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# Analysis of Earned Value Concepts from Time and Cost on Construction Projects

(Case Study: On the Construction Project of Building X Islamic Boarding School in Karanganyar Regency)

**[1]*Muhammad Nur Sahid, [2]Gotot Slamet Mulyono, [3]Agus Riyanto, [4]Abdul Fatah Purnomo**

[1,2,3,4]Civil Engineering, Universitas Muhammadiyah Surakarta, Indonesia
*Corresponding Author E-mail: mns260@ums.ac.id

***Abstract* - The construction of the X Islamic Boarding School Building in Karanganyar Regency began on November 29, 2020 and is planned to be completed on May 29, 2021 or for 26 weeks of work. This study aims to analyze whether the implementation of the construction of the X Islamic Boarding School Building in Karanganyar Regency is in accordance with the plan or not when viewed in terms of time and cost, as well as rescheduling activities using the PDM (Precedence Diagram Method) method. The occurrence of delays becomes an evaluation material for the course of the project. Job evaluation is carried out from week 1 to week 14, so that there is a remaining time of 12 weeks out of a total of 26 calendar weeks or until week 15 according to the contract. The realization of the construction of the X Islamic Boarding School Building in Karanganyar Regency until the 14th week experienced a delay of -4.83% from the planned schedule. In terms of the cost of realizing the use of funds until the 14th week of Rp. 6,598,698,046, - while the planning cost is Rp 6,944,462,075, - which means that the expenditure is smaller than the budget. Furthermore, rescheduling is carried out using the Precedence Diagram Method (PDM) and crashing on the critical path. The results of the rescheduling analysis are the remaining 12 weeks with the remaining cost of Rp6,438,427,160,-. Then from the rescheduling, an acceleration experiment (Crashing) was carried out by alternative means of adding working hours (overtime). Then from the crashing results, the most optimal activity in terms of cost and time was selected, namely the crashing experiment on the 3rd floor ceiling painting activity on the critical path 1, critical path 2, critical path 4 and critical path 5 with a total duration of 69 days or faster. 3 days from the normal duration with an additional fee of Rp 6,577,012.**

***Keywords:*** cost, crashing, PDM, project control, reschedule, time.

## I. INTRODUCTION

In a construction project, quality control, time and cost are very important, so they must be implemented and considered properly. Problems that arise during the implementation of a construction project, whether it is not on time, costs that exceed the budget, or quality that does not meet specifications can result in the project not being as planned.

In order for the X building construction project at the Karanganyar Islamic boarding school to run as planned, it is necessary to control the time and cost of the project. For this reason, the authors control time and costs in the completion of the X Building project at the Islamic boarding school in Karanganyar district.

## II. RESEARCH METHOD

Stages of research are steps to achieve the goal of a problem object, in order to facilitate the preparation process; the following stages are carried out.

Phase I: Conduct library research and search for journals
Phase II: Conducting data collection
Stage III: Calculating and analyzing with the theory of the concept of value results
Stage IV: Rescheduling or rescheduling
Stage V: Create a Network Diagram using the PDM method
Stage VI: Acceleration
Stage VII: conclusion

## III. RESULTS AND DISCUSSION

### Time Schedule Analysis Based on Plan and Realization

The implementation of the construction of the Karanganyar Islamic Boarding School Building X started with the preparation work of the 1st floor building, th second floor building, building, 2, 3rd floor building, roofing and electrical work. For carrying out the work, there are work achievements every week. For more clarity, we present a table of analysis of the weight of the plan and the weight of realization as below:

 

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**Table 1: Analysis of Time Schedule and Implementation Achievement on Projects**

| Week | Period | Planned Weight (%) | Realized Weight (%) | Deviation (%) | Description |
|---|---|---|---|---|---|
| 1 | 29 Nov-5 Dec2020 | 1,06 | 1,14 | 0,08 | Faster |
| 2 | 6 -12 Dec2020 | 2,13 | 3,92 | 1,79 | Faster |
| 3 | 13 -19 Dec2020 | 5,61 | 7,49 | 1,88 | Faster |
| 4 | 20 -26 Dec2020 | 9,10 | 10,45 | 1,36 | Faster |
| 5 | 27 Des-2 Jan 2021 | 12,58 | 12,07 | -0,51 | Slow |
| 6 | 3 -9 Jan 2021 | 16,11 | 15,34 | -0,77 | Slow |
| 7 | 10 -16 Jan 2021 | 20,72 | 21,05 | 0,34 | Faster |
| 8 | 17-23 Jan 2021 | 25,32 | 26,52 | 1,19 | Faster |
| 9 | 24 -30 Jan 2021 | 30,22 | 32,19 | 1,96 | Faster |
| 10 | 31 Jan -6 Feb 2021 | 35,83 | 35,70 | -0,13 | Slow |
| 11 | 7 -13 Feb 2021 | 41,12 | 42,02 | 0,90 | Faster |
| 12 | 14 -20 Feb 2021 | 46,82 | 46,87 | 0,05 | Faster |
| 13 | 21 -27 Feb 2021 | 52,03 | 49,78 | -2,25 | Slow |
| 14 | 28 Feb -6 Mar 2021 | 56,76 | 51,92 | -4,83 | Slow |
| 15 | 7 -13 Mar 2021 | 67,46 | - | - | - |
| 16 | 14 -20 Mar 2021 | 67,46 | - | - | - |
| 17 | 21 -27 Mar 2021 | 72,36 | - | - | - |
| 18 | 28 Mar-3 Aprl 2021 | 77,02 | - | - | - |
| 19 | 4 -10 Aprl 2021 | 81,42 | - | - | - |
| 20 | 11 -17 Aprl 2021 | 85,93 | - | - | - |
| 21 | 18 -24 Aprl 2021 | 89,31 | - | - | - |
| 22 | 25 Aprl -1 May2021 | 92,31 | - | - | - |
| 23 | 2 -8 May2021 | 94,97 | - | - | - |
| 24 | 9 -15 May2021 | 97,36 | - | - | - |
| 25 | 16 -22 May2021 | 99 | - | - | - |
| 26 | 23 -29 May2021 | 100 | - | - | - |

**Analysis of the Concept Value of Results against Time and Cost**

Performance in the implementation of project work can be measured by indicators that can integrate cost and time aspects. There are several parameters that become a reference in analyzing project performance with the concept of result value, namely BCWS, BCWP and ACWP.

An example of calculating BCWS in the 1st week of work on building X Islamic boarding school in the Karangayar area is as follows:

BCWS = % plan weight x project value

= 3,526% x Rp 13,374,038,675,46

= IDR 142,102,510

Example of BCWP calculation in the 1st week of building project X:

Islamic boarding schools in the Karanganyar area as follows.

BCWP = % realized weight x project value

= 1.14% x IDR 13,374,038,675

= IDR 152,907,823

ACWP analysis is a calculation of material costs, equipment costs, wage costs, general and administrative costs carried out from the 1st week to the 14th week.

