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Time and Cost Analysis of Road Construction Projects Using *Earned Value*

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ABSTRACT

In project implementation, it is very rare to find projects that are carried out according to plan, there are often delays in project implementation that are detrimental, as well as the Jl. Sp. Handil Bakti (Sp. Serapat) – KM.17 (By Pass Banjarmasin). This study examines the progress of work and deviations that occur as well as the factors and impacts of delays.

In this study, the *Earned Value is* used to analyze the progress of work with the amount of cost and time that has been used so that an estimate of the cost needs to be made until the end of project implementation and the possibility of a deviation as well as direct interviews to get the factors and impacts of delays.

The results of the analysis using *Earned Value* from the 1st week to the 20th week, the project duration (ECD) is faster than the plan, which is 110 weeks and the total cost is Rp. 146.063.967.764.75 smaller than the plan of Rp. 158,773,106,401.70. The results of interviews with related parties regarding the factors and impacts of delays were due to bad weather which caused flooding at the beginning of the project implementation so the project design was re-planned.

Keywords: Result value method, *planned value, earned value, actual cost*, delay factor, the impact of delay.

1. INTRODUCTION

In the Jl. Sp. Handil Bakti (Sp. Serapat) – KM.17 (Bypass Banjarmasin) with a planned project duration from November 2020 to December 2022 (111 weeks) or 776 calendar days, 2 addendums have been made. As of the 19th week of the period March 22 to March 28, 2021, the workload is 2.28% while the work plan until the 19th week is 4.83% where in the 19th week there is a delay of 2.54%. This study aims to determine the possibility of deviations in cost and time, determine the estimated total cost and time during the project progress to completion, and determine the factors and impacts of delays. Based on this explanation, the authors are interested in conducting research on "Time and Cost Analysis on Road Construction Projects With the *Earned Value"*, which in this study will produce an evaluation that will estimate the completion time and total costs required for the construction project.

2. LITERATURE REVIEW

Measuring Time and Cost Performance with The Earned Value Method

According to Danto (2016), in determining project performance by means of *Earned Value*, the information displayed is in the form of indicators in a quantitative form showing information on the progress of costs and project schedules, as follows:

a. Budgeted Cost for Work Scheduled (BCWS)

BCWS = BCWS Weight x Total Budget

b. Budgeted Cost of Work Performed (BCWP)

BCWP = Percentage of Work Completed(%) x BAC

c. Actual Cost of Work Performed (ACWP)

ACWP = Direct Costs + Indirect Costs

$$\text{ACWP weight} = \frac{\text{ACWP}}{\text{Total Anggaran (BAC)}} \times 100\%$$

Criteria *Earned Value Management System* (EVMS)

In the implementation of project management based on the concept of *earned value*, Fleming and Koppelmen (1994) have explained 10 criteria for the implementation of project management based on *earned value*, namely management commitment, establishing project scope with WBS, creating *management control cells*, assigning functional responsibilities for each smallest part of project management, making *earned value baseline*, using formal project scheduling processes, managing indirect costs, estimating project completion costs, reporting project status, and compiling *a historical database*.

The Concept of Earned Value on Project Performance

Soemardi, et al. (2006) stated that the use of the concept of *Earned Value* in project performance appraisal is explained in the following figure:

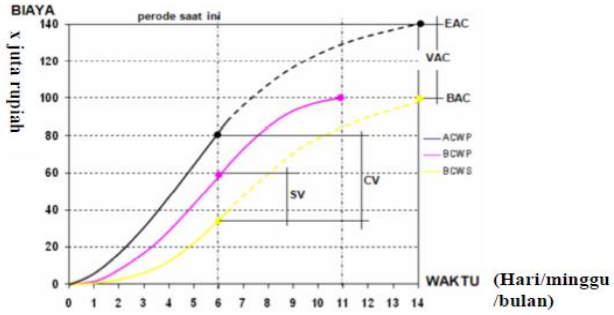

Figure 1. Graph of Earned Value

Soemardi, et al. (2006) explain the terms associated with this assessment, namely as follows:

a. Cost Variance (CV)

   (CV) = EV-AC or CV = BCWP-ACWP

   where:

   EV: BCWP: earned value

   AC: ACWP: actual cost

   CV: cost variance or cost deviation

b. Schedule Variance (SV)

   Schedule Variance (SV) = BCWP – BCWS

   where:

   BCWS: cost plan

   BCWP: cost plan based on real progress in the field

   SV: schedule variance or time deviation

c. Budgeted Variance (BV)

   Budgeted Variance (BV) = BCWS – ACWP

   where:

   BCWS: plan cost

   ACWP: actual cost

   BV: budgeted variance or budget deviation

d. Cost Performance Index (CPI)

   $\text{CPI} = \frac{\text{BCWP}}{\text{ACWP}}$

   where:

   ACWP : actual cost

   BCWP : cost plan based on real progress in the field

   CPI : Cost Performance Index or cost efficiency factor

e. Schedule Performance Index (SPI)

   $\text{SPI} = \frac{\text{BCWP}}{\text{BCWS}}$

   where:

