Analysis of Project Acceleration with CPM Methodand PDM on Housing Development Project in Maluku 3 West Seram

Muhammad Farhan Ipaenin[1], Rudi Serang[2], Semuel. P. Papilaya[3]

State Polytechnic, Ambon, Indonesia

***Abstract*— *In the development process of a construction project frequent unwanted things such as delays in the work on the project. Many factors cause the delay, one way to anticipate the acceleration. In doing acceleration, cost and quality factors must be considered, in order to obtain the optimum cost and quality within the required standards. Housing Development Projects have been selected for research studies because of delays in implementation. Critical Path Method and PDM can be used to perform scheduling of project implementation with the consideration that this method is more effective and efficient. Optimization of time and costs obtained from the Crash Program with Network Planning methods PDM system by adding hours of work on each job accelerated. The acceleration is done on the job dilintasan slope critical with the lowest cost. Results of the analysis showed the total budget of the project cost under normal conditions of Rp15,229,000,000.00 with implementation duration of 120 days, in the alternative condition after crashing with the addition of maximum working hours for four hours obtained for Rp15,218,910,720.73 or less 0,07% of the total budget cost of the project on the condition normal and duration of project implementation gained 115 working days or sooner 4.17% of the normal duration.*

Keywords*— *Cost slope, Crashing, Critical Path, PDM.

I. INTRODUCTION

There are three components of the success of a construction project, including the factors of cost, quality and time. In a period that has been provided, a contractor must be able to manage construction projects systematically in order to achieve success in accordance with the project plan. But in reality, the operator of the project contractor can not complete the work within the time planned.

Problems are often found in field is the delay time of execution. Delays in result by several things including, land issues, design changes, delays in the auction, as well as weather conditions in the field.Delays that exceed the limit will be penalized in the form of a fine of 1/1000 of the contract value per day, according to Presidential Decree No. 54 of 2010 Article 120. Then the project implementers will attempt to shorten the duration of the project, so the project completion time can be in accordance with the plan.One effort to shorten the duration of the project is to accelerate the implementation of the,

In this study, the authors conducted a case study on the Maluku 3 Flats Construction Project located in the village of Ety, Piru city, West Seram district with a contract value of Rp. 15,229,000,000.00 and implementation time is 120 calendar days. This building is planned for 3 floors with a capacity of 168 people. The problem in this development project was chosen because it was delayed in its implementation, the author will conduct an analysis of the acceleration of project completion with the Analysis Method that will be used namely the CPM (Critical Pert Method) and PDM (Precedence Diagram Method) and Project crashes. The purpose of this research is to accelerate project implementation time by determining the critical trajectory of a project so that it can be done to reduce the maximum duration with the most economical cost of activities that are still possible to be reduced.

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II. LITERATURE REVIEW

2.1 Understanding Project

Projects can be interpreted as a temporary activity that takes place within a limited period, with a particular resource allocation and is intended to produce a product or deliverable that quality criteria have been outlined clearly. The scope of these tasks can be a plant, the manufacture of new products or implementation of research and development.

2.2 Project Scheduling

Scheduling can be defined as the time available for the implementation of each part in order to completing a project such that achieved optimal results, taking into account the existing limitations.

a. Techniques In Scheduling

Broadly speaking scheduling techniques can be classified into:

1) Bar Chart Methods (Gant Chart)

Bar Chart Gantt introduced by Hendry I. and Frederick W. Taylor in early 1917. The bar chart is a set list of activities that are organized into columns vertical direction. Column horizontal direction indicates a time scale. When start and end of an activity can be seen clearly, while the duration of the activities described by the length of the bars.

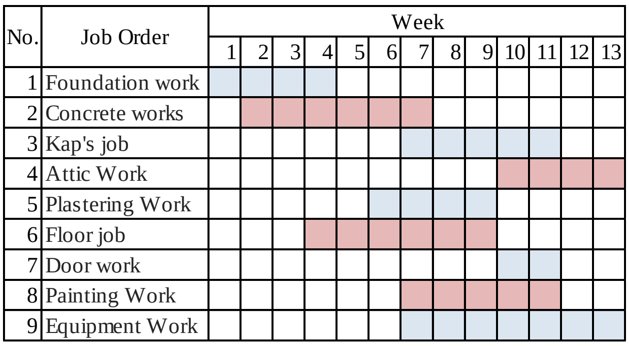

Fig.1: Example Bar Chart

2) CPM Method (Critical Path Method)

In this method of work (activity) is symbolized by two arrows, while the node as a marker of start and end of a job. The relationship between activities in the form of relationship possible only finish to start. In this method known as the "dummy" which is a facility that can be considered as an activity that does not exist duration.