 

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**Table 2: Recapitulation of BCWS, BCWP and ACWP Building Construction projects X Islamic Boarding School in Karanganyar Regency**

| Week | Cumulative BCWS (Rp) | Cumulative BCWP (Rp) | Cumulative ACWP (Rp) |
|---|---|---|---|
| 1 | Rp 142.102.511 | Rp 152.907.823 | Rp 147.433.723 |
| 2 | Rp 284.205.022 | Rp 524.002.811 | Rp 496.545.064 |
| 3 | Rp 750.435.850 | Rp 1.001.687.056 | Rp 943.989.882 |
| 4 | Rp 1.216.666.678 | Rp 1.398.247.477 | Rp 1.300.929.453 |
| 5 | Rp 1.682.897.506 | Rp 1.614.328.895 | Rp 1.508.428.920 |
| 6 | Rp 2.154.420.287 | Rp 2.052.061.078 | Rp 1.934.272.772 |
| 7 | Rp 2.770.595.568 | Rp 2.815.805.668 | Rp 2.680.646.996 |
| 8 | Rp 3.386.770.850 | Rp 3.546.519.678 | Rp 3.341.566.306 |
| 9 | Rp 4.042.144.874 | Rp 4.304.530.430 | Rp 4.079.833.942 |
| 10 | Rp 4.791.852.162 | Rp 4.774.529.072 | Rp 4.520.046.672 |
| 11 | Rp 5.499.527.626 | Rp 5.619.612.564 | Rp 5.337.508.013 |
| 12 | Rp 6.261.562.206 | Rp 6.268.143.176 | Rp 5.963.511.417 |
| 13 | Rp 6.957.989.879 | Rp 6.657.307.178 | Rp 6.300.475.513 |
| 14 | Rp 7.590.581.954 | Rp 6.944.462.075 | Rp 6.615.294.573 |
| 15 | Rp 8.305.772.884 | - | - |
| 16 | Rp 9.021.800.515 | - | - |
| 17 | Rp 9.677.534.653 | - | - |
| 18 | Rp 10.300.669.049 | - | - |
| 19 | Rp 10.889.393.429 | - | - |
| 20 | Rp 11.492.322.959 | - | - |
| 21 | Rp 11.943.981.605 | - | - |
| 22 | Rp 12.345.932.653 | - | - |
| 23 | Rp 12.700.981.926 | - | - |
| 24 | Rp 13.021.546.273 | - | - |
| 25 | Rp 13.247.945.397 | - | - |
| 26 | Rp 13.374.038.675 | - | - |

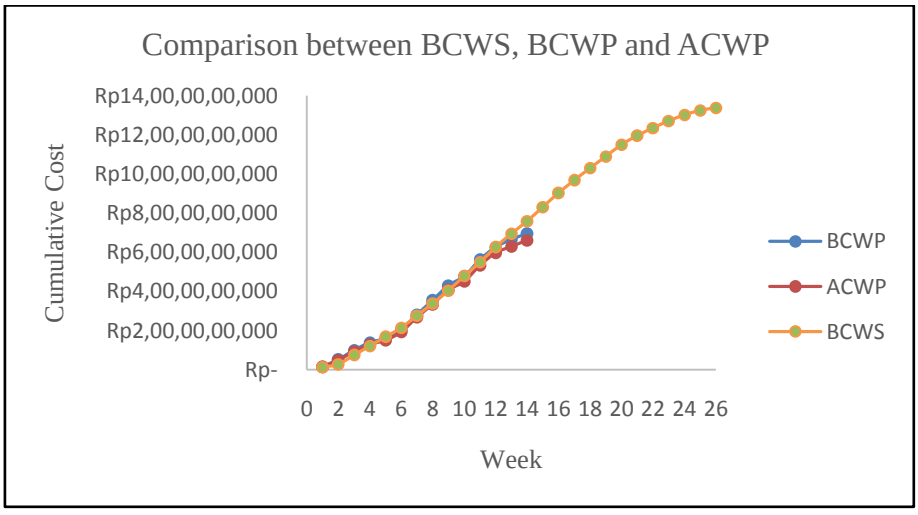


**Figure 1: Comparison between BCWS, BCWP and ACWP values from week 1 to week 14**

### Cost Parameter with Earned Value Concept

An example of the calculation carried out at week 14 is as follows.

 

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*Cost Variance (CV)*
CV = BCWP – ACWP
= IDR 6,944,462,075 - IDR 6,615,294,573
= IDR 329,167,502

*Cost Performance Index (CPI)*
CPI = BCWP / ACWP
= IDR 6,944,462,075 / IDR 6,615,294,573
= 1.050

From the results of the calculation of the CPI at week 14 obtained a CPI value of 1.050. This shows that the costs used in project completion are less than the planned costs.

*Estimate at Complete (EAC)*
The EAC calculation for residual work is as follows.
ETC = (Total Project Cost – BCWP) / CPI
= (Rp 13,374,038,675 - 6,944,462,075 ) / 1,050
= IDR 6,124,814,670
Estimated cost for remaining work (ETC) is IDR 6,124,814,670.

EAC = ACWP + ETC
= IDR 6,615,294,573 + IDR 6,124,814,670
= IDR 12,740,109,242

From the calculation of the Estimation All Cost (EAC) in the 14th week, the estimated total cost of the project is IDR 12,740,109,242.

**Calculating Time Parameters with Result Value Concept**

*An example of the calculation carried out at week 14 is as follows.*

*Schedule Variance (SV)*
SV = BCWP – BCWS
= IDR 6,944,462,075 – IDR 7,590,581,954
= (-) IDR 646,119,879

*Schedule Performance Index (SPI)*
SPI = BCWP / BCWS
= IDR 6,944,462,075 / IDR 7,590,581,954
= 0.915

The recapitulation of the analysis of the concept of yield value in the 14th month is as follows.

1. BCWS = IDR 7,590,581,954
2. BCWP = IDR 6,944,462,075
3. ACWP = IDR 6,615,294,573
4. CV = IDR 329,167,502
5. CPI = 1.050
6. ETC = IDR 6,124,814,670
7. EAC = IDR 12,740,109,242
8. SV = (-) IDR 646,119,879
9. SPI = 0.915

 

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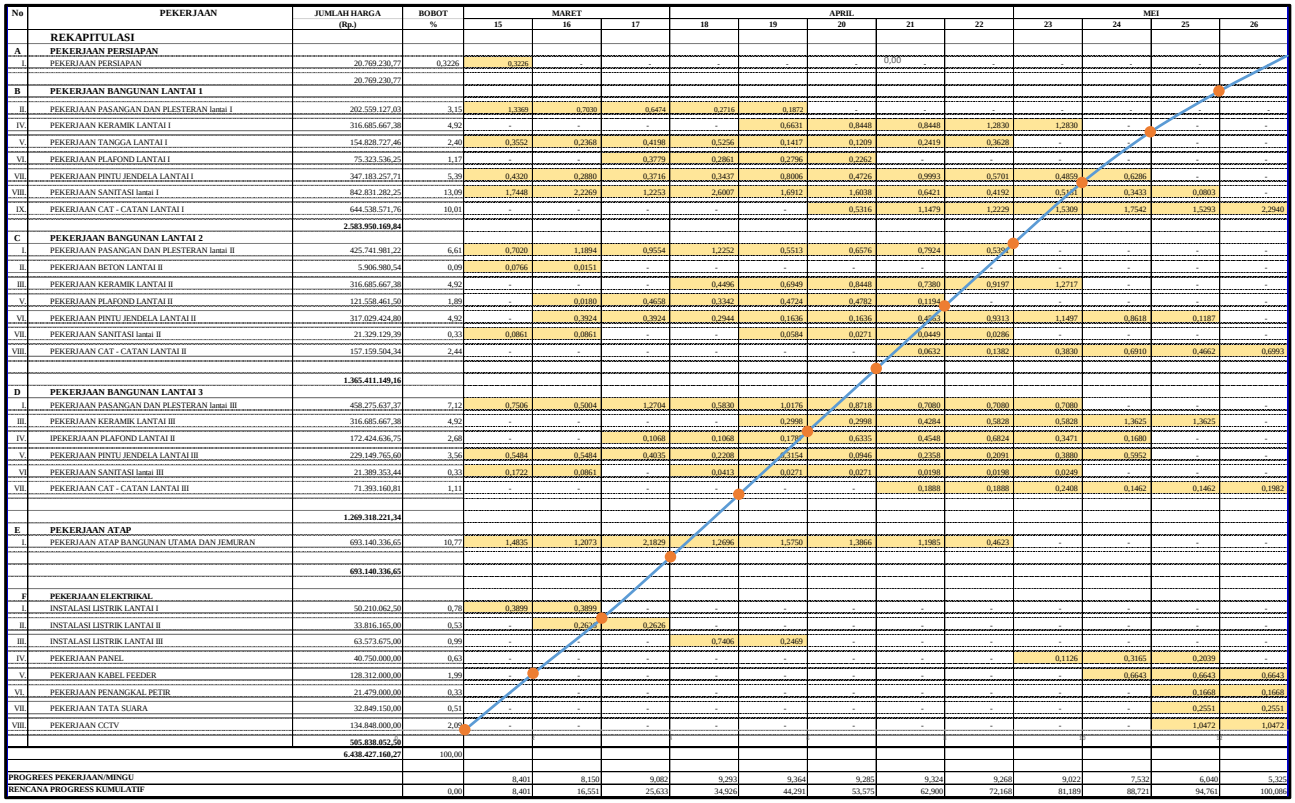
**Rescheduling**