   BCWS : plan cost

   BCWP : cost plan based on real progress in the field

SPI : Schedule Performance Index or performance efficiency factor

Predicted Cost and Project Completion Time According to Suharto (1995), this *Earned Value* can also be used to estimate the final cost of the project and also the project completion time.

a. Estimate to Complete (ETC)

- ETC for progress <50%

ETC = Total Budget – EV

- ETC for progress >50%

ETC = (Total Budget – EV)/CPI

b. Estimate at Completion (EAC)

EAC = AC+ETC or $\mathrm{EAC} = \mathrm{ACWP} + \frac{(\mathrm{BAC}-\mathrm{BCWP})}{(\mathrm{CPIxSPI})}$

where:

EAC: estimated final project completion cost

ACWP: actual cost

BCWP: cost plan based on actual progress in the field

ETC: estimated costs for remaining work

BAC: cost plan on end of project

CPI: cost effectiveness

SPI: work performance against plan

c. Time Estimate (TE)

TE = ATE + (OD - (ATE x SPI) / SPI)

where:

TE (Time Estimated): Estimated completion time

ATE (Actual Time Expended): The time taken

OD (Original Duration): Planned time

Causes of Project Delay

According to Kraiem and Dickman (dalan Proboyo, 1999), the causes of delays in project implementation time can be categorized into three (3) major groups, namely:

a. Compensable Delay

b. NonExcusable Delay

c. Excusable Delay

3. METHOD

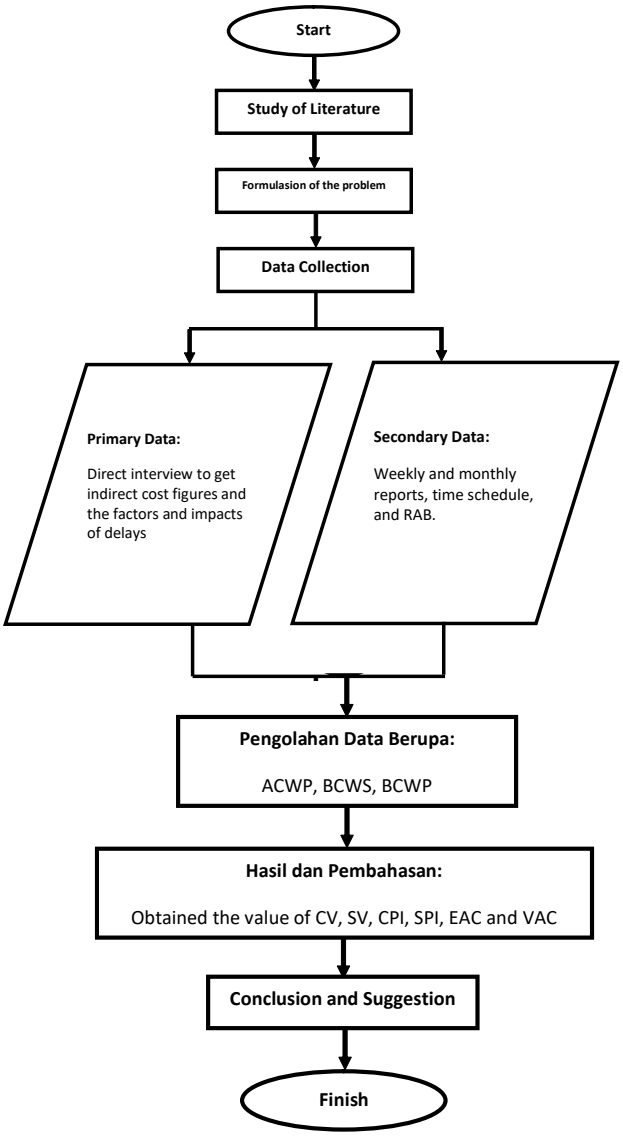

Figure 2. Methodology Flowchart

4. RESULT AND DISCUSSION

Table 1. Cumulative Work

Week	*Addendum*	Work Plan Percentage (%)	Performance Weight(%)
1		0,09 %	0,03 %
2		0,17 %	0,07 %
3		0,28 %	0,27 %
4		0,50 %	0,46 %
5		0,73 %	0,56 %
6		0,92 %	1,12 %
7		1,07 %	1,18 %
8		1,21 %	1,32 %
9		1,36 %	1,32 %
10		1,52 %	1,51 %
11		1,70 %	1,53 %
12	**Addendum 01**	1,92 %	1,57 %
13		2,13 %	1,78 %
14	**Addendum 01**	2,41 %	1,79 %
15		2,70 %	1,82 %
16		3,04 %	1,84 %
17		3,52 %	1,88 %
18		4,18 %	1,96 %
19		4,83 %	2,28 %
20	**Addendum 02**	2,38 %	2,39 %

The initial budget for this project is Rp. 174,650,417,000.00 including VAT (Value Added Tax) of 10% and the net value of project implementation excluding 10% VAT is Rp. 158,773,106,401.70.