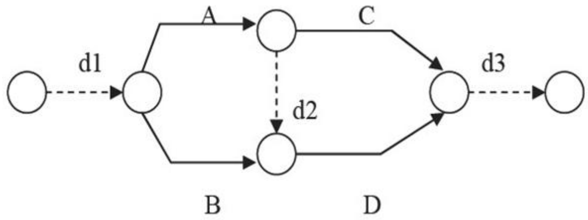

Fig.2: Methods AOA Network Diagram

3) PDM method (Precedence Diagram Method)

Methods Precedence Diagram Method (PDM) is a refinement of the CPM, because in principle CPM uses only one kind of relationship that ties the end of the initial activity and an activity can be started when the events that preceded it finished. Activities and events in the diagram precedent methods node written in the form of a rectangular box. The boxes marked an activity, which must be specified identity and activities over time. While the event is an activity ends. Each node has two events are the beginning and the end.

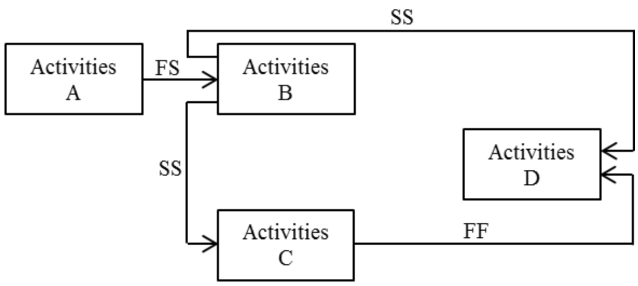

Fig.3: Network Diagram PDM

b. Critical Path

This path requires maximum attention of project managers, especially in the period of planning and implementation of work / activity concerned, for example, be given top priority in the allocation of resources can be a labor, equipment or working hours. In addition the project life can be known of how long the duration of the critical path are obtained.

2.3 Acceleration Project Duration

According to Syah (2004) crash program or accelerated implementation of the work means shortening (implementation) project. The amount / number is equal to the life of the project / the amount of time available to a critical path. Acceleration of implementation of the work means that efforts to shorten the critical path on the network work plan is concerned.

Meanwhile, according to Husen (2010) project crashing done so that the work completed by the exchange of cross-time and cost and to increase the number of shift work, hours of work, number of employees, the availability of

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materials, and using equipment that is more productive and installation methods faster as direct cost component cost. Project crashing or crash the program is done by using the network planning schedule improvements that are on the critical path. The consequence is the rising cost crashing project (direct costs).

To further analyze the relationship between time and cost of an activity, then used the following definition:

a. Period of normal

Is the period of time required to conduct to completion, in an efficient manner but beyond consideration of their overtime and other special efforts, such as hiring more sophisticated equipment.

b. The normal cost

Are the direct costs necessary to complete a period of normal activities. There are fees and charges Normal Normal Material wages.

Normal fee formula:

$$\text{coefficient} = \frac{\textit{Material costs / Wage}}{\textit{Material and Wage Costs}}$$

Total Normal Cost = coefficient xNormal Costx Volume of Work

c. This period of time is shortened (crash time)

Is the shortest time to complete an activity which is technically still possible. Here are considered resource rather than an obstacle.

The formula to calculate the duration of crashing:

Duration crashing = (Volume of Work) / (working capacity 12 hours x number of workers)

d. The cost for the shortened time (crashes cost)

Is the sum of direct costs to finish the job with the shortest period of time.

Total Wages Labor formula:

= ((Normal wage + wage hour to hour wage 1+ to 2+ wage + wage hour to 3 hours to 4) xDurationcrashx number of labor)

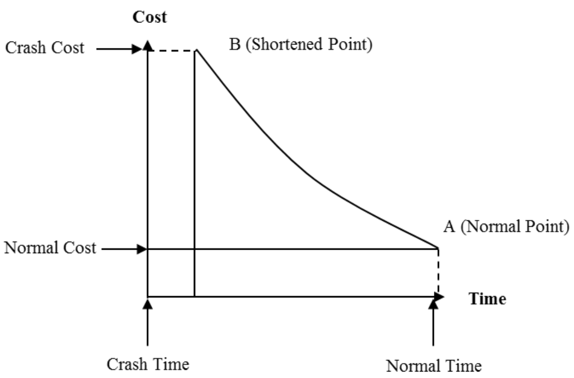

Fig.4: Relationships normal time-cost and shortened

The relationship between time and cost depicted as a graph in Figure 3. Point A shows the normal points, while point B is shortened. The line connecting point A to B is called the time-cost curves. In general, this line can be regarded as a straight line, when it is not (eg, concave) then held a calculation per segment consisting of several straight lines. If known shape of the curve-time cost of an activity, which means that by knowing how slope or angle of slope, it can be calculated how much it costs to shorten the time of day with the formula:

$$\textit{cost slope} = \frac{\textit{crash cost} - \textit{Normal cost}}{\textit{Normal time} - \textit{Crash time}}$$

The total project costs are the sum of direct costs and indirect costs used during project implementation. The amount of this fee is dependent by the length of time (duration) of the project's completion, both of them changes with time and the progress of the project. While it can not be calculated with certain formulas, but in general, the longer the project goes higher cumulative indirect costs are required.

