INTERNATIONAL JOURNAL ON ADVANCED TECHNOLOGY, ENGINEERING, AND INFORMATION SYSTEM (IJATEIS)

ANALYSIS OF COST AND TIME PERFORMANCE IN THE WADUNGASRI MARKET CHANNEL NORMALIZATION WORK IN SIDOARJO USING THE EARNED VALUE METHOD

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Abstract

The construction project management for Wadungasri Sidoarjo Market Drainage Normalization aims to achieve cost, quality, and time objectives within a 100-day timeframe. This study addresses a 7.44% delay experienced by contractors, seeking to establish early warning mechanisms for poor project performance. The Earned Value Method is employed, integrating time and cost value concepts. Key indicators such as Cost Variance (CV), Schedule Variance (SV), work productivity index (CPI), time productivity index (SPI), project completion cost forecast (EAC), and project completion schedule forecast (ECD) are utilized. The results reveal a required cost of Rp 563,044,547.85 (ETC) and a 65-day timeframe (ETS) at the end of the 7th week, with a 0.64% increase in project completion cost (EAC) over the contract cost. The project completion time (EAS) is estimated at 114 days, reflecting a 0.14% extension. The analysis emphasizes the importance for construction service providers to implement efficient methods and consistent supervision to avoid delays in the Wadungasri Sidoarjo Market Drainage Normalization projec.

Keywords: *Cost, Time, Earned Value*

1. INTRODUCTION

Urban drainage is one of the vital infrastructures for urban areas that functions to drain surface water to water bodies (rivers) or to artificial infiltration structures. A poorly designed drainage system will result in environmental degradation, economic loss and reduced housing quality, including waterlogging, flooding, and damage to existing infrastructure. This results in disruption of city functions, obstruction of human mobility and the emergence of various diseases.

Urban growth and the development of the development sector have a significant impact on changes in the value of surface runoff, which in turn affects the drainage system. The increase in residential areas and their facilities causes land use that was originally open and water escapes that function as infiltration areas, to turn into areas that are covered with pavement and are impermeable, thus reducing their function as infiltration areas. In addition, changes in land use also cause land criticality, so that existing land will be easily eroded.

Project is defined as an activity that has a certain period of time, with limited resource allocation, to carry out a task that has been outlined. So that project management is broadly applied to all stages of the project, starting from the planning, design, procurement and implementation stages, so that to apply it will be more complicated and complex, because the resources available are different and varied and have intermediate goals, according to the project stage. The goal of project management itself is to achieve

proper control of a project to ensure that its completion can be in accordance with its schedule within the specified budget and quality limits (Chmielarz, 2015).

Control needs to be carried out on this work, because the project implementation has experienced delays (Sobari & Lutfi, 2018). Cost and time control is carried out so that delays in the final implementation time can be prevented. In addition, additional costs due to these delays can be optimized.

A construction project, project cost control is important in the process of managing project costs. In its activities, there are many problems such as wasteful use of materials, unskilled labor and untimely project completion time, causing wasteful costs that are not in accordance with planning. Planning, cost and time control are part of overall construction project management. In addition to the assessment of the quality aspect, the performance of a project can also be assessed from the aspects of cost and time. The costs that have been incurred and the time used to complete a job must be measured continuously for deviations from the plan (Tarore et al., 2012). The existence of significant cost and time deviations provides an indication of poor project management.

In addition, time is very important for project completion and can be determined when it ends. It can also be known whether it is efficient or not to complete the project. At the project planning stage, it is necessary to estimate the duration of the project implementation time. The completion time of a project varies, as a result the estimated completion time of a project cannot be ascertained. The level of accuracy of the estimated project completion time is determined by the accuracy of the estimated duration of each activity in the project. In addition to the accuracy of the time estimate, confirmation of the relationship between activities is also required for project planning. To estimate the time and cost of a project, optimization is required. The implementation of a project is rarely found to run exactly as planned. Generally, there are delays in the time and progress of the work, but there are also projects that have accelerated from the original planned schedule.

