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Research Paper

Analysis Time and Cost Control in Ship Hull Construction Projects at PT. Bengkulu SamuderaTehnik

Fabianus Hambu[1], LaluMulyadi [2], LiesKurniawatiWulandari *[3]
[1] *Postgraduate StudentInstituteTechnologyNationalMalang–Indonesia*
[23] *LecturersInstituteTechnologyNationalMalang–Indonesia*
[*] *Corresponding Author*

ABSTRACT: *The purpose of the research is to analyze the implementation of ship body construction project work at PT. Bengkulu SamuderaTehnik, analyze time and cost performance by assessing performance based on project performance indicators and analyze control with acceleration of time and cost performance of project implementation.*
The method used in this analysis is the Earned Value Method (EVM) to assess time and cost performance through time and cost performance indicators. EVM analysis is carried out by calculating the PV, EV and AC values based on time schedule data, RAB, and work progress data. Based on the PV, EV and AC values, an analysis of time and cost performance indicators can be carried out by analyzing the Schedule Variance (SV), Schedule Performance Index (SPI), Cost Variance (CV) and Cost Performance Index (CPI) value indicators. Control analysis using the Time Cost Trade Off (TCTO) method for the remaining time that has been calculated. The results of the research analysis on the ship body construction project at PT Bengkulu SamuderaTehnik are the project experience delay than planned with SPI index is 0.7 < 1, and the costs incurred more small from the budget with CPI Index 1.4 > 1. Implementation Time remaining is 19 Weeks and For Cost remaining is as big as Rp.9,685,719,731 . Control acceleration time done with the TCTO Method and the selected alternatives is with addition power work on the track critical that is work construction and work piping . Implementation time shortened by 7 weeks from 25 Weeks normal duration for reach remainder time work at the end project that is 19 Weeks . With Crash Cost is as big as for each job in succession is Rp . 80,978,036 for construction work and Rp. 126,040,853 for piping system work

Keywords: *Time and Cost Management, Ship Body, TCTO.*

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I.INTRODUCTION

Progress in industrial activities requires several aspects of management or administration that are required to have high performance, accuracy, economy, integration, speed, precision, accuracy and security in order to obtain final results that are in accordance with the objectives, these aspects of course have a very close relationship with project management.

The construction of the Ship at PT. Bengkulu SamuderaTehnik is inseparable from the problems of time, cost and quality so that it is necessary to carry out control stages to minimize ongoing problems. Based on the contract and planning data, the project should be completed within 240 working days or 40 weeks, which means that the project progress reaches 100% of the plan, with the total cost of the work reviewed being Rp. Rp. 10,960,943,544 . Based on the project work progress report data at the time of reporting, namely in the 27th week, the progress experienced a delay with progress only reaching 38.6% of the supposed 57.5%. The remaining normal time that should be completed is 78 days or 13 .

Study This thesis is to conduct a control analysis of the time and cost aspects with *Earned Value Method* (EVM) to assess the project's time and cost performance index, so that control steps are made with the CPM Method by applying the *Time Cost Trade Off method* . In addition, this study also deepens the application of Project Management in shipbuilding projects,

II.MATERIALS AND METHODS

2.1. Conceptual Framework

Control analysis results to time and cost on the project development construction ships at PT. Bengkulu Samudera Technique This is as *early warning* on ongoing projects walking and references project development boat furthermore .studyThisanalyzed,frameworkconceptualstudyarrangedbased onbackgroundbehind,problems and research objectives.

Parameterinstudyreferring to primary data, secondary data and the methods used :

1) Secondary Data : Plan Budget Cost , Time Schedule, Progress Report
2) Primary Data : Interview & participants Observation
3) EVM Method : Parameter *Cost Variance, Schedule Variance, Cost Performance Index* , *Schedule Performance Index* , ETC, ETS and TCPI
4) TCTO Method : *Critical Path,* alternative acceleration

Table 1CPI & SPI Index Parameters

Index	Mark	Information
CPI	> 1	AC that is issued more small from mark job earned (EV)
	1 <	AC that is issued more big from mark job earned (EV)
	1	AC that is issued The same with mark job earned (EV)
SPI	> 1	Project Performance more fast from timetable plan (PV)
	1 <	Project Performance more slow from timetable plan (PV)
	1	Project Performance The same with timetable plan (PV)

(Source : Nurtsani et et al., 2017)

2.1. Hypothesis Study

The hypothesis that is to be proven in this research is the index performance time and cost project on time reporting as *early warning* and control measures For speed up implementation worker with the most efficient alternative .

