

A Time and Cost Analysis to Pier Construction Project in Tuban by Earned Value Analysis Method

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ABSTRACT : The development of a project must be attentive to certain aspects of cost, quality and the implementation time. Planning and control need to be carried out to increase the likelihood of success in a project. The condition of the pier construction project in Tuban as the research object in this study is experiencing delay, so this research is intended to provide the cost and time analysis results as approached with a method of Earned Value Analysis (EVA). A project status can be identified early and in more accurate way with EVA, so this method can be used as a basis for improving the project condition by calculating three indicators; Planned Value (PV), Earned Value (EV) and Actual Cost (AC). These indicators were used in the analysis of this research. The research procedure was carried out by collecting, summarizing and analyzing data. The required data is the cost budget plan, time schedule, weekly project progress report and weekly actual costs, and by processing these data, the planning value (PV), result value (EV), and actual value (AC) will be produced. Result of the research analysis were in the form of Cost Performance Index or CPI value where until the 29th week revealing a value below 1 (<1) meaning there was a cost overrun in this project, and the CPI value for the 30th week to 49th week is above 1 (>1) meaning there is a cost underrun in this project which in the 49th week has CPI value of 1.11. Meanwhile, for the time performance index or SPI, until the 19th week has a value of above 1 (>1) meaning there is an acceleration progress in this project, while at the 20th to 49th weeks the SPI value is below 1 (<1) meaning the project is experiencing a delay, with a SPI value for the 49th week is 0.81. With a total contract of Rp. 10,403,914,724 and the CPI value of 1.11, it is expected that the project is able to put into completion with a remaining cost of only Rp. 2,047,216,930. This study was conducted in the 49th week of the 54 weeks project plan schedule, and by assumption of no changes in project performance (or the project performance remain the same until project completion), it is expected that the project will be completed within 62 weeks, meaning it requires an additional 8 weeks of time from the initial contract.

KEYWORDS: Cost Variance, Planned Value, Earned Value, Earned Value Analysis, Schedule Variance

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I. INTRODUCTION

Tuban Regency has a topography of limestone hills with a large anticline geological structure extending from west to east with the height of land area ranges from 0-500 meters above sea level. Northern and southern parts of Tuban Regency are lowlands with a height of 0-15 meters above sea level located around the coast and along the river of Bengawan Solo where it has a typical beach that has sufficient depth for large ship docked. In early 1990, PT. Semen Indonesia (Persero) Tbk. established a factory in this area where in 2010 the Holcim Cement Factory was built and today the factory's name changes into PT. Solusi Bangun Indonesia. [1]

PT. Solusi Bangun Indonesia Tbk. or abbreviated as SBI is a business unit belongs to PT. Semen Indonesia (Persero) Tbk. abbreviated to SIG that dealing with fulfillment of export market demand of up to 500 thousand tons of cement per year, where today is carrying out a construction project to expand its cement factory in Tuban. The expansion includes increasing the Special Terminal's capacity from 15,000 DWT into 50,000 DWT which executed by expanding the trestle and new pier from the existing pier.

The work implementation on a project must have a control component in its quality, time and cost control aspects. For controlling the time and cost of a project, it can use several methods such as Critical Path Method (CPM), or a combination of CPM and PERT (Program Evaluation and Review Technique) or Earned Value Analysis (EVA) / Earned Value Concept. EVA is a method to measure and evaluate the progress and work

performance of a project as reported by several studies that EVA method is an effective way to evaluate and control project risks by measuring the progress of a project in a periodical time. [2,3,4,5]

As the real condition from work implementation progress of this project up to September 25 had only reached 69.10 % from the prior planning of 92.70 %. Meanwhile, the contract ends on 7 December 2023 (as evident in Table 4). This delay has an impact to project financing segment.

Given the certain work condition and acted as a sub-contractor responsible for the system of main materials and main work equipment provider, in which the method of carrying out work is from the main contractor, this study tries to use Earned Value Analysis method to control the time and costs on this project.