In the implementation of construction projects, the main objectives of management are three things, namely cost, quality, and time. A project is said to be successful in its management if the project can be completed with a predetermined level of quality or quality (Kartikasari & Inayaturrochmah, 2018). Thus, it is very necessary to have planning and scheduling techniques or methods that can help manage project implementation. According to Nurhayati (2010), a project is an effort or activity organized to achieve important goals, objectives, and expectations using the available budget and resources, which must be completed within the planned time period. So time and cost are very influential on the success and failure of a project (Soeharto, 1999). Systematic project management is needed to ensure that the time for carrying out work is in accordance with the schedule or can be faster so that the costs incurred are smaller than the budget so as to benefit and avoid delays in project completion which have an impact on cost losses and result in fines. In the implementation of a project in the field, it is not uncommon for many projects to experience delays in completion and even stop the implementation. This also has an impact on the swelling of project costs which causes the project to experience losses. Whereas as a project contractor seeking cost benefits is the goal. Therefore, it is necessary to control so that deviations that occur can be overcome, so that the project can be completed as planned. The success of a project cannot be

separated from a series of activities which include the planning, implementation and supervision stages, so that the predetermined goals can be achieved. In an effort to complete a construction project, a good technique or management method is needed to improve efficiency, productivity and quality of work. In connection with that, it is necessary supervision and control measures in all sectors, especially time and cost control.

The implementation of a project activity takes place faster than the planned schedule, not necessarily using the costs that have been allocated efficiently. If this happens, then at the end of the work the amount of implementation costs will exceed the budget planned at the beginning of the planning. As a result, the achievement of the work is not achieved as planned. Therefore, it is necessary to analyze the cost and time in an integrated manner, so that at the time of reporting the work can be accurately known achievement, and the total cost and time required in the completion of the project. Based on the results of the analysis, the necessary improvements can be made so that the work reaches the target. In general, there is no one project that in carrying out its activities can run smoothly from start to finish without experiencing changes from the initial plan, even more so for large and complex projects.

This is usually due to the lack of data and information required at the time of preparing the initial plan, so that some aspects of the planning are made based on forecasts of future conditions. After the project is underway, the data and information in the initial plan must be analyzed and compared with the results of physical implementation in the field, then the necessary improvements are made, and often even re-planning must be done so that the work can achieve the target. To analyze and compare whether the results of the work achieve the predetermined goals or not, it is necessary to have controls that can be used as benchmarks and measurement methods that are able to provide an indication of the achievement of the desired goals, namely control: cost, quality and time.

Cost and Time Planning and Control is part of overall construction project management. In addition to quality assessment, the performance of a project can also be assessed in terms of cost and time. The costs that have been incurred and the time used in completing a job must be measured continuously for deviations from the plan. The existence of significant cost and time deviations indicates poor project management. With the existence of project performance indicators in terms of cost and time this allows preventive action so that project implementation goes according to plan.

One of the project control methods is the Earned Value Concept method. According to Andrzej Czemplik (2014) the Earned Value Concept is a control method used to control project costs and schedules in an integrated and efficient manner. This method shows project performance information on reporting a period and shows the estimated time and cost to complete all projects. Based on performance indicators at the time of reporting. The Earned Value concept is a development of the Variance Analysis concept (Balaka, 2014). In Variance Analysis only some of the work results at the reporting time are shown compared to the budget or schedule (Pabalik et al., 2018).

The weakness of the Variant Analysis method is that it only analyzes variations in cost and schedule each separately so that it cannot reveal performance problems carried out on a project (Kartikasari, 2014). Whereas with the Earned Value Concept method, the performance of the activities being carried out can be known and can increase effectiveness in monitoring project activities. Over time, a refinement of the method was

found, namely the Earned Schedule (ES) method (Rakasyiwi et al., 2022). This method has better results in evaluating project time performance and predicting the final project time (Pancaningrum, 2017). The Earned Schedule (ES) method is an extension of the Earned Value Method (EVM). The Earned Schedule method uses time units to calculate project schedule control, not cost units like the EVM method (Aditama, 2021).

