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COST AND TIME ANALYSIS USING METHODS EARNED VALUE

Harisa Ramadhani Putra, Koespiadi, Wateno Oetomo
Faculty of Engineering, University of 17 August 1945 Surabaya, Indonesia
Email: ramaharisa27@gmail.com, koespiadi65@gmail.com, wateno@untag-sby.ac.id

ABSTRACT
The earned value concept is one of the tools used in project management that integrates cost and time. The earned value concept presents three dimensions, namely the physical completion of the project (the percent complete) which reflects the planned absorption of costs (budgeted cost), the actual costs that have been incurred or what is called actual cost and what is obtained from the costs that have been incurred or what is called earned value. From these three dimensions, with the concept of earned value, it can be connected between cost and time performance derived from the calculation of the variance of cost and time. In the earned value method, monitoring or evaluation is required at a time to determine the performance of a project. Control was carried out on the Tanjung Uncang Pier Construction Project in Batam City, because the project implementation was delayed from planning. The research objectives are to analyze the estimated time required to complete the project and analyze the estimated final cost of the project. The result of the research is based on Schedule Variance (SV) and Schedule Performance Index (SPI), the work performance of the Tanjung Uncang Pier Development Project Batam City is not as expected and does not achieve the planned work target and is experiencing delays. The estimated time required to complete the Tanjung Uncang Pier Development Project Batam City based on week 22 is 257 days while the planned time is 245 days. This shows that the completion time is 12 days later than planned. The estimated cost of the project implementation of the Tanjung Uncang Pier Construction Project of Batam City is smaller than the contract value, which is Rp 40,038,455,635.00.
Keywords: The Percent Complete, Actual Cost, Earned ValueI

NTRODUCTION

Development projects have specific features that cannot be repeated (Manning, 2008). A project that occurs on one project will not be repeated on another. The cause of this phenomenon is due to the variety of conditions that affect the implementation period of a development project. Geographical differences, rainfall, earthquakes, and soil conditions are some of the factors that affect the idiosyncrasies of construction projects(CHANGE, 2003).

In construction management, the arrangements of planning, implementation, and control in the construction service industry can be adjusted to the availability of resources. In the construction industry, it is important for service providers to be able to compete and run projects

on time and in accordance with the specifications stated in the Work Plan and Predetermined Conditions.

Making a work plan is one of the first steps of planning. Planning is made to achieve high effectiveness and efficiency of the resources to be used during the implementation of the construction project(Ozorhon & Cinar, 2015). The planned resources are manpower, machinery, methods, materials, and money(Lester, 1943). These resources should be planned as efficiently and effectively as possible in order to obtain minimum implementation costs. In implementation, we must arrange the classification of work according to their respective qualifications. Proper assessment with the right allocation of resources supports the success of a project.

Projects rarely go exactly as planned. Usually, there are delays in the project - both in terms of time and progress of work - that do not fit according to the original plan. However, in some cases, there are also projects that are completed ahead of schedule. According to Kusjadmikahadi, delays in construction projects can be interpreted as an increase in the duration required to complete the project according to the schedule that has been set and stated in the contract(Assaf & Al-Hejji, 2006). Completion of work that does not match the allotted time is one of the disadvantages in increasing the level of productivity. This will obviously lead to waste in spending, both in the form of funds used for government projects and in the form of increased investment costs and losses on private projects. Active involvement in management plays an important role in achieving successful management of such problems can be an inhibiting factor in the progress of project work, so that the project cannot be implemented in line with the established plan. A frequent mistake in projects is delays, which often lead to disputes and demands between owners and contractors(Kikwasi, 2012). The impact is very detrimental to both contractors and owners, because it can have an impact on very high costs. The consequence that will be experienced by the contractor is a penalty penalty in accordance with the contract agreement, plus additional overhead costs that will continue throughout the project. From the owner's perspective, delays in the project will lead to a reduction in revenue as the facility cannot be operated as planned. Differences in views between contractors as executors and consultants as supervisors and planners often occur in the field, especially if planners are not involved in the process of implementing the project. The result of this difference results in two impacts, namely an increase in costs for the project and a delay in completing the project from the planned schedule. In order for losses in the project to be avoided, we can do a forecasting of completion costs.

