the project as a whole.

a. Input Activities Project

Activity determination begins by defining project activities and entering the duration of each activity followed by defining its predecessor. That each activity on the project has a predecessor activity as the basis for implementing and calculating the completion time of activities in Table 1 and create network planning Figure 1 according to project data.

Table 1. Description of Activities, Duration, and Predecessors Activities

NO	Activity	Description of activities	Duration (Day)	Predecessor
1.	A	Mobilization	4	-
2.	B	Worker Barracks Loading	7	A
3.	C	Land Clearing	7	A
4.	D	Backfill and Compaction	14	C
5.	E	Stake Fabrication and Mobilization	11	A
6.	F	Erection	20	E
7.	G	Stake Head Cutting	7	F
8.	H	Reinforcing	17	G
9.	I	Formwork	19	H
10.	J	Casting	14	I
11.	K	Roof Frame Work	7	J
12.	L	Roof Closure	3	K
13.	M	Water Installation Sparring	7	F
14.	N	Genset Room	30	D
15.	O	Septic Tank Fabrication	14	A
16.	P	Making infiltration and septic tanks	2	O
17.	Q	Mobilization	3	P, N, B, L, M
18.	R	Making Keet Directors, Work Barracks, Work Losses During the Implementation Period	3	Q
19.	S	Practical Column Work	21	R
20.	T	Lightweight Brick Wall Pair	14	R
21.	U	Plaster and Acian	30	AP, S

NO	Activity	Description of activities	Duration (Day)	Predecessor
22.	V	Install GRC Partition wall	30	Z
23.	W	Travertine and Conwood wall mount	20	U
24.	X	Ceiling Work	20	U
25.	Y	Door and Window Works	15	Z
26.	Z	Floor job	45	X
27.	AA	Painting Job	20	U
28.	AB	Glass Canopy Roof Work	7	X
29.	AC	Storage Works	1	T
30.	AD	Submission of New Electrical Installation	45	R
31.	AE	Incoming and Outgoing Cubicle Jobs	14	AM
32.	AF	Transformer Work	4	AM
33.	AG	Bed Lift Jobs	120	R
34.	AH	Electrical Installation Installation	30	T
35.	AI	Internal telephone jobs	7	T
36.	AJ	Sound System Jobs	7	T
37.	AK	CCTV Jobs	7	T
38.	AL	AC jobs	14	AH
39.	AM	Feeder Cable Work	7	T
40.	AN	Electrical Panel Work	5	AH
41.	AO	Lightning Protection Job	2	AF, AE
42.	AP	Plumbing Job	21	R
43.	AQ	Sanitary Work	7	AP
44.	AR	Hydrant Job	14	U

After entering project activities and determining predecessor activities, a network diagram is prepared to find a critical path where the float/slack value is zero, the slack value calculation is obtained by subtracting the latest start time minus the earliest start time or subtracting the earliest finish time minus the latest finish time end.

