Determining Performance Contractor's Work Using Earned Value Methods in Pertamina FFED Dumai, Cilacap & Kasim in Indonesia [1, 2]

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Abstract

One of the exciting challenges of a job implementation is controlling the work to follow what is planned in terms of cost, quality, and time. The Earned Value Method (EVM) is a way to monitor work effectively and efficiently. With EVM, several things can be observed, such as Budgeted Cost Work Performed (BCWP) or also called Earned Value (EV), Actual Cost Work Performed (ACWP) or Actual Cost (AC), Schedule Performance Index (SPI), Cost Performance Index (CPI) where everything is compared to the Budgeted Cost Work Schedule (BCWS) which is also known as the Planned Value (PV). In addition, EVM can also predict project duration by calculating Estimate at Completion (EAC), Estimate to complete (ETC), To Complete Performance Index (TCPI), and also Budget at Completion (BAC) values.

Keywords: Budgeted Cost Work Schedule (BCWS), Budgeted Work Performed (BCWP), Actual Cost Work Performed (ACWP), Schedule Variance (SV), Cost Variance (CV), Schedule Performance Index (SPI), Cost Performance Index (CPI), Estimate at Completion (EAC), Estimate to Complete (ETC), To Complete Performance Index (TCPI), Budget at Completion (BAC)

Introduction

"The world's energy needs continue to increase. According to the World Energy Agency (IEA) projections, by 2030, the world's energy demand will increase by 45%, or an average increase of 1.6% per year. Based on the IEA's projections for the period 2006-2030, the world's energy demand mostly comes from non-OECD countries, which is 87%. Fossil fuels supply around 80%

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[2] This paper was originally prepared during a 6-month long Graduate-Level Competency Development/Capacity Building Program developed by PT Mitrata Citragraha, and led by Dr. Paul D. Giammalvo to prepare candidates for AACE CCP or other Certifications. https://build-project-management-competency.com/our-faqs/

of the world's energy needs. The position of coal also marked energy growth during this period as the second most important supplier of energy sources after oil."[3]

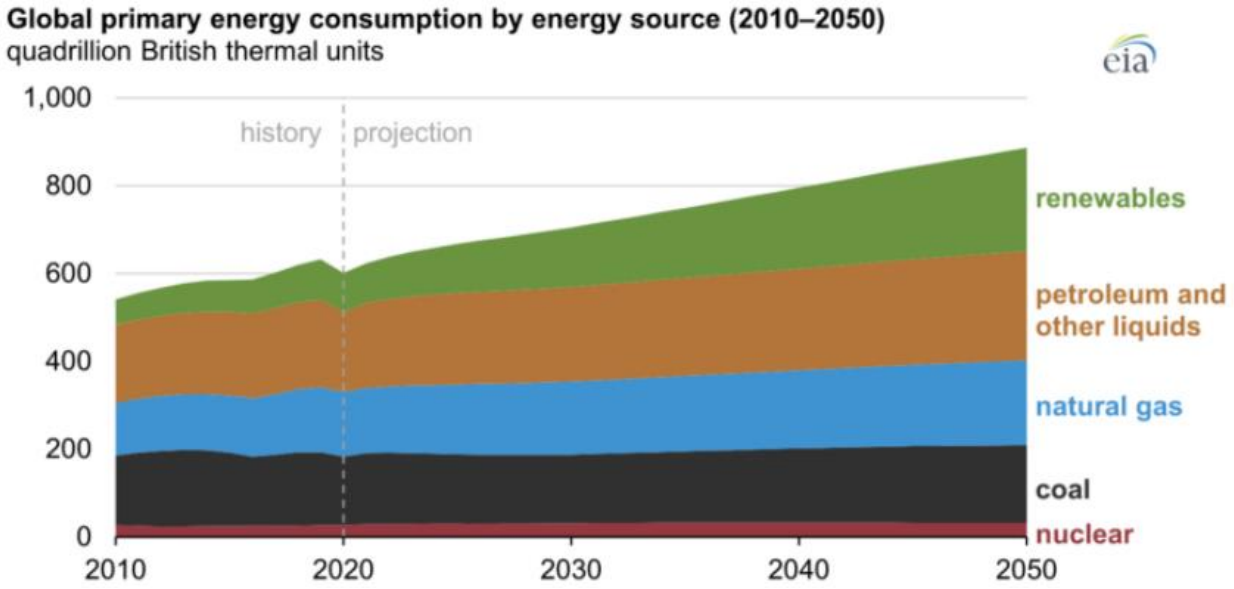


Figure 1 Global Primary Energy Consumption by Energy Source (2010-2050)[4]

"Pertamina, as a State-Owned Enterprise, has the task of carrying out activities from the Government to fulfill domestic energy needs. This Company is active in the upstream and downstream portions of the oil and gas business."[5]. "The upstream sector includes exploration and production of oil, gas, and geothermal energy, while downstream activities include processing, marketing, trading, and shipping".[6]. PT Kilang Pertamina Internasional as a Sub Holding is responsible for oil processing activities into oil products and petrochemical products, which are found in some refineries that are already operating as well as projects that are being carried out."[7].