So far, discussions related to Cost and Time Analysis of Pier Construction Project in Tuban Regency by employing the Earned Value Analysis method have not been carried out by many researchers. Therefore, the writers raise problem study of 1) how the cost and time work performance of the Pier construction will become when the EVA method applied? 2) how is the analysis from sub-contractor side in calculating the remaining actual cost for project completion also the time estimation for the project completion?

II. LITERATURE REVIEW

2.1. Time Management

Time management is an activity covering all processes and procedures necessary for a project to make it run on time. Time becomes one of many performance resources that must be managed in effective and efficient way. Time management also a part of activities held in construction project in the form of time recording and time control. Then, poor time management, inappropriate selection of procurement methods, less participation from top level management, poor construction work planning, lack of software use, poor recordings, and others will result in delays in project implementation time as well as cost overrun, disputes, legal problems also neglected project implementation. [6]

Mackenzie defines ‘time management as required function to maintain the precise time allocation until project completion’. Project implementation through its natural e-cycle (concept, concept development, scheduling and completion) means there will be process of time planning, time estimation, time scheduling and schedule control. An effective project management is critical for construction project, since in project time management include all processes required in an effort to ensure the project completion time is achieved. [7]

There are five main processes in time management of a project according to Soemardi et al. [8]:

1. Definition of activities. The process of identifying all specific activities that must be carried out in order to achieve all project goals and objectives or commonly called as project deliverable. This process will produce groupings of all activities within the scope of project, ranging from the highest level to the smallest level of work activity that called as Work Breakdown Structure (WBS).
2. Sequence of activities. The activity sequencing process involves the identification and documentation of interactive logical relationship where each activity must be sequenced in accurate to support schedule development so a realistic schedule can be obtained. In this process, computer application can be used to make the work implementation easier or to be able conducted in manual way. Manual techniques are proven to be effective for small scale projects and in early stages of large-scale projects (when a precise detail still not required to do).
3. Estimation of activity duration. Activity duration estimation is a process of retrieving information in relation to the scope of the project and all required resources which then followed by calculating the duration estimation of all required activities for the project which will be used as input for developing the work schedule. Accuracy level of the duration estimation is very dependent to the amount of available information.
4. Schedule development. Developing a schedule has a meaning of determining the time where an activity in a project will start and when this activity must be finished. Project schedule creation is an iteration of the input process involving estimation of time duration and cost to the estimation of project schedule determination.
5. Schedule control. Schedule control is a process to guarantee the work performance carried out in accordance with the planned time allocation. Several aspects need to be considered in schedule control are certain influential factors which cause the schedule to change, determining changes to schedule and taking action if the project implementation differs from the initial project planning.

In construction management filed, there are some methods that able to be used within a project as follows:

1. Gantt Chart is a visual aid used for planning, scheduling and monitoring project progress. It shows the start and end time of each activity within the project along with the relationships between these activities. Gantt charts is very useful to understand the sequence and duration of activities in a project as well as for monitoring the overall progress of a project. Meanwhile, Widyastuti in Khofifah and Moentamaria said that Gantt Chart method is a planning diagram used for scheduling type of activities that have more than one process and having different process sequences. Furthermore, Suwinardi in Khofifah and Moentamaria stated that advantages of Gantt chart method are simple, easy to make, able to show time, able to show activities sequence, and can be

