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COST AND TIME ANALYSIS USING EARNED VALUE METHOD CONSTRUCTION OF UPBJJ BUILDING OPEN UNIVERSITY OF SURABAYA PHASE II

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ABSTRACT
Project delays often become a source of disputes and claims between owners and contractors, making them highly costly. Contractors face penalties as specified in the contract and incur overhead costs during the ongoing project. From the owner's perspective, project delays lead to reduced revenue due to the postponement of facility operations. A project is prone to delays if planning and control are not executed accurately. Various factors in construction projects can extend the duration, resulting in project completion delays. Therefore, considering this background, this research aims to assess the planning of the construction of Building II at Open University Surabaya Regional Office (UPBJJ) in terms of cost and time performance. The study utilizes the earned value method to analyze the cost and time aspects of the construction project. Based on the analysis, the Estimate at Complete (EAC) indicates an estimated cost of Rp. 73,908,443,223.09 for completing the project. Additionally, the Time Estimate (TE) analysis suggests a projected duration of 53 weeks for project completion.
Keywords: Earned Value,*Cost Performance Index, Schedule Performance Index*

INTRODUCTION

Surabaya iscapitalEast Java Provincewhich is the center of government and economy ofEast Java Provinceas well as the largest city in the province(Hardiningsih, Januarti, Maryono, & Srimindarti, 2020). Surabaya is also a city located in East Java, Indonesia. Surabaya is the second largest city inIndonesia after Jakarta city(Murtadho & Rozqin, 2018). This city is located 800 km east of Jakarta, or 435 km northwestDenpasar,Bali. The location of this city is on the north coastJava Islandthe eastern part facingMadura Straitas well asJava Sea.

The vision of the Open University (UT) as a world-quality Open Distance Education University (PTTJJ) leads to mission refinement which includes providing access to world-quality higher education, developing the PTTJJ system, and disseminating the results of scientific and institutional studies.(Efendi, Zainuddin, & Ahmad, 2022) UT Surabaya's focus on building construction aims to increase UT's representation as a more representative distance education institution, improve

service quality, and meet technical, cost and administrative standards. The construction of this building must comply with the requirements for safety, health, comfort, efficiency, and contribute to the development of architecture in Indonesia. In the context of project management, it is important to understand factors such as time, cost, and quality. Control methods such as the Earned Value Method (EVM) and Earned Schedule (ES) are used to measure project progress, optimize resources, and ensure project success.

This research highlights the need for careful construction planning and efficient project management to achieve success in building construction projects(Shenhar, Dvir, Levy, & Maltz, 2001). Factors such as time, cost, and quality play a key role in determining project outcomes(AKINTAN et al., 2022). The use of the Earned Value Method helps in measuring the physical progress of work, predicting final project costs, and monitoring project performance in an integrated manner. Furthermore, the Earned Schedule (ES) method provides a new approach by using time units to control the project schedule.(Belassi & Tukel, 1996)

The importance of careful planning and efficient project management is emphasized in overcoming operational problems and avoiding project delays(Kerzner, 2017). Controlling costs, time and quality is the key to ensuring conformity between project planning and implementation(Stellingwerf & Zandhuis, 2013). Therefore, project control efforts must involve careful evaluation of implementation methods, tool use, and scheduling. The basic concepts of Earned Value and variance analysis help in making forecasts of target achievement, as well as providing a comprehensive third dimension in evaluating project performance . Thus, the use of this method can increase understanding of the relationship between cost, schedule and physical progress of the project.

Project delays are often a source of disputes and demands between owners and contractors, so that delays can be very expensive. The contractor will be subject to penalties according to the contract and will also experience overhead costs while the project is still ongoing. From the owner's side, project delays will have the impact of reducing income due to delays in operating the facilities.(Hatzis, 2002)

A project tends to experience delays if planning and control are not carried out properly(Olawale & Sun, 2010). Various things can happen in a construction project that can cause work time to increase, resulting in project completion being delayed.

So, with this background, this research tries to examine the construction planning for the UPBJJ building at the Open University of Surabaya phase II in terms of cost and time performance, so that it can be taken into consideration in the implementation of building construction in the future. The aspect of financing which is quite large is a concern in this research so that several construction alternatives are carried out with the aim of achieving cost efficiency and implementation time(Ajayi et al., 2015). However, there was a problem with the implementation, namely a delay of more than 10% in the 11th week which resulted in Show Cause Meeting. This is used as the basis for conducting this research which does not correct errors or correct calculations that have been made by planners because this research aims at the Earned Value Method (EVM) so that construction costs are obtained efficiently byUPBJJ Building Construction case studyUniversityOpen Surabaya Phase II .