Based on the above description, it can generally be concluded that the earned value method concept as a construction project control instrument is needed by a project manager to manage the project he is handling (Witjaksana & Reresi, 2012). Based on this cost and time performance, a project manager can identify the performance of the overall project and the work packages in it and then predict the cost and time performance of project completion. The results of the project performance evaluation can be used as an early warning if there are performance inefficiencies in project completion so that management policies and changes in implementation methods can be made so that cost overruns and delays in project completion can be prevented.

The use of the earned value concept began in the late 20th century in the manufacturing industry (Gardjito, 2017). An overview of EVM was included in the PMBOK Guide® First Edition in 1987 and subsequent editions. EVM gained momentum in 2000, when several states in the United States required the use of EVM on all government projects.

In the implementation of construction projects, the main objectives of management are three things, namely cost, quality and time. A project is said to be successful in its management if the project can be completed with a predetermined level of quality or quality. Thus, it is very necessary to have the right planning and scheduling techniques or methods that can help manage project implementation effectively. In the Wadungasri Sidoarjo Market Channel Normalization work which absorbs a budget of Rp 804,924,300.00 (Eight Hundred Four Million Nine Hundred Twenty Four Thousand Three Hundred Rupiah) must be completed within an estimated time of 100 calendar days, with a minimum of limited time and implementation constraints such as, for example, the difficulty of mobilizing materials to the job site, the contractor experienced a delay in work of 7.12% to be a significant problem for the ongoing work of Normalization of Wadungasri Market Channels Sidoarjo, then the calculation of the Earned Value concept is used in the management of the work of Normalization of Wadungasri Market Channels Sidoarjo which will integrate the concept of the value of time and cost.

The results of using the Earned Value method can be calculated various factors that show the progress and performance of project implementation such as cost variance or Cost Variance (CV), time variance or Schedule Variance (SV), work productivity index (CPI), time productivity index (SPI), project completion cost forecast (EAC), and project completion schedule forecast (ECD), which will certainly greatly assist the performance of contractors in managing their work performance. The results of the project performance evaluation obtained can be used as an early warning if there is a lack of performance in the implementation of construction projects, the main objectives of management are three things, namely cost, quality and time. A project is said to be successful in its management if the project can be completed with a predetermined level

of quality or quality. Thus, it is very necessary to have the right planning and scheduling techniques or methods that can help manage project implementation effectively.

Based on the description of the background above, the purpose of this study is to obtain cost and time performance with the Earned Value method with CV, SV, SPI, CPI, EAC, and ECD indicators, and to obtain an estimate of the cost and time required to complete the Wadungasri Sidoarjo Market Channel Normalization work.

2. RESEARCH METHODS

In the research conducted on the construction of the Kedungbanteng Pump House building in Tanggulangin Sidoarjo, data collection as research material was obtained from the executing contractor and also some from the supervisory consultant. The types of data collected are secondary data types and literature studies, including:

1. Project implementation schedule (Time Schedule)
    a. S curve (Master schedule)
    b. Actual S-curve of the project

2. Cost Budget Plan (RAB)
3. Project Weekly Report
4. Actual Cost

Data analysis techniques performed on Earned Value are:

1. Project Performance Analysis

a. Cost and Schedule Analysis
    a. Planned Value (PV)
    b. Earned Value (EV)
    c. Actual Cost (AC)

b. Analysis of Variance

Analysis of variance is used to determine the extent to which results are predicted from what was predicted.
    a. Cost Variance (CV)
    b. Schedule Variance (SV)

c. Performance Index Analysis

Index Performance used to determine efficiency of resource utilization
    a. Schedule Performance Index (SPI)
    b. Obtained by dividing EV by PV.
    c. Cost Performance Index (CPI)