BCWS Analysis

Table 2. Recapitulation of BCWS Value Calculation

Week	BAC (Rp)	BCWS weight (%)		BCWS (%)	
		Weekly	Cumulative	Weekly	Cumulative
1	Rp158.773.106.401,70	0,09%	0,09%	Rp 142.895.795,76	Rp142.895.795,76
2		0,08%	0,17%	Rp 127.018.485,12	Rp269.914.280,88
3		0,11%	0,28%	Rp 174.650.417,04	Rp444.564.697,92
4		0,22%	0,50%	Rp 349.300.834,08	Rp793.865.532,01
5		0,23%	0,73%	Rp 365.178.144,72	Rp1.159.043.676,73
6		0,19%	0,92%	Rp 301.668.902,16	Rp1.460.712.578,90
7		0,15%	1,07%	Rp 238.159.659,60	Rp1.698.872.238,50
8		0,14%	1,21%	Rp 222.282.348,96	Rp1.921.154.587,46
9		0,15%	1,36%	Rp 238.159.659,60	Rp2.159.314.247,06
10		0,16%	1,52%	Rp 254.036.970,24	Rp2.413.351.217,31
11		0,18%	1,70%	Rp 285.791.591,52	Rp2.699.142.808,83
12		0,22%	1,92%	Rp 349.300.834,08	Rp3.048.443.642,91
13		0,21%	2,13%	Rp 333.423.523,44	Rp3.381.867.166,36
14		0,28%	2,41%	Rp 444.564.697,92	Rp3.826.431.864,28
15		0,29%	2,70%	Rp 460.442.008,56	Rp4.286.873.872,85
16		0,34%	3,04%	Rp 539.828.561,77	Rp4.826.702.434,61
17		0,48%	3,52%	Rp 762.110.910,73	Rp5.588.813.345,34
18		0,66%	4,18%	Rp1.047.902.502,25	Rp6.636.715.847,59
19		0,65%	4,83%	Rp1.032.025.191,61	Rp7.668.741.039,20
20		0,10%	2,38%	Rp 158.773.106,40	Rp3.778.799.932,36

ACWP Analysis

Table 3. ACWP Calculation Recapitulation

Weekly	Direct Cost (Rp)	Direct Cost Cumulative (Rp)	Indirect Cost (Rp)	Tax (Rp)	ACWP (Rp)	ACWP Cumulative (Rp)	ACWP Weight (%)	
							Weekly	Cumulative
1	Rp39.058.184,17	Rp39.058.184,17	Rp18.973.386,22	Rp379.467.724,30	Rp58.031.570,39	Rp58.031.570,39	0,04	0,04
2	Rp39.058.184,17	Rp78.116.368,34	Rp18.973.386,22		Rp58.031.570,39	Rp116.063.140,78	0,04	0,08
3	Rp273.407.289,22	Rp351.523.657,56	Rp18.973.386,22		Rp292.380.675,44	Rp408.443.816,22	0,18	0,26
4	Rp247.368.499,77	Rp598.892.157,33	Rp18.973.386,22		Rp266.341.885,99	Rp674.785.702,21	0,17	0,43
5	Rp130.193.947,25	Rp729.086.104,58	Rp18.973.386,22		Rp149.167.333,47	Rp823.953.035,68	0,09	0,52
6	Rp729.086.104,60	Rp1.458.172.209,18	Rp18.973.386,22		Rp748.059.490,82	Rp1.572.012.526,50	0,47	0,99
7	Rp91.135.763,07	Rp1.549.307.972,25	Rp18.973.386,22		Rp110.109.149,29	Rp1.682.121.675,79	0,07	1,06
8	Rp182.271.526,15	Rp1.731.579.498,40	Rp18.973.386,22		Rp201.244.912,37	Rp1.883.366.588,16	0,13	1,19
9	Rp0,00	Rp1.731.579.498,40	Rp18.973.386,22		Rp18.973.386,22	Rp1.902.339.974,38	0,01	1,20
10	Rp234.349.105,05	Rp1.965.928.603,45	Rp18.973.386,22		Rp253.322.491,27	Rp2.155.662.465,65	0,16	1,36
11	Rp39.058.184,17	Rp2.004.986.787,62	Rp18.973.386,22		Rp58.031.570,39	Rp2.213.694.036,04	0,04	1,40
12	Rp39.058.184,17	Rp2.044.044.971,79	Rp18.973.386,22		Rp58.031.570,39	Rp2.271.725.606,43	0,04	1,44
13	Rp286.426.683,95	Rp2.330.471.655,74	Rp18.973.386,22		Rp305.400.070,17	Rp2.577.125.676,60	0,19	1,63
14	Rp13.019.394,72	Rp2.343.491.050,46	Rp18.973.386,22		Rp31.992.780,94	Rp2.609.118.457,54	0,02	1,65
15	Rp39.058.184,17	Rp2.382.549.234,63	Rp18.973.386,22		Rp58.031.570,39	Rp2.667.150.027,93	0,04	1,69
16	Rp26.038.789,45	Rp2.408.588.024,08	Rp18.973.386,22		Rp45.012.175,67	Rp2.712.162.203,60	0,03	1,72
17	Rp52.077.578,90	Rp2.460.665.602,98	Rp18.973.386,22		Rp71.050.965,12	Rp2.783.213.168,72	0,04	1,76
18	Rp104.155.157,80	Rp2.564.820.760,78	Rp18.973.386,22		Rp123.128.544,02	Rp2.906.341.712,74	0,08	1,84
19	Rp416.620.631,20	Rp2.981.441.391,98	Rp18.973.386,22		Rp435.594.017,42	Rp3.341.935.730,16	0,27	2,11
20	Rp143.213.341,97	Rp3.124.654.733,95	Rp18.973.386,22		Rp162.186.728,19	Rp3.504.122.458,35	0,10	2,21