This research formulates problems regarding cost and time performance in the construction of the UPBJJ Building, Open University of Surabaya Phase II using the

Earned Value method. The problem formulation includes evaluating work costs and time, while the research objective is to obtain cost and time performance based on the Earned Value Method. The benefits of research involve increasing students' insight and knowledge in applying civil engineering science, contributing to institutions in analyzing field problems using this method(Nejati, Shafaei, Salamzadeh, & Daraei, 2011), and becoming a reference for further research in construction management science. Research limitations involve the UPBJJ Building Construction project at Surabaya Open University Phase II, with a focus on further architectural and MEP work, as well as exceptions to structural work.

RESEARCH METHODS

This research describes a research flow chart to facilitate the preparation of a thesis report(Boudah, 2010). The research location is in Surabaya, East Java, with a focus on the construction of the UPBJJ Building, Surabaya Open University, Phase II. Surabaya is a strategic metropolitan city, economic, financial and business center in East Java. Education in Surabaya is developing rapidly, attracting thousands of pupils and students from various regions in Indonesia. The description of research variables involves cost component analysis, variance analysis, and performance indices. The results of the analysis will provide information about project performance, including estimated costs and project completion time(Mitchell, 2006).

RESULTS AND DISCUSSION

A. Cost component

1. BCWS (Budgeted Cost of Work Schedule)

BCWS (Budgeted Cost of Work Schedule) is the planned cost based on the completed project implementation schedule. The weekly BCWS value can be obtained based on the weekly plan weight in the Time Schedule. The basic calculation for work in the 1st month can be seen as below:

Total Project Budget = Rp. 64,319,272,652

Plan Weight*Time Schedule*= 0.57%

BCWS Weight = Time Schedule Plan Weight x Total Project Budget= 0.57% x Rp. 64,319,272,651 = Rp. 368,888,272

Further results can be seen in table 1.

Table 1. Recapitulation of BCWS Analysis Results

Recapitulation of BCWS Analysis			
Month	**Project Budget Value**	**Weight (%)**	**BCWS (Rp)**
1	IDR 64,319,272,652	0.57	IDR 368,888,272
2	IDR 64,319,272,652	10.38	IDR 6,677,852,028
3	IDR 64,319,272,652	23.03	IDR 14,810,430,900
4	IDR 64,319,272,652	25.54	IDR 16,429,134,352
5	IDR 64,319,272,652	65.98	IDR 42,438,744,606
6	IDR 64,319,272,652	88.22	IDR 56,739,778,691
7	IDR 64,319,272,652	100.00	IDR 64,319,272,652

Source: Researcher Analysis Data, 2023

Table 1. BCWS value from month 1 to month 7 using a contract value of Rp. 64,319,272,652. To get the results of the budgeted work schedule costs, the project budget value is multiplied by the weight of the work plan and produces the work schedule costs.