The use of the concept of earned value is one of the methods used in project management that combines aspects of cost and time(Vanhoucke, 2009). The concept of earned value presents three dimensions, namely the physical completion of the project (the percent complete) which reflects the budgeted cost plan, the actual costs that have been incurred or what is called the actual cost and what is obtained from the costs that have been incurred or called earned value

(Sruthi & Aravindan, 2020). In these three aspects, earned value becomes a concept that connects cost and time performance through the calculation of cost and time variance(Jeyakumar, 2013). By considering these cost and time aspects, a project manager can evaluate the overall performance of the project and each piece of work within it, which in turn allows him to forecast the cost and time performance required to complete the project(Ahuja & Nandakumar, 1985). The results of the project performance evaluation can be used as an early warning if there is an inefficiency in project completion. Thus, management actions and changes in implementation methods can be taken to prevent increased costs and delays in project completion. The existence of project performance indicators in terms of cost and time also allows preventive measures to keep the project implementation in accordance with the plan. Based on the illustration provided, an investigation is needed to control the project using the Earned Value method that combines cost and time factors(Naizghi, 2021).

In the earned value method, it is necessary to supervise or assess at a point in time to evaluate the progress of the project. In this case, control is carried out on the Tanjung Uncang Pier Construction Project in Batam City by PT. Tri Sinergi Persada. The approach used in managing costs and time in the field uses Time Schedule. This method is most commonly used in construction projects, the percentage of the project plan as well as the percentage of realization are depicted in the S-curve graph. Control is carried out on the Tanjung Uncang Pier Construction Project in Batam City because in the implementation of the Tanjung Uncang Pier Project Batam City experienced obstacles in the form of a fairly difficult erection location and unfavorable weather. This situation causes some equipment to be damaged and seepage in the deadman and capping beam areas until there is a delay in project implementation compared to the predetermined planning(Merritt et al., 2002). Efforts to ensure that projects are completed on time are carried out by exercising control over costs and time. In addition, the increase in costs caused by such delays can be overcome efficiently.

RESEARCH METHODS

This study uses a quantitative descriptive approach to describe the condition of the Tanjung Uncang Pier Development project in Batam City(Bloomfield & Fisher, 2019) . Quantitative descriptive methods are used to analyze existing data, focusing on measuring project cost and time performance using the Earned Value method(Bloomfield & Fisher, 2019). This approach allows researchers to provide a clear picture of the extent to which the project is in delay or overbudget. The object of this research is the Tanjung Uncang Pier Construction Project in Batam City in 2023. The study population covers the entire project, while the research sample is the activities related to the construction of the pier. The primary and secondary data used include the time schedule for the implementation of work, daily reports, weekly reports of work, and cost budget plans.

The research location was carried out at the Tanjung Uncang Pier Construction Project in Batam City, with a research duration of approximately 4 months. The research instruments used include daily reports, weather reports, materials, tools, project implementation schedules, and cost budget plans. The data collection procedure is carried out by obtaining secondary data from the project implementing contractor(Elsayah, 2016). Data analysis was carried out using the Earned Value method, which includes the calculation of BCWS, BCWP, ACWP for the cost aspect, as well as the calculation of SV, SPI, ETS, and EAS for the time aspect(Thoengsal & Tumpu, 2022). The results of this analysis are used to evaluate project performance and provide estimates of the cost and time of completion of the remaining work.

The design of this research is well structured, starting from problem identification, primary and secondary data collection, application of the Earned Value method, to conclusions and suggestions. In addition, the research design flowchart provides a visual overview that helps understand the research steps. By using this approach, it is hoped that this research can contribute in understanding and overcoming challenges that may arise in construction projects.

RESULTS AND DISCUSSION

BCWS, BCWP, ACWP Calculation

The use of the EV method in this project produces *Planned Value (*BCWS), *Earned Value* (BCWP), *Actual Cost* (ACWP), then compared continuously in each phase of the project to completion. Information on how to use costs and value obtained quickly throughout the project *life cycle* is helpful for a fast and integrated project control and monitoring system. Methods used in controlling cost and time in the field is to use *Time Schedule*. This method is often used on construction projects and the percentage of project plan and percentage of realization are depicted in an S-curve graph (Abdul-Rahman & Wang, 2011).