2.2. Definition Operational

- Ship Building Project :The Ship Building Project is a complex building that requires a very high level of precision, very standard materials according to specifications. as well as involving various expertise in supporting project implementation to achieve the expected goals involving the disciplines of Ship Building itself, ship machinery, ship electricity, piping, interior buildings and civil buildings
- Management Project time : Project time management is defined as the creation, updating, and monitoring of a schedule for all project activities.
- Management Cost project : Steps or the means necessary to complete a project within the allocated budget
- Control project :part of the construction management process that influences the final results of the project, which aims to minimize deviations that may occur during project implementation.
- Analysis EVM: A project control technique that provides quantitative measures of performance. It involves budgeting the work scheduled to be done.
- Analysis *Time Cost Trade Off* : a method used to speed up the implementation time of a project by conducting testing of all activities in a project that is focused on activities that are on the critical path in a deliberate and systematic manner

2.2. Data Analysis Methods

1) Analysis *Earned Value Method* (EVM)

- Analysis Indicator *Earned Value* :Three indicators that can be used as a reference in analyzing project performance , Analysis of *Planned Value* (PV), *Earned Value* (EV) and *Actual Cost* (AC) Indicators
- Analysis Variance :In Variance analysis, calculations are carried out to obtain *the Schedule Variance (* SV) value and *the Cost Variance (* CV) value.

- Analysis Index Performance :To determine performance, you can calculate the Cost Performance Indicator (CPI) and Schedule Performance Indicator (SPI) values.
- ETC and EAC analysis :Forestimatecostendproject and project completion time

2) Time Cost Trade Off (TCTO) Analysis
- Creating Network Diagrams and Analysis work track critical of work Remaining
- Time Cost Trade Off Analysis : Additional working hours and workforce
- Make comparison normal time and cost and the most efficient crash time and cost .

III.RESULTSANDDISCUSSION

4.1. Characteristics and Implementation Methods project Ship construction at PT. Bengkulu Samudera Technique

The implementation of shipbuilding projects is highly dependent on the availability and productivity of the workforce, ensuring completion within the planned timeframe. In this case, the work at PT. BST experienced delays due to several factors, such as suboptimal resource allocation, particularly in workforce placement and planning, and several other issues related to materials and work equipment .

Given the project's delays, a control analysis is necessary, assessing project performance to the extent that delays affect costs and time at the end of the project. Further control is then carried out to ensure the project operates optimally according to plan.

4.2. Earned Value Method (EVM) Analysis

1) CV and CPI Analysis Results

Based on the SV and CV Variance analysis, which was reviewed in the 27th week of the total project implementation time, the analysis results can conclude that the project experienced delays from the plan and costs were smaller than those budgeted.

Table 2Results of SV & CV Analysis

SV & CV Indicators		
Schedule Varian ce(SV)	*Cost Variance (* CV)	Information
-Rp 2,074,931,254.21 (-)	Rp 1,282,916,532.75 (+)	In Week 27, the project experienced delays and actual costs were less than planned costs.

(source : Calculation analysis with MS. Excel)

2) CPI and SPI Analysis Results

the CPI and SPI analysis , which was reviewed in the 27th week of the total project implementation time, the analysis results can conclude that the project experienced delays from the plan and costs were smaller than those budgeted.

Table 3CPI & SPI Analysis Results

CPI & SPI Indicators		
SPI	CPI	Information
0.7	1.4	By Week 27, project performance was behind schedule and costs incurred were less than revenues.

(source : Calculation analysis with MS. Excel)

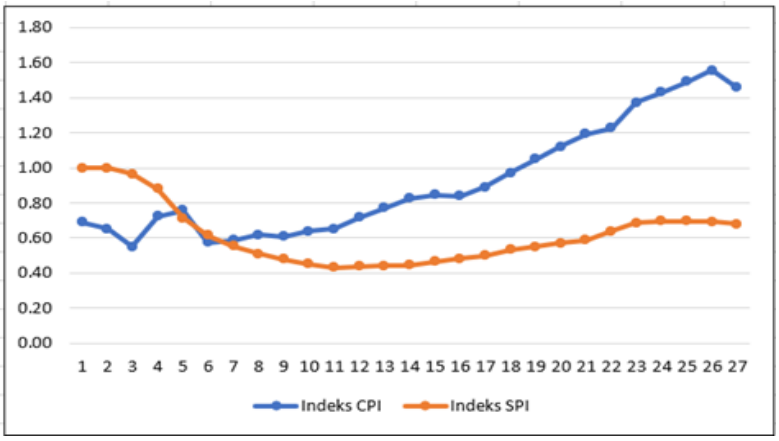

Figure 1Graph CPI & SPI
index (source : MS. Excel calculations)

graph of CPI and SPI values shows that the CPI value in weeks 1 to 18 is <1, the actual project cost is more than the budgeted value. In weeks 19 to 27, the CPI value is > 1, the actual project cost is less than the budgeted value.