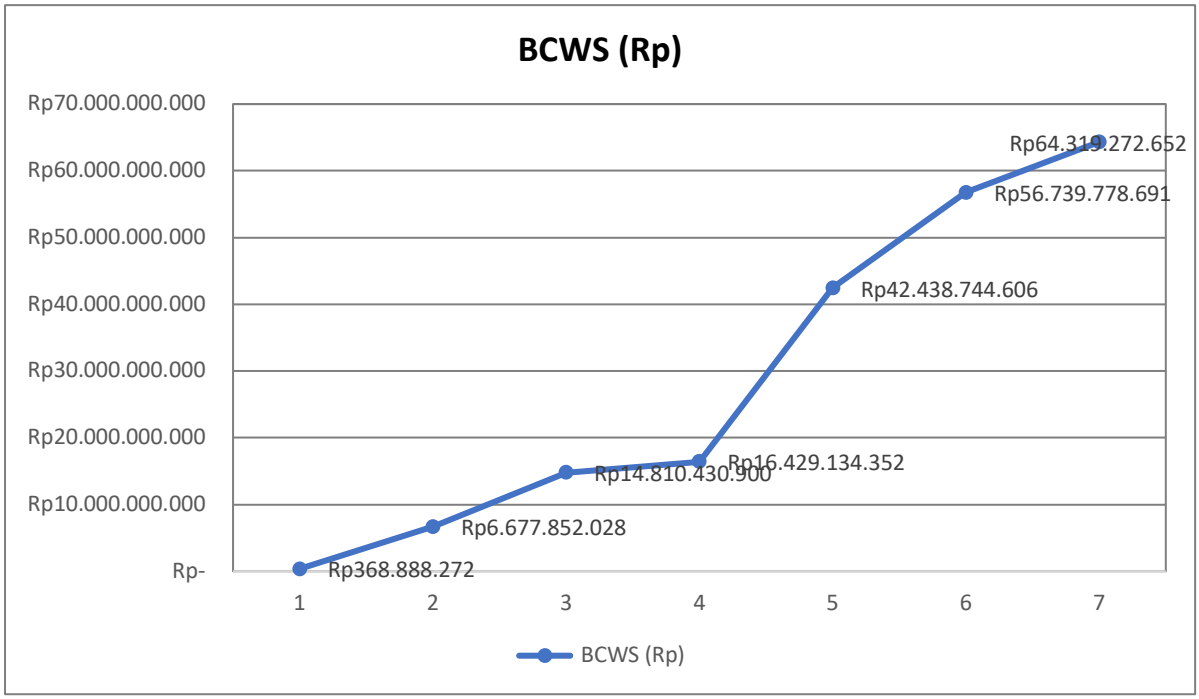

Figure 1.BCWS Every Month

Table 2. BCWS Analysis Results weeks 1 to 31

Recapitulation of BCWS Analysis			
Sunday	**Project Budget Value**	**Weight (%)**	**BCWS (Rp)**
1	IDR 64,319,272,652	-	Rp -
2	IDR 64,319,272,652	0.03	IDR 21,510,307
3	IDR 64,319,272,652	0.30	IDR 191,680,064
4	IDR 64,319,272,652	0.57	IDR 368,888,272
5	IDR 64,319,272,652	2.38	IDR 1,533,744,744
6	IDR 64,319,272,652	3.83	IDR 2,466,525,148
7	IDR 64,319,272,652	5.51	IDR 3,542,227,953
8	IDR 64,319,272,652	7.61	IDR 4,895,672,202
9	IDR 64,319,272,652	10.38	IDR 6,677,852,028
10	IDR 64,319,272,652	13.79	IDR 8,867,126,080
11	IDR 64,319,272,652	18.81	IDR 12,097,553,551
12	IDR 64,319,272,652	23.05	IDR 14,823,854,315
13	IDR 64,319,272,652	23.03	IDR 14,810,430,900
14	IDR 64,319,272,652	23.27	IDR 14,970,167,126
15	IDR 64,319,272,652	23.69	IDR 15,236,394,170
16	IDR 64,319,272,652	24.50	IDR 15,757,768,908
17	IDR 64,319,272,652	25.54	IDR 16,429,134,352
18	IDR 64,319,272,652	27.10	IDR 17,433,116,426

19	IDR 64,319,272,652	28.66	IDR 18,437,098,499
20	IDR 64,319,272,652	30.23	IDR 19,441,080,573
21	IDR 64,319,272,652	31.79	IDR 20,445,062,647
22	IDR 64,319,272,652	65.98	IDR 42,438,744,606
23	IDR 64,319,272,652	74.20	IDR 47,722,677,832
24	IDR 64,319,272,652	83.18	IDR 53,499,480,962
25	IDR 64,319,272,652	85.70	IDR 55,119,629,826
26	IDR 64,319,272,652	88.22	IDR 56,739,778,691
27	IDR 64,319,272,652	91.31	IDR 58,732,067,980
28	IDR 64,319,272,652	94.45	IDR 60,749,998,244
29	IDR 64,319,272,652	97.32	IDR 62,596,244,770
30	IDR 64,319,272,652	99.72	IDR 64,141,624,386
31	IDR 64,319,272,652	100.00	IDR 64,319,272,652

Source: Researcher Analysis Data, 2023

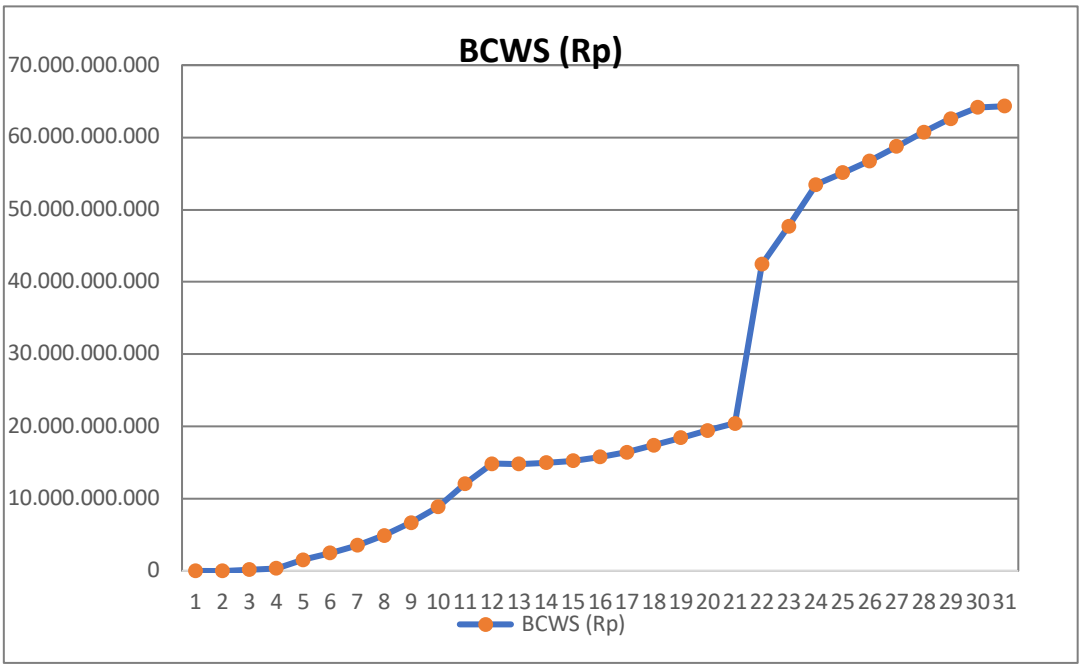

Figure 2.BCWS Every Sunday

2. BCWP (Budgeted Cost of Work Performed)

BCWP (Budgeted Cost of Work Performed) is the value of the results of all work that has been completed. BCWP calculations can be calculated using actual work weight data in the Time Schedule. The basic calculation for work in the 1st month can be seen as below:

Total Project Budget = Rp. 64,319,272,652

Plan Weight*Time Schedule*= 0.65%

BCWP Weight = Time Schedule Plan Weight x Total Project Budget = 0.65% x Rp. 64,319,272,651 = Rp. 414,998,771.60

Further results can be seen in table 3.

Table 3. Recapitulation of BCWP Analysis Results

Recapitulation of BCWP Analysis			
Month	**Project Budget Value**	**Weight (%)**	**BCWP (Rp)**
1	IDR 64,319,272,652	0.65	IDR 414,998,772
2	IDR 64,319,272,652	4.23	IDR 2,721,602,811
3	IDR 64,319,272,652	11.09	IDR 7,134,223,959
4	IDR 64,319,272,652		
5	IDR 64,319,272,652		
6	IDR 64,319,272,652		
7	IDR 64,319,272,652		

Source: Researcher Analysis Data, 2023

OnTable 3. BCWP value from month 1 to month 4 using a contract value of Rp. 64,319,272,652, it can be seen that the use of realized costs against the budget issued each month for physical work.

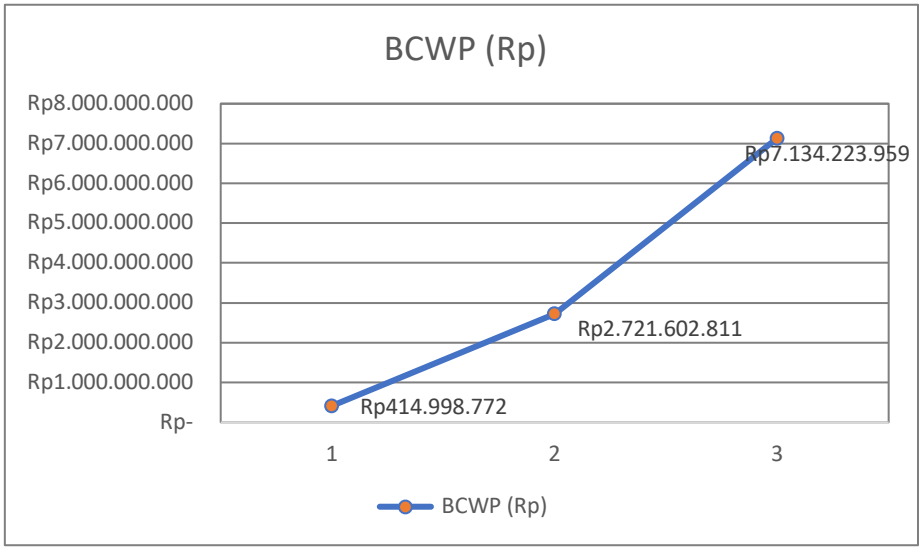

Figure 3.BCWP Every Month

Table 4. BCWP Analysis Results for weeks 1 to 31

Recapitulation of BCWP Analysis			
Sunday	**Project Budget Value**	**Weight (%)**	**BCWP (Rp)**
1	IDR 64,319,272,652	-	Rp -
2	IDR 64,319,272,652	0.04	IDR 27,238,384
3	IDR 64,319,272,652	0.36	IDR 230,999,485
4	IDR 64,319,272,652	0.65	IDR 414,998,772
5	IDR 64,319,272,652	0.81	IDR 518,705,864
6	IDR 64,319,272,652	1.21	IDR 777,543,579
7	IDR 64,319,272,652	1.98	IDR 1,270,581,380
8	IDR 64,319,272,652	2.29	IDR 1,469,827,394
9	IDR 64,319,272,652	4.23	IDR 2,721,602,811
10	IDR 64,319,272,652	5.38	IDR 3,459,990,953
11	IDR 64,319,272,652	6.61	IDR 4,250,925,049
12	IDR 64,319,272,652	8.08	IDR 5,195,247,034

13	IDR 64,319,272,652	11.09	IDR 7,134,223,959
14	IDR 64,319,272,652	13.91	IDR 8,946,376,486
15	IDR 64,319,272,652	19.35	IDR 12,443,197,872
16	IDR 64,319,272,652	22.60	IDR 14,538,179,963
17	IDR 64,319,272,652		
18	IDR 64,319,272,652		
19	IDR 64,319,272,652		
20	IDR 64,319,272,652		
21	IDR 64,319,272,652		
22	IDR 64,319,272,652		
23	IDR 64,319,272,652		
24	IDR 64,319,272,652		
25	IDR 64,319,272,652		
26	IDR 64,319,272,652		
27	IDR 64,319,272,652		
28	IDR 64,319,272,652		
29	IDR 64,319,272,652		
30	IDR 64,319,272,652		
31	IDR 64,319,272,652		