2. Estimated Cost and Final Time of Work
    a) *Estimate to Complete* (ETC
    b) *Estimate at Complete* (EAC)
    c) *Time Estimate* (TE)

3. Analyze Project Progress or Delay Factors

To analyze the factors that cause project progress or delay, it is done by:

a) Interviews with the implementing contractor (*Site Engineer Manager*, supervisors and logistics) and direct observation of daily project performance.
b) Checking material delivery whether it is in accordance with the material arrival schedule.
c) Checking the weekly report to find out the percentage of work that has been done for one week.
d) Checking daily reports to determine the pattern of labor use, tool use, material use, weather conditions and field work hours.

Before analyzing in doing this research, it is necessary to arrange the work steps according to the flow chart that has been made, namely:

a. Determine the background.
b. Formulate the problem.
c. Collect data (Time Schedule, RAB, weekly project progress report, actual cost) to calculate PV, EV, AC.
d. Perform performance analysis to calculate CV, SV, CPI and SPI.
e. Calculate the estimated cost of the remaining work Estimate To Complete (ETC).
f. Calculate the estimated final cost of the project, Estimate At Completion (EAC).
g. Calculate the estimated project completion time Time Estimate (TE).
h. Analyze project progress or delay factors.
i. Draw conclusions.

3. RESULT AND DISCUSSION

3.1. Analysis Result

3.1.1. Planned Value (Pv) / Bcws Calculation

Planned Value (PV) is the budgeted cost of work scheduled for a certain period and specified in the budget, or also called Budgeted Cost of Work Scheduled (BCWS). Obtained by multiplying the percentage of planned progress contained in the time schedule with the project implementation costs listed in the RAB.

PV or BCWS = (% progress plan) x (Budget) Calculation of PV or BCWS in week 1
PV or BCWS = (% plan) x (Total project budget) PV or BCWS = (1.16%) x (Rp. 804,924,300)
PV or BCWS = Rp 9,325,085.15

For the calculation of the next week, it can be done in the same way as the calculation above, seen in table 1 below:

Table 1. PV or BCWS

Sunday	Cumulative Plan	Budget	PV OR BCWS
1	1,16	804.924.300,00	9.325.085,15
2	1,87	804.924.300,00	15.024.567,86
3	2,87	804.924.300,00	23.081.658,71
4	7,65	804.924.300,00	61.584.114,56

Sunday	Cumulative Plan	Budget	PV OR BCWS
5	8,86	804.924.300,00	71.323.801,06
6	23,62	804.924.300,00	190.112.428,39
7	38,38	804.924.300,00	308.901.055,71
8	38,64	804.924.300,00	311.059.631,47
9	43,74	804.924.300,00	352.072.570,93
10	51,89	804.924.300,00	417.679.108,73
11	77,76	804.924.300,00	625.907.845,17
12	84,35	804.924.300,00	678.921.945,80
13	94,63	804.924.300,00	761.713.986,77
14	98,21	804.924.300,00	790.516.365,47
15	100,00	804.924.300,00	804.924.300,00