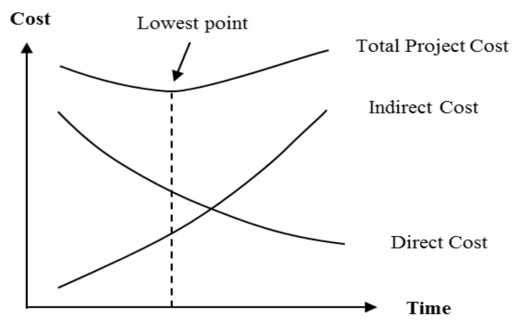

Fig.5: Grafik time relationship with the total costs, direct costs and indirect costs

III. RESEARCH METHODOLOGY

3.1 Research sites

This case study was carried out in the Maluku 3 Flats Construction Project located in Ety Village, West Seram Regency, Maluku Province

Fig.6: Research Location Map

3.2 Data Collection Technique

Data collection techniques used by the author in this study are:

a. Field Study

Field studies conducted to obtain primary data by conducting surveys directly on the construction project Rusun Maluku 3 which is the object of research, which conducted interviews with the supervising consultants, contractors, and workers at the project site and the parties related to the scope of the project.

b. Library Studies

Literature study was conducted to obtain secondary data in order to support the primary data. The data collection is done by reading and studying books, browse the internet and journals related to the acceleration of the implementation of the project.

3.3 Data Types

The type of data used in this paper are:

a. Primary Data

Is the data that can only be obtained from the original source or first. The primary data such as interviews with the parties involved in the implementation of such projects on the causes of delay in the execution

b. Secondary Data

Secondary data is data that has been provided so that only needs to be sought, collected and processed are obtained from the relevant agencies, including:

- Budget plan
- Unit Price Analysis Works
- Price Wages and Materials
- Project Plan
- Thime Schedule
- Project Report
- Methods Of Implementation
- Contract Change Order

3.4 Data Analysis

In the acceleration of the duration of the project is done by increasing the hours worked four hours, which is expected in a day the volume of work produced greater. Application of this method requires the calculation of crashes and crash duration, the instrument in this study using the Precedence Diagram Method (PDM) with the help of Microsoft Project to determine the critical path of the project, which will further speed up the calculation in activities which are on the critical path.