[3]ESDM. (2018). *Hingga 2030, Permintaan Energi Dunia Meningkat 45 %*. KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL REPUBLIK INDONESIA. https://www.esdm.go.id/id/media-center/arsip-berita/hingga-2030-permintaan-energi-dunia-meningkat-45-
[4] *EIA Expects Energy Demand to Increase Almost 50 Percent Worldwide by 2050*. (2021, October 26). EIA Expects Energy Demand to Increase Almost 50 Percent Worldwide by 2050
[5] Indonesia-investments. (2022). *Pertamina*. INDONESIA-INVESTMENTS REPUBLIK INDONESIA. https://www.indonesia-investments.com/id/bisnis/profil-perusahaan/pertamina/item341
[6]Pertamina. (2020). *Pertamina*. Kegiatan Usaha Hulu. https://www.pertamina.com/id/hulu
[7]Pertamina. (2020). *Pertamina*. Refining & Petrochemical Subholding. https://www.pertamina.com/id/refining-petrochemical-subholding

Based on the regulations stipulated by the Government about Standards and Quality (Specifications of Diesel Fuel Oil), the sulfur content in the Diesel products will be reduced gradually from the current 2500 ppm to 500 ppm in 2021 and 50 ppm in 2025, as shown in the following table:

Year		2019	2020	2021	2022	2023	2024	2025
Sulfur content	ppm	2500	2500	500	500	500	500	50

Table 1 Sulphur Content Regulation [8]

To comply with the regulation requirement, OWNER has proposed to upgrade the diesel processing in RU II Dumai, RU IV Cilacap, and RU VII Kasim.

"The fundamental concept in the application of cost and schedule control is that of earned value. Earned value is the budgeted value for an element of work that has been completed. That value is determined from what had initially been planned for accomplishing that element of work. For example, if a mock-up unit for $300,000 were planned, when that mock-up unit is complete, then $300,000 worth of budget is earned. The time of accomplishment and true costs of that unit has no effect on what is earned for it, but these will be measured against the earned value to determine the cost and schedule variances. Earned value has other names and abbreviations, such as EV, performance, accomplishment, work done, and Budgeted Cost for Work Performed (BCWP)."[9]

Earned Value for Fixed Budget

"Project's budget is expressed in both work hours and dollars, which are the only common denominators of the many accounts within a project. Earned value is keyed to the project budget. Fixed budgets constrain many projects; others have floating or variable budgets. Earned value techniques can be applied in both situations, although there are differences in the details of the application. The basics of earned value will be explained by assuming the fixed budget situation. Under earned value, a direct relationship is established between the percent complete of an

[8] By Author
[9] Humprey & Associates, Project Management Using Earned Value, fourth edition, 2018, Chapter 20, page 405

account and the budget for that account. Under earned value, a direct connection is established between the percent complete of an account and the budget for that account. This relationship is expressed by the following formula. "[10]