Rescheduling is carried out on work that has not been completed and which has not been done at all until all workcompleted 100%, but in rescheduling still pay attention to the implementation deadline according to the previously agreed contract.

**Remaining Work Time Control**

Time control is carried out after evaluating and identifying work that has not been realized from the 1st week to the 14th week based on the work realization report from the supervisory consultant and seen from the existing time schedule until the 14th week.



| No | PEKERJAAN | JUMLAH HARGA (Rp.) | BOBOT % | MARET | | | APRIL | | | | | MEI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| | **REKAPITULASI** | | | | | | | | | | | | | | |
| A | **PEKERJAAN PERSIAPAN** | | | | | | | | | | | | | | |
| I. | PEKERJAAN PERSIAPAN | 20.769.230,77 | 0,3226 | 0,3226 | - | - | - | - | - | 0,00 | - | - | - | - | - |
| | | 20.769.230,77 | | | | | | | | | | | | | |
| B | **PEKERJAAN BANGUNAN LANTAI 1** | | | | | | | | | | | | | | |
| II. | PEKERJAAN PASANGAN DAN PLESTERAN lantai I | 202.559.127,03 | 3,15 | 1,3369 | 0,7039 | 0,6474 | 0,2716 | 0,1872 | - | - | - | - | - | - | - |
| IV. | PEKERJAAN KERAMIK LANTAI I | 316.685.667,38 | 4,92 | - | - | - | - | 0,6631 | 0,8448 | 0,8448 | 1,2830 | 1,2830 | - | - | - |
| V. | PEKERJAAN TANGGA LANTAI I | 154.828.727,46 | 2,40 | 0,3552 | 0,2368 | 0,4198 | 0,5256 | 0,1417 | 0,1209 | 0,2419 | 0,3628 | - | - | - | - |
| VI. | PEKERJAAN PLAFOND LANTAI I | 75.323.536,25 | 1,17 | - | - | 0,3779 | 0,2861 | 0,2796 | 0,2262 | - | - | - | - | - | - |
| VII. | PEKERJAAN PINTU JENDELA LANTAI I | 347.183.257,71 | 5,39 | 0,4320 | 0,2880 | 0,3716 | 0,3437 | 0,8006 | 0,4726 | 0,9993 | 0,5701 | 0,4809 | 0,6286 | - | - |
| VIII. | PEKERJAAN SANITASI lantai I | 842.831.282,25 | 13,09 | 1,7448 | 2,2269 | 1,2253 | 2,6007 | 1,6912 | 1,6038 | 0,6421 | 0,4192 | 0,5101 | 0,3433 | 0,0803 | - |
| IX. | PEKERJAAN CAT - CATAN LANTAI I | 644.538.571,76 | 10,01 | - | - | - | - | - | 0,5316 | 1,1479 | 1,2225 | 1,5309 | 1,7542 | 1,5293 | 2,2940 |
| | | **2.583.950.169,84** | | | | | | | | | | | | | |
| C | **PEKERJAAN BANGUNAN LANTAI 2** | | | | | | | | | | | | | | |
| I. | PEKERJAAN PASANGAN DAN PLESTERAN lantai II | 425.741.981,22 | 6,61 | 0,7020 | 1,1894 | 0,9554 | 1,2252 | 0,5513 | 0,6576 | 0,7924 | 0,5397 | - | - | - | - |
| II. | PEKERJAAN BETON LANTAI II | 5.906.980,54 | 0,09 | 0,0766 | 0,0151 | - | - | - | - | - | - | - | - | - | - |
| III. | PEKERJAAN KERAMIK LANTAI II | 316.685.667,38 | 4,92 | - | - | - | 0,4496 | 0,6949 | 0,8448 | 0,7380 | 0,9197 | 1,2717 | - | - | - |
| V. | PEKERJAAN PLAFOND LANTAI II | 121.558.461,50 | 1,89 | - | 0,0180 | 0,4658 | 0,3342 | 0,4724 | 0,4782 | 0,1194 | - | - | - | - | - |
| VI. | PEKERJAAN PINTU JENDELA LANTAI II | 317.029.424,80 | 4,92 | - | 0,3924 | 0,3924 | 0,2944 | 0,1636 | 0,1636 | 0,4911 | 0,9313 | 1,1497 | 0,8618 | 0,1187 | - |
| VII. | PEKERJAAN SANITASI lantai II | 21.329.129,39 | 0,33 | 0,0861 | 0,0861 | - | - | 0,0584 | 0,0271 | 0,0443 | 0,0286 | - | - | - | - |
| VIII. | PEKERJAAN CAT - CATAN LANTAI II | 157.159.504,34 | 2,44 | - | - | - | - | - | - | 0,0632 | 0,1382 | 0,3830 | 0,6910 | 0,4662 | 0,6993 |
| | | **1.365.411.149,16** | | | | | | | | | | | | | |
| D | **PEKERJAAN BANGUNAN LANTAI 3** | | | | | | | | | | | | | | |
| I. | PEKERJAAN PASANGAN DAN PLESTERAN lantai III | 458.275.637,37 | 7,12 | 0,7506 | 0,5004 | 1,2704 | 0,5830 | 1,0176 | 0,8718 | 0,7080 | 0,7080 | 0,7080 | - | - | - |
| III. | PEKERJAAN KERAMIK LANTAI III | 316.685.667,38 | 4,92 | - | - | - | - | 0,2998 | 0,2998 | 0,4284 | 0,5828 | 0,5828 | 1,3625 | 1,3625 | - |
| IV. | IPEKERJAAN PLAFOND LANTAI II | 172.424.636,75 | 2,68 | - | - | 0,1068 | 0,1068 | 0,1780 | 0,6335 | 0,4548 | 0,6824 | 0,3471 | 0,1680 | - | - |
| V. | PEKERJAAN PINTU JENDELA LANTAI III | 229.149.765,60 | 3,56 | 0,5484 | 0,5484 | 0,4035 | 0,2208 | 0,3154 | 0,0946 | 0,2358 | 0,2091 | 0,3880 | 0,5952 | - | - |
| VI. | PEKERJAAN SANITASI lantai III | 21.389.353,44 | 0,33 | 0,1722 | 0,0861 | - | 0,0413 | 0,0271 | 0,0271 | 0,0198 | 0,0198 | 0,0249 | - | - | - |
| VII. | PEKERJAAN CAT - CATAN LANTAI III | 71.393.160,81 | 1,11 | - | - | - | - | - | - | 0,1888 | 0,1888 | 0,2408 | 0,1462 | 0,1462 | 0,1982 |
| | | **1.269.318.221,34** | | | | | | | | | | | | | |
| E | **PEKERJAAN ATAP** | | | | | | | | | | | | | | |
| I. | PEKERJAAN ATAP BANGUNAN UTAMA DAN JEMURAN | 693.140.336,65 | 10,77 | 1,4835 | 1,2073 | 2,1829 | 1,2696 | 1,5750 | 1,3866 | 1,1985 | 0,4623 | - | - | - | - |
| | | **693.140.336,65** | | | | | | | | | | | | | |
| F | **PEKERJAAN ELEKTRIKAL** | | | | | | | | | | | | | | |
| I. | INSTALASI LISTRIK LANTAI I | 50.210.062,50 | 0,78 | 0,3899 | 0,3899 | - | - | - | - | - | - | - | - | - | - |
| II. | INSTALASI LISTRIK LANTAI II | 33.816.165,00 | 0,53 | - | 0,2626 | 0,2626 | - | - | - | - | - | - | - | - | - |
| III. | INSTALASI LISTRIK LANTAI III | 63.573.675,00 | 0,99 | - | - | - | 0,7406 | 0,2469 | - | - | - | - | - | - | - |
| IV. | PEKERJAAN PANEL | 40.750.000,00 | 0,63 | - | - | - | - | - | - | - | - | 0,1126 | 0,3165 | 0,2039 | - |
| V. | PEKERJAAN KABEL FEEDER | 128.312.000,00 | 1,99 | - | - | - | - | - | - | - | - | - | 0,6643 | 0,6643 | 0,6643 |
| VI. | PEKERJAAN PENANGKAL PETIR | 21.479.000,00 | 0,33 | - | - | - | - | - | - | - | - | - | - | 0,1668 | 0,1668 |
| VII. | PEKERJAAN TATA SUARA | 32.849.150,00 | 0,51 | - | - | - | - | - | - | - | - | - | - | 0,2551 | 0,2551 |
| VIII. | PEKERJAAN CCTV | 134.848.000,00 | 2,09 | - | - | - | - | - | - | - | - | - | - | 1,0472 | 1,0472 |
| | | **505.838.052,50** | | | | | | | | | | | | | |
| | | **6.438.427.160,27** | 100,00 | | | | | | | | | | | | |
| PROGREES PEKERJAAN/MINGU | | | | 8,401 | 8,150 | 9,082 | 9,293 | 9,364 | 9,285 | 9,324 | 9,268 | 9,022 | 7,532 | 6,040 | 5,325 |
| RENCANA PROGRESS KUMULATIF | | | 0,00 | 8,401 | 16,551 | 25,633 | 34,926 | 44,291 | 53,575 | 62,900 | 72,168 | 81,189 | 88,721 | 94,761 | 100,086 |