Source: Contract Schedule

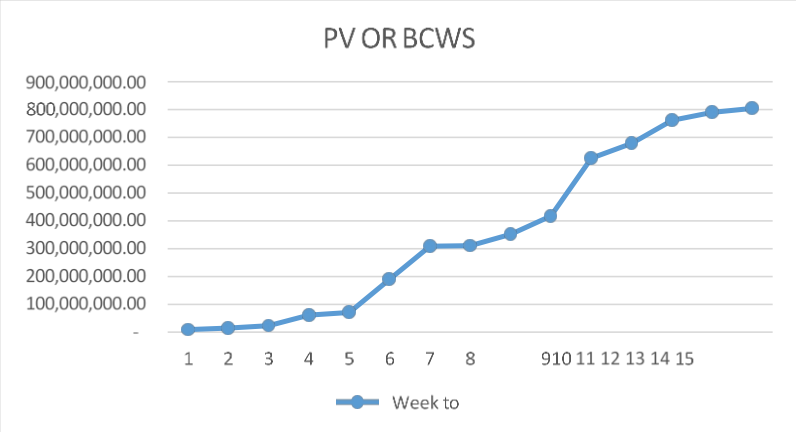

Figure 1. Planned Value (PV) Graph / Budgeted Cost of Work Schedule BCWS
Source: Contract Schedule

Description:

Planned Value (PV) / Budgeted Cost of Work Schedule graph and table (BCWS) can see the cost expenditure every week according to the contract.

3.1.2. Earned Value (EV) Or BCWP

Calculation Earned Value (EV) or BCWP is the budgeted cost for work that has been completed, obtained by multiplying the percentage of progress that has been carried out with the budget.

EV or BCWP = (% actual progress) x (Budget)
EV or BCWP calculation in week 1 EV or BCWP = (% actual progress) x (Total project budget)
EV or BCWP = (1.23%) x (Rp. Rp 804,924,300)
EV or BCWP = Rp. 9,900,568.89

For the next week's calculations can be seen in table 4.2 below:

Table 2. EV or BCWP

Sunday	Cumulative Actual	Budget	EV or BCWP
1	1,23	804.924.300,00	9.900.568,89
2	2,09	804.924.300,00	16.822.917,87
3	3,56	804.924.300,00	28.655.305,08
4	8,89	804.924.300,00	71.557.770,27
5	12,98	804.924.300,00	104.479.174,14
6	19,77	804.924.300,00	159.133.534,11
7	30,05	804.924.300,00	241.879.752,15

Source: Weekly progress

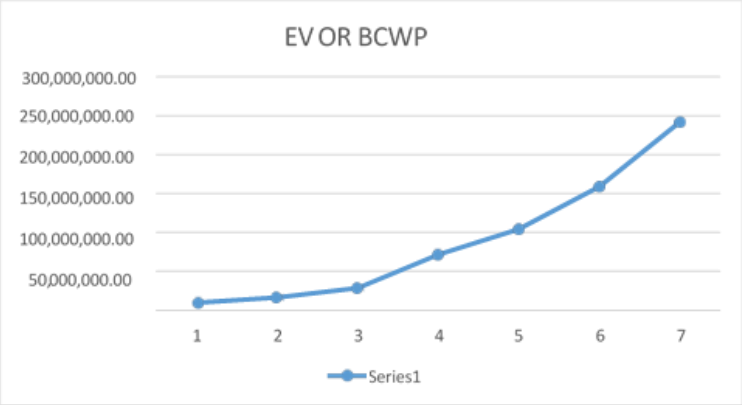

Figure 2. Earned Value / BCWP Chart

Description:

Graph and table Earned Value (EV) / Budgeted Cost of Work Performanced (BCWP) can be seen there is a delay in week 7 can not be seen.

3.1.3. Calculation Of Actual Cost (AC)

Actual Cost (AC) or also called Actual Cost of Work Performed (ACWP) is the actual cost used (Real Cost).

Table 3. ACWP

Sunday	ACWP
1	8.910.512,00
2	15.140.626,08
3	25.789.774,57
4	64.401.993,24
5	94.031.256,73
6	143.220.180,70
7	217.691.776,94