Based on the S-curve graph of project planning and realization, the percentage of work until week 22, because in week 22 there is an increase in the percentage of work volume. The actual physical percentage (realization) of the project tends to be smaller or later than planned. The earned *value analysis* was conducted at week 22.

1. BCWS (Budgeted Cost of Work Schedule) Calculation

BCWS (*Budgeted Cost of Work Schedule*) describes the budget plan up to a certain period against the volume of project plans to be worked on.

BCWSper week = % Weekly Plan Weighting × Contract Value

The evaluation of the Tanjung Uncang Pier Construction Project in Batam City was carried out in the 22nd week. From the BCWS value in each week accumulated until week 22, as follows:

BCWS = % plan weight x project value

= 4.86% x IDR 40,236,396,033 = IDR 1,955,488,847.20

The BCWS value for the 22nd week was IDR 1,955,488,847.20 and then accumulated in the previous week, so that the BCWS value for the 22nd week became IDR 33,533,012,453.90. The recapitulation of the BCWS calculation is as follows:

Table 1. BCWS Tanjung Uncang Pier Construction Project Batam City

	BudgetProject (BAC)	ProgressPlan(%)	Cumulative Plan Progress	CostBCS Plan (IDR)	BCWSKumulative
1	40.236.396.033	0,16	0,16	64.378.233,65	64.378.233,65
2	40.236.396.033	0,16	0,32	64.378.233,65	128.756.467,31
3	40.236.396.033	1,45	1,77	583.427.742,48	712.184.209,78
4	40.236.396.033	1,65	3,42	663.900.534,54	1.376.084.744,33
5	40.236.396.033	3,49	6,91	1.404.250.221,55	2.780.334.965,88
6	40.236.396.033	3,4	10,31	1.368.037.465,12	4.148.372.431,00
7	40.236.396.033	4,39	14,7	1.766.377.785,85	5.914.750.216,85
8	40.236.396.033	5,67	20,37	2.281.403.655,07	8.196.153.871,92
9	40.236.396.033	3,73	24,1	1.500.817.572,03	9.696.971.443,95
10	40.236.396.033	4,1	28,2	1.649.692.237,35	11.346.663.681,31
11	40.236.396.033	4,14	32,34	1.665.786.795,77	13.012.450.477,07
12	40.236.396.033	4,14	36,48	1.665.786.795,77	14.678.237.272,84
13	40.236.396.033	4,3	40,78	1.730.165.029,42	16.408.402.302,26
14	40.236.396.033	3,44	44,22	1.384.132.023,54	17.792.534.325,79
15	40.236.396.033	3,9	48,12	1.569.219.445,29	19.361.753.771,08
16	40.236.396.033	5,13	53,25	2.064.127.116,49	21.425.880.887,57
17	40.236.396.033	5,22	58,47	2.100.339.872,92	23.526.220.760,50
18	40.236.396.033	5,23	63,7	2.104.363.512,53	25.630.584.273,02
19	40.236.396.033	4,85	68,55	1.951.465.207,60	27.582.049.480,62
20	40.236.396.033	5,1	73,65	2.052.056.197,68	29.634.105.678,30
21	40.236.396.033	4,83	78,48	1.943.417.928,39	31.577.523.606,70
22	40.236.396.033	4,86	83,34	1.955.488.847,20	33.533.012.453,90

Table 1 is a recapitulation of the BCWS calculation each week. From the calculation results, the progress of the plan in the 22nd week was 4.86%. The value is accumulated with the progress of the plan in the previous week.

So that the progress of the plan until the 22nd week is 83.34%. The cumulative BCWS plan cost is IDR 33,533,012,453.90 with a difference of IDR 6,703,383,579.1 to the project value.

2. BCWP (Budgeted Cost for Work Performed) Calculation

BCWP (*Budgeted Cost for Work Performed*) describes the project plan budget for a given period against what has been done at the actual volume of work.