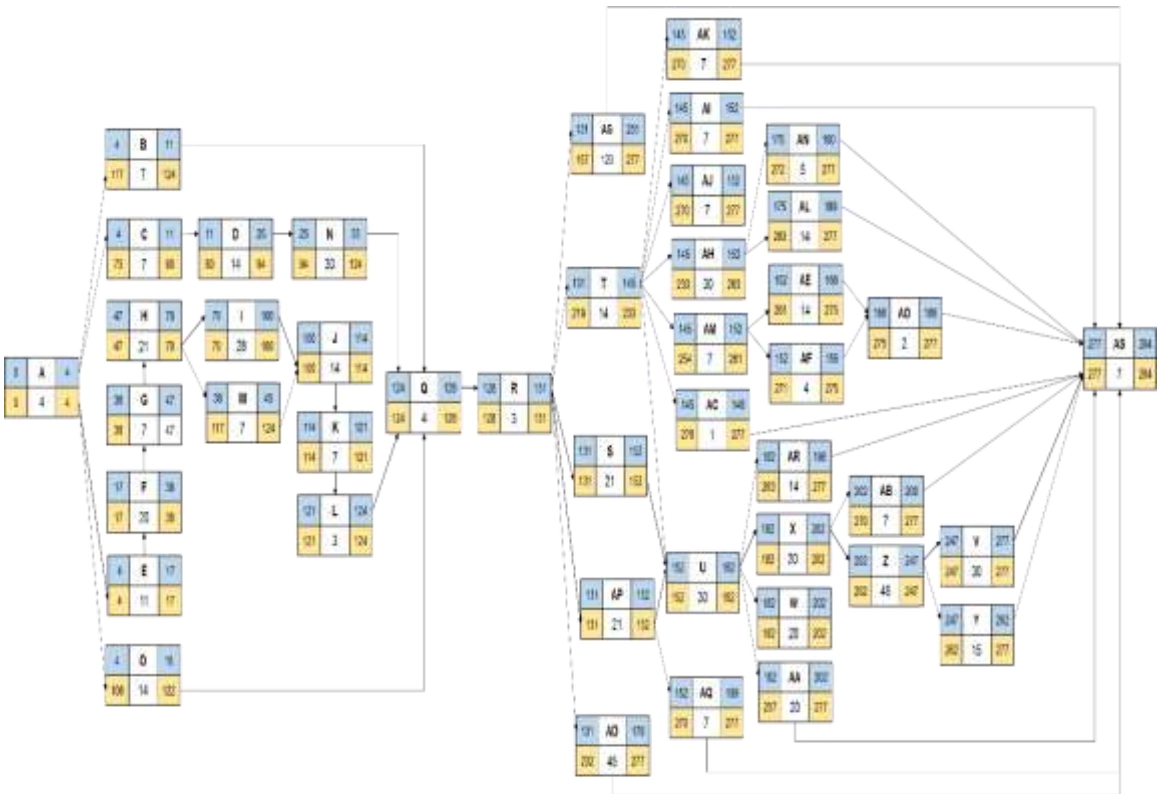


Figure 1. Network Planning Building Construction

Table 2. Slack Calculation

No	Activity	Predessor	Durasi	Early Start	Early Finish	Late Start	Late Finish	Slack
1	A	-	4	0	4	0	4	0
2	B	A	7	4	11	117	124	113
3	C	A	7	4	11	73	80	69
4	D	C	14	11	25	80	94	69
5	E	A	13	4	17	4	17	0
6	F	E	21	17	38	17	38	0
7	G	F	9	38	47	38	47	0
8	H	G	23	47	70	47	70	0
9	I	H	30	70	100	70	100	0
10	J	I	14	100	114	100	114	0
11	K	J	7	114	121	114	121	0
12	L	K	3	121	124	121	124	0
13	M	F	7	38	45	117	124	79
14	N	D	30	25	55	94	124	69
15	O	A	14	4	18	108	122	104
16	P	O	2	18	20	122	124	104
17	Q	P, N, B, L, M	4	124	128	124	128	0
18	R	Q	3	128	131	128	131	0
19	S	R	21	131	152	131	152	0
20	T	R	14	131	145	219	233	88
21	U	AP, S	30	152	182	152	182	0
22	V	Z	30	247	277	247	277	0
23	W	U	20	182	202	257	277	75
24	X	U	20	182	202	182	202	0
25	Y	Z	15	247	262	262	277	15
26	Z	X	45	202	247	202	247	0
27	AA	U	20	182	202	257	277	75
28	AB	X	7	202	209	270	277	68
29	AC	T	1	145	146	276	277	131
30	AD	R	45	131	176	232	277	101
31	AE	AM	14	152	166	261	275	109
32	AF	AM	4	152	156	271	275	119
33	AG	R	120	131	251	157	277	26
34	AH	T	30	145	175	233	263	88
35	AI	T	7	145	152	270	277	125
36	AJ	T	7	145	152	270	277	125
37	AK	T	7	145	152	270	277	125
38	AL	AH	14	175	189	263	277	88
39	AM	T	7	145	152	254	261	109
40	AN	AH	5	175	180	272	277	97
41	AO	AF, AE	2	166	168	275	277	109
42	AP	R	21	131	152	131	152	0
43	AQ	AP	7	152	159	270	277	118
44	AR	U	14	182	196	263	277	81
45	AS	AN, AG, Y, AA, W, AD, AB AR,	7	277	284	277	284	0

Based on the results of the CPM calculation in Table 2, then it is described in the form of a network diagram that has been adjusted to the results obtained. The following can be seen in Figure 5 network diagram using the CPM method. A series of activities that fall into the critical of path using the CPM method is a critical of path that is on the path A, E, F, G, H, I, J, K, L, Q, R, S, U, V, X, Z, AP, and AS.