Source: Actual Cost of Implementation

3.1.4. Actual Cost of Work Performed (ACWP)

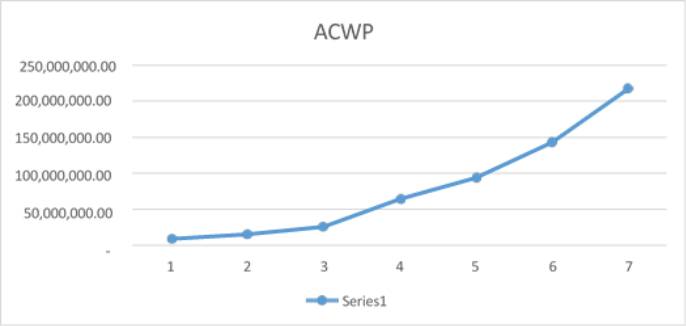

Figure 3. Graph of Actual Cost of Work Performed (ACWP)

From the Actual Cost of Work Performed (ACWP) graph and table, it can be seen that the tactical expenditure is actually. From the three data above, the comparison data between Planned Value (PV), Earned Value (EV), Actual Cost (AC) is obtained as shown in the following table:

Table 4. Comparison of Planned Value (PV), Earned Value (EV), Actual Cost (AC)

Sunday	PV OR BCWS	EV or BCWP	ACWP
1	9.325.085,15	9.900.568,89	8.910.512,00
2	15.024.567,86	16.822.917,87	15.140.626,08
3	23.081.658,71	28.655.305,08	25.789.774,57
4	61.584.114,56	71.557.770,27	64.401.993,24
5	71.323.801,06	104.479.174,14	94.031.256,73
6	190.112.428,39	159.133.534,11	143.220.180,70
7	308.901.055,71	241.879.752,15	217.691.776,94

Source: RAB, Financial Schedule, Actual Cost

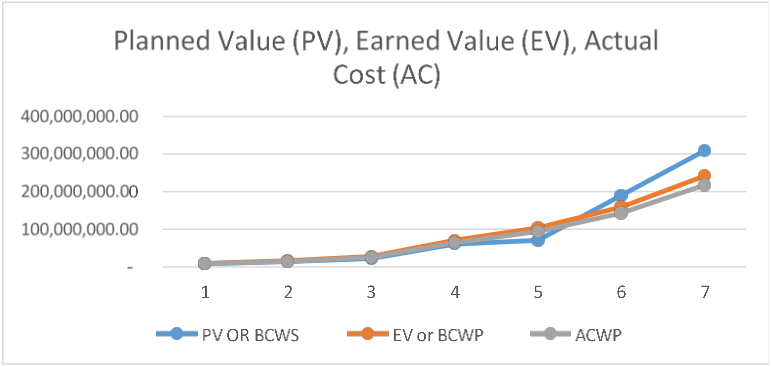

Figure 4. Comparison Chart of Planned Value (PV), Earned Value (EV), Actual Cost (AC)

1. In week 6 to week 7 the project experienced work delays, this is indicated by the EV or BCWP value which is smaller than the PV or BCWS value.

2. For actual costs or ACWP in week 6 to week 7, the cost expenditure is greater with the ACWP graph marked higher than EV / BCWP.

3.1.5. Computation Performance Project, Estimation Cost And Completion Time Project

a. Calculation of Time and Cost Variance Analysis

a) Time Variant Calculation

At week 6 review, the SV value at week 6 is obtained from the subtraction of Earned Value/BCWP and Planed Value/BCWS at week 6.

SV = EV - PV
SV = Rp 159,133,534.11 - Rp 190,112,428.39 = -Rp 30,978,894.28

Negative values indicate time of project implementation running late from the initial planning.

b) Cost Variance Calculation

Review of the calculation of CV cost variance at week 6, obtained from the reduction of Earned Value and Actual Cost at week 6.

CV = EV - AC
CV = Rp 159,133,534.11 - Rp 143,220,180.70 = -Rp 15,913,353.41

A positive value indicates that the costs incurred are less than the planned budget. The SV and CV values indicate that the project is delayed or running faster than planned and the costs incurred are greater than or less than the planned budget, for the calculation of the next week can be done in the same way as the calculation above, seen in the following table.