BCWP per week = % Weekly Realization Weight × Contract Value

The BCWP calculation is obtained from the weight of work realization against the budget plan costs and then accumulated every week. The weight of work realization is obtained from weekly reports on project progress. The calculation of BCWP for the 22nd week of the Tanjung Uncang Pier Construction Project project in Batam City is as follows:

BCWP = % realized weight x project value

= 73.69 % x IDR 40,236,396,033 = IDR 29,650,200,236.72

The BCWP value for the 22nd week was IDR 1,810,637,821.49, then accumulated in the previous week, so that the BCWP value up to the 22nd week became IDR 29,650,200,236.72. The recapitulation of the BCWP calculation is as follows:

Table 2. BCWP Calculation Recapitulation

Sunday	Project Budget (BAC)	Plan Progress (%)	Cumulative Plan Progress	BCWP Plan Fee (Rp)	Cumulative BCWP
1	40.236.396.033,00	0,07	0,07	28.165.477,22	28.165.477,22
2	40.236.396.033,00	0,07	0,14	28.165.477,22	56.330.954,45
3	40.236.396.033,00	2,39	2,53	961.649.865,19	1.017.980.819,63
4	40.236.396.033,00	2,45	4,98	985.791.702,81	2.003.772.522,44
5	40.236.396.033,00	10,41	15,39	4.188.608.827,04	6.192.381.349,48
6	40.236.396.033,00	7,4	22,79	2.977.493.306,44	9.169.874.655,92
7	40.236.396.033,00	11,53	34,32	4.639.256.462,60	13.809.131.118,53

Sunday	Project Budget (BAC)	Plan Progress (%)	Cumulative Plan Progress	BCWP Plan Fee (Rp)	Cumulative BCWP
8	40.236.396.033,00	2,2	36,52	885.200.712,73	14.694.331.831,25
9	40.236.396.033,00	6,37	42,89	2.563.058.427,30	17.257.390.258,55
10	40.236.396.033,00	0,83	43,72	333.962.087,07	17.591.352.345,63
11	40.236.396.033,00	0,94	44,66	378.222.122,71	17.969.574.468,34
12	40.236.396.033,00	0,43	45,09	173.016.502,94	18.142.590.971,28
13	40.236.396.033,00	4,6	49,69	1.850.874.217,52	19.993.465.188,80
14	40.236.396.033,00	1,8	51,49	724.255.128,59	20.717.720.317,39
15	40.236.396.033,00	1,3	52,79	523.073.148,43	21.240.793.465,82
16	40.236.396.033,00	1,4	54,19	563.309.544,46	21.804.103.010,28
17	40.236.396.033,00	5,3	59,49	2.132.528.989,75	23.936.632.000,03
18	40.236.396.033,00	2,4	61,89	965.673.504,79	24.902.305.504,82
19	40.236.396.033,00	0,9	62,79	362.127.564,30	25.264.433.069,12
20	40.236.396.033,00	4,1	66,89	1.649.692.237,35	26.914.125.306,47
21	40.236.396.033,00	2,3	69,19	925.437.108,76	27.839.562.415,23
22	40.236.396.033,00	4,5	73,69	1.810.637.821,49	29.650.200.236,72

In table 2, it can be seen that the value of project progress progress until week 22 is 73.69%. The cumulative BCWP value until week 22 is IDR 29,650,200,236.72

3. ACWP (Actual Cost for Work Performed) Calculation

ACWP (*Actual Cost for Work Performed*) describes the actual budget spent on the execution of work at the state of actual work volume. *Actual Cost* Week consists of the following costs:

Direct Costs:

Material Cost

Labor Cost

Indirect Costs

a) Office overhead: Staff salaries, Office equipment

b) Field Overhead: Fencing, Board of Directors, Security, Transportation/Fuel

The ACWP value for the 22nd week was IDR 1,797,963,356.73, then accumulated in the previous week, so that the ACWP value up to the 22nd week became IDR 29,504,337,957.65. The recapitulation of the ACWP calculation is as follows:

Table 3. ACWP Tanjung Uncang Pier Construction Project Batam City

Sunday	Project Budget(BAC)	Indirect Costs	Direct Costs	ACWP(Rp)	ACWPCumulative
1	40.236.396.033	2.316.802,22	24.598.675	26.915.477,22	26.915.477,22
2	40.236.396.033	1.236.638,22	25.678.839	26.915.477,22	53.830.954,45
3	40.236.396.033	84.477.540,19	875.922.325	960.399.865,19	1.014.230.819,63
4	40.236.396.033	91.791.102,81	892.750.600	984.541.702,81	1.998.772.522,44
5	40.236.396.033	263.387.598,04	3.926.471.229	4.189.858.827,04	6.188.631.349,48
6	40.236.396.033	105.154.071,44	2.873.589.235	2.978.743.306,44	9.167.374.655,92
7	40.236.396.033	431.450.851,02	4.175.330.816,34	4.606.781.667,37	13.774.156.323,29
8	40.236.396.033	82.323.666,28	796.680.641,45	879.004.307,74	14.653.160.631,02
9	40.236.396.033	238.364.433,74	2.306.752.584,57	2.545.117.018,31	17.198.277.649,34
10	40.236.396.033	31.058.474,10	300.565.878,37	331.624.352,46	17.529.902.001,80
11	40.236.396.033	35.174.657,41	340.399.910,44	375.574.567,85	17.905.476.569,65
12	40.236.396.033	16.090.534,77	155.714.852,65	171.805.387,42	18.077.281.957,07
13	40.236.396.033	172.131.302,23	1.665.786.795,77	1.837.918.098	19.915.200.055,07
14	40.236.396.033	67.355.726,96	651.829.615,73	719.185.342,69	20.634.385.397,76
15	40.236.396.033	48.645.802,80	470.765.833,59	519.411.636,39	21.153.797.034,15
16	40.236.396.033	52.387.787,63	506.978.590,02	559.366.377,65	21.713.163.411,80
17	40.236.396.033	198.325.196,05	1.919.276.090,77	2.117.601.286,82	23.830.764.698,62
18	40.236.396.033	89.807.635,95	869.106.154,31	958.913.790,26	24.789.678.488,88
19	40.236.396.033	33.677.863,48	325.914.807,87	359.592.671,35	25.149.271.160,23
20	40.236.396.033	153.421.378,07	1.484.723.013,62	1.638.144.391,69	26.787.415.551,92
21	40.236.396.033	86.065.651,11	832.893.397,88	918.959.049	27.706.374.600,92
22	40.236.396.033	168.389.317,40	1.629.574.039,34	1.797.963.356,73	29.504.337.957,65

The three indicators that have been calculated (BCWS, BCWP, ACWP) provide an overview of cost and time achievement, as follows:

4. Calculation Based on Cost Aspect

Earned Value *analysis* is seen from the cost aspect, used *Cost Variance* (CV), *Cost Performance Index* (CPI), *Estimate at Complete* (EAC). The details of the calculation of these parameters are as follows:

a. *Cost Variance* (CV)

Cost variance is the difference between the magnitude of the value of project performance results (BCWP) and actual costs that have been incurred (ACWP).

The calculation of CV value in week 22, is as follows: CV = BCWP – ACWP
= IDR 29,650,200,236.72 – IDR 29,504,337,957.65
= IDR 145,862,279.07

From the results of CV calculations in the 22nd week, a CV value of IDR 145,862,279.07 was obtained, which means that the CV value is greater than 0 (CV > 0) or a positive value. This indicates that the cost used in the completion of the project is less than the planned cost.

b. *Cost Performance Index* (CPI)

The calculation of the CPI value in the 22nd week, is as follows: CPI = BCWP / ACWP
= IDR 29,650,200,236.72 / IDR 29,504,337,957.65
= 1.01

A value of 1.01 is obtained, indicating that the cost used in the completion of the project is less than the planned cost.

c. *Estimate at Complete* (EAC)

EAC = ACWP + ETC

Before determining the EAC value, *Estimate to Complete* (ETC) is calculated first. Then EAC calculations are carried out, the calculations are as follows:

ETC = (BAC – BCWP) / CPI
= (IDR 40,236,396,033.00 - IDR 29,650,200,237) / 1.01
= IDR 10,534,117,678
EAC = ACWP + ETC
= IDR 29,504,337,958 + IDR 10,534,117,678
= IDR 40,038,455,635

5. Calculation Based on Time Aspect

Details of the calculation by integrating aspects of time, as follows:

a. *Schedule Variance* (SV)