3.5 Flowchart of Research

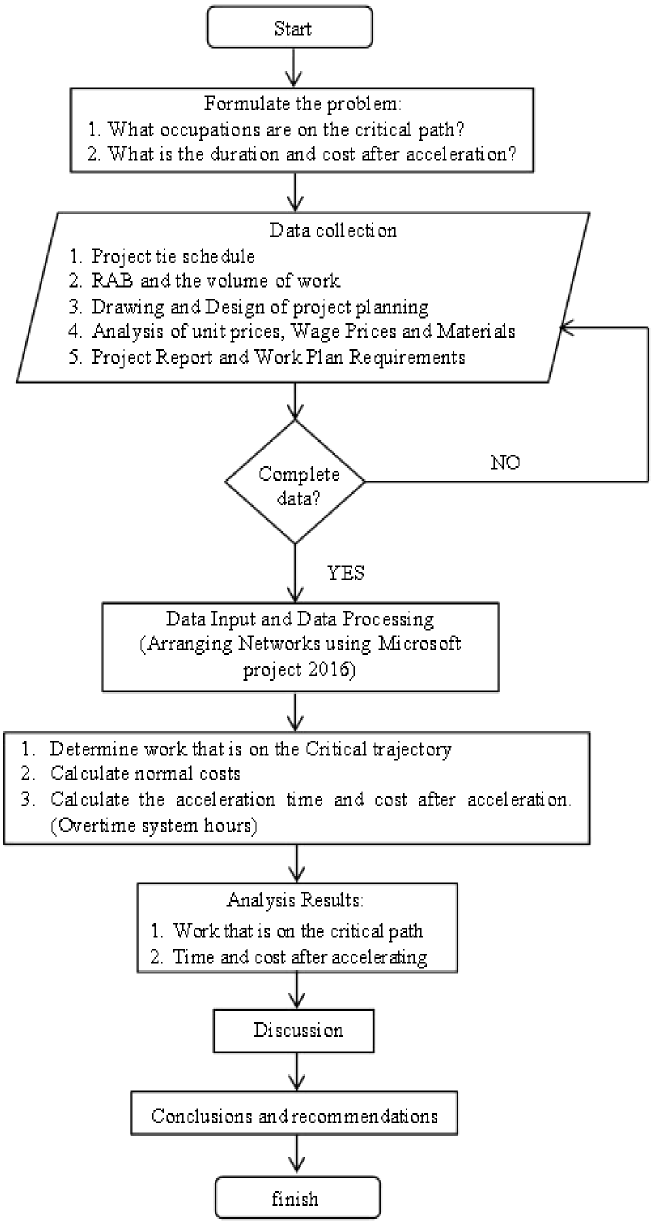

Fig.7: Flowchart

IV. RESULTS AND DISCUSSION

4.1 Data Project

The project name : Development of Flats in Maluku 3 West Seram

Project owner : Office PUPR

Project Implementation: PT. Prima Konstruksi

Project Planner: CV. Data Teknik

Project superintendent: PT. Matra Hasta Konsultan

Project Location: District of West Seram

Project duration: 120 calendar days

Implementation Period: August 23, 2018 to December 20, 2018

Source of funds : APBN 2018

Tabel.1: Price Wage Workers

WAGE PRICE	UNIT	UNIT PRICE
Foreman	OH	Rp 120,000.00
Foreman	OH	Rp 100,000.00
Bricklayer	OH	Rp 95,000.00
Carpenter	OH	Rp 95,000.00
Blacksmith	OH	Rp 95,000.00
worker	OH	Rp 70,000.00

Before conducting research, project data analysis is carried out in the form of Time Schedule and Budget Plan. Data obtained from the project will be analyzed again to get a faster project completion time by adding additional working hours. The analysis is only focused on the addition of working hours, while the material under normal conditions and the acceleration conditions are the same.

The analysis was performed to determine the difference in cost between a normal condition and the condition of the acceleration. Accelerate the process of project completion time by compressing the duration of the work that is in the critical path and possible to undertake additional work hours to four hours.

4.2 Determination of Critical Path

Once the duration of every job known to further define the relationship of each job, after the job is completed every relationship is modeled into a Microsoft project, it will get some work items that are on the critical path

Table.2: Jobs That Are Being on the Critical Path

ID	Job description	Duration Normal
5	Iron Concrete Column 1st Floor	4
9	Iron Concrete Wall Scroll 1st Floor	3
10	Formwork Wall Scroll 1st Floor	4
21	Iron Concrete Column 2rd Floor	4
26	Formwork Beam 2nd Floor	6
29	Reinforcement Plate 2nd floor	6
30	Formwork of the 2ndfloor plate	5
33	Iron Concrete Wall Scroll 2nd Floor	3
42	Iron Concrete Column 3rd Floor	5
46	Iron Concrete 3rd Floor Beams	5
47	Formwork Beam 3rd Floor	5
50	Reinforcement Plate 3rd floor	5
51	Formwork Plat 3rd floors	5
59	Iron Concrete Column Floor Roof	3
64	Formwork Beam Floor Roof	3
68	Floor plate roof formwork	3
71	Concrete Steel Ring Beam Stand Easel	3
87	Light Steel Frame Roof coverings	9

4.3 Calculating Duration and Cost Jobs

Critical activities in Table 1 above are then analyzed to determine the activities that will be accelerated. Analysis of the acceleration of these activities is based on critical activities that have the lowest cost slope value. Critical activities that will be accelerated are calculated based on data on the direct cost of the work to obtain additional work costs, as for one example of the calculation is as follows:

❖ **Iron Works Concrete Column 1st Floor**

1) Determining Work Productivity

Work Productivity = 1 / (Coefficient of Labor)
worker = 0007
Blacksmith = 0007
Foreman = 0.0007
Foreman = 0.0004
(Coefficient obtained from the AHS project)
worker = 1 /0007 = 142.86 m^3 / day
Blacksmith = 1 /0007 = 142.86 m^3 / day
Foreman = 1 /0.0007 = 1428.57 m^3 / day
Foreman = 1 /0.0004 = 2500 m^3 / day

2) Determining Total Workforce Index

Total Employment Index = (Volume of Work) / (Productivity JobsxLength Work)
Volume = 6,988.3 m3
duration = 4 days
worker = 6,988.3/(142.86 x 4) = 8.15 OH
The smith = 6,988.3 / (142.86 x 4) = 8.15 OH
Head Plumbers = 6,988.3 / (1428.57 x 4) = 0.82 OH
Foreman= 6,988.3/(2500.00 x 4) = 0.47 The OH

Table 3: Coefficients Productivity In Overtime Hours

Overtime Hours (hours)	Decreased Productivity Index	Job Performance (hourly)	Percentage of Job Performance (%)	Productivity Reduction coefficient
a	b	c=b*a	d	e=100%-D
a				
1	0.1	0.1	10	0.9
2	0.1	0.2	20	0.8
3	0.1	0.3	30	0.7
4	0.1	0.4	40	0.6

3) Calculating Normal Labor Wages

Price wage = Total Labor x Price Unit Labor
Workers = 8.15 xRp. 70,000 = Rp. 570,713.62
The smith = 8.15 xRp. 95,000 = Rp. 774,539.91
Head Plumbers = 0.82 xRp. 100,000 = Rp. 81,530.52
Foreman = 0:47 xRp. 120,000= Rp. 55,906.64

4) Acceleration Analysis duration By Adding Four Hours

Productivity of labor each day is already known from previous analyzes by duration of normal working hours is 8 hours / day. So that the duration will be calculated crashing more hours four hours / day taking into account the decline in labor productivity during overtime hours.