Based on Figure 5, the project of completion time by using the CPM method is 101 days. With the analysis that Paths A, E, F, G, H, I, J, K, L, Q, R, S, U, V, X, Z, AP, and AS are paths that do not have work time between the completion of one activity stage with other activities with the start stage of the next activity.

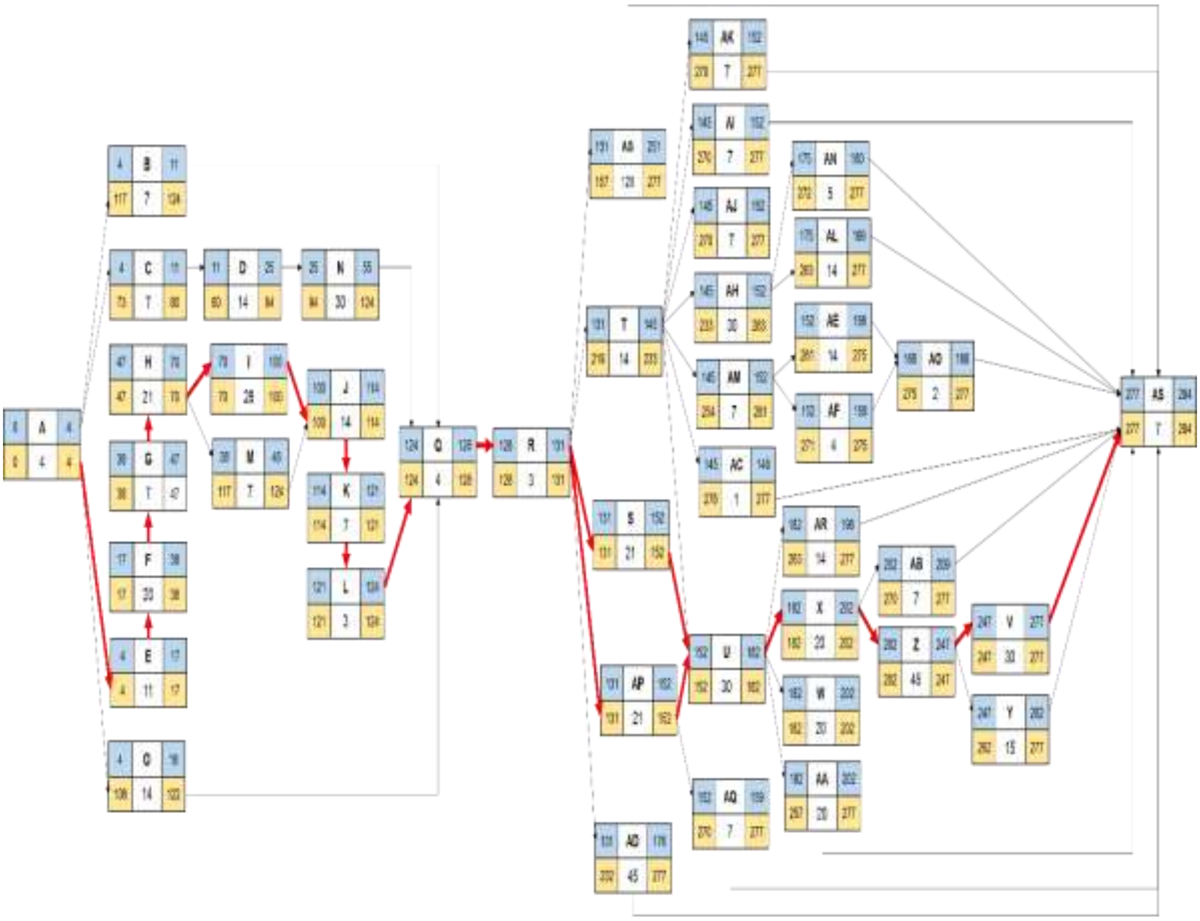


Figure 2. Critical Path

b. **Acceleration Time**

Calculating crash duration look in Table 3 :

$$\text{Crash Duration} = \frac{\text{Working hours} \times \text{Initial Duration}}{\text{Working hours} + (a \times b)}$$

Where :

a = Number of overtime hours

b = Coefficient of decrease in work productivity

= 0.9 for 1 hour overtime

= 0.8 for 2 hours of overtime

= 0.7 for 3 hours of overtime

Initial Duration of Activity A = 4 days

$$\text{Crash Duration} = \frac{8\ \text{H} \times 4\ \text{days}}{8\ \text{hours} + (1 \times 0.9)} = 3.59 \text{ to } 4 \text{ days}$$