**Figure 2: Recapitulation of Time Schedule Rescheduling**

Making a network or network planning is done with MS Preject 2019 Software. From the PDM network, the project completion time with normal conditions is

72 days. From the PDM network that has been created with MS. Project 2019 is known to have critical activities that form a critical trajectory. After making the PDM network, then further experimenting with crashing or accelerating the duration of work by adding working hours (overtime) to critical activities, then choosing an alternative which of the critical paths is the best for crashing. Here is the critical path.

**Table 3: Critical path 1**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd floor | 18 |
| 3 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 4 | D.1.1 Steel truss structure instalation | 18 |
| 5 | D.1.2 Purlin +bracesand ridge batten installation | 12 |
| 6 | D.1.6 Light steel rafter installation | 18 |
| 7 | D.1.7 Ceramic roof cover installation | 24 |
| 8 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 9 | C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 |
| 10 | C.3.5 3 x 7 mm (medium) gypsum ceiling list installation 3rd floor | 12 |

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| | | |
|---|---|---|
| 11 | C.6.3 Ceiling painting 3rd floor | 18 |
| 12 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

**Table 4: Critical path 2**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd floor | 18 |
| 3 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 4 | D.1.1 Steel truss structure instalation | 18 |
| 5 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 6 | D.1.6 Light steel rafter installation | 18 |
| 7 | D.1.7 Ceramic roof cover installation | 24 |
| 8 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 9 | C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 |
| 10 | C.6.3 Ceiling painting 3rd floor | 18 |
| 11 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

**Table 5: Critical path 3**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd floor | 18 |
| 3 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 4 | D.1.1 Steel truss structure instalation | 18 |
| 5 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 6 | D.1.6 Light steel rafter installation | 18 |
| 7 | D.1.7 Ceramic roof cover installation | 24 |
| 8 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 9 | C.2.1 50 x 50cm milan ceramic installation | 24 |
| 10 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

**Table 6: Critical path 4**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 3 | D.1.1 Steel truss structure instalation | 18 |
| 4 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 5 | D.1.6 Light steel rafter installation | 18 |
| 6 | D.1.7 Ceramic roof cover installation | 24 |
| 7 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 8 | C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 |
| 9 | C.3.5 Ceiling gypsum list 3 x 7 mm (medium)3rd floor | 12 |
| 10 | C.6.3 Ceiling painting 3rd floor | 18 |
| 11 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

**Table 7: Critical path 5**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 3 | D.1.1 Steel truss structure instalation | 18 |
| 4 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 5 | D.1.6 Light steel rafter installation | 18 |
| 6 | D.1.7 Ceramic roof cover installation | 24 |
| 7 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 8 | C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 |
| 9 | C.6.3 Ceiling painting 3rd floor | 18 |
| 10 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

 

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**Table 8: Critical path 6**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 3 | D.1.1 Steel truss structure instalation | 18 |
| 4 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 5 | D.1.6 Light steel rafter installation | 18 |
| 6 | D.1.7 Ceramic roof cover installation | 24 |
| 7 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 8 | C.2.1 50 x 50cm milan ceramic installation | 24 |
| 9 | C.6.2 Interior wall painting 3rd floor | 24 |
| Total Duration | | 72 |

**Table 9: Jobs in the critical path**

| No | Description | Duration |
|---|---|---|
| 1 | A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 |
| 2 | B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd floor | 18 |
| 3 | C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 |
| 4 | C.2.1 50 x 50cm milan ceramic installation | 24 |
| 5 | C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 |
| 6 | C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 |
| 7 | C.3.5 Ceiling gypsum list 3 x 7 mm (medium)3rd floor | 12 |
| 8 | C.6.2 Interior wall painting 3rd floor | 24 |
| 9 | C.6.3 Ceiling painting 3rd floor | 18 |
| 10 | D.1.1 Steel truss structure instalation | 18 |
| 11 | D.1.2 Purlin +braces and ridge batten installation | 12 |
| 12 | D.1.6 Light steel rafter installation | 18 |
| 13 | D.1.7 Ceramic roof cover installation | 24 |

## Crashing Analysis in Critical Jobs with Additional Working Hours (Overtime)

Before Crashing, we calculate the number of resources per day on critical jobs. Take the example of work C.3.1. Install the galvanized hollow ceiling frame