BCWP Analysis

Table 4. Recapitulation of BCWP Calculation

Weekly	Realization Weight (%)	Cumulative Weight (%)	BAC (Rp)	BCWP (Rp)	BCWP Cumulative (Rp)
1	0,03%	0,03%	Rp158.773.106.401,70	Rp47.631.931,92	Rp47.631.931,92
2	0,03%	0,06%		Rp47.631.931,92	Rp95.263.863,84
3	0,21%	0,27%		Rp333.423.523,44	Rp428.687.387,28
4	0,19%	0,46%		Rp301.668.902,16	Rp730.356.289,45
5	0,10%	0,56%		Rp158.773.106,40	Rp889.129.395,85
6	0,56%	1,12%		Rp889.129.395,85	Rp1.778.258.791,70
7	0,07%	1,19%		Rp111.141.174,48	Rp1.889.399.966,18
8	0,14%	1,33%		Rp222.282.348,96	Rp2.111.682.315,14
9	0,00%	1,33%		Rp0,00	Rp2.111.682.315,14
10	0,18%	1,51%		Rp285.791.591,52	Rp2.397.473.906,67
11	0,03%	1,54%		Rp47.631.931,92	Rp2.445.105.838,59
12	0,03%	1,57%		Rp47.631.931,92	Rp2.492.737.770,51
13	0,22%	1,79%		Rp349.300.834,08	Rp2.842.038.604,59
14	0,01%	1,80%		Rp15.877.310,64	Rp2.857.915.915,23
15	0,03%	1,83%		Rp47.631.931,92	Rp2.905.547.847,15
16	0,02%	1,85%		Rp31.754.621,28	Rp2.937.302.468,43
17	0,04%	1,89%		Rp63.509.242,56	Rp3.000.811.710,99
18	0,08%	1,97%		Rp127.018.485,12	Rp3.127.830.196,11
19	0,32%	2,29%		Rp508.073.940,49	Rp3.635.904.136,60
20	0,11%	2,40%		Rp174.650.417,04	Rp3.810.554.553,64

SV Analysis

Table 5. Recap of SV Calculation

Weekly	BCWS (Rp)	BCWP (Rp)	SV (Rp)
1	Rp142.895.795,76	Rp47.631.931,92	-Rp95.263.863,84
2	Rp269.914.280,88	Rp95.263.863,84	-Rp174.650.417,04
3	Rp444.564.697,92	Rp428.687.387,28	-Rp15.877.310,64
4	Rp793.865.532,01	Rp730.356.289,45	-Rp63.509.242,56
5	Rp1.159.043.676,73	Rp889.129.395,85	-Rp269.914.280,88
6	Rp1.460.712.578,90	Rp1.778.258.791,70	Rp317.546.212,80
7	Rp1.698.872.238,50	Rp1.889.399.966,18	Rp190.527.727,68
8	Rp1.921.154.587,46	Rp2.111.682.315,14	Rp190.527.727,68
9	Rp2.159.314.247,06	Rp2.111.682.315,14	-Rp47.631.931,92
10	Rp2.413.351.217,31	Rp2.397.473.906,67	-Rp15.877.310,64
11	Rp2.699.142.808,83	Rp2.445.105.838,59	-Rp254.036.970,24
12	Rp3.048.443.642,91	Rp2.492.737.770,51	-Rp555.705.872,40
13	Rp3.381.867.166,36	Rp2.842.038.604,59	-Rp539.828.561,77
14	Rp3.826.431.864,28	Rp2.857.915.915,23	-Rp968.515.949,05
15	Rp4.286.873.872,85	Rp2.905.547.847,15	-Rp1.381.326.025,70
16	Rp4.826.702.434,61	Rp2.937.302.468,43	-Rp1.889.399.966,18
17	Rp5.588.813.345,34	Rp3.000.811.710,99	-Rp2.588.001.634,35
18	Rp6.636.715.847,59	Rp3.127.830.196,11	-Rp3.508.885.651,48
19	Rp7.668.741.039,20	Rp3.635.904.136,60	-Rp4.032.836.902,60
20	Rp3.778.799.932,36	Rp3.810.554.553,64	Rp31.754.621,28