Source: Researcher Analysis Data, 2023

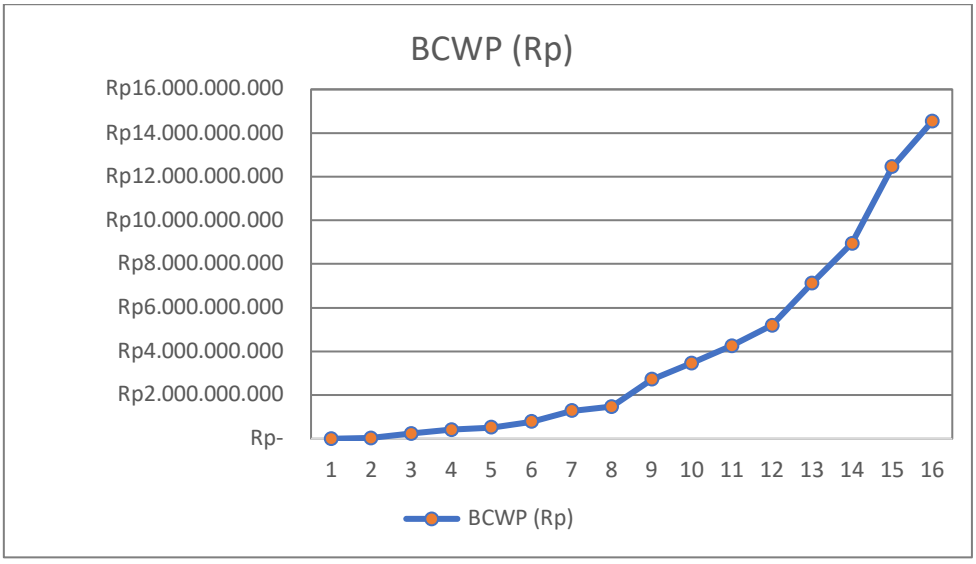

Figure 4.BCWP Every Week

3. ACWP (Actual Cost of Work Performed)

ACWP (Actual Cost of Work Performed) is the actual cost incurred for work that has been completed according to the work plan weight data in the Time Schedule. The basic calculation for work in the 1st month can be seen as below:

Actual Cost = Total Project – (10% x total project cost) = Rp. 64,319,272,651 –(10% x Rp. 64,319,272,651) = Rp. 57,887,345,386

Plan Weight*Time Schedule*= 0.65%

ACWP Weight = Realized Time Schedule Weight x Actual Cost = 0.65% x IDR 57,887,345,386 = IDR 37,349,889,444

Further results can be seen in table 5.

Table 5. Recapitulation of ACWP Analysis Results

Rekapitulasi Analisa ACWP									
Minggu	Biaya Langsung		Rencana		Biaya Tidak Langsung		Bobot (%)	ACWP	
1	Rp	-	Rp	-	Rp	-	-	Rp	-
2	Rp	27,238,384	Rp	21,510,307	Rp	1,075,515	0.03	Rp	28,313,899
3	Rp	230,999,485	Rp	191,680,064	Rp	9,584,003	0.30	Rp	240,583,488
4	Rp	414,998,772	Rp	368,888,272	Rp	18,444,414	0.57	Rp	433,443,185
5	Rp	518,705,864	Rp	1,533,744,744	Rp	76,687,237	2.38	Rp	595,393,101
6	Rp	777,543,579	Rp	2,466,525,148	Rp	123,326,257	3.83	Rp	900,869,837
7	Rp	1,270,581,380	Rp	3,542,227,953	Rp	177,111,398	5.51	Rp	1,447,692,778
8	Rp	1,469,827,394	Rp	4,895,672,202	Rp	244,783,610	7.61	Rp	1,714,611,004
9	Rp	2,721,602,811	Rp	6,677,852,028	Rp	333,892,601	10.38	Rp	3,055,495,413
10	Rp	3,459,990,953	Rp	8,867,126,080	Rp	443,356,304	13.79	Rp	3,903,347,257
11	Rp	4,250,925,049	Rp	12,097,553,551	Rp	604,877,678	18.81	Rp	4,855,802,726
12	Rp	5,195,247,034	Rp	14,823,854,315	Rp	741,192,716	23.05	Rp	5,936,439,750
13	Rp	7,134,223,959	Rp	14,810,430,900	Rp	740,521,545	23.03	Rp	7,874,745,504
14	Rp	8,946,376,486	Rp	14,970,167,126	Rp	748,508,356	23.27	Rp	9,694,884,842
15	Rp	12,443,197,872	Rp	15,236,394,170	Rp	761,819,709	23.69	Rp	13,205,017,581
16	Rp	14,538,179,963	Rp	15,757,768,908	Rp	787,888,445	24.50	Rp	15,326,068,408

Source: Researcher Analysis Data, 2023

From table 5, it can be seen that the value of ACWP results up to the 16th week of costs that have been carried out with a total cost ofRp.15,326,068,408 with Totalweight of 24.50%. Actual costs in the field are usually incurred for use of work, project tools, and so on.