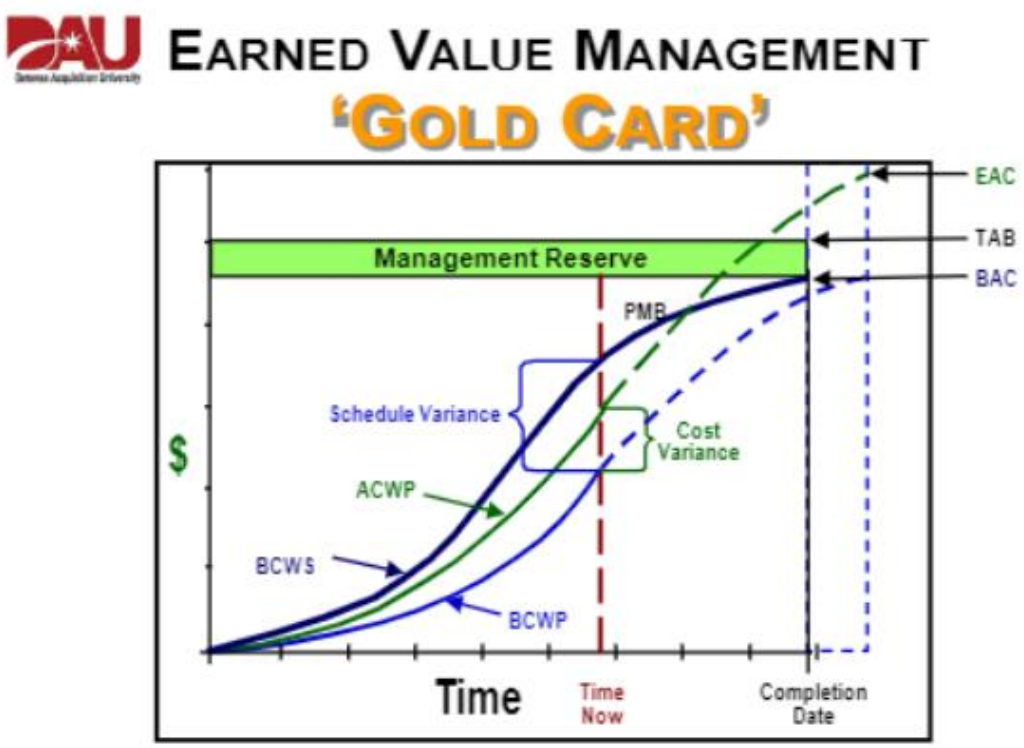


Figure 2 Relationship Between BCWS, BCWP, and ACWP [11]

Acronyms

TAB (Total Allocated Budget): Sums of All Budget for Work on Contract
PMB (Performance Measurement Baseline): Contract time-phased budget plan."[12]

Schedule Performance Index (CPI)

$$\text{“}SPI = \frac{BCWP}{BCWS}$$

[10] AACE International. (2007). *Skills & Knowledge of Cost Engineering – 5th Edition, A Special Publication of AACE International-the Association* (5th ed.). AACE International. for the Advancement of Cost Engineering, Chapter 14, Progress Measurement & Earned Value,
[11] Authorzilla. (2010, September). *DAU Gold Card Value Management*. Gold Card Value Management. https://authorzilla.com/NQNKX/dau-evm-gold-card-pdf-acqnotes.html
[12] ibid

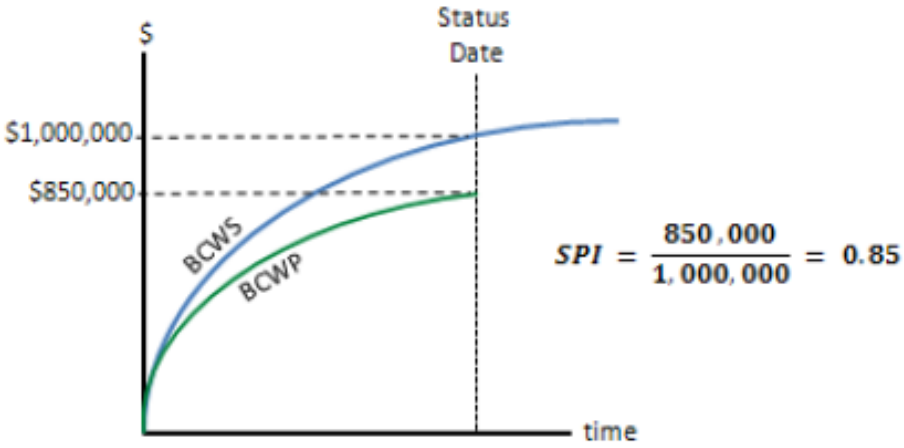


Figure 3 SPI Examples[13]

Budgeted Cost for Work Performed (BCWP)

- ✓ The value of completed work is expressed the amount of the performance budget allocated to the task. This equals the sum of the budgets for completed work packages and the completed portions of open work packages.
- ✓ Typically represents cumulative to-date values unless some other time period is specified.
- ✓ Also known as the Earned Value (EV).

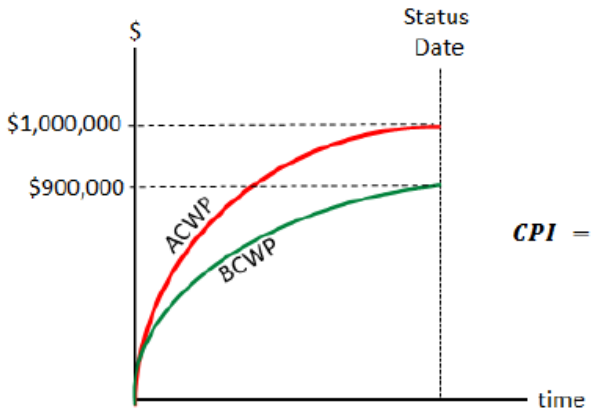
Budgeted Cost for Work Scheduled (BCWS)

- ✓ The value of completed work is expressed the amount of the performance budget allocated to the task. This is equal to the sum of the budgets for completed work packages and the completed portions of open work packages.
- ✓ Typically represents cumulative to-date values unless some of the other time periods are specified.
- ✓ Also known as the Planned Value (PV)."[14]