Work Volume = 714 $m^2$

Normal duration (Dn) = 18 days

Production per day = 39.67 $m^2$/day

**Table 10: Requirements for the number of resources per day in normal work**

| No | Personnel | coeff | Volume/day | Worker needs | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4=2*3 | | |
| 1 | Workers | 0,100 | 39,67 | 4,0 | Rounded up | 4 |
| 2 | Mason | 0,050 | 39,67 | 2,0 | Rounded up | 2 |
| 3 | Chief handyman | 0,005 | 39,67 | 0,2 | Rounded up | 1 |
| 4 | Foreman | 0,005 | 39,67 | 0,2 | Rounded up | 1 |

**Table 11: Labor costs**

| Personnel | Total of Personnel | Duration(Day) | Salary | 2 hours overtime salary | Total |
|---|---|---|---|---|---|
| [a] | [b] | [c] | [d] | [e] | [f] |
| Workers | 4 | 18 | 70.000,00 | | Rp 5.040.000,00 |
| Mason | 2 | 18 | 75.000,00 | | Rp 2.700.000,00 |
| Chief handyman | 1 | 18 | 80.000,00 | | Rp 1.440.000,00 |
| Foreman | 1 | 18 | 85.000,00 | | Rp 1.530.000,00 |
| Total | | | | | Rp 10.710.000,00 |

| Equipment type | Volume(Ton) | Equipment cost | | Total | TotalCost |
|---|---|---|---|---|---|
| | | Tool rental | Total | | |
| [g] | [h] | [i] | [j]=[h]x[i] | [k] | [i]=[f]+[k] |
| - | - | - | - | | |
| | | | | - | Rp 10.710.000,00 |

 

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1. Work volume = 714 m2
2. Normal duration (Dn) = 18 days
3. Production per day = 39.67 m2/day
4. Normal working hours per day = 7 hours
5. Number of workers
   a. Worker = 4
   b. Mason = 2
   c. Chief Builder = 1
   d. Foreman = 1

6. Labor productivity
   a. Worker = 39.67 m2/day/4 = 9.92 m2
   b. Mason = 39.67 m2/day/2 = 19.83 m2
   c. Chief handyman = 39.67 m2/day/1 = 39 ,67 m2
   d. Foreman = 39.67 m2/day/1 = 39.67 m2

7. Normal productivity per hour
   a. Workers = 9.92 / 7 = 1.42 m2/hour
   b. Mason= 19.83 / 7= 39.67 / 7 = 2.83 m2/hour
   c. Craftsman head= 5.67 m2/hour
   d. Foreman = 39.67 / 7 = 5.67 m2/hour

8. Normal productivity 2 hours
   a. Workers =1.42 x 2= 2.83 x 2 = 2.84 m2/hour
   b. Mason = 5.66 m2/hour
   c. Chief handyman= 5.67 x 2= 5.67 x 2 = 11.34 m2/hour
   d. Foreman = 11.34 m2/hour

9. 1 hour overtime productivity
   a. Workers = 1.42 / 1.1 = 1.29 m2/hour
   b. Mason 2.83 / 1.1= 5.67 / 1.1 = 2.58 m2/hour
   c. Craftsman head = 5.15 m2/hour
   d. Foreman = 5.67 / 1.1 = 5.15 m2/hour

10. 2nd hour overtime productivity
    a. Workers= 1.42 / 1.22.83 / 1.2 = 1.18 m2/hour
    b. Mason = 2.36 m2/hour
    c. Chief handyman
    d. Foreman = 5.67 / 1.2= 5.67 / 1.2 = 4.72 m2/hour= 4.72 m2/hour

11. 2 hours overtime productivity
    a. Worker = 1.29+ 1.18 = 2.47 m2/hour
    b. Mason = 2.58 + 2.36 = 4.94 m2/hour
    c. Foreman = 5.15 + 4.72 = 14.81 m2/hour
    d. Foreman = 5.15 + 4.72 = 14.81 m2/hour

**Crashing Fee on Additional Working Hours (Overtime)**

In this calculation, the addition of 2 hours of overtime work is used for the crashing job. An example of calculating overtime work wages is as follows.

**Table 13: Labor overtime costs**

| Resource | Salary/hours | 1 hour Overtime salary | 2hour Overtime salary | Total Upah |
|---|---|---|---|---|
| 1 | 2 | 3=2*1,5 | 4=2*2 | 5=3+4 |
| Workers | Rp 8.750 | Rp 13.125 | Rp 17.500 | Rp 30.625 |

 

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| | | | | |
|---|---|---|---|---|
| Mason | Rp 9.375 | Rp 14.063 | Rp 18.750 | Rp 32.813 |
| Chief handyman | Rp 10.000 | Rp 15.000 | Rp 20.000 | Rp 35.000 |
| Foreman | Rp 10.625 | Rp 15.938 | Rp 21.250 | Rp 37.188 |

**Table 14: Cost of work C.3.1. Install the galvanized hollow ceiling frame crash duration**

| Personnel | Number ofpersonnel | Duration (Day) | Salary | 2 hours overtime salary | Total |
|---|---|---|---|---|---|
| [a] | [b] | [c] | [d] | [e] | [f] |
| Workers | 4 | 15 | 70.000,00 | Rp 30.625 | Rp 6.037.500,00 |
| Mason | 2 | 15 | 75.000,00 | Rp 32.813 | Rp 3.234.375,00 |
| Chief handyman | 1 | 15 | 80.000,00 | Rp 35.000 | Rp 1.725.000,00 |
| Foreman | 1 | 15 | 85.000,00 | Rp 37.188 | Rp 1.832.812,50 |
| Total | | | | | Rp 12.829.687,50 |

| Equipment type | Volume (Ton) | Equipment Cost | | Total | TotalCost |
|---|---|---|---|---|---|
| | | Tool rental | Total | | |
| [g] | [h] | [i] | [j]=[h]x[i] | [k] | [i]=[f]+[k] |
| | | | | | Rp 12.829.687,50 |

*Incremental Cost (Ic)*
= Crash Cost – Normal Cost
= Rp 12.829.687,50 – Rp 10.710.000,00
= Rp 2.119.687,50

By the same way of calculating the total costs incurred due to the crashing process with the addition of 2 hours of work (overtime) per day on jobs that are on other critical paths, it can be concluded as follows.

**Table 15: Recapitulation of the time and cost of the work carried out by crashing with additional working hours (overtime)**

| Job Description | Alternative to increase working hours (overtime) | | | | | |
|---|---|---|---|---|---|---|
| | Normal | | Crashing | | | |
| | Duration(Dn) | Cost(Cc) | Duration(Dc) | Cost(Cc) | di=Dn-Dc | Incremental Cost (Ic) |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | Rp 9.990.000,00 | 5 | Rp 11.967.187,50 | 1 | Rp 1.977.187,50 |
| B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd floor | 18 | Rp 23.400.000,00 | 15 | Rp 28.031.250,00 | 3 | Rp 4.631.250,00 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 18 | Rp 31.230.000,00 | 15 | Rp 37.410.937,50 | 3 | Rp 6.180.937,50 |
| C.2.1 50 x 50cm milan ceramic installation | 24 | Rp 41.640.000,00 | 20 | Rp 49.881.250,00 | 4 | Rp 8.241.250,00 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 | Rp 10.710.000,00 | 15 | Rp 12.829.687,50 | 3 | Rp 2.119.687,50 |
| C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 | Rp 17.190.000,00 | 15 | Rp 20.592.187,50 | 3 | Rp 3.402.187,50 |
| C.3.5 Ceiling gypsum list 3 x 7 mm (medium) 3rd floor | 12 | Rp 14.160.000,00 | 10 | Rp 16.962.500,00 | 2 | Rp 2.802.500,00 |
| C.6.2 Interior wall painting 3rd floor | 24 | Rp 9.240.000,00 | 20 | Rp 11.068.750,00 | 4 | Rp 1.828.750,00 |
| C.6.3 Ceiling painting 3rd floor | 18 | Rp 6.930.000,00 | 15 | Rp 8.301.562,50 | 3 | Rp 1.371.562,50 |
| D.1.1 Steel truss structure instalation | 18 | Rp 35.550.000,00 | 15 | Rp 42.585.937,50 | 3 | Rp 7.035.937,50 |
| D.1.2 Purlin +braces and ridge batten installation | 12 | Rp 32.520.000,00 | 10 | Rp 38.956.250,00 | 2 | Rp 6.436.250,00 |
| D.1.6 Light steel rafter installation | 18 | Rp 13.410.000,00 | 15 | Rp 16.064.062,50 | 3 | Rp 2.654.062,50 |
| D.1.7 Ceramic roof cover installation | 24 | Rp 17.760.000,00 | 20 | Rp 21.275.000,00 | 4 | Rp 3.515.000,00 |

 

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After knowing the details of the costs and crashing times of these critical activities, then enter the costs and crashing times into the critical path one by one. The details are as follows.