Table 5. Time Variant (SV) and Cost Variant (CV)

Sunday	Planned Value (PV) / Budgeted Cost of Work Schedule BCWS	EV or BCWP	Actual Cost of Work Performed (ACWP)	Schedule Variant (SV)	Cost Variant (CV)
1	9.325.085,15	9.900.568,89	8.910.512,00	575.483,74	990.056,89
2	15.024.567,86	16.822.917,87	15.140.626,08	1.798.350,01	1.682.291,79
3	23.081.658,71	28.655.305,08	25.789.774,57	5.573.646,37	2.865.530,51
4	61.584.114,56	71.557.770,27	64.401.993,24	9.973.655,71	7.155.777,03
5	71.323.801,06	104.479.174,14	94.031.256,73	33.155.373,08	10.447.917,41
6	190.112.428,39	159.133.534,11	143.220.180,70	(30.978.894,28)	15.913.353,41
7	308.901.055,71	241.879.752,15	217.691.776,94	(67.021.303,56)	24.187.975,22

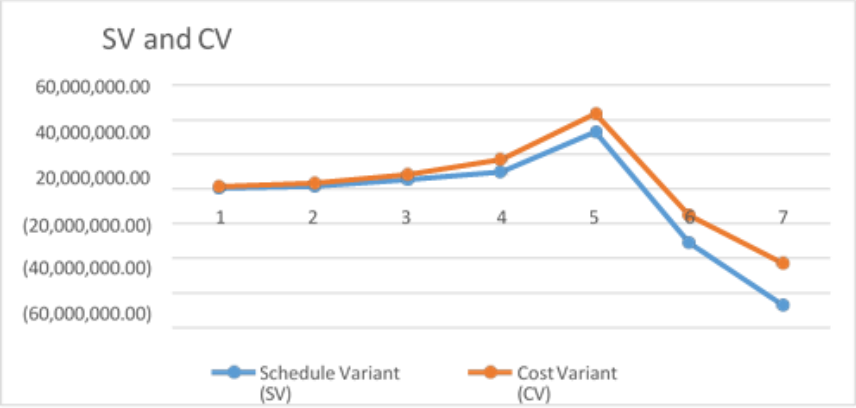

Figure 5. Comparison of Schedule Variant (SV) and Cost Variant (CV)

1. Project analysis at week 6, the SV (negative) value of -Rp 30,978,894.28 and CV of Rp 15,913,353.41 indicate that the work is delayed from the plan by using costs less than the budget plan.
2. Project analysis at week 7, the SV (negative) value of -Rp 67,021,303.56 and CV of Rp 24,187,975.22 indicate that the work is delayed from the plan by using costs less than the budget plan.

c) Achievement Index Calculation

1) Calculation of Time Performance Index (SPI)

In the week 6 review, the SPI value in week 6 is obtained from the comparison between Earned Value and Planed Value in week 6.

SPI = EV/PV

SPI = -Rp 30,978,894.28 / Rp 190,112,428.39 = -0.16

An SPI value of less than 1 indicates that the work time performance is not as expected or is delayed from what has been planned.

2) Calculation of Cost Performance Index (CPI)

At week 6 review, the CPI value at week 6 is obtained from the comparison between Earned Value and Actual Cost at week 6.

CPI = EV/AC

CPI = -Rp30,978,894.28 / Rp 143,220,180.70 = -0.22

A CPI value of less than 1 indicates that cost performance is poor because the costs incurred (AC) are greater than the value gained (EV). For the calculation of SPI and CPI values in the following week, the same calculation is done as above, the SPI and CPI values can be seen in the following table:

Table 6. Time Performance Index (SPI) and Cost Performance Index (CPI)