Table 3. Acceleration Time

No	Activity	Predessor	Durasi	Accelerate	No	Activity	Predessor	Durasi	Accelerate
1	A	-	4	0	24	X	U	20	182
2	B	A	7	4	25	Y	Z	15	247
3	C	A	7	4	26	Z	X	45	202
4	D	C	14	11	27	AA	U	20	182
5	E	A	13	4	28	AB	X	7	202
6	F	E	21	17	29	AC	T	1	145
7	G	F	9	38	30	AD	R	45	131

No	Activity	Predessor	Durasi	Accelerate	No	Activity	Predessor	Durasi	Accelerate
8	H	G	23	47	31	AE	AM	14	152
9	I	H	30	70	32	AF	AM	4	152
10	J	I	14	100	33	AG	R	120	131
11	K	J	7	114	34	AH	T	30	145
12	L	K	3	121	35	AI	T	7	145
13	M	F	7	38	36	AJ	T	7	145
14	N	D	30	25	37	AK	T	7	145
15	O	A	14	4	38	AL	AH	14	175
16	P	O	2	18	39	AM	T	7	145
17	Q	P,N,B,L, M	4	124	40	AN	AH	5	175
18	R	Q	3	128	41	AO	AF, AE	2	166
19	S	R	21	131	42	AP	R	21	131
20	T	R	14	131	43	AQ	AP	7	152
21	U	AP, S	30	152	44	AR	U	14	182
22	V	Z	30	247	45	AS	AN, AG, Y, AA, W, AD, AB AR,	7	277
23	W	U	20	182					

c. Optimization Goal Programming

By obtaining the objective function and the formulation of the constraints, the next step is to formulate the formulation in the form of goal programming so that it can be completed according to the provisions. The following is the initial programming goal formulation according to the limitations and objectives, including:

1) Target Total Time or Duration of Project Work:
DA + DE + DF + DG + DH + DI + DJ + DK + DL + DQ + DR + DS + DU + DV + Dx + DZ + + DAP + DAS ≤ 277

2) Target Cost or Wages of Project Worker :
699.500DA + 944.500DE + 822.000DF + 1.067.000DG + 822.000DH + 1.527.000DI + 699.500DJ + 9.595.000DK + 607.000DL + 699.500DQ + 607.000DR + 499.500DS + 499.500DU + 1.894.500DV + 607.000Dx + 1.527.000DZ + 837.000DAP + 699.500DAS ≤ 285.873.000

After that input the formulation into lingo program as shown in figure 3.

d. Cost

The calculation of project costs in terms of workers' wages is divided into 2, namely the wages of workers in normal conditions and accelerated conditions, in normal conditions workers are paid according to normal wages while in accelerated conditions they are paid 1.5 times the normal wage so that the details of wages can be seen from the table 4.

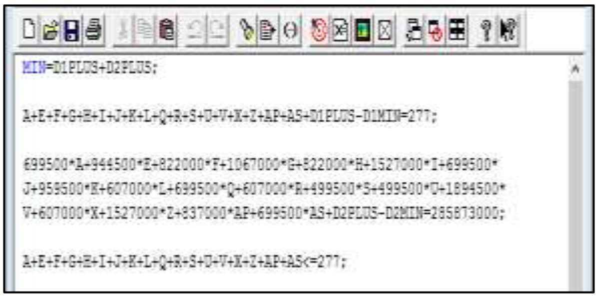


Figure 3. Formulation in Lingo Software

Goal programming calculation results shown in figure 4. There are have shortest duration in building project Results obtained total optimal duration of 250 days.