a. Labor Productivity

Hourly productivity = (Work Productivity a day) / (Length of normal business hours)

Labor Productivity Overtime = (Productivity a day + (overtime x Productivity an hour x coefficient))

worker

=>Productivity an hour = 142.86 / 8 = 17.86 OH

=>12 hour productivity = (142.86 + (4 x 17.86 x 0.6)) = 185.71 kg / day

Blacksmith

=>Productivity an hour = 142.86 / 8 = 17.86 OH

=>12 hour productivity = (142.86 + (4 x 17.86 x 0.6)) = 185.71 kg / day

Foreman

=>Productivity an hour = 1428.57 / 8 = 178.57 OH

=>12 hour productivity = (1428.57 + (4 x 178.57 x 0.6))

= 1857.14 kg / day

Foreman

=>Productivity an hour = 2500.00 / 8 = 312.50 OH

=>12 hour productivity = (2500+ (4 x 312.5 x 0.6))

= 3250. kg / day

b. Specify the duration after four hours plus overtime hours

The duration of the work crashing = (Volume of Work) / (Productivity working 12 hours x number of workers)

Workers = (6,988.3) / (185.71 x 12:23) ≈ 3 days

The smith = (6,988.3) / (185.71 x 12:23) ≈ 3 days

Head Plumbers = (6,988.3) / (178.57 x 1:22) ≈ 3 days

Foreman= (6,988.3) / (312.50 x 0.70) ≈ 3 days

c. Determining the total additional cost and wage labor

Added 1st hour overtime wage = 1,5 x (1/173) x (normal wage) x(working days a month)

Addition of second overtime wage = 2 x (1/173) x (normal wage)x (working days a month)

Normal wage

Workers = Rp. 70.000.00

Blacksmith = Rp. 95000.00

Head Plumbers = Rp. 100.000.00

Foreman= Rp. 120,000.00

Wage Overtime Hours 1st

Workers = 1.5 x (1/173) x Rp 95000.00 x 24 = Rp14,566.47

The smith = 1.5 x (1/173) x Rp. 70.000.00 x 24

= Rp19,768.79

Head Plumbers = 1.5 x (1/173) x Rp. 100.000.00 x 24

= Rp20,809.25

Foreman= 1, 5 x (1/173) x Rp 120,000.00 x 24

= Rp24,971.10

Wages Overtime Hours 2nd

Workers = 2 x (1) / 173 x Rp 95000.00 x 24

= Rp19,421.97

The smith = 2 x (1/173) x Rp. 70.000.00 x 24

= Rp26,358.38

Head Plumbers = 2 x (1/173) x Rp. 100.000.00 x 24

= Rp27,745.66

Foreman= 1, 5 x (1/173) x Rp 120,000.00 x 24

= Rp33,294.80

Wages Overtime Hours 3rd

Workers = 2 x (1/173) x Rp 95000.00 x 24

= Rp19,421.97

The smith = 2 x (1/173) x Rp. 70.000.00 x 24

= Rp26,358.38

Head Plumbers = 2 x (1/173) x Rp. 100.000.00 x 24

= Rp27,745.66

Foreman= 1, 5 x (1/173) x Rp 120,000.00 x 24

= Rp33,294.80

Wages Overtime Hours 4th

Workers = 2 x (1/173) x Rp 95000.00 x 24

= Rp19,421.97

The smith = 2 x (1/173) x Rp. 70.000.00 x 24

= Rp26,358.38

Head Plumbers = 2 x (1/173) x Rp. 100.000.00 x 24

= Rp27,745.66

Foreman= 1, 5 x (1/173) x Rp 120,000.00 x 24

= Rp33,294.80

Total cost / day

(Normal wage + 1st hour wage + 2nd hour wage + 3rd hour wage + 4th hour wage)

Workers = 70,000 + 14.566 + 19.421 +19.421 + 19.421 = Rp. 142,832

The smith = 95,000 + 26.358 + 26.358 + 26.358 + 26.358 = Rp. 193,844

Foreman= 100,000 + 27.745 + 27.745 + 27.745 +27.745 = Rp. 204.046

Foreman= 120,000 + 33, 294 + 33.294 + 33.294 + 33.294 = Rp. 244,855

Total laborwages

(Total cost a day x the duration of the work item x number of labor)

Workers = Rp. 142.832 x 3 x 12:23 = Rp. 5,240,339

Blacksmith = Rp. 142.832 x 3 x 12:23 = Rp. 7,111,888

Head Plumbers = Rp. 204.046 x 3 x 1:22 = Rp. 748.620

Foreman= Rp. 244.855 x 3 x 0.70= Rp. 513.339

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Cost Slope

(crash cost - normal cost) / (normal duration - crash duration)

Cost slope a day = (Rp13,614,186 - Rp8,896,144.09) / (4-3) = Rp. 4,718,041.74

Cost Slope total = Cost slope a day x (normal duration - the duration of the crash)