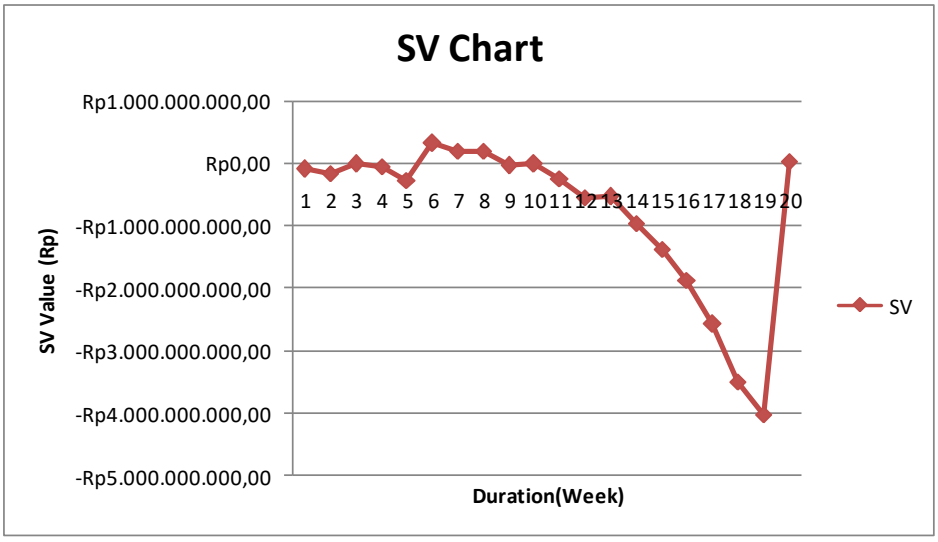

Figure 3. Graph of SV During the Review Period

From the 1st week until the 5th week of work, the SV value is negative, which means the work is slower than the planned time, the 6th to 8th week of the SV value is positive, which means the work is faster than the planned time. Meanwhile, from the 9th

week to the 19th week, the SV value returned to a negative value and in the 20th week the SV value became positive after the addendum was carried out.

CV Analysis

Table 6. Recap of Calculation of CV

Weekly	BCWP (Rp)	ACWP (Rp)	CV (Rp)
1	Rp47.631.931,92	Rp58.031.570,39	-Rp10.399.638,47
2	Rp95.263.863,84	Rp116.063.140,78	-Rp20.799.276,94
3	Rp428.687.387,28	Rp408.443.816,22	Rp20.243.571,06
4	Rp730.356.289,45	Rp674.785.702,21	Rp55.570.587,24
5	Rp889.129.395,85	Rp823.953.035,68	Rp65.176.360,17
6	Rp1.778.258.791,70	Rp1.572.012.526,50	Rp206.246.265,20
7	Rp1.889.399.966,18	Rp1.682.121.675,79	Rp207.278.290,39
8	Rp2.111.682.315,14	Rp1.883.366.588,16	Rp228.315.726,98
9	Rp2.111.682.315,14	Rp1.902.339.974,38	Rp209.342.340,76
10	Rp2.397.473.906,67	Rp2.155.662.465,65	Rp241.811.441,02
11	Rp2.445.105.838,59	Rp2.213.694.036,04	Rp231.411.802,55
12	Rp2.492.737.770,51	Rp2.271.725.606,43	Rp221.012.164,08
13	Rp2.842.038.604,59	Rp2.577.125.676,60	Rp264.912.927,99
14	Rp2.857.915.915,23	Rp2.609.118.457,54	Rp248.797.457,69
15	Rp2.905.547.847,15	Rp2.667.150.027,93	Rp238.397.819,22
16	Rp2.937.302.468,43	Rp2.712.162.203,60	Rp225.140.264,83
17	Rp3.000.811.710,99	Rp2.783.213.168,72	Rp217.598.542,27
18	Rp3.127.830.196,11	Rp2.906.341.712,74	Rp221.488.483,37
19	Rp3.635.904.136,60	Rp3.341.935.730,16	Rp293.968.406,44
20	Rp3.810.554.553,64	Rp3.504.122.458,35	Rp306.432.095,29