Sunday	PV or BCWS	EV or BCWP	ACWP	SPI	CPI
1	9.325.085,15	9.900.568,89	8.910.512,00	1,06	1,11
2	15.024.567,86	16.822.917,87	15.140.626,08	1,12	1,11
3	23.081.658,71	28.655.305,08	25.789.774,57	1,24	1,11
4	61.584.114,56	71.557.770,27	64.401.993,24	1,16	1,11
5	71.323.801,06	104.479.174,14	94.031.256,73	1,46	1,11
6	190.112.428,39	159.133.534,11	143.220.180,70	0,84	1,11
7	308.901.055,71	241.879.752,15	217.691.776,94	0,78	1,11

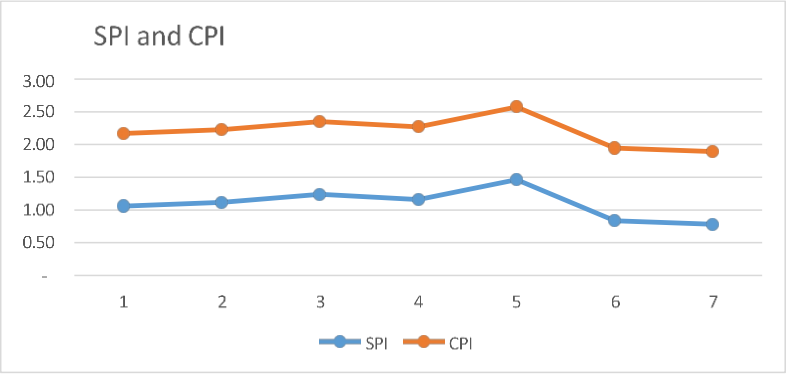

Figure 6. Comparison chart of SPI and CPIA project performance analysis:

In week 7, the SPI value < 1, namely 0.78 and CPI < 1, namely 1.11, this shows that in week 7 the project performance is delayed at a cost that is less than budgeted.

d) Calculation of Estimated Project Time and Cost

1) Calculation of Final Estimated Project Time

Cost or schedule forecasts are useful because they provide an early warning of what will happen in the future, if trends at the time of reporting do not change. At the end of the review at week 7, the estimated remaining work time, estimate Temporary Schedule (ETS) is as follows:

ETS = (remaining time) / SPI
ETS = (100 -49)/0.78
ETS = 51/0.78=65

While the estimated time of completion of all work, Estimate All Schedule (EAS):

EAS = finish time + ETS
EAS = 49 + 65
EAS = 114 days

From the above calculations, it is obtained that the processing time is 14 days longer than the planned schedule of 100 days, this can be anticipated by accelerating the delivery of the u ditch and providing tools for its installation so that it can be completed according to schedule.

2) Calculation of Final Project Cost Estimate

At the end of the review i.e. week 7, the estimated remaining work time, estimate Temporary Cost (ETC) is as follows:

ETC = Budget - BCWP
ETC = Rp 804,924,300- Rp 241,879,752.15
ETC = Rp 563,044,547.85
EAC = ACWP + ETC
EAC = Rp 217,691,776.94 + Rp 563,044,547.85EAC = Rp 780,736,324.79

From the above calculations, the final cost value is less than the contract cost.

4. CONCLUSION

Based on the analysis that has been done, the things that can be concluded from this research are the cost obtained by Estimate Temporary Cost (ETC) is IDR 563,044,547.85, and the time required by Estimate Temporary Schedule (ETS) at the end of the 7th week review is 65 days. The change in cost to complete the Estimate All Csst (EAC) project is 0.64% greater than the contract cost. While the time to complete the Estimate All Schedule (EAS) project is 114 days. With the addition of 14 days, the rate of change in project completion time is 0.14% longer.

Based on the results of the analysis of the research carried out in the project Normalization Wadungasri market drainage channel Sidoarjo so that in the future there is no more time delay, the researcher provides the following suggestions that construction service providers who carry out development work, must apply good and efficient implementation methods in all stages of work with consistent supervision, and future research is expected to use data analysis with the CPM Method, or the Ms. Project Program so that the analysis results are even better.

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