- used repeatedly in ongoing production scheduling, whether simple scheduling or complex project scheduling. [9]
2. Program Evaluation and Review Technique (PERT) is a project analysis method used to estimate project duration by considering many variabilities and uncertainties for completion time of each activity. PERT uses three-time estimation (optimistic, most likely and pessimistic) to provide a more realistic picture of the project duration. Meanwhile, Sucipto said that program evaluation and review technique method is a network-based scheduling method of project that requires three-time estimation for each activity of the related project. By using three-time estimation method, probability of project completion on a specific date can be calculated for its start and end time of the activity or event flaps. [10]
 3. Critical Path Method (CPM) is a project management technique for planning and controlling project schedules. CPM helps in identifying critical path which is the sequence of activities that determines total duration of the project. This method is useful for ensuring the project will be finished right on time by managing important activities that cannot be late. Meanwhile, Nasution et al. stated that Critical Path Method is a method of analyzing path of activities by showing longest total time and the fastest project completion time by predicting the total duration of the project time. The critical path method basically is a time-oriented method, in a sense that CPM will result in time determination. [11]
 4. Earned Value Management (EVM) is a project management technique that combines the cost and schedule work performance assessments to measure the overall progress of a project. This method provides useful information about the work performance of a project related to the established budget and schedule. Meanwhile, Suharto in Atmaja et al. stated that Earned Value Management is a concept for calculating the cost amount according to the budget of the work that has been completed or implemented (Budgeted Cost of Work Performed) at the related project. [12]

2.2. The Cost Management

Project Cost Management is a method uses technology to measure cost and productivity through full life cycle of company-level project. Project Cost Management includes several specific project management functions which include estimating work control, field data collection, scheduling, and accounting and design.

Project Cost Management includes processes involved in planning, estimating, budgeting, financing, funding, managing and controlling costs so that projects can be completed within the approved budget. There are four processes of Project Cost Management as explained in the following paragraph:

1. Plan cost management – the process for establishing policies, procedures and documentation to plan, to manage, to incur, and to control project costs. The main benefit of this process is able to provide guidance and direction on how the costs will be managed throughout the project process.
2. Estimate costs – the process of developing estimates of the financial resources required to complete project activities. The main benefit of this process is determining cost amount required to complete project work.
3. Determine budget – the process of combining the cost estimation of individual activities or from work packages to establish a cost baseline. The main benefit of this process is to determine a cost baseline against which project work performance can be monitored and controlled.
4. Control costs – the process of monitoring project status to update any cost requirements and manage changes to be in accordance with the cost baseline. The main benefit of this process is providing a way to recognize discrepancies of a plan and take corrective action and minimize risks.

2.3. Earned Value Analysis

Earned Value Analysis (EVA) is an analysis method used to assess the work performance of project by evaluating comparison between planned work, completed (work that has been carried out) work, and incurred costs. This method is very useful in controlling project costs and schedules more effectively. EVA is a project management method integrates three main elements: earned value, planned value and actual costs. The primary goal is measuring the project work performance in objective way and provide an early indication of the status from the project regarding its schedule and budget.

2.3.1. Hierarchy Structure (AHP)

There are three basic indicators as the references in analyzing the project work performance based on the earned value concept: 1) Planned Value (PV) – the budget allocation based on the work plan which has been prepared for a certain time; 2) Earned Value (EV) – the value received from work completion over a certain period of time; and 3) Actual Cost (AC) – the representation of total expenditure incurred for completing the work in a certain period.

2.3.2. Cost Variance and Integrated Schedule

Cost variance is a way to understand to what extent the predicted result happen from what was assumed in prior time. The cost and schedule variances are:

1. Cost variance (CV) Cost variance or abbreviated as CV is the difference found between value obtained after completing work packages with the actual costs incurred during project implementation.

$$CV = EV - AC \dots\dots\dots (1)$$

2. Schedule variance (SV) Schedule variance or abbreviated as SV is the difference between earned value and planned value, where it shows the implementation of project work.

$$SV = EV - PV \dots\dots\dots (2)$$

3. Productivity and work performance indexes, these indexes are used to determine any estimation of the resource needed in the project within the work performance index.
4. Cost performance index (CPI), the efficiency factor of incurred costs can be considered by comparing the value of work that physically have been completed (EV) with the cost incurred in the same period (AC).

$$CPI = EV / AC \dots\dots\dots (3)$$

Where:

- CPI > 1 : Expenses are smaller than project budget
- CPI < 1 : Expenses are bigger than project budget
- CPI = 1 : Expenses are equal to the budget

5. Schedule performance index (SPI), the work performance efficiency factor in completing the work can be calculated by comparing the value from work that has been physically completed (EV) with the planned cost incurred based on the work plan (PV).

$$SPI = EV / PV \dots\dots\dots (4)$$

Where:

- SPI > 1 : Project is working faster than time scheduled
- SPI < 1 : Project is working slower than time scheduled
- SPI = 1 : Project is working as the expected time scheduled (in accordance to the schedule)

2.3.3. Projection of Cost and Time Period of Project Completion

1. Estimate to complete (ETC), ETC is cost estimation for the remaining project with assumption that trend of work performance of a project will remain the same until the end of the project.

ETC for Progress < 50%
 $ETC = Total\ Budget - EV \dots\dots\dots (5)$

ETC for Progress > 50%
 $SPI = EV / PV \dots\dots\dots (6)$

2. Estimate at Complete (EAC), EAC is the total estimation at the end of a project which obtained from actual costs plus ETC value.

$$EAC = AC + ETC \dots\dots\dots (7)$$

3. Time Estimation (TE), TE is a time estimation for a project completion with the assumption use to estimate the completion time is an assumption that project work performance will remain the same as it was just like at the review time.

$$TE = ATE + (OD - ATE \times SPI) / (SPI) \dots\dots\dots (8)$$

Description:

TE : Time estimation
ATE : Actual time estimation
OD : Original duration

Where:

TE : Assumption of project completion time
ATE : Time that has been taken, obtained from total time of project lasted until the time of review
OD : The planned time as obtained from the amount of time from the start to the end of the project

III. RESEARCH METHOD

3.1. Data Collection

Data used in this research is taken from project implementation schedule which obtained from the main contractor, also monthly progress data and actual weekly cost expenditures that obtained from the finance department of the sub contractor's office.

3.2. Data Source

The data source of this research is coming from secondary data source include: 1) Work contract (from sub-contractor); 2) Weekly expenses (from sub-contractors); 3) Work schedule (from main contractor); 4) General project data (from sub-contractors); and 5) Weekly work progress (from main contractor).

3.3. Data Analysis

1. Variance analysis

In variance analysis, two aspects that analyzed are the budget and schedule aspects. Schedule variance is employed to calculate deviation value between PV and EV. Meanwhile, the cost variance is employed to calculate the difference between value obtained after completing work packages to the actual cost.

$$\text{Schedule Variance (SV)} = \text{EV} - \text{PV}$$

$$\text{Cost Variance (CV)} = \text{EV} - \text{AC}$$

A negative SV value indicates a delay, while a negative CV indicates the cost aspect is higher than the budget (cost overrun).

2. Time and work performance index

The project management division always know type of resources for the project as expressed into the work performance index or the productivity index. Both indexes are based on the schedule index (SPI = Schedule Performance) and Work performance Index (CPI = Cost Performance Index) with calculation formula as described below:

$$\text{Schedule Performance (SPI)} = \text{EV} / \text{PV}$$

$$\text{Cost Performance Index (CPI)} = \text{EV} / \text{AC}$$

SPI value < 1 indicates there is a delay on progress, while a CPI value < 1 indicates that costs are higher than the available budget.

3. Estimation of time and cost at the end of the project

If there is no change at the reporting time, and if there still remains of work that has not been completed in a certain period, it is assumed that the work performance remains as reported. The calculations conducted in this section are include calculating estimated costs for remaining work (ETC), total construction project cost (EAC), estimated time for all works completion (ETS), estimated total time for project completion (EAS) with the following description:

$$\text{EAC} = \text{BAC} / \text{CPI}$$

$$\text{ETC} = \text{EAC} - \text{AC}$$

$$\text{ETS} = (\text{Remaining Time}) / \text{Schedule Performance Index}$$

$$\text{EAS} = (\text{Time Completion}) + \text{ETS}$$

IV. RESULT AND DISCUSSION

4.1. Cost Analysis by Earned Value Analysis Method

4.1.1. Calculation of Planned Value (PV)

The PV calculation for each week is obtained from multiplying weight of the planned work in the implementation schedule with the total contract value for that week, the calculation uses the formula of:

$$PV = \text{Weekly Planning Progress (\%)} \times \text{Total of Contract}$$

For instance, on the fifth (5th) week, the weekly planning is 0,13%, then;

$$PV = 0,13\% \times \text{Rp. } 10.403.914.724 = \text{Rp. } 13.854.000$$

As the next step, a calculation for finding the cumulative value also performed with the result of PV value listed on the following table.

Table 1. The calculation of planned value (PV)

Week of	Weight of Plan	Cumulative	Planned Value	Cumulative PV
1	0,03%	0,03%	2.951.679	2.951.679
2	0,03%	0,06%	2.951.679	5.903.358
3	0,10%	0,16%	10.922.361	16.825.720
4	0,13%	0,29%	13.854.000	30.679.720
5	0,13%	0,43%	13.854.000	44.533.720
6	0,20%	0,63%	21.033.760	65.567.480
7	0,42%	1,05%	43.396.559	108.964.039
8	0,88%	1,93%	91.613.299	200.577.337
9	1,02%	2,94%	105.749.029	306.326.366
10	1,35%	4,30%	140.582.064	446.908.430
11	2,12%	6,41%	220.263.812	667.172.242
12	2,19%	8,61%	228.167.855	895.340.097
13	2,36%	10,96%	245.215.479	1.140.555.576
14	2,36%	13,32%	245.215.479	1.385.771.055
15	2,78%	16,10%	289.111.763	1.674.882.818
16	2,90%	19,00%	302.064.824	1.976.947.643
17	2,92%	21,92%	303.314.527	2.280.262.170
18	2,94%	24,86%	306.295.961	2.586.558.131
19	3,07%	27,93%	319.477.892	2.906.036.023
20	3,37%	31,30%	350.909.253	3.256.945.276
21	0,00%	31,30%	-	3.256.945.276
22	0,00%	31,30%	-	3.256.945.276
23	4,16%	35,47%	433.234.904	3.690.180.180
24	4,10%	39,57%	426.740.062	4.116.920.242
25	4,32%	43,89%	449.833.273	4.566.753.515
26	4,31%	48,20%	448.281.964	5.015.035.479
27	4,09%	52,30%	425.919.166	5.440.954.644
28	3,81%	56,11%	396.887.958	5.837.842.602
29	3,12%	59,23%	324.644.915	6.162.487.517
30	2,97%	62,20%	309.148.599	6.471.636.116
31	2,57%	64,78%	267.690.909	6.739.327.025
32	2,37%	67,15%	246.917.366	6.986.244.391

Week of	Weight of Plan	Cumulative	Planned Value	Cumulative PV
33	2,37%	69,52%	246.917.366	7.233.161.757
34	2,37%	71,90%	246.917.366	7.480.079.123
35	2,18%	74,07%	226.492.800	7.706.571.924
36	2,07%	76,14%	215.486.005	7.922.057.928
37	1,79%	77,94%	186.625.330	8.108.683.258
38	1,79%	79,73%	186.625.330	8.295.308.588
39	1,79%	81,53%	186.625.330	8.481.933.917
40	1,79%	83,32%	186.625.330	8.668.559.247
41	1,79%	85,11%	186.625.330	8.855.184.576
42	1,79%	86,91%	186.625.330	9.041.809.906
43	1,79%	88,70%	186.625.330	9.228.435.235
44	1,79%	90,50%	186.625.330	9.415.060.565
45	1,54%	92,03%	159.974.333	9.575.034.898
46	1,47%	93,50%	152.812.758	9.727.847.656
47	1,44%	94,94%	149.792.997	9.877.640.653
48	1,10%	96,05%	114.959.962	9.992.600.616
49	0,93%	96,98%	96.639.621	10.089.240.237