Schedule Variance is the difference between the magnitude of the project performance results (BCWP) and the planned budget (BCWS). SV = BCWP – BCWS

The calculation of SV values in the 22nd week, is as follows:

SV = BCWP – BCWS
= IDR 29,650,200,236.72 – IDR 33,533,012,453.90
=Rp - 3,882,812,217.18

From the results of these calculations, an SV value of Rp - 3,882,812,217.18 SV has a negative value indicating that the project is delayed from the planned schedule, the work package carried out is less than planned.

b. *Schedule Performance Index* (SPI)

Project maintainers often want to know resource usage, which can be expressed as a productivity index or performance index. schedule performance index (*Schedule Performance Index* = SPI). The schedule productivity index is in the form of the value of resource use efficiency at the time the evaluation is carried out.

SPI = BCWP/BCWS

The calculation of the SPI value in the 22nd week, is as follows:

SPI = BCWP/BCWS

= IDR 29,650,200,236.72 / IDR 33,533,012,453.90

= 0.88

From the results of this calculation, an SPI value of 0.88 was obtained. An SPI value of less than 1 indicates that the project is experiencing delays. Work performance is not as expected and has not been able to achieve the planned work targets.

c. *Estimate Temporary Schedule* (ETS)

Time remaining = 91 days

Time to complete = 154 days

SPI = 0.88

ETS = (remaining time) / SPI

= 91 / 0.88

= 102.91 = 103 days

d. *Estimate At Schedule* (EAS)

EAS = End time + ETS

Estimated project completion time

Week 22 EAS value

EAS = End time+ETS

= 154 + 103

= 257 days

Time difference = Time execution plan – EAS

= 245 days – 257 days

= -12 days

The estimated project completion time using cumulative calculations, based on week 22 is 257 days while the plan time is 245 days. This indicates that the turnaround time is 12 days later than planned

Analysis of Project Implementation Acceleration

After analyzing the implementation of the construction work of Tanjung Uncang Pier Batam City using the Earn Value Analysis method, it was found that the project had a delay in its implementation, then an acceleration option was carried out to see how fast the implementation time was and how much it cost after the acceleration was carried out in its processing time. The work items that will be accelerated are jobs that are in a critical trajectory, to see what work is included in the critical path used by the Microsoft Project application.

4. Analysis Using Program Crashes

Program crashes are one way to speed up project completion time, namely by reducing the completion time of activities that are on a critical trajectory that will affect project completion time. The work that is on a critical trajectory, namely Piling Work and Concrete G35 work, but because the review is carried out in week 22 where Piling Work has been completed, the acceleration will be carried out, namely the G35 Concrete work. The acceleration of the completion of the Tanjung Uncang Pier Construction Project in Batam City is carried out using overtime hours. The work plan that will be carried out in accelerating the completion time of an activity with the overtime hour method is as follows:

a. Normal activities use 8 hours of work and 1 hour of rest (08.00-17.00 WIB), while overtime work is carried out after normal working time for 4 hours per day (18.00-22.00 WIB). Overtime labor is the same as regular labor.
b. The price of wages for workers for overtime work is calculated 2 times the hourly wage during normal working time.
c. Productivity for overtime work is calculated at 60% of normal productivity. This decrease in productivity is due to fatigue, limited visibility at night and cooler weather conditions.

4. Calculating the acceleration of work completion time

The calculation of the acceleration of project completion time is carried out on work that is on the critical trajectory, namely the G35 Concrete work.

a. Piling Head Cutting Work:

Daily productivity = $\frac{bobot\ pekerjaan}{durasi\ rencana}$

Daily productivity = = 0.001013$\frac{0,13}{126}$

Hourly productivity = $\frac{Produktifitas\ harian}{8\ jam}$

Hourly productivity = = 0.00013$\frac{0,001013}{8\ jam}$

Furthermore, the completion time of the activity after a crash is carried out:

Daily productivity after crash = (8 x 0.00013) + (4 x 0.6 x 0.00013) = 0.0013

Time to complete = = 96.92 days$\frac{0,13}{0,0013}$

So the time needed to complete the piling head cutting job after a crash is 96.92 days, so the accelerated time is 29.08 days.