= Rp. 4,718,041.74 x (4-3) = Rp. 4,718,041.74

Teble.4: Cost SlopeCalculation Results

ID	Job Description	Normal		Crash		Cost Slope (Rp)
		Duration	Cost (Rp)	Duration	Cost (Rp)	
5	Iron Concrete Column 1st Floor	4	8,896,144.09	3	13,614,185.83	4,718,041.74
9	Iron Concrete Wall Scroll 1st Floor	3	7,184,812.00	2	9,773,559.29	2,588,747.29
10	Formwork Wall Scroll 1st Floor	4	14,879,066.40	3	22,770,131.96	7,891,065.56
21	Iron Concrete Column 2rd Floor	4	6,164,566.15	3	9,433,924.21	3,269,358.06
26	Formwork Beam 2nd Floor	6	44,260,642.80	5	75,260,148.88	30,999,506.08
29	Reinforcement Plate 2nd floor	6	13,938,929.91	5	23,701,552.30	9,762,622.39
30	Formwork of the 2ndfloor plate	5	62,537,197.80	4	102,083,841.96	39,546,644.16
33	Iron Concrete Wall Scroll 2nd Floor	3	4,781,948.12	2	6,504,923.65	1,722,975.53
42	Iron Concrete Column 3rd Floor	5	6,164,566.15	4	10,062,852.49	3,898,286.34
46	Iron Concrete 3rd Floor Beams	5	2,044,785.60	4	3,337,846.55	5,869,265.32
47	Formwork Beam 3rd Floor	5	43,792,491.60	4	71,485,546.98	27,693,055.38
50	Reinforcement Plate 3rd floor	5	13,938,929.91	4	22,753,490.21	8,814,560.30
51	Formwork Plat 3rd floors	5	62,537,197.80	4	102,083,841.96	39,546,644.16
59	Iron Concrete Column Floor Roof	3	2,705,990.64	2	3,680,981.49	974,990.85
64	Formwork Beam Floor Roof	3	43,792,491.60	2	59,571,289.15	15,778,797.55
68	Floor plate roof formwork	3	15,583,837.50	2	21,198,823.27	5,614,985.77
71	Concrete Steel Ring Beam Stand Easel	3	1,084,901.52	2	1,475,800.53	390,899.01
87	Light Steel Frame Roof coverings	9	48,958,856.10	7	77,698,993.85	28,740,137.75

4.4 Analysis of Direct Costs and Indirect Costs

Once the analysis process is complete acceleration and already get the duration of acceleration, then will calculate the total cost of the project in normal condition and the condition after acceleration. The project costs consist of direct costs and indirect costs. Following the calculation of the total project cost.

1) In Normal Condition

Normal duration = 120 days

Budget Plan = Rp. 15,229,000,000

In the normal cost calculation obtained weighting of 91% direct costs and indirect costs weight by 9% (6% profit and a 3% overhead). Because the profit and overhead costs are part of indirect costs, so in this study was taken the value of profit of 6% of the total project costs and overhead costs 3% of the total cost of the project. From the description above, it can look for the value of profit and overhead costs in the following manner.

Profit = Total project costs x6%
= Rp. 15,229,000,000 x 6%
= Rp. 913,740,000

Overhead costs = Total cost of project x 3%
= Rp. 15,229,000,000x 3%
= Rp. 456,870,000

Overhead / day = (Overhead) / Length
= (Rp.456,870,000) / 120
= Rp. 3,807,250

After getting the value of profit and overhead, then the next can be calculated direct cost and indirect cost

Direct cost = 91% x Total cost of the project
= 91% xRp. 15,229,000,000
= Rp. 13,858,390,000

Indirect cost = Profit + Overhead
= Rp. 913,740,036 + USD. 456,870,018
= Rp. 1,370,610,000

Total project cost
= Direct costs + Indirect costs
= Rp. 13,858,390,000 + Rp. 1,370,610,000
= Rp. 15,229,000,000

2) In the Accelerated Conditions (Crashing)

In this study the acceleration performed on activities that are on the critical path at an additional cost for each job in the previous calculation. To obtain optimum charge time and then crashing in phases starting from the work that has cost the smallest slope to slope the greatest cost, in order to get the time and the lowest cost.

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Compression 1st Phase:

❖ Concrete Steel Ring Beam Stand Easel
Duration crashing = 1 day
Total Length = 120-1 = 119 days
Cost slope = Rp. 390,899/ day

The direct costs include:

A. The direct costs of normal = Rp. 13,858,390,000
B. Additional charges = Rp. 390.899
C. The total direct cost acceleration = A + B
= Rp. 13,858,390,000 + Rp. 390.899
= Rp. 13,858,780,899

Indirect costs include:

D. Overhead (119 x Rp. 3,807,250) = Rp. 453,062,750
E. Profit = Rp. 913,740,000
F. Total indirect costs =D + E = Rp. 1,366,802,750

Total cost of the project:

= Direct Costs + Indirect Costs
= Rp. 13,858,780,899 + Rp. 1,366,802,750
= Rp. 15,225,583,649

And so forth until the compression stage 18. The optimum total cost obtained if the sum of the direct and indirect costs reached the lowest value. The optimum time and costs can be seen in Table 5.