Cost Performance Index (CPI)

$$CPI = \frac{BCWP}{ACWP}$$

[13] NDIA, A Guide to Managing Programs Using Predictive Measures, page 5, March 26, 2021, Revision 3
[14] Ibid, page 5



$$CPI = \frac{900,000}{1,000,000} = 0.90$$

Figure 4 CPI Examples [15]

Budgeted Cost for Work Performed (BCWP)

- ✓ The value of completed work is expressed the amount of the performance budget allocated to the task. This equals the sum of the budgets for completed work packages and the completed portions of open work packages.
- ✓ Typically represents cumulative to-date values unless some other period is specified.
- ✓ Also known to as the Earned Value (EV)

Actual Cost Work Performed (ACWP)

- ✓ The sum of the actual costs incurred for all work performed within a given period. This includes the actual costs for completed work packages and the costs to perform the completed portions of open work packages.
- ✓ Typically represents cumulative to-date values unless some other time period is specified.
- ✓ Also known to as the Actual Cost (AC)

Estimate to Complete (ETC)

- ✓ The estimated cost to complete the remaining scope of a project. This includes the projected cost of completing in-progress work packages, as well as an estimate of the cost to complete all future work packages and planning packages.

[15] Ibid, page 39

Estimate at Completion (EAC)

- ✓ The projected total cost of a project. This is equal to the sum of all costs incurred to date and estimated costs going forward.
- ✓ EAC = ACWP + ETC

Budgeted Cost for Work Remaining (BCWR)

- ✓ The budget value of all work yet to be performed. This includes the unearned budget for in-progress work packages, as well as the budget for all future work packages and planning packages.

Budgeted at Complete (BAC)

- ✓ The projected total cost of a project. This is equal to the sum of all costs incurred to date and estimated costs going forward.
- ✓ BAC = BCWP + BCWR"[16]

Cost and Schedule Performance

"The methods for calculating percent complete, schedule variance (SV), schedule performance index (SPI), cost variance (CV), and cost performance index (CPI), as described under the fixed budget system, are fully applicable in the variable budget system."[17]

Earned Value Management

"The work completed within a given period is measured by EVM, which compares it to the intended value of the work scheduled for that time period and the actual cost of the job completed. EVM, a crucial management idea, improves acquisition program supervision. Understanding the performance state and calculating the cost and time to execute a task using the metrics produced from these values."[18]

"The two primary purposes for implementing an EVM system are to:

1) Promote the adoption of efficient internal cost and schedule management controls, and

[16] ibid, page 44
[17] Humprey & Associates, Page 405, Project Management Using Earned Value, fourth edition, Humprey
[18] GAO US government accountability office. (2020). page 207, *COST ESTIMATING AND ASSESSMENT GUIDE, Best Practices for Developing and Managing Program Costs* (GAO-20-195G), March 2020

2) To help the customer determine the state of the contract by product, give them timely and reliable data. In order to integrate program planning and execution across cost, schedule, and technical disciplines, an efficient EVM system includes management processes."[19]

Problem Statement

"To carry out a project with cost, quality and time according to the plan, it is necessary to have a tested monitoring and evaluation tool. Especially if the budget for the work must be in accordance with the budget, failure in planning and implementing work will result in not achieving the goals of the Government in fulfilling domestic energy needs."[20]

This study aims to optimize the project's schedule and cost by using earned value method to monitor and evaluate projects in Pertamina refineries. The Author also seeks the answer to the following questions:

1. Why should we use the earned value method?
2. What are the challenges of using the earned value method in carrying out the work?
3. What are the advantages for Pertamina by implementing EVM?

Methodology

"The methodology is defined as "Research methodology," which comes from the word "Method," which means the right way to do something, and "Logos," which means knowledge or knowledge. So, methodology implies doing something by carefully using the mind to achieve a goal. While "Research" is an activity to search, record, formulate and analyze until compiling the report."[21]

[19] Gao us government accountability office. (2020). page 208, *COST ESTIMATING AND ASSESSMENT GUIDE, Best Practices for Developing and Managing Program Costs* (GAO-20-195G).
[20] By Author
[21] Sahayu, wening,(2016). TEORI METODOLOGI PENELITIAN. *TEORI METODOLOGI PENELITIAN*.

Engineering Economic Analysis Procedure	Engineering Design Process (see Figure P1-15 on p. 18)
Step	*Activity*
1. Problem recognition, definition, and evaluation.	1. Problem/need definition.
	2. Problem/need formulation and evaluation.
2. Development of the feasible alternatives.	3. Synthesis of possible solutions (alternatives).
3. Development of the outcomes and cash flows for each alternative.	
4. Selection of a criterion (or criteria).	4. Analysis, optimization, and evaluation.
5. Analysis and comparison of the alternatives.	
6. Selection of the preferred alternative.	5. Specification of preferred alternative.
7. Performance monitoring and post-evaluation of results.	6. Communication.