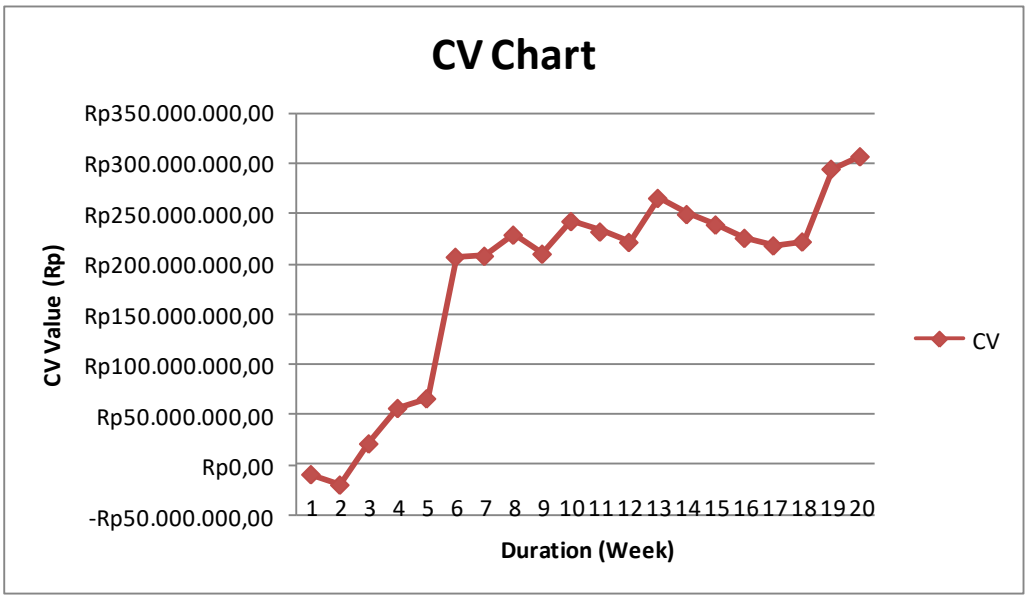

Figure 4. CV Graph During the Review Period

Cost Variance Graph during the 20-week review period, in the 1st and second week of negative CV values, means that the costs incurred exceed the budget. From the 3rd to the 20th week, the CV value is positive, which means that the costs incurred do not exceed the planned budget.

BV Analysis

Table 7. Recap of Calculation of Weekly BV

Weekly	BCWS (Rp)	ACWP (Rp)	BV (Rp)
1	Rp142.895.795,76	Rp58.031.570,39	Rp84.864.225,37
2	Rp269.914.280,88	Rp116.063.140,78	Rp153.851.140,10
3	Rp444.564.697,92	Rp408.443.816,22	Rp36.120.881,70
4	Rp793.865.532,01	Rp674.785.702,21	Rp119.079.829,80
5	Rp1.159.043.676,73	Rp823.953.035,68	Rp335.090.641,05
6	Rp1.460.712.578,90	Rp1.572.012.526,50	-Rp111.299.947,60
7	Rp1.698.872.238,50	Rp1.682.121.675,79	Rp16.750.562,71
8	Rp1.921.154.587,46	Rp1.883.366.588,16	Rp37.787.999,30
9	Rp2.159.314.247,06	Rp1.902.339.974,38	Rp256.974.272,68
10	Rp2.413.351.217,31	Rp2.155.662.465,65	Rp257.688.751,66
11	Rp2.699.142.808,83	Rp2.213.694.036,04	Rp485.448.772,79
12	Rp3.048.443.642,91	Rp2.271.725.606,43	Rp776.718.036,48
13	Rp3.381.867.166,36	Rp2.577.125.676,60	Rp804.741.489,76
14	Rp3.826.431.864,28	Rp2.609.118.457,54	Rp1.217.313.406,74
15	Rp4.286.873.872,85	Rp2.667.150.027,93	Rp1.619.723.844,92
16	Rp4.826.702.434,61	Rp2.712.162.203,60	Rp2.114.540.231,01
17	Rp5.588.813.345,34	Rp2.783.213.168,72	Rp2.805.600.176,62
18	Rp6.636.715.847,59	Rp2.906.341.712,74	Rp3.730.374.134,85
19	Rp7.668.741.039,20	Rp3.341.935.730,16	Rp4.326.805.309,04
20	Rp3.778.799.932,36	Rp3.504.122.458,35	Rp274.677.474,01

Table 8. CV and SV During Review Period

Weekly	SV	CV	Time Analysis Based On SV	Cost Analysis Based on CV
1	-Rp95.263.863,84	-Rp10.399.638,47	Late	More Cost
2	-Rp174.650.417,04	-Rp20.799.276,94	Late	More Cost
3	-Rp15.877.310,64	Rp20.243.571,06	Late	Less Cost
4	-Rp63.509.242,56	Rp55.570.587,24	Late	Less Cost
5	-Rp269.914.280,88	Rp65.176.360,17	Late	Less Cost
6	Rp317.546.212,80	Rp206.246.265,20	Faster	Less Cost
7	Rp190.527.727,68	Rp207.278.290,39	Faster	Less Cost
8	Rp190.527.727,68	Rp228.315.726,98	Faster	Less Cost
9	-Rp47.631.931,92	Rp209.342.340,76	Late	Less Cost
10	-Rp15.877.310,64	Rp241.811.441,02	Late	Less Cost
11	-Rp254.036.970,24	Rp231.411.802,55	Late	Less Cost
12	-Rp555.705.872,40	Rp221.012.164,08	Late	Less Cost
13	-Rp539.828.561,77	Rp264.912.927,99	Late	Less Cost
14	-Rp968.515.949,05	Rp248.797.457,69	Late	Less Cost
15	-Rp1.381.326.025,70	Rp238.397.819,22	Late	Less Cost
16	-Rp1.889.399.966,18	Rp225.140.264,83	Late	Less Cost
17	-Rp2.588.001.634,35	Rp217.598.542,27	Late	Less Cost
18	-Rp3.508.885.651,48	Rp221.488.483,37	Late	Less Cost
19	-Rp4.032.836.902,60	Rp293.968.406,44	Late	Less Cost
20	Rp31.754.621,28	Rp306.432.095,29	Faster	Less Cost

Schedule Performance Index (SPI)