4.1.2. The Earned Value (EV) Calculation

From the EV calculation for each week, the result is obtained from multiplying the actual work weight in the implementation schedule by the total contract value for that week with the formula of:

$$EV = \text{weekly actual progress (\%)} \times \text{Total of contract}$$

For instance, on the fifth (5th) week, the weekly actual progress is 0,13 %, then;

$$EV = 0,96\% \times \text{Rp. } 10.403.914.724 = \text{Rp. } 99.765.322$$

As the next step, a calculation for finding the cumulative value also performed with the result of EV value listed on the following table.

Table 2. The calculation of earned value (EV)

Week of	Weight of Plan	Cumulative	Planned Value	Cumulative PV
1	0,29%	0,29%	29.802.131	29.802.131
2	0,65%	0,94%	67.802.400	97.604.531
3	0,75%	1,68%	77.656.776	175.261.307
4	0,86%	2,54%	88.987.653	264.248.960
5	0,96%	3,50%	99.765.322	364.014.282
6	1,68%	5,18%	174.798.504	538.812.786
7	0,83%	6,01%	86.297.273	625.110.059
8	0,96%	6,97%	99.765.445	724.875.504
9	1,28%	8,24%	132.876.532	857.752.036
10	1,18%	9,42%	122.345.669	980.097.705
11	1,21%	10,63%	125.678.765	1.105.776.470
12	2,99%	13,62%	310.819.954	1.416.596.424
13	1,50%	15,11%	155.785.715	1.572.382.139
14	1,23%	16,34%	127.785.650	1.700.167.789
15	1,90%	18,24%	197.857.356	1.898.025.145

Week of	Weight of Plan	Cumulative	Planned Value	Cumulative PV
16	2,90%	21,14%	301.714.139	2.199.739.284
17	3,49%	24,63%	363.020.886	2.562.760.170
18	2,77%	27,40%	288.020.654	2.850.780.824
19	1,71%	29,11%	178.020.546	3.028.801.370
20	2,14%	31,26%	223.021.458	3.251.822.828
21	0,00%	31,26%	-	3.251.822.828
22	0,00%	31,26%	-	3.251.822.828
23	0,87%	32,13%	90.626.314	3.342.449.142
24	1,23%	33,35%	127.656.544	3.470.105.686
25	1,29%	34,64%	134.325.400	3.604.431.086
26	1,20%	35,84%	124.565.435	3.728.996.521
27	0,96%	36,81%	100.320.549	3.829.317.070
28	1,42%	38,22%	147.516.270	3.976.833.340
29	4,56%	42,78%	474.251.975	4.451.085.315
30	3,89%	46,67%	404.510.600	4.855.595.915
31	1,97%	48,64%	204.511.196	5.060.107.111
32	1,74%	50,38%	180.876.545	5.240.983.656
33	1,90%	52,28%	198.076.543	5.439.060.199
34	1,92%	54,20%	200.125.435	5.639.185.634
35	1,80%	56,00%	186.789.545	5.825.975.179
36	2,85%	58,85%	296.607.392	6.122.582.571
37	0,63%	59,48%	65.787.652	6.188.370.223
38	0,64%	60,12%	66.564.543	6.254.934.766
39	0,73%	60,85%	75.650.435	6.330.585.201
40	0,75%	61,60%	78.099.805	6.408.685.006
41	1,05%	62,65%	108.943.520	6.517.628.526
42	1,38%	64,03%	143.545.320	6.661.173.846
43	1,50%	65,52%	155.678.540	6.816.852.386
44	0,86%	66,38%	89.765.950	6.906.618.336
45	2,71%	69,10%	282.180.850	7.188.799.186
46	1,80%	70,90%	187.654.235	7.376.453.421
47	2,45%	73,35%	254.777.895	7.631.231.316
48	2,17%	75,52%	225.350.101	7.856.581.417
49	2,62%	78,14%	272.830.333	8.129.411.750