Table 2 The General Relationship between the Engineering Economy Analysis Procedure and the Engineering Design Process [22]

The engineering design process, which is depicted in Table 2's right-hand column, uses the seven-step technique to help with decision-making. In this instance, information from design-related activities is added to steps in the economic analysis process that are connected to them. As shown in Table 2, there is a general correlation between the design-related tasks and the work involved in the economic analysis process." [23]

Step 1 Problem Recognition, Definition, and Evaluation

" In the framework of implementation, the activities of providing diesel fuel (BBM) which is marketed domestically and to obtain certainty of the quality of domestic energy by taking into account technological developments, producer capabilities, consumer capabilities, and needs, occupational safety and health, environmental management, as well as the development of the obligation to use biofuels (BBN) in the form of biodiesel, the Director General of Oil and Gas stipulate Decree Number 146.K/10/DJM/2020 concerning Standards and Quality (Specifications) of Diesel Fuel Types Marketed Domestically."[24]

[22] Sullivan william g, wicks elin m., koelling c. patrick, wicks,. (2015). Page 7, *Engineering Economy* (16th ed.). Pearson.
[23] ibid
[24] Ministry of energy and mineral resources. (2022). *Keputusan Dirjen Migas Nomor 146.K/10/DJM/2020 Tentang Standar Dan Mutu (Spesifikasi) Bahan Bakar Mi...* MINISTRY OF ENERGY AND MINERAL RESOURCES REPUBLIC OF INDONESIA. https://www.esdm.go.id/en/berita-unit/directorate-general-of-oil-and-gas/keputusan-

Step 2 Development of the Feasible Alternatives

Based on the regulatory form Government, Pertamina, as a State-Owned Company, plans to upgrade diesel processing at RU II Dumai, RU IV Cilacap, and RU VII Kasim.

1. RU II Dumai

In the context of Refinery Unit II Dumai diesel processing, after the execution of the Open Access project phase I and the declining production of Sumatran Light Crude (SLC) and Duri Crude Oil (DCO), RU II Dumai will process mostly sour crude such as Banyu Urip Crude Oil (BUCO), Crude Cinta, etc. By processing these types of crude, the Pool of Solar products from the Dumai Refinery (DMI) and Sungai Pakning (SPK) refineries will tend to have a sulfur content of ± 880-2000 ppm-wt and ± 1000 ppm-wt in the diesel product. "[25]

2. RU IV Cilacap

Refinery Unit IV, located in the district of Cilacap, Central Java Province, has several operating areas, including two areas of Fuel Oil Complex (FOC I and FOC II) with main products such as gasoline, avtur, diesel, LPG, etc. FOC I process 100% middle east crude (Arabian Light Crude/ALC) with a sulfur content of around 1.8% wt, while FOC II processes mixed crude (cocktail crude) with a sulfur content of around 0.2%-wt. RU IV Cilacap is currently capable of producing diesel fuel with a sulfur content of 2500 ppm. "[26]

3. RU VII Kasim

Refinery Unit VII is located on Papua island, close to Kasim Marine Terminal (KMT) Petro China, approximately 90 km south of Sorong city. Fuel production from RU VII Kasim covers fuel consumption in Maluku and Papua. RU VII Kasim capacity is ten mbsd, currently processing Walio Mix Crude (100%) with sulfur content around 3700 ppm. RU VII Kasim is presently capable of producing diesel fuel with a sulfur content of 2500-3500 ppm."[27]

dirjen-migas-nomor-146k-10-djm-2020-tentang-standar-dan-mutu-spesifikasi-bahan-bakar-minyak-jenis-solar-yang-dipasarkan-di-dalam-negeri
[25] By Author
[26] By Author
[27] By Author

PROJECT LOCATION

1. Refinery Unit – II Dumai

Refinery Unit (RU) II is located in Dumai, Riau Province. The DHT Complex will locate in the existing refinery area. The preliminary plotted area will follow the picture as shown below. This project's area size (green box) is approximately 75.000 m2."[28]