*Crashing on 1st critical path*

**Table 16: Recapitulation of crashing results for each activity on the 1st critical path**

| *Crashing* on the 1st Critical Path | | | | | | |
|---|---|---|---|---|---|---|
| Accelerated Activities | Duration | | Total | Cost | | |
| | Normal | *Crashing* | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd | 12 | 2 + Overtime | 70 | Rp 14.160.000 | Rp 22.144.466 | Rp 7.984.466 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd | 12 | 2 + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| D.1.1 Steel truss structure instalation | 18 | 3 + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.6 Light steel rafter installation | 18 | 3 + Overtime | 69 | Rp 23.400.000 | Rp 33.236.700 | Rp 9.836.700 |
| D.1.7 Ceramic roof cover installation | 18 | 3 + Overtime | 69 | Rp 17.190.000 | Rp 25.797.637 | Rp 8.607.637 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 | 3 + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 | 3+ Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |
| C.3.5 3 x 7 mm (medium) gypsum ceiling list installation 3rd | 18 | 3 + Overtime | 69 | Rp 6.930.000 | Rp 13.507.012 | Rp 6.577.012 |
| C.6.3 Ceiling painting 3rd floor | 24 | 4 + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |

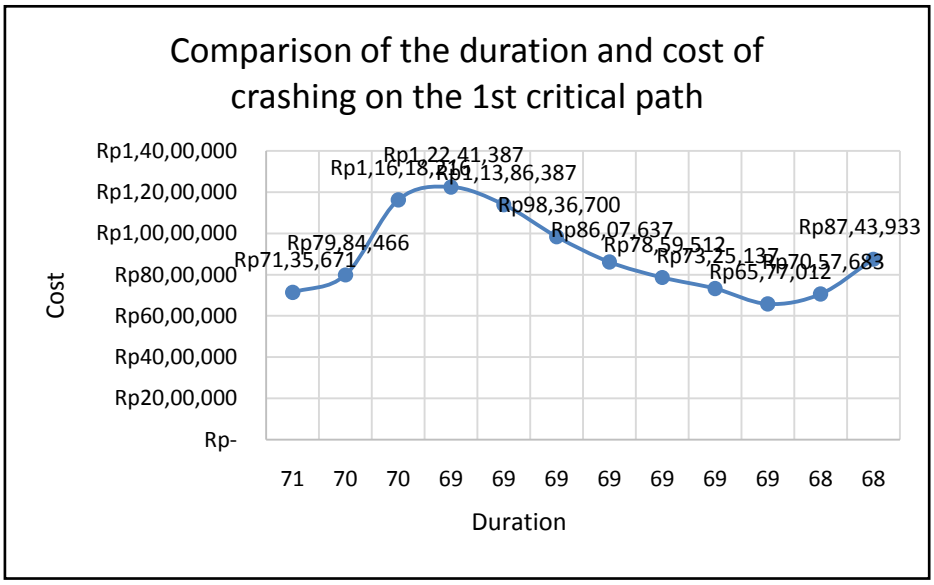


**Figure 3 : Comparison of Duration and Additional Costs due to Crashing On the 1stCritical Path**

*Crashing on 2nd Critical Path*

**Table 17 : Recapitulation of crashing results for each activity on the 2nd critical path**

| Crashingon the 2ndCritical Path | | | | | | |
|---|---|---|---|---|---|---|
| Accelerated Activities | Duratin | | Total | Cost | | |
| | Normal | *Crashing* | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd | 12 | 2 + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd | 18 | 3 + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.1 Steel truss structure instalation | 18 | 3 + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 + Overtime | 69 | Rp 23.400.000 | Rp 33.236.700 | Rp 9.836.700 |
| D.1.6 Light steel rafter installation | 18 | 3 + Overtime | 69 | Rp 17.190.000 | Rp 25.797.637 | Rp 8.607.637 |
| D.1.7 Ceramic roof cover installation | 18 | 3 + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 | 3 + Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |
| C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 | 3 + Overtime | 69 | Rp 6.930.000 | Rp 13.507.012 | Rp 6.577.012 |
| C.6.3 Ceiling painting 3rd floor | 24 | 4 + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |

 

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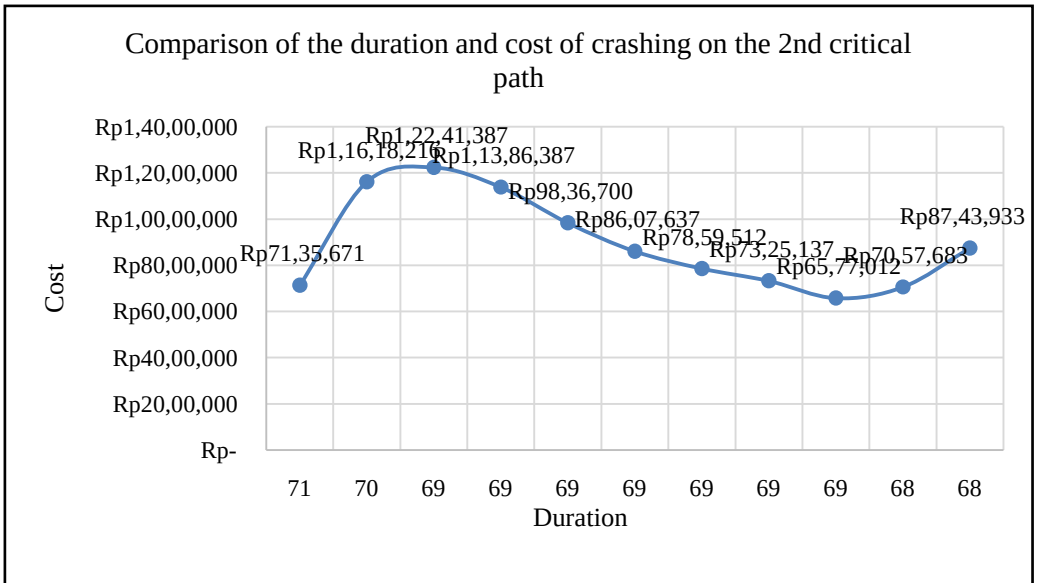