4.2. Analysis of Time and Cost Performance

4.2.1. Cost Performance Index (CPI) Analysis

CPI is the cost efficiency factor which has been incurred which calculated by comparing the value of work that has been physically completed (EV) with the actual cost that have been incurred in the same period (AC).

$$CPI = EV : AC$$

The example of CPI calculation for the fifth week:

EV at the fifth week = Rp. 364.014.282

AC at the fifth week = Rp. 692.135.795

CPI at the fifth week = 0,53

Table 3. The cost performance index (CPI) analysis

Week of	Weight of Plan	Cumulative	Planned Value
1	29.802.131	49.199.000	0,61
2	97.604.531	208.815.850	0,47
3	175.261.307	405.233.350	0,43
4	264.248.960	547.315.220	0,48
5	364.014.282	692.135.795	0,53
6	538.812.786	894.614.439	0,60
7	625.110.059	1.000.807.439	0,62
8	724.875.504	1.061.107.439	0,68
9	857.752.036	1.195.247.439	0,72
10	980.097.705	1.679.742.639	0,58
11	1.105.776.470	1.773.292.639	0,62
12	1416.596.424	2.001.194.239	0,71
13	1.572.382.139	2.076.194.239	0,76
14	1.700.167.789	2.424.069.239	0,70
15	1.898.025.145	2.505.569.239	0,76
16	2.199.739.284	2.541.569.239	0,87
17	2.562.760.170	2.703.069.239	0,95
18	2.850.780.824	3.221.782.639	0,88
19	3.028.801.370	3.311.457.639	0,91
20	3.251.822.828	3.442.367.639	0,94
21	3.251.822.828	3.442.367.639	0,94
22	3.251.822.828	3.442.367.639	0,94
23	3.342.449.142	3.754.657.639	0,89
24	3.470.105.686	3.898.232.639	0,89
25	3.604.431.086	3.975.232.639	0,91
26	3.728.996.521	4.079.982.639	0,91
27	3.829.317.070	4.440.382.639	0,86
28	3.976.833.340	4.518.057.639	0,88
29	4.451.085.315	4.578.057.639	0,97
30	4.855.595.915	4.712.557.639	1,03
31	5.060.107.111	4.982.957.639	1,02
32	5.240.983.656	5.136.632.639	1,02
33	5.439.060.199	5.214.032.639	1,04
34	5.639.185.634	5.307.032.639	1,06
35	5.825.975.179	5.394.432.639	1,08
36	6.122.582.571	5.650.432.639	1,08
37	6.188.370.223	5.797.607.639	1,07
38	6.254.934.766	5.880.107.639	1,06
39	6.330.585.201	5.957.107.639	1,06
40	6.408.685.006	6.187.107.639	1,04
41	6.517.628.526	6.265.282.639	1,04
42	6.661.173.846	6.363.882.639	1,05
43	6.816.852.386	6.445.882.639	1,06
44	6.906.618.336	6.653.882.639	1,04

Week of	Weight of Plan	Cumulative	Planned Value
45	7.188.799.186	6.822.557.639	1,05
46	7.376.453.421	6.904.557.639	1,07
47	7.631.231.316	6.987.557.639	1,09
48	7.856.581.417	7.055.557.639	1,11
49	8.129.411.750	7.317.057.639	1,11

4.2.2. Schedule Performance Index (SPI) Analysis

SPI is a work performance efficiency factor that has been implemented which calculated by comparing the value of work that has been physically completed (EV) with the value of work according to work plan schedule (PV).

$$SPI = EV : PV$$

The example of CPI calculation for the fifth week:

EV at the fifth week = Rp. 364.014.282

AC at the fifth week = Rp. 44.533.720

CPI at the fifth week = 8,17

Table 4. Schedule performance index (SPI) analysis

Week of	Weight of Plan	Cumulative	Planned Value
1	2.951.679	29.802.131	10,10
2	5.903.358	97.604.531	16,53
3	16.825.720	175.261.307	10,42
4	30.679.720	264.248.960	8,61
5	44.533.720	364.014.282	8,17
6	65.567.480	538.812.786	8,22
7	108.964.039	625.110.059	5,74
8	200.577.337	724.875.504	3,61
9	306.326.366	857.752.036	2,80
10	446.908.430	980.097.705	2,19
11	667.172.242	1.105.776.470	1,66
12	895.340.097	1.416.596.424	1,58
13	1.140.555.576	1.572.382.139	1,38
14	1.385.771.055	1.700.167.789	1,23
15	1.674.882.818	1.898.025.145	1,13
16	1.976.947.643	2.199.739.284	1,11
17	2.280.262.170	2.562.760.170	1,12
18	2.586.558.131	2.850.780.824	1,10
19	2.906.036.023	3.028.801.370	1,04
20	3.256.945.276	3.251.822.828	1,00
21	3.256.945.276	3.251.822.828	1,00
22	3.256.945.276	3.251.822.828	1,00
23	3.690.180.180	3.342.449.142	0,91
24	4.116.920.242	3.470.105.686	0,84
25	4.566.753.515	3.604.431.086	0,79
26	5.015.035.479	3.728.996.521	0,74
27	5.440.954.644	3.829.317.070	0,70

Week of	Weight of Plan	Cumulative	Planned Value
28	5.837.842.602	3.976.833.340	0,68
29	6.162.487.517	4.451.085.315	0,72
30	6.471.636.116	4.855.595.915	0,75
31	6.739.327.025	5.060.107.111	0,75
32	6.986.244.391	5.240.983.656	0,75
33	7.233.161.757	5.439.060.199	0,75
34	7.480.079.123	5.639.185.634	0,75
35	7.706.571.924	5.825.975.179	0,76
36	7.922.057.928	6.122.582.571	0,77
37	8.108.683.258	6.188.370.223	0,76
38	8.295.308.588	6.254.934.766	0,75
39	8.481.933.917	6.330.585.201	0,75
40	8.668.559.247	6.408.685.006	0,74
41	8.855.184.576	6.517.628.526	0,74
42	9.041.809.906	6.661.173.846	0,74
43	9.228.435.235	6.816.852.386	0,74
44	9.415.060.565	6.906.618.336	0,73
45	9.575.034.898	7.188.799.186	0,75
46	9.727.847.656	7.376.453.421	0,76
47	9.877.640.653	7.631.231.316	0,77
48	9.992.600.616	7.856.581.417	0,79
49	10.089.240.237	8.129.411.750	0,81

V. CONCLUSION

From the result of the cost and time analysis conducted for Pier Construction project in Tuban by employing the Earned Value Analysis, there are several conclusions can be withdrawn by the writers as stated below:

1. CPI or the cost performance index gained value of below 1 (< 1) until the 29th week meaning there is a cost overrun in the project. While at the 30th to 49th week, the CPI value is above 1 (> 1) meaning there is a cost underrun in the project and at the 49th week the CPI value is 1.11. The SPI or time performance index has a value of above 1 (> 1) until the 19th week meaning there is an acceleration in progress in the project, whereas for the 20th to 49th weeks the SPI value is found to be below 1 (< 1) meaning that there is a delay in the project, and the SPI value for the 49th week is 0.81.
2. The total contract value of this project is Rp.10,403,914,724 and the CPI value is 1.11, then expectation of this project is able to be completed with a remaining cost of only Rp.2,047,216,930. The research was conducted in the 49th week for 54 weeks of project plan schedule. With assumption of changes in project work performance remains the same, it is expected that the project will be completed within 62 weeks, meaning that an additional of 8 weeks of time is required from the initial contract.

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