Table 9. Recap of SPI Calculation

Weekly	BCWP (Rp)	BCWS (Rp)	SPI
1	Rp47.631.931,92	Rp142.895.795,76	0,333
2	Rp95.263.863,84	Rp269.914.280,88	0,353
3	Rp428.687.387,28	Rp444.564.697,92	0,964
4	Rp730.356.289,45	Rp793.865.532,01	0,920
5	Rp889.129.395,85	Rp1.159.043.676,73	0,767
6	Rp1.778.258.791,70	Rp1.460.712.578,90	1,217
7	Rp1.889.399.966,18	Rp1.698.872.238,50	1,112
8	Rp2.111.682.315,14	Rp1.921.154.587,46	1,099
9	Rp2.111.682.315,14	Rp2.159.314.247,06	0,978
10	Rp2.397.473.906,67	Rp2.413.351.217,31	0,993
11	Rp2.445.105.838,59	Rp2.699.142.808,83	0,906
12	Rp2.492.737.770,51	Rp3.048.443.642,91	0,818
13	Rp2.842.038.604,59	Rp3.381.867.166,36	0,840
14	Rp2.857.915.915,23	Rp3.826.431.864,28	0,747
15	Rp2.905.547.847,15	Rp4.286.873.872,85	0,678
16	Rp2.937.302.468,43	Rp4.826.702.434,61	0,609
17	Rp3.000.811.710,99	Rp5.588.813.345,34	0,537
18	Rp3.127.830.196,11	Rp6.636.715.847,59	0,471
19	Rp3.635.904.136,60	Rp7.668.741.039,20	0,474
20	Rp3.810.554.553,64	Rp3.778.799.932,36	1,008

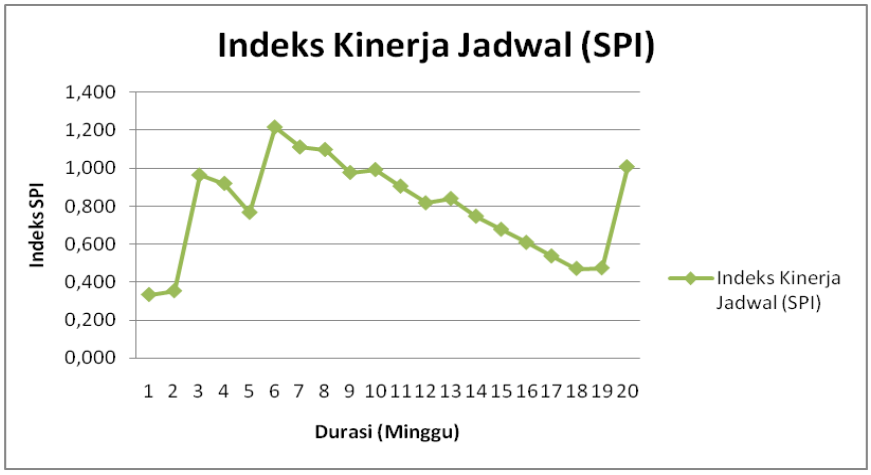

Figure 5. Graph of SPI During the Review Period

In the 1st to 5th week the SPI value is less than 1 (one) means that the project is experiencing delays, but the performance of the schedule each week is progressing, week 6 to week 8 the SPI value is above 1 (one) which means the progress of the work is good and faster than planned, in the 9th week to the 19th week of SPI is less than 1, work progress in the 20th week or the following week the project schedule performance index increases.

Cost Performance Index (CPI)

Table 10. Recap of CPI Calculation

Weekly	BCWP (Rp)	ACWP (Rp)	CPI
1	Rp47.631.931,92	Rp58.031.570,39	0,821
2	Rp95.263.863,84	Rp116.063.140,78	0,821
3	Rp428.687.387,28	Rp408.443.816,22	1,050
4	Rp730.356.289,45	Rp674.785.702,21	1,082
5	Rp889.129.395,85	Rp823.953.035,68	1,079
6	Rp1.778.258.791,70	Rp1.572.012.526,50	1,131
7	Rp1.889.399.966,18	Rp1.682.121.675,79	1,123
8	Rp2.111.682.315,14	Rp1.883.366.588,16	1,121
9	Rp2.111.682.315,14	Rp1.902.339.974,38	1,110
10	Rp2.397.473.906,67	Rp2.155.662.465,65	1,112
11	Rp2.445.105.838,59	Rp2.213.694.036,04	1,105
12	Rp2.492.737.770,51	Rp2.271.725.606,43	1,097
13	Rp2.842.038.604,59	Rp2.577.125.676,60	1,103
14	Rp2.857.915.915,23	Rp2.609.118.457,54	1,095
15	Rp2.905.547.847,15	Rp2.667.150.027,93	1,089
16	Rp2.937.302.468,43	Rp2.712.162.203,60	1,083
17	Rp3.000.811.710,99	Rp2.783.213.168,72	1,078
18	Rp3.127.830.196,11	Rp2.906.341.712,74	1,076
19	Rp3.635.904.136,60	Rp3.341.935.730,16	1,088
20	Rp3.810.554.553,64	Rp3.504.122.458,35	1,087