Table.5: Cost and Time Optimum

ID	Job description	Duration	Direct costs (Rp)	Indirect costs (Rp)	Total costs (Rp)
	Normal	120	13,858,390,000.00	1,370,610,000.00	15,229,000,000.00
71	Concrete Steel Ring Beam Stand Easel	119	13,858,780,899.01	1,366,802,750.00	15,225,583,649.01
59	Iron Concrete Column Floor Roof	118	13,859,755,889.85	1,362,995,500.00	15,222,751,389.85
33	Iron Concrete Wall Scroll 2nd Floor	117	13,861,478,865.38	1,359,188,250.00	15,220,667,115.38
9	Iron Concrete Wall Scroll 2nd Floor	116	13,864,067,612.67	1,355,381,000.00	15,219,448,612.67
21	**Iron Concrete Column 2nd Floor**	**115**	**13,867,336,970.73**	**1,351,573,750.00**	**15,218,910,720.73**
42	Iron Concrete Column 3rd Floor	114	13,871,235,257.07	1,347,766,500.00	15,219,001,757.07
5	Iron Concrete Column 1st Floor	113	13,875,953,298.81	1,343,959,250.00	15,219,912,548.81
68	Formwork Plate Floor Roof	112	13,881,568,284.57	1,340,152,000.00	15,221,720,284.57
46	Iron Concrete 3rd Floor Beams	111	13,887,437,549.90	1,336,344,750.00	15,223,782,299.90
10	Formwork Wall Scroll 1st Floor	110	13,895,328,615.46	1,332,537,500.00	15,227,866,115.46
50	Iron Concrete 3rd Floor Plat	109	13,904,143,175.76	1,328,730,250.00	15,232,873,425.76
29	Reinforcement Plate 2nd Floor	108	13,913,905,798.15	1,324,923,000.00	15,238,828,798.15
64	Formwork Beam Floor Roof	107	13,929,684,595.70	1,321,115,750.00	15,250,800,345.70
47	Formwork Beam 3rd Floor	106	13,957,377,651.09	1,317,308,500.00	15,274,686,151.09
87	Lightweight steel roof truss cover	104	13,986,117,788.83	1,309,694,000.00	15,295,811,788.83
26	Formwork Beam 2nd Floor	103	14,017,117,294.92	1,305,886,750.00	15,323,004,044.92
30	Formwork 2nd Floor Plat	102	14,056,663,939.08	1,302,079,500.00	15,358,743,439.08
51	Formwork 3rd Floor Plat	101	14,096,210,583.23	1,298,272,250.00	15,394,482,833.23

Table 5 shows, the shorter the duration of the project there will be an increase in direct costs while indirect cost decreased. The total project costs derived from the sum of direct costs and indirect costs, the most optimum cost obtained at the 4th stage of compression to the work of reinforced concrete column 2nd floor with a reduction in cost of Rp. 10,089,279.27 from normal total cost of Rp. 15,229,000,000.00 to Rp. 15,218,910,720.73 with the reduction of as many as five days from the time of the normal duration of 120 days to 115 days.

The percentage of the project cost and time efficiency are as follows:

Time Efficiency Project

(120 days - 115 days) / 120 days x 100% = 4,17%

Cost Efficiency Project

(Rp. 15,229,000,000.00 - Rp. 15,218,910,720.73) / Rp. 15,229,000,000.00 x 100% = 0,07%

Graph project cost and time relationship after accelerated in the alternative Extra working hours in *Fig.8* display the optimum fee which may be lower than the total cost of the project, this is due to increase in direct costs less than the decrease in indirect costs so that the total project cost is also reduced.