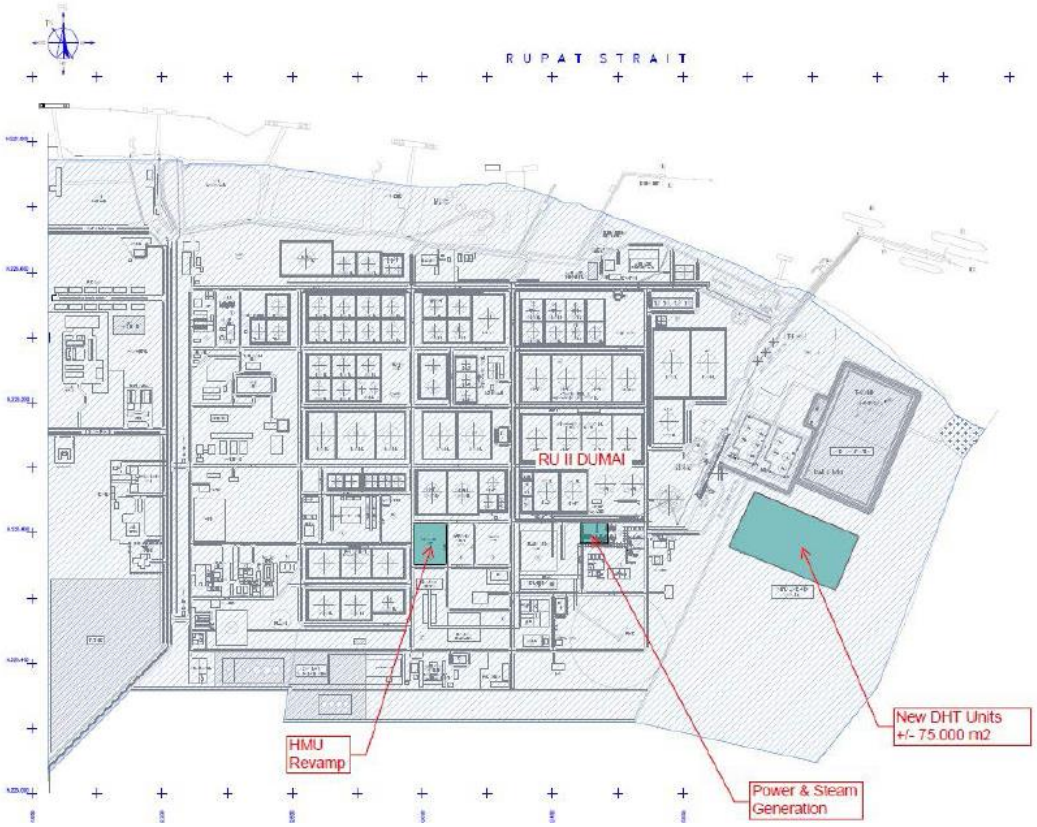


Figure 5 Project Location for DHT RU II Dumai

2. Refinery Unit – IV Cilacap

Refinery Unit (RU) IV is located in Cilacap, Central Java Province. The DHT Complex will be located in the existing refinery area. The preliminary plotted area will follow the picture as shown below. The available area size for this project is approximately 80,000 m2."[29]