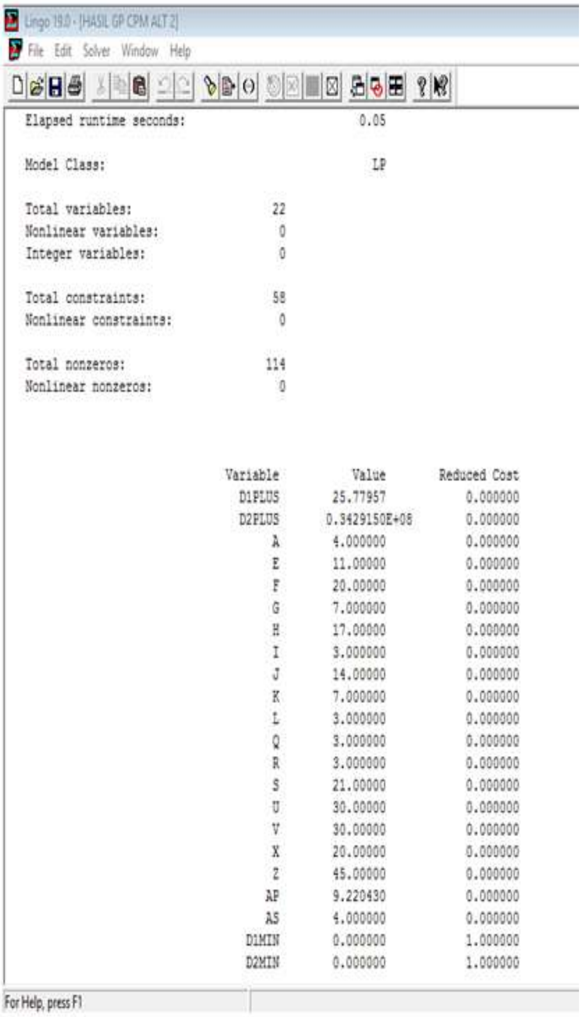


Figure 4. Results Of Goal Programming With Lingo

Table 4. Comparison of Normal Cost and Accelerate Cost

Aktivity	Duration	Foreman	Craftsman	Labourer	Accelerate Cost	Normal Cost
A	4	1	1	4	Rp 3.322.992	Rp 2.798.000
B	7	1	2	4	Rp 6.833.512	Rp 5.754.000
C	7	1	6	6	Rp 12.693.800	Rp 10.689.000
D	14	1	1	1	Rp 6.268.920	Rp 5.278.000
E	11	1	3	4	Rp 12.338.524	Rp 10.389.500
F	20	1	2	4	Rp 19.524.320	Rp 16.440.000
G	7	1	4	4	Rp 8.870.064	Rp 7.469.000
H	17	1	2	4	Rp 16.595.672	Rp 13.974.000
I	19	1	6	6	Rp 34.454.600	Rp 29.013.000
J	14	1	1	4	Rp 11.630.472	Rp 9.793.000
K	7	1	4	3	Rp 7.976.472	Rp 6.716.500
L	3	1	2	2	Rp 2.162.712	Rp 1.821.000
M	7	1	2	1	Rp 4.152.736	Rp 3.496.500
N	30	1	4	6	Rp 45.673.920	Rp 38.460.000
O	14	1	2	4	Rp 13.667.024	Rp 11.508.000
P	2	1	2	4	Rp 1.952.432	Rp 1.644.000
Q	3	1	1	4	Rp 2.492.244	Rp 2.098.500
R	3	1	2	2	Rp 2.162.712	Rp 1.821.000
S	21	1	2	1	Rp 12.458.208	Rp 10.489.500
T	14	1	2	1	Rp 8.305.472	Rp 6.993.000
U	30	1	2	1	Rp 17.797.440	Rp 14.985.000
V	30	1	9	6	Rp 67.494.120	Rp 56.835.000
W	20	1	9	6	Rp 44.996.080	Rp 37.890.000
X	20	1	2	2	Rp 14.418.080	Rp 12.140.000
Y	15	1	6	6	Rp 27.201.000	Rp 22.905.000
Z	45	1	6	6	Rp 81.603.000	Rp 68.715.000
AA	20	1	4	24	Rp 76.405.440	Rp 64.340.000
AB	7	1	6	3	Rp 10.013.024	Rp 8.431.500
AC	1	1	1	2	Rp 575.436	Rp 484.500
AD	45		1		Rp 6.546.060	Rp 5.512.500
AE	14	1	4		Rp 10.591.392	Rp 8.918.000
AF	4	1	4		Rp 3.026.112	Rp 2.548.000
AG	120	1	6		Rp 125.695.680	Rp 105.840.000
AH	30	1	3	3	Rp 29.820.840	Rp 25.110.000
AI	7	1	4	2	Rp 7.082.880	Rp 5.964.000
AJ	7	1	4	2	Rp 7.082.880	Rp 5.964.000
AK	7	1	3		Rp 4.277.420	Rp 3.601.500
AL	14	1	6		Rp 14.664.496	Rp 12.348.000
AM	7	1	2	2	Rp 5.046.328	Rp 4.249.000
AN	5	1	2		Rp 2.327.960	Rp 1.960.000
AO	2	1	2		Rp 931.184	Rp 784.000
AP	21	1	3	3	Rp 20.874.588	Rp 17.577.000
AQ	7	1	1	1	Rp 3.134.460	Rp 2.639.000
AR	14	1	6	2	Rp 18.238.864	Rp 15.358.000
AS	4	1	1	4	Rp 3.322.992	Rp 2.798.000
Total					**Rp 807.738.337**	**Rp.733.914.500**