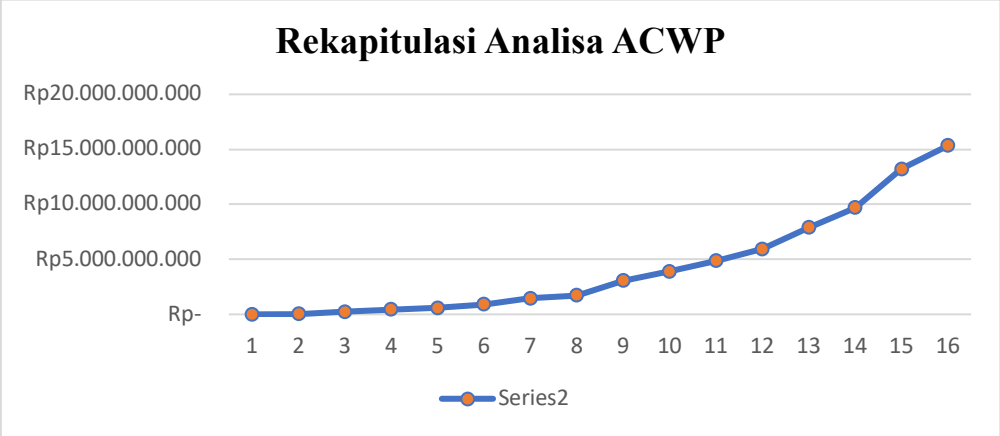

Figure 5.ACWP

From figure 5 you can seeView the graph of ACWP costs incurred for the project from week 1 to week 16 with total costsRp. 15,326,068,408

4. Variance Calculation

a. Time Variance (SV)

The Time Variance Value (SV) can be calculated by calculating the basic Time Variance (SV) value in the 1st month

SV = BCWP – BCWS

=Rp. 296,313,875 – 335,584,388

= - Rp. 39,270,514

The SV calculation result is minus, which means there is a delay in the time of work implementation. For further calculations, the SV value is as in table 4.7

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Table 6. Calculation of Time Variance Value (SV) Each Month

BULAN	BCWP		BCWS		SV		KET
1	Rp	296,313,875	Rp	335,584,389	-Rp	39,270,514	TERLAMBAT
2	Rp	631,898,264	Rp	628,328,217	Rp	3,570,047	SESUAI
3	Rp	1,142,414,940	Rp	1,213,815,874	-Rp	71,400,934	TERLAMBAT
4	Rp	1,820,723,811	Rp	1,831,433,951	-Rp	10,710,140	TERLAMBAT
5	Rp	3,034,539,685	Rp	3,070,240,152	-Rp	35,700,467	TERLAMBAT
6	Rp	5,247,968,632	Rp	5,340,789,845	-Rp	92,821,214	TERLAMBAT
7	Rp	9,631,985,964	Rp	9,735,517,318	-Rp	103,531,354	TERLAMBAT
8	Rp	16,482,905,559	Rp	16,597,147,053	-Rp	114,241,494	TERLAMBAT

Source: Researcher Analysis Data, 2023

It can be seen from table 6implementation of project work from the 1st month to the 8th month. Project implementation in the 1st month was delayed, then in the 2nd month it was appropriate, but in the 3rd month there was a delay up to the 8th month. For details, see graph 6.

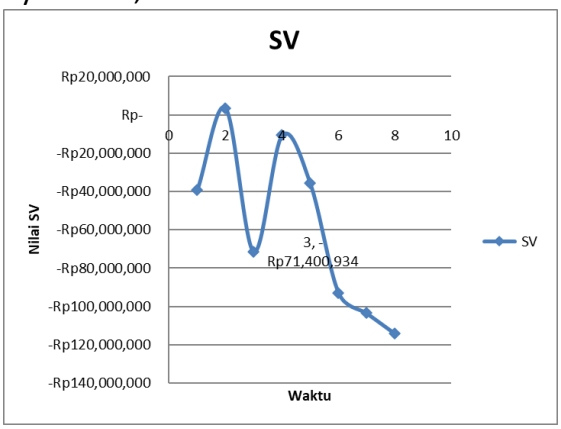

Figure 6.SV Every Month

It can be seen from graph 4.6 that the SV value from the 1st month can be seen that when the numbers (SV) are obtained there is a delay. Only in the 2nd month the work was appropriate.