The SPI value in weeks 1 and 2 = 1 means that the project implementation time is the same as planned. In weeks 3 to 27, the SPI value is < 1, the project is delayed from the planned schedule.

3) Recapitulation of EVM Analysis Results

Table 4Recapitulation EVM Analysis

Earned Value Parameters	Mark	Information
PV	Rp. 6,300,960,626.60	Planned costs for week 27
EV	Rp 4,290,146,982.66	Cost based on progress realization
AC	Rp 2,943,112,840	Cost current as of week 27
SV	-Rp 2,010,813,643.95	time more than planned
CV	Rp 1,347,034,143.01	Cost not enough from the budget
CPI	1.5	Cost not enough from the budget
SPI	0.7	time more than planned
EAC	Rp 9,685,719,731	Total Cost at the end project
ETS	47 Weeks	47 > 40 (late)
ETC	19 Weeks	Time is up Project
TCPI	1	Project Performance Experience Decline

(source : Calculation analysis with MS. Excel)

4.3. Analysis Control With TCTO

1.) Analysis work Remaining on track Critical

Based on the planning time schedule for the work remaining so made table description work For work remaining

- Construction Works : A
- Piping System Works : B
- Electrical Works : C
- Interior and Furniture Works :D
- Painting : E
- Mechanical and Mechanical Works : F

Table 5Definition Description Work Remaining

Task	Week Duration (Remaining Normal time)	Preceding Work
A	10	0
B	15	A
C	8	A
D	6	A,C
E	5	A
F	10	A

(source : Data *Time Schedule*)

Based on Table 5 , the critical path for the above work can be identified using the MS Project program. **Based on the planning time schedule and the work description table above, *a Gantt chart can be created* using MS Project as shown in the figure.**

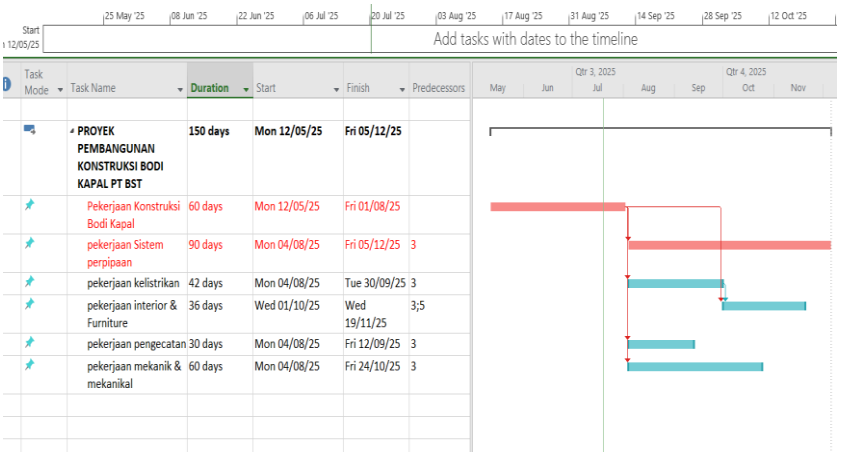

Figure 2***Gantt chart*** of **Critical Path Work Normal Time**
(Source : MS. Project Analysis)

Based on analysis track critical in figure 2, the work is on the right track critical is work with Task A and B, respectively is work Steel Construction (Shipbody) and work system piping . With Thus the acceleration steps done at work work Construction body ships and jobs system piping .Based on EVM estimated time method finished at the end project is 19 weeks , while simulation time required For remainder work is 25 weeks , meaning project need done acceleration with crashing method with Time Cost Trade Off.

2.) Analysis *Time Cost Trade Off* (TCTO)
Analysis done at work track critical that is work construction steel and systems piping with alternative acceleration with additional working hours and manpower Work .
Analysis results calculation For every alternative can seen in the table

- Work Steel Construction
  - The addition of 3 working hours means the time is shortened to 48 days from the normal time of 60 days, the crash cost is Rp. 104,423,424.66, the cost slope is Rp. 2,377,639.61
  - By adding 4 hours of work, the time can be shortened to 46 days from the normal time of 60 days, with a crash cost of Rp. 111,802,448.63, with a cost slope of Rp. 2,565,047.70.
  - Adding 1 work group can shorten the time to 40 days from the normal time of 60 days, crash cost is Rp. 79,991,780.82, cost slope is Rp. 205,000.00
  - Adding 2 work groups can shorten the time to 30 days from the normal time of 60 days ,the crash cost is Rp. 80,978,036.30, the cost slope is Rp. 170,465.17