e. Indirect Cost

It is also necessary to pay attention to several things in calculating project costs such as direct and indirect costs of the warehouse, operating labor costs, and operating costs if the equipment is leased as well as investment, depreciation, repair, maintenance, and mobilization costs if the equipment is not leased.

The calculation of equipment costs is adjusted to the activities carried out by acceleration, namely project activities E (1 Day), F (2 Days), G (1 Day), H (2 Days), I (3 Days), J (1 Day), K (1 Day), S, (2 Days), U (3 Days), V (3 days), X (2 Days), Z (5 Days), AP (2 Days) and AS (1 Day) namely the cost of equipment to carry out construction work. In calculating this cost, In addition, it is necessary to pay attention to several factors and regarding the costs of entering and leaving the warehouse, operational labor costs, and operational costs if the equipment is leased as well as investment, depreciation, repair, and maintenance, and mobilization costs if the equipment is not leased, including table 5.

Table 5. Additional Activity Cost without Accelerate Time

Activity	Equipment	Cost (Per Day)	Normal	Accelerate	GP
E	Rent Truck Trailer	Rp. 42.000.000	11	10	10
F	Rent Mobile Crane	Rp. 390.000	20	18	18
G	Rent Mobile Crane	Rp. 145.000	7	6	6
H	Rent Scafolding	Rp. 1.440.000	17	19	17
I	Rent Scafolding	Rp. 1.440.000	19	25	19
J	Rent Scafolding	Rp. 1.440.000	14	13	13
K	Rent Mobile Crane	Rp. 390.000	7	6	6
S	Rent Mobile Crane	Rp. 390.000	21	-	-
U	Rent Scafolding	Rp. 1.440.000	30	27	27
V	Rent Scafolding	Rp. 1.440.000	30	30	30
X	Rent Scafolding	Rp. 1.440.000	20	20	20
AP	Rent Scafolding	Rp. 1.440.000	21	21	21
AS	Rent Truck Trailer	Rp. 42.000.000	4	6	6
Electricity	PLN	Rp. 120.000	277	260	250
Water	PDAM	Rp. 90.000	277	260	250
Insurance	Personal Insurance	Rp. 2.333.333	277	260	250

Comparison of the total cost of normal time with acceleration time and optimization goal programming is :

a. Normal Time in 284 days :
1) Workers' Wages : Rp. 733.914.500
2) Indirect Cost : Rp. 1.571.678.241
3) Penalty Cost 7days: Rp. 176.700.611 +
4) Total : Rp. 2.597.098.352

b. Accelerate Time in 257 days :
1) Workers' Wages : Rp. 848.719.000
2) Indirect Cost : Rp.1.566.696.580
3) Penalty Cost : Rp. 0 +
4) Total : Rp.2.415.415.580

c. Optimization Time in 250 days :
1) Workers' Wages : Rp. 821.262.111
2) Equipment Cost : Rp. 1.529.743.250
3) Penalty Cost 7 days: Rp. 0 +
4) Total : Rp. 2.351.005.361

4. CONCLUSION

Based on the data analysis and discussion that has been carried out in this study, the conclusion that can be drawn in this study is the number of days that can be completed in this project using the CPM scheduling method is 257 days. However, without using this method, the project completion time would take 284 days. In addition, the company can save costs of Rp. 181,682,772 while avoiding penalty fees due to project delays. while using goal programming optimization, the optimal time duration is 250 days with a cost efficiency of Rp. 246.092.991.

So that by applying the calculation to the CPM method, the company can perform project efficiency for 27 days while using goal programming optimization have project efficiency for 34 days simultaneously being able to streamline the budget by using network planning. By using Network Planning using the goal programming method as a tool, companies can find out which activities need to be prioritized so as not to experience project completion delays. Initial planning in scheduling techniques must be more mature in order to facilitate the implementation of the project schedule

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