Table 7.Calculation of Time Variance Value (SV) Every Week

MINGGU	BCWP		BCWS		SV		KET
1	Rp	-	Rp	-	Rp	-	SESUAI
2	Rp	27,238,384	Rp	21,510,307	Rp	5,728,077	SESUAI
3	Rp	230,999,485	Rp	191,680,064	Rp	39,319,421	SESUAI
4	Rp	414,998,772	Rp	368,888,272	Rp	46,110,500	SESUAI
5	Rp	518,705,864	Rp	1,533,744,744	-Rp	1,015,038,880	TERLAMBAT
6	Rp	777,543,579	Rp	2,466,525,148	-Rp	1,688,981,569	TERLAMBAT
7	Rp	1,270,581,380	Rp	3,542,227,953	-Rp	2,271,646,572	TERLAMBAT
8	Rp	1,469,827,394	Rp	4,895,672,202	-Rp	3,425,844,808	TERLAMBAT
9	Rp	2,721,602,811	Rp	6,677,852,028	-Rp	3,956,249,217	TERLAMBAT
10	Rp	3,459,990,953	Rp	8,867,126,080	-Rp	5,407,135,127	TERLAMBAT
11	Rp	4,250,925,049	Rp	12,097,553,551	-Rp	7,846,628,502	TERLAMBAT
12	Rp	5,195,247,034	Rp	14,823,854,315	-Rp	9,628,607,281	TERLAMBAT
13	Rp	7,134,223,959	Rp	14,810,430,900	-Rp	7,676,206,941	TERLAMBAT
14	Rp	8,946,376,486	Rp	14,970,167,126	-Rp	6,023,790,640	TERLAMBAT
15	Rp	12,443,197,872	Rp	15,236,394,170	-Rp	2,793,196,298	TERLAMBAT
16	Rp	14,538,179,963	Rp	15,757,768,908	-Rp	1,219,588,945	TERLAMBAT

Source: Researcher Analysis Data, 2023

From table 7It can be seen that from week 5 there was a delay until week 16. Below is a graph for the SV value.

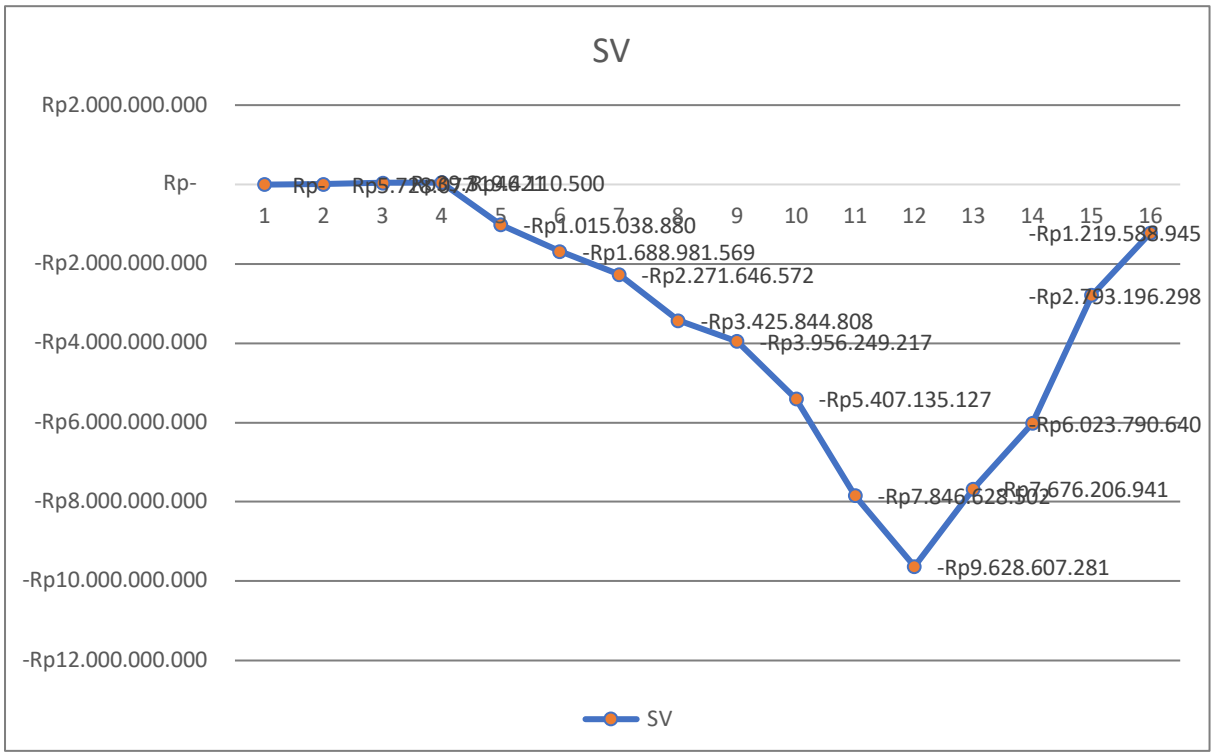

Figure 7.SV Every Sunday

b. Cost Variance (CV)
The Cost Variance Value (CV) can be calculated by calculating the basic Cost Variance (CV) value in the 1st month
CV = BCWP – ACWP
= Rp. 414,998,772– Rp. 410,395,650
= Rp4,603,121