Table 4. Time Acceleration on Critical Trajectories

TANJUNG UNCANG PIER BATAM CITY	Duration plan	Turnaround time	accelerated time
Concrete G35 Pile cap 1500x1500x800 c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
4.1Cut off Piling head	126	96,923077	29,076923
4.2Formwork	168	129,23077	38,769231
4.3Reinforcement	140	107,69231	32,307692
4.4Readymix concrete	119	91,538462	27,461538
Concrete G35 Anchore 400x1200mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
5.3Formwork	133	102,30769	30,692308
Concrete G35 Cover head 1000x2000mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
6.1Formwork	147	113,07692	33,923077
Concrete G35 Beam dilation 1000x800mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
7.1Formwork	126	96,92	29,076
Concrete G35 Beam 500x800mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
8.1Formwork	140	107,69	32,307
TANJUNG UNCANG PIER BATAM CITY	Duration plan	Turnaround time	accelerated time
Concrete G35 Beam to existing berth 300x500mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
9.1Formwork	182	140	42

3. Calculating Crash Cost of Work

As a result of the acceleration of the time to complete activities, there is an increase in costs in terms of payment of workers' wages or known as worker crash costs. Broadly speaking, the calculation is carried out as follows:

a. Piling Head Cutting Work:

Calculating normal daily wages $= \frac{harga\ total\ upah\ kerja}{waktu\ penyelesaian\ kegiatan\ normal}$

= $\frac{51.334.046}{126}$= IDR 407,413

Calculating normal hourly wages = $\frac{upah\ kerja\ perhari\ normal}{8}$

= = IDR 50,927 $\frac{Rp.407.413}{8}$

Calculate overtime pay for 1 day

= 4 (2 x normal hourly wages)

= 4 (2 x IDR 50,927) = IDR 407,416

Calculating workers' crash cost wages per day

= (8 x IDR 50,927) + IDR 407,416

= Rp. 814.832

Calculate total crash cost

= Crash Cost of Workers per Day x Crash Duration

= IDR 814,832 x 96.9 days = IDR 78,957,220

After calculating *the crash* cost, then calculate the *cost slope* of each job

Table 5. Crash Cost Total and Cost Slope

Job Name	The value of the work	Total crash cost	Cost Slope
Concrete G35 Pile cap 1500x1500x800 c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
4.1Cut off Piling head	51.334.046,34	78.956.652,22	27.622.605,89
4.2Formwork	249.312.351,71	383.555.181,08	134.242.829,38
4.3Reinforcement	1.684.352.699,69	2.591.496.939,38	907.144.239,69
4.4Readymix concrete	564.674.509,70	868.649.712,15	303.975.202,45
Concrete G35 Anchore 400x1200mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
5.3Formwork	93.846.491,09	144.382.473,74	50.535.982,65
Concrete G35 Cover head 1000x2000mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			

Job Name	The value of the work	Total crash cost	Cost Slope
6.1Formwork	194.933.794,35	299.959.348,86	105.025.554,51
Concrete G35 Beam dilation 1000x800mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
7.1Formwork	21.855.774,12	33.624.267,87	11.768.493,76
Concrete G35 Beam 500x800mm c/w rebar. form. excavation. compaction base. sand fill. lean concrete and backfill			
8.1Formwork	149.222.181,91	229.572.587,55	80.350.405,64

4. Calculating Total Cost After Acceleration

After calculating the crash cost, the job completion time is 244 days, then the total cost of work and additional costs of each crashed work can be summed.

So the total cost due to the *crash* :

= Direct costs + indirect costs

= IDR 37,690,283,913 + IDR 4,187,809,324 = IDR 41,878,093,237

CONCLUSION

Based on the research objectives and the results of the discussion, it can be concluded that the performance of the Tanjung Uncang Pier Construction project in Batam City is not in line with expectations and has experienced delays, as stated by the Schedule Variance (SV) and Schedule Performance Index (SPI). The project did not reach its planned target, with a completion time of 257 days compared to the planned time of 245 days, indicating a delay of 12 days. Although the estimated cost of project implementation is smaller than the contract value, which is Rp. 40,038,455,635, the option of accelerating work takes 244 days at a greater cost, which is Rp. 41,878,093,237.

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