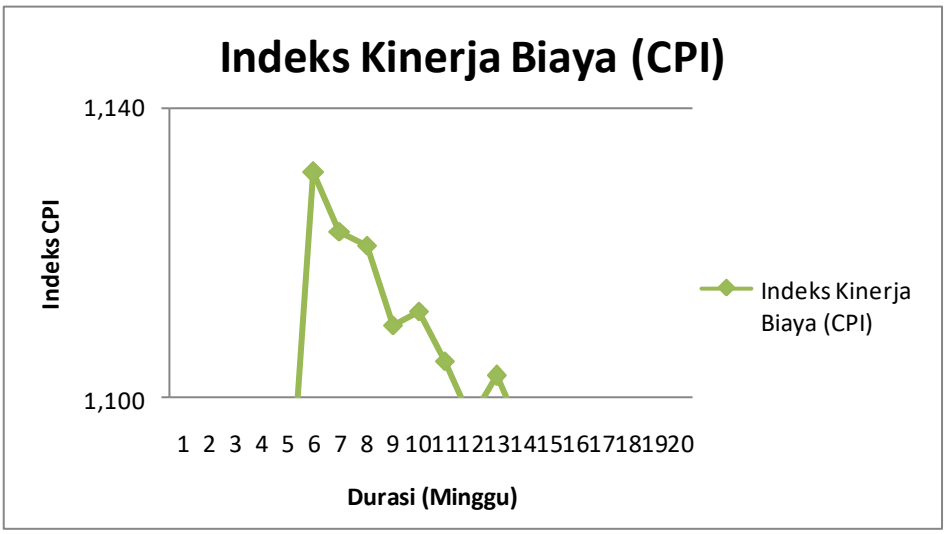

Figure 6. Graph of CPI During the Review Period

Estimated at Completion Date

Elapsed Time = 20 weeks

Remaining execution time = 91 weeks

$$\text{ECD} = \left(\frac{\text{Remaining Time}}{\text{SPI}}\right) + \text{Elapsed Time}$$

$$= \left(\frac{91 \text{ week}}{1{,}008}\right) + 20 \text{ week}$$

= 110 Weeks (Meaning that the project completion is going faster than planned)

Estimated to Complete

Total project budget (BAC) = IDR 158,773,106,401.70

BCWP (Until the 20th week) = IDR 3.810.554.553,64

CPI = 1.087

$$\text{ETC} = \frac{(\text{BAC} - \text{BCWP})}{\text{CPI}}$$

$$= \frac{(\text{IDR } 158.773.106.401{,}70 - \text{IDR } 3.810.554.553{,}64)}{1{,}087}$$

= IDR 142.559.845.306,40

Estimated Cost at the Time of Project Completion (EAC)

Total project cost budget (BAC) = IDR 158,773,106,401.70

ACWP (Until the 20th week) = IDR 3.504.122.458,35

Estimate to Complete (ETC) = IDR 142.559.845.306,40

EAC = ETC + ACWP

= IDR 142,559,845,306.40 + IDR 3,504,122,458.35

= IDR 146,063,967,764.75

Remaining budget = BAC – EAC

= IDR 158,773,106,401.70 - IDR 146,063,967,764.75

= IDR 12,709,138,636.95

Interview Results

Based on the answers to the questions asked in the interview, can be drawn several things that became the factors of the delay, namely, the main factor was due to the occurrence of large floods at the construction project site at the beginning of the project, the intensity of rainfall heavy rains, and the roads are congested with large vehicles and traffic jams. Meanwhile, the impact of the delay was that many roads were damaged due to flooding, added work that should only be maintained and widening, and long traffic jams where construction projects were carried out so that trucks carrying materials for the project were delayed.

5.CONCLUSIONS AND SUGGESTIONS

The conclusions that can be drawn from the results of this discussion are as follows:

a) Cost deviations and time deviations are divided into three conditions, namely:
   1) The first condition is that the implementation of work is late and the costs incurred are greater than the planned budget. This condition occurred on Week 1 and Week 2 of project implementation (16 November–29 November 2020).
   2) The second condition is that the implementation of the work is late and the costs incurred are smaller than the planned budget. This condition occurs from Week 1 to Week 5 of project implementation (November 30–December 20, 2020) and from Week 9 to Week 19 (January 11-March 28, 2021).
   3) The third condition is the implementation of the work faster with a smaller cost of work. This condition occurs from Week 6 to Week 8 of project implementation (21 December 2020–10 January 2021) and on Sunday 20 (29 March–4 April 2021).

b) Based on the results of the analysis using *Earned Value*, the prediction results are as follows:
   1) The achievement of the total cost is Rp. 146.063.967.764.75 while the total budget plan is Rp. 158,773,106,401.70 with the remaining budget of Rp. 12,709,138,636.95. The value of this profit is obtained if the level of work productivity remains.
   2) The total time required for the implementation of this project is 110 weeks or faster than the planned target time of 111 weeks.

c) Based on the results of direct interviews with related parties in the project, it was found that the main factors causing delays were flooding and impacts, namely damaged roads and re-planning.

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