**Figure 4 : Comparison of Duration and Additional Costs due to Crashing on Critical Pass 2**

*Crashing on 3rd Critical Path*

**Table 17 :Recapitulation of crashing results for each activity on the 3rd critical path**

| Crashingon the 3rd Critical Path | | | | | | |
|---|---|---|---|---|---|---|
| Accelerated Activities | Duration | | Total | Cost | | |
| | Normal | *Crashing* | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| B.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand in 2nd | 12 | 2 + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd | 18 | 3 + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.1 Steel truss structure instalation | 18 | 3 + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 + Overtime | 69 | Rp 23.400.000 | Rp 33.236.700 | Rp 9.836.700 |
| D.1.6 Light steel rafter installation | 18 | 3 + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| D.1.7 Ceramic roof cover installation | 18 | 3 + Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 24 | 4 + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.2.1 50 x 50cm milan ceramic installation | 24 | 4 + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 + Overtime | 68 | Rp 41.640.000 | Rp 55.110.183 | Rp 13.470.183 |

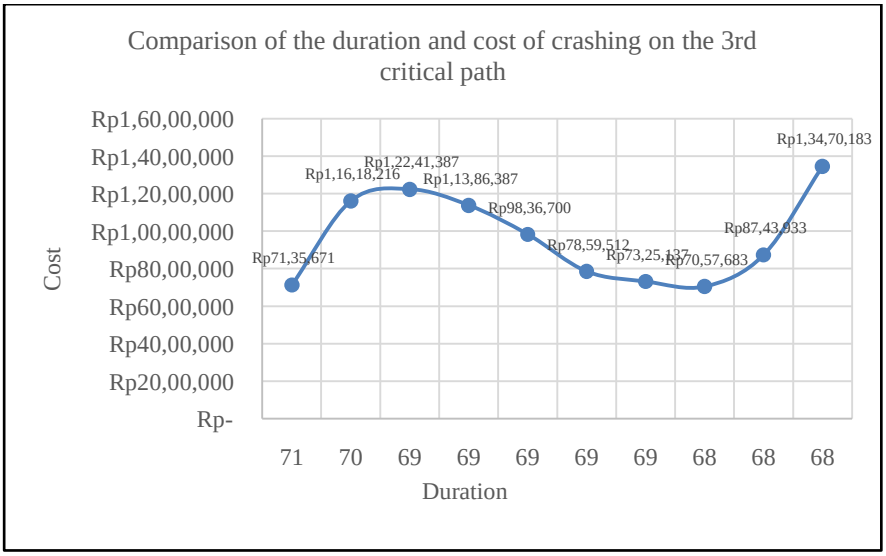


**Figure 5: Comparison of Duration and Additional Costs due to Crashing on 3rd Critical Path**

 

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*Crashing on the 4th Critical trajectory*

**Table 18: Recapitulation of crashing results for each activity on the 4th critical path**

| Crashingon 4th Critical Path | | | | | | | |
|---|---|---|---|---|---|---|---|
| Accelerated Activities | Duration | | | Total Duration | Cost | | |
| | Normal | *Crashing* | | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 | + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 12 | 2 | + Overtime | 70 | Rp 14.160.000 | Rp 22.144.466 | Rp 7.984.466 |
| D.1.1 Steel truss structure instalation | 12 | 2 | + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 | + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.6 Light steel rafter installation | 18 | 3 | + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.7 Ceramic roof cover installation | 18 | 3 | + Overtime | 69 | Rp 17.190.000 | Rp 25.797.637 | Rp 8.607.637 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 | 3 | + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 | 3 | + Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |
| C.3.5 Ceiling gypsum list 3 x 7 mm (medium)3rd floor | 18 | 3 | + Overtime | 69 | Rp 6.930.000 | Rp 13.507.012 | Rp 6.577.012 |
| C.6.3 Ceiling painting 3rd floor | 24 | 4 | + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 | + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |

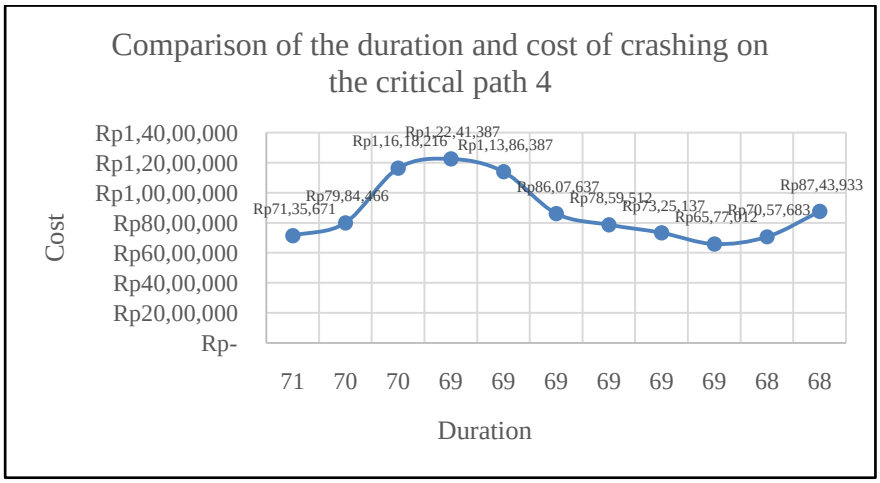


**Figure 6: Comparison of Duration and Additional Costs due to Crashing in Critical Path 4**

*Crashing on the 5th Critical Path*

**Table 19: Recapitulation of crashing results for each activity on the 5th critical path**

| *Crashing* on the 5th Critical Path | | | | | | | |
|---|---|---|---|---|---|---|---|
| Accelerated Activities | Duration | | | Total Duration | Cost | | |
| | Normal | *Crashing* | | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 | + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd floor | 12 | 2 | + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| D.1.1 Steel truss structure instalation | 18 | 3 | + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 | + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.6 Light steel rafter installation | 18 | 3 | + Overtime | 69 | Rp 17.190.000 | Rp 25.797.637 | Rp 8.607.637 |
| D.1.7 Ceramic roof cover installation | 18 | 3 | + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 18 | 3 | + Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |

 

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C.3.2 Ceiling cover installation with 9mm gypsum 3rd floor | 18 | 3 | + Overtime | 69 | Rp 6.930.000 | Rp 13.507.012 | Rp 6.577.012 |
| C.6.3 Ceiling painting 3rd floor | 24 | 4 | + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 | + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |

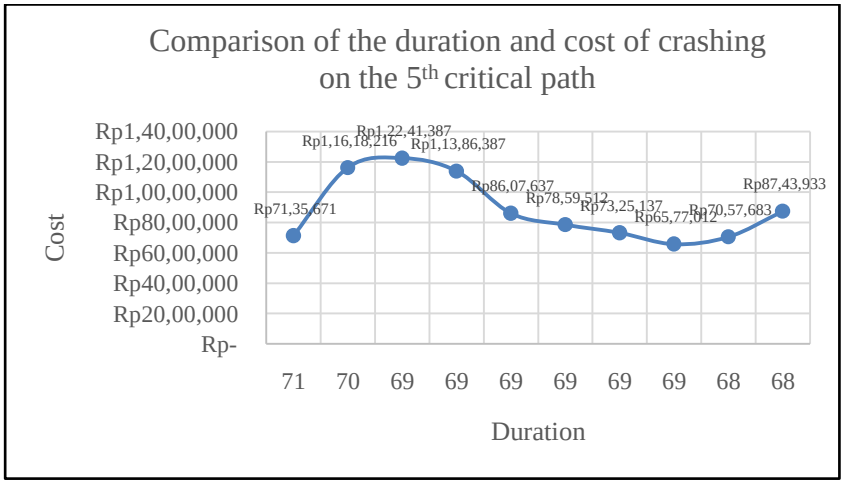


**Figure 7: Comparison of Duration and Additional Costs due to Crashing On 5th Critical Path**

*Crashing on the 6th critical path*

**Table 20: Recapitulation of crashing results for each activity on the 6th critical path**

| *Crashing* onthe 6th Critical Path | | | | | | | |
|---|---|---|---|---|---|---|---|
| Accelerated Activities | Duration | | | Total | Cost | | |
| | Normal | *Crashing* | | | Normal | *Crashing* | *IncementalCost* |
| A.1.1 Wall instalation 1/2 mixed bricks 1 pc: 5 sand | 6 | 1 | + Overtime | 71 | Rp 9.990.000 | Rp 17.125.671 | Rp 7.135.671 |
| C.1.1 Wallinstalation 1/2 mixed bricks 1 pc: 5 sand in 3rd | 12 | 2 | + Overtime | 70 | Rp 32.520.000 | Rp 44.138.216 | Rp 11.618.216 |
| D.1.1 Steel truss structure instalation | 18 | 3 | + Overtime | 69 | Rp 35.550.000 | Rp 47.791.387 | Rp 12.241.387 |
| D.1.2 Purlin +braces and ridge batten installation | 18 | 3 | + Overtime | 69 | Rp 31.230.000 | Rp 42.616.387 | Rp 11.386.387 |
| D.1.6 Light steel rafter installation | 18 | 3 | + Overtime | 69 | Rp 13.410.000 | Rp 21.269.512 | Rp 7.859.512 |
| D.1.7 Ceramic roof cover installation | 18 | 3 | + Overtime | 69 | Rp 10.710.000 | Rp 18.035.137 | Rp 7.325.137 |
| C.3.1 Galvanis hollow ceiling structure installation 3rd floor | 24 | 4 | + Overtime | 68 | Rp 9.240.000 | Rp 16.297.683 | Rp 7.057.683 |
| C.2.1 50 x 50cm milan ceramic installation | 24 | 4 | + Overtime | 68 | Rp 17.760.000 | Rp 26.503.933 | Rp 8.743.933 |
| C.6.2 Interior wall painting 3rd floor | 24 | 4 | + Overtime | 68 | Rp 41.640.000 | Rp 55.110.183 | Rp 13.470.183 |

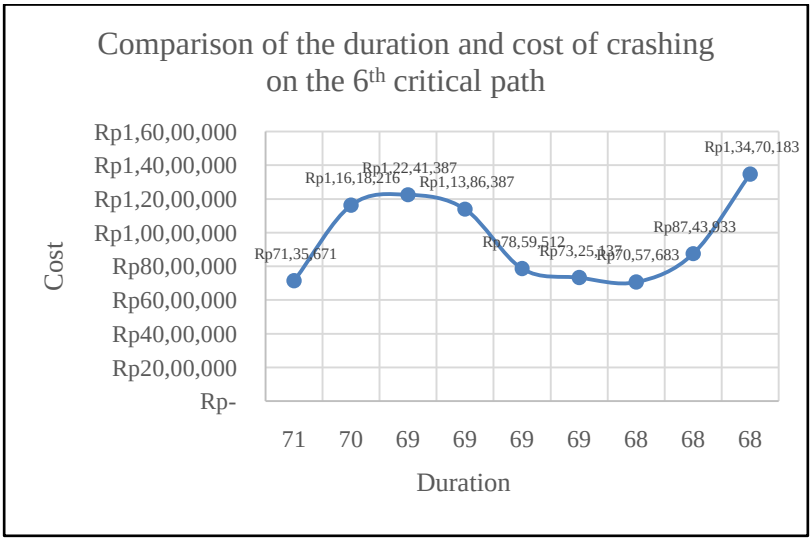


**Figure 8: Comparison of Duration and Additional Costs due to Crashing on Critical Pass 6**

To provide a comparison of the results of time and cost analysis crashing in order to get the best crashing experiment between critical path from one to six, then a comparison graph is made as follows.

 

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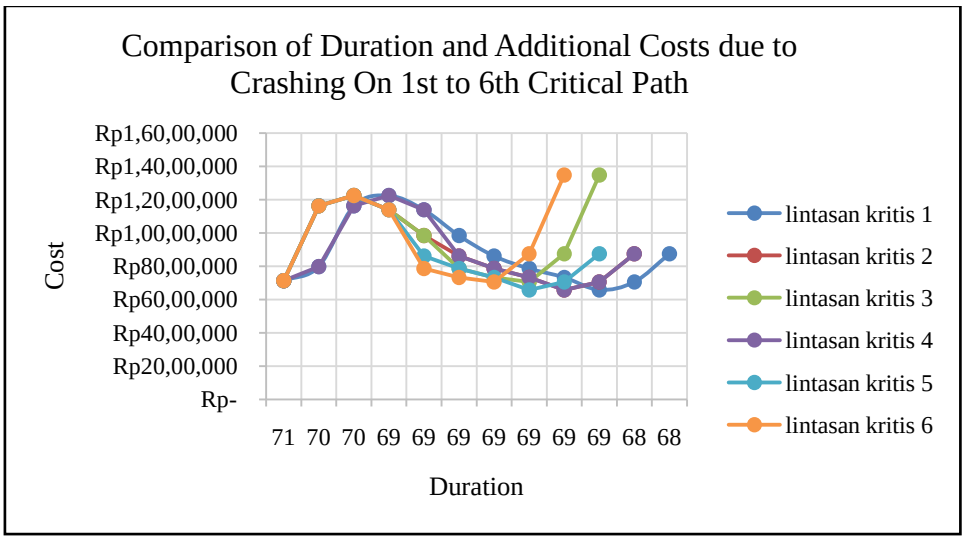


**Figure 9: Comparison of Duration and Additional Costs due to Crashing On 1st to 6th Critical Path**

Based on the graph of the comparison of duration and costs due to crashing on critical paths one to six above, it can be seen that the most optimal activity for crashing is to add working hours to the ceiling painting job on the 3rd floor on critical path 1, critical path 2, critical path 4 and critical path 5 with a total project completion duration of 69 working days or 3 days faster than normal time with an additional cost of Rp. 6,577,012,-

## IV. CONCLUSION

After conducting research and discussion, it can be concluded as follows:

The First, the realization of the construction of Building X Pondok Pesantren in Karanganyar has not been according to plan. In terms of time, the project experienced a shortage of work for two consecutive weeks. The cost of realizing the use of funds until week 14 is Rp. 6,615,294,573, while the planning cost is Rp. 6,944,462,075, which means that the expenditure is lower than the planning.

The second, Based on the results of the research and discussion above, the Schedule Variance (SV) that occurred until the 14th week was (-) Rp. 646,119,879, (SV value =-). This shows that the implementation of the project took longer than the planned schedule. Meanwhile, the cost variance (CV) that occurred until the 14th week was Rp. 329,167,502,-(CV =+). This shows that the costs incurred until the 14th week are smaller than the planned costs.

The third, Critical activities in the construction of Islamic Boarding School Building X in Karanganyar based on the PDM network method are the work of installing walls and mixed bricks. 1 pc: 5 psr 1st floor, installing mixed brick walls1 pc: 5 psr 2nd floor, installing mixed brick wallsOn the third, 1 pc: 5 psr floor, ceramic work, ceiling frame work, ceiling covering work, ceiling list work, wall painting work on the floor.

The Fourth, paint the third floor ceiling, steel truss work, gording work, iron railings and roofs, light steel batten rib work, and ceramic tile roof covering work.

The last, Based on the results of the research and discussion above, the most optimal cost and time after using the PDM method is to crash using the method of adding working hours (overtime) on the ceiling painting job on the 3rd floor on the critical path 1, track 2. critical 2, critical path 4 and critical path 5, with a total duration of project completion being 69 days, or 3 days faster than normal time with an additional cost of Rp. 6,577,012,-

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