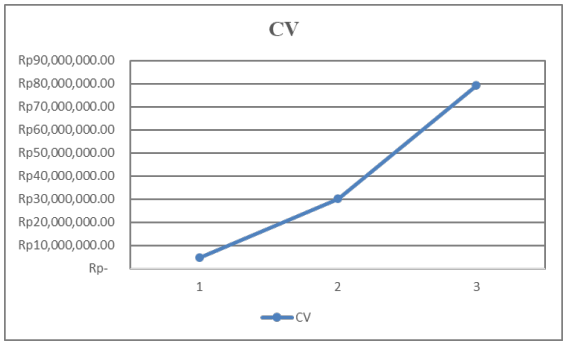

Figure 8.CV Every Month

Table 8. Calculation of Cost Variance Value (CV) Each Month

BULAN	BCWP	ACWP	CV
1	Rp 414,998,771.60	Rp 410,395,650.24	Rp 4,603,121.36
2	Rp 2,721,602,811.39	Rp 2,691,415,088.20	Rp 30,187,723.19
3	Rp 7,134,223,958.91	Rp 7,055,091,920.57	Rp 79,132,038.34

Source: Researcher Analysis Data, 2023

Table 8 shows the cost variance (CV) value from month 1 to month 3 where the project has been running for 3 months.

The cost variance value (CV) is the value obtained after completing part of the work with the actual value of project implementation. The CV value is used to determine whether the project is within budget or exceeds budget. The cost variance value shows positive, meaning the costs incurred are greater or wasteful.

The following is a table for the cost variance values from week 1 to week 16.

Table 9. Calculation of Cost Variance Value (CV) Every Week

MINGGU	BCWP	ACWP	CV
1	Rp -	Rp -	Rp -
2	Rp 27,238,384.11	Rp 28,313,899.44	-Rp 1,075,515.34
3	Rp 230,999,484.91	Rp 240,583,488.09	-Rp 9,584,003.18
4	Rp 414,998,771.60	Rp 433,443,185.20	-Rp 18,444,413.60
5	Rp 518,705,863.94	Rp 595,393,101.13	-Rp 76,687,237.19
6	Rp 777,543,579.40	Rp 900,869,836.83	-Rp 123,326,257.42
7	Rp 1,270,581,380.40	Rp 1,447,692,778.04	-Rp 177,111,397.64
8	Rp 1,469,827,393.85	Rp 1,714,611,003.93	-Rp 244,783,610.08
9	Rp 2,721,602,811.39	Rp 3,055,495,412.79	-Rp 333,892,601.41
10	Rp 3,459,990,953.04	Rp 3,903,347,257.06	-Rp 443,356,304.02
11	Rp 4,250,925,048.84	Rp 4,855,802,726.40	-Rp 604,877,677.56
12	Rp 5,195,247,034.29	Rp 5,936,439,750.05	-Rp 741,192,715.76
13	Rp 7,134,223,958.91	Rp 7,874,745,503.90	-Rp 740,521,544.99
14	Rp 8,946,376,486.14	Rp 9,694,884,842.45	-Rp 748,508,356.31
15	Rp 12,443,197,872.37	Rp 13,205,017,580.88	-Rp 761,819,708.51
16	Rp 14,538,179,963.02	Rp 15,326,068,408.43	-Rp 787,888,445.41

Source: Researcher Analysis Data, 2023

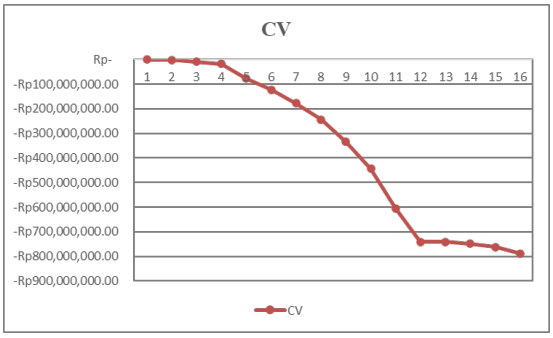

Figure 9.CV Every Week

5. Performance Index Calculation

Schedule Performance Index (SPI)

SPI is a performance efficiency factor in completing work that can be shown by a comparison between the value of work that has been physically completed (EV) and the planned costs incurred based on the work plan (PV).

CONCLUSION

The conclusions from the analysis of the Surabaya Open University UPBJJ Building Construction Phase II project are as follows: First, based on the Estiame at Complete (EAC) analysis, the estimated cost required for the project to be completed is IDR. 73,908,443,223.09. Second, the results of the Time Estimate (TE) analysis show that the time needed to complete the work until the project is completed is 53 weeks.

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