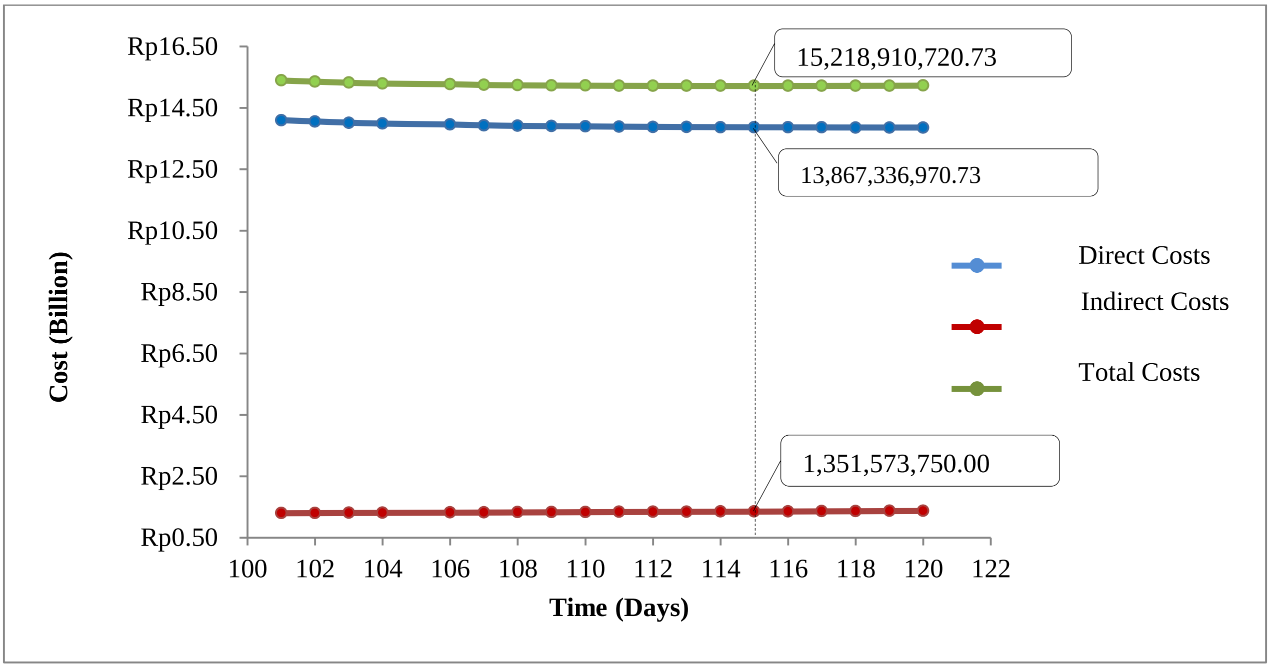

Fig.8: Relationships Graph Costs and Time

V. CONCLUSION

1) Critical path on the job structure are at work iron concrete column 1st floor, iron concrete wall scroll 1st floor, formwork wall scroll 1st floor, iron concrete column 2rd floor, formwork beam 2nd floor, reinforcement plate 2nd floor, formwork of the 2ndfloor plate, iron concrete wall scroll 2nd floor, iron concrete column 3rd floor, iron concrete 3rd floor beams, formwork beam 3rd floor, reinforcement plate 3rd floor, formwork plat 3rd floors, iron concrete column floor roof, formwork beam floor roof, floor plate roof formwork, concrete steel ring beam stand easel, light steel frame roof coverings.

2) The total project cost under normal conditions is at Rp15,229,000,000.00 with a duration of 120 days of work of the project. From the analysis in this study obtained optimum total cost of the project in a condition after crashing with the addition of alternative work hours over four hours obtained for Rp15,218,910,720.73 or less 0:07% of the project costs in normal conditions and duration of project implementation 115 working days or sooner 4:17 % of normal duration.

REFERENCES

[1] Budiono. 2006. SimulasiWaktu Dan BiayaPadaKonstruksi PIER PadaJalanLayangSuprapto Jakarta. Jakarta : Universitas Indonesia

[2] Ervianto, wulfram. I. 2002. Manajemen Proyek Konstruksi. Yogyakarta: Andi. Ervianto,

[3] Frederika, Ariany. 2010. AnalisisPercepatan Pelaksanaandengan Menambah Jam Kerja Optimum padaProyekKonstruksi. (Studi Kasus :Proyek Pembangunan Super Villa, PetiTenget-Badung), Journal (online). Denpasar: Universitas Udayana.

[4] Hendriputri, AjengAfifah. 2018. PercepatanJadwal (Crashing) MenggunakanSistem Shift DenganAnalisis PDM (Precendence Diagramming Method). TugasAkhir. Yogyakarta: Uiversitas Islam Indonesia.

[5] Husen, Abrar. 2010. ManajemenProyekEdisiRevisi. Yogyakarta: Andi.

[6] Republik Indonesia. 2004. Keputusan Menteri Tenaga Kerjadan Transmigrasi Republik Indonesia. Nomor Kep.102/MEN/VI/2004.

[7] Soeharto, Iman. 1999. Manajemen Proyek : Dari Konseptual Sampai Operasional. Edisi 2, Cetakan 1. Jakarta: Erlangga.

[8] Santoso, Wahyu. 2017. Analisis Percepatan Proyek Menggunakan Metode Crashing DenganPenambahan Jam KerjaEmpat Jam danSistem Shift Kerja. TugasAkhir. Yogyakarta: Uiversitas Islam Indonesia.

[9] Syah, Mahendra. 2004. Manajemen Proyek Jakarta : Gramedia.

[10] Utiarahmandan Hinelo., 2013, JurnalIlmiah TeknikSipil NO.1 Vol.1, Optimalisasi Pelaksanaan Proyekdengan Metode Jaringan Kerja PDM (StudiKasus Pembangunan Gedung Pusat Layanan Administrasi Terpadu). Gorontalo: Universitas Negeri Gorontalo