- Work Pipe System
  - 3 hours added , shortened to 71 days from the normal 90 days, crash cost of Rp. 161,366,325.78 ,cost slope of Rp. 1,982,349.50
  - The addition of 4 working hours can shorten the time to 69 days from the normal time of 90 days , the

crash cost is Rp. 176,009,604.85 , the cost slope is Rp. 2,709,422.37

- Adding 1 work group can shorten the time to 45 days from the normal time of 90 days ,the crash cost is Rp. 125,451,703.90 , with a cost slope of Rp. 127,000.00
- The addition of 2 work groups can shorten the time to 30 days from the normal time of 90 days ,the crash cost is Rp. 128,679,452.05 , the cost slope is Rp. 105,141.00

Based on analysis calculation *Time Cost Trade Off* (TCTO) on work construction body ships and systems piping . The selected alternative For speed up time implementation project with the smallest cost slope is with addition of 2 groups work . Calculation results able seen in table 6.

Table 6TCTO Analysis Results

Job description	Normal Duration	Acceleration Duration	Normal Fee	Acceleration Fee a n	Cost Slope
Steel Construction Work	60	30	Rp. 75,891,781	Rp. 80,978,036	Rp. 169,542
Piping System Work	90	3 0	Rp. 119,736,986	Rp.126,040,853	Rp. 105,064

(source : Calculation analysis with MS. Excel)

Based on acceleration time with alternative addition group Work for each job shortened by 30 days . The addition of labor means the work can be completed in 108 working days, meaning the work is accelerated for 18 weeks, where the work is only focused on construction work and piping system work. The resulting accelerated time compared to the remaining work time with the normal duration is 25 weeks, meaning it is more than the remaining time of 19 weeks based on the EVM analysis.
so create a Gantt chart of the results acceleration as following :

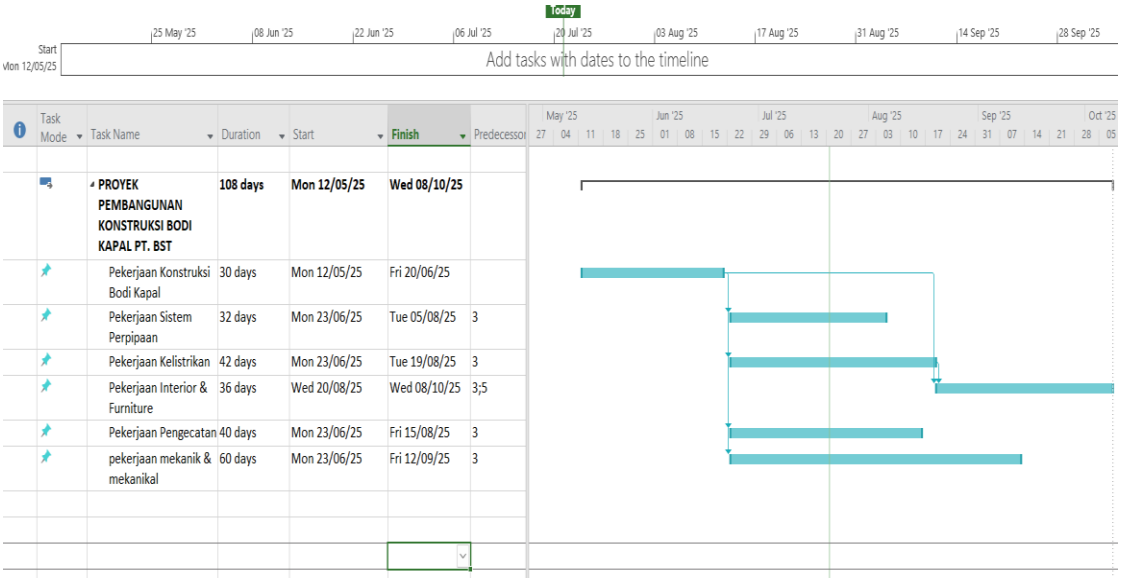

Figure 3*Gantt chart of* Critical Path Work Acceleration Time (Source : MS. Project Analysis)

IV.CONCLUSION

Based on the research results, it can be concluded that in the week 27th time reporting project experience delay than planned with SPI index is 0.7 < 1, and the costs incurred more small from the budget with CPI Index 1.4 > 1. Implementation Time remaining is 19 weeks . Control acceleration time done with the TCTO Method and the selected alternatives is with addition power work on the track critical that is work construction and work piping . Implementation time shortened to be 18 weeks from 25 Weeks normal duration for reach remainder time work at the end project that is 19 Weeks . With *Crash Cost* is as big as for each job in

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