[28] By Author
[29] By Author

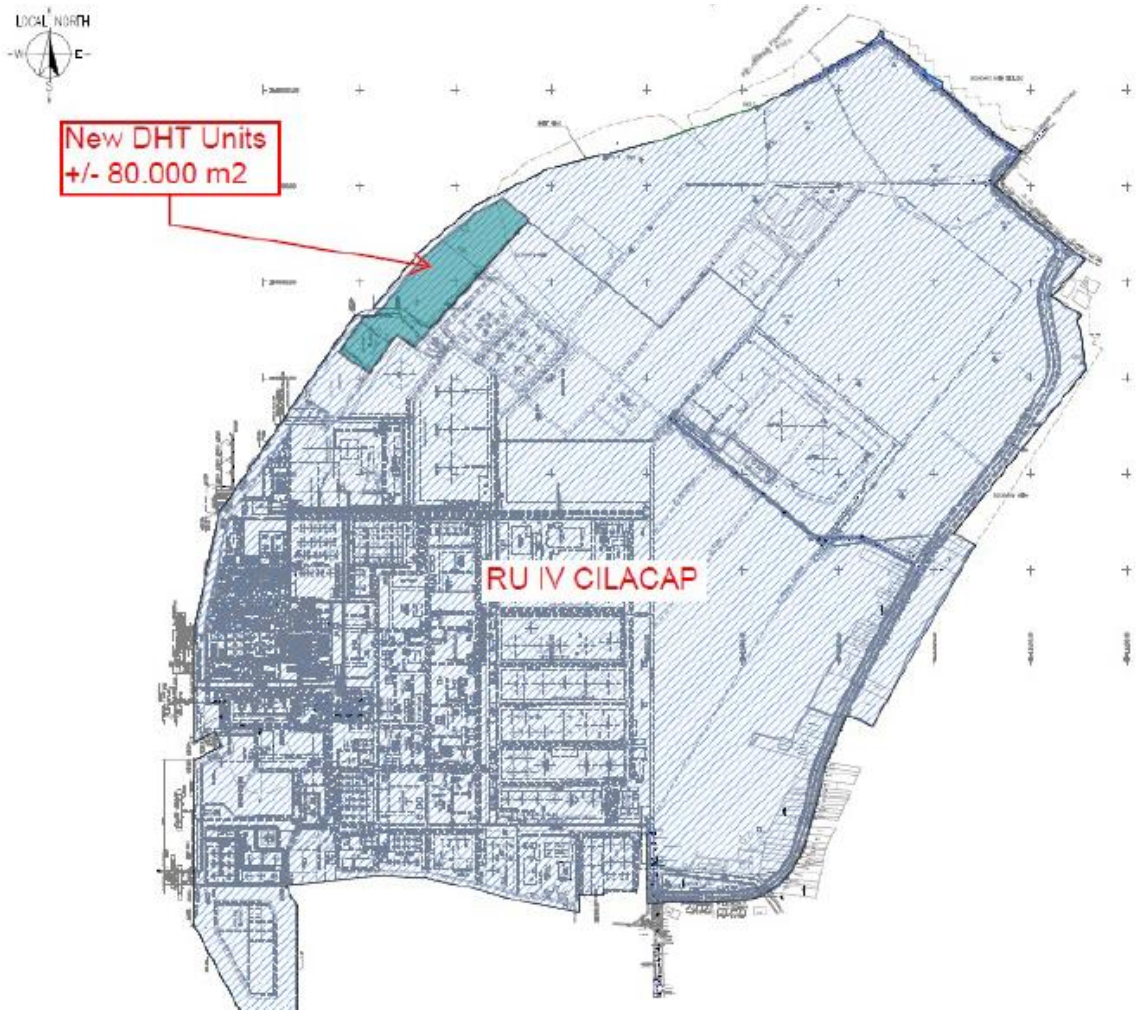


Figure 6 Project Location for DHT RU IV Cilacap

3. Refinery Unit – VII Kasim

Refinery Unit (RU) VII is located on Papua island, close to Kasim Marine Terminal (KMT) Petro China, approximately 90 km on the south side of Sorong city. The DHT Complex will locate in the existing refinery area. The preliminary plotted area will follow the picture as shown below. The available area size for this project is approximately 16,500 m2."[30]

[30] By Author

Figure 7 Project Location for DHT RU VII Kasim

Step 3 Development of the Outcomes

This essay's goal is to explain how the Independent Estimates at Completion (IEAC) method can be used to measure performance.

Performance Indices

Cost Performance Index (CPI

Under the efficiency concept, the purpose of the Cost Performance Index (CPIE) is to indicate the efficiency with which work has been accomplished.

$$\boldsymbol{CPI} = \frac{\boldsymbol{EV}}{\boldsymbol{AC}} = \frac{\boldsymbol{BCWP}}{\boldsymbol{ACWP}}$$

The CPIE, as defined above, displays an efficiency percentage for the work completed."[31]

[31] Humprey & associates. (2018). Page 478, *Project Management Using Earned Value* (4th ed.). Humprey & Associates.

Schedule Performance Index (SPI)

Schedule Performance Index is defined as

$$SPI = \frac{EV}{PV} = \frac{BCWP}{ACWP}$$

The SPI is merely another measure of schedule performance, providing a picture of the relative rate at which work is being completed compared to the planned rate."[32]

To Complete Performance Index (TCPI)

While the CPI_E looks at performance in the past, the TCPI represents projected performance in the future based on the EAC. It compares the budget for remaining work with the estimate for remaining work, allowing a measure of required performance to achieve the estimate at completion.

$$TCPI_{EAC} = \frac{BAC - BCWP_{cum}}{EAC - ACWP_{cum}}$$

Independent Estimates at Completion (IEAC)

"Independent EAC Calculations may be used to predict the final cost of a project. This result can then be compared with the reported estimate at completion (EAC). Typically, an independent EAC (or IEAC) is derived by adding cumulative actual cost to the budgeted cost of the work remaining, which is modified by a performance factor such as the Cost Performance Index (CPI_E)

$$\mathbf{IEAC} = \left(\mathbf{Actual\ Cost\ to\ Date} + \frac{\mathbf{Budgeted\ Cost\ of\ Work\ Remaining}}{\mathbf{Performance\ Factor}}\right)$$

The term "Budgeted cost of work remaining" is defined as Budgeted at Completion (BAC) minus cumulative earned value (EV), or the Budgeted Cost of Work Remaining (BCWR). "[33]

There are many ways of developing Independent Estimates at Completion (IEAC). Four useful calculations are as follows:

[32] ibid
[33] ibid

IEAC	Formula	Assumption	Comments
IEAC1	$= ACWP + \frac{BAC - BCWPcum}{CPI}$	Future cost performance will be the same as all past cost performance.	"Best Case" when CPI is less than 1.0 and "Worst Case" when CPI is greater than 1.0.
IEAC2	$= ACWP + \frac{BAC - BCWPcum}{SPI}$	Future cost performance will be influence by past schedule performance.	Use with caution as SPI is diluted by LOE and loses accuracy over the last third of the project.
IEAC3	$= ACWP + \frac{BAC - BCWPcum}{SPI \times CPI}$	Future cost performance will be influence by past schedule and cost performance.	In contrast to IEAC1, this calculation typically yields the "Worst Case" when SPI and CPI are less than 1.0.
IEAC4	$= ACWP + \frac{BAC - BCWPcum}{(0.2 \times SPI) + (0.8 \times CPI)}$	Similar to IEAC3, except increased weight is placed on CPI.	More reliable than IEAC3 late in a project since less weight is given to SPI.

Table 3 Four Common Ways of Calculating IEAC[34]

Independent Estimated Completion Date (IECD)

"In calculating an Independent Estimate at Completion (IEAC), the date on which it is believed that the work will be completed must also be estimated. The Independent Estimated Completion Date (IECD) is determined by adding the estimated number of Months to Complete (MTC) the remaining work to the time now date.

$$\mathbf{IECD = Time\ Now\ Date + MTC}$$

There are numerous ways to determine how many more months the task needs to be completed (MTC). The computation could be done using

1. the current Budget value

$$\mathbf{MTC} = \frac{BAC - EV_{cum}}{PV_{cur}} = \frac{BAC - BCWP_{cum}}{BCWS_{cur}}$$

2. an average Budget value

$$\mathbf{MTC} = \frac{BAC - EV_{cum}}{PV_{avg}} = \frac{BAC - BCWP_{cum}}{BCWS_{avg}}$$

[34] NDIA, A Guide to Managing Programs Using Predictive Measures, page 46, March 26, 2021, Revision 3.

3. the current Earned value

$$\mathbf{MTC} = \frac{BAC - EV_{cum}}{EV_{cur}} = \frac{BAC - BCWP_{cum}}{BCWP_{cur}}$$ an

4. average Earned Value

$$\mathbf{MTC} = \frac{BAC - EV_{cum}}{EV_{avg}} = \frac{BAC - BCWP_{cum}}{BCWP_{avg}}$$ "[35]

Average Performance Rate Required to Achieve the Estimated Completion Date (ECD)

"Just as the TCPI formula can be used to evaluate the cost performance required to achieve the EAC, the average rate or performance required to achieve the estimated completion date can be calculated

$$\boldsymbol{Average\ Performance\ to\ Complete} = \frac{BAC - EV_{cum}}{MTC} = \frac{BAC - BCWP_{cum}}{MTC}$$

Subsequent to this calculation, a comparison can then be made to further evaluate future performance by analyzing past performance:

$$\boldsymbol{Past\ Average\ Performance} = \frac{EV_{cum}}{MTD} = \frac{BCWP_{cum}}{MTD}$$

Where MTD = Months to Date"[36]

Step 4 Selection of a Criterion (or Criteria)

"Project data as follows and will be calculated using several criteria mentioned in Step 3.
Project Value : IDR 45,787,000,000
Man-Hour Planning : 144,589 man-hour
Duration : 6 months
Latest Data 4 months after signed contract (The Latest Data as of Beginning October)"[37]

[35] Humprey & associates. (2018). Page 482, *Project Management Using Earned Value* (4th ed.). Humprey & Associates..
[36] Humprey & associates. (2018). Page 482-483, *Project Management Using Earned Value* (4th ed.). Humprey & Associates.
[37] By Author

Period	M1	M2	M3	M4	M5	M6
BCWS	632	3.397	9.240	9.716	11.131	11.671
BCWP	673	3.727	3.750	7.363	-	-
ACWP	749	2.487	6.579	3.858	-	-
BCWS-Cummulative	632	4.029	13.269	22.985	34.116	45.787
BCWP-Cummulative	673	4.400	8.150	15.513		
ACWP-Cummulative	749	3.236	9.815	13.673		
SV	41	371	(5.119)	(7.472)		
CV	(76)	1.165	(1.665)	1.839		
SPI	1,07	1,09	0,61	0,67		
CPI	0,90	1,36	0,83	1,13		

Table 4 Calculation of Earned Value Methods [38]

By using several criteria, the following results are obtained.

Data	Result
ACWP	13.673.336.004
BAC	32.113.663.996
BCWP	15.512.635.600
BCWS	22.985.074.000
BCWP(avg)	5.747.184.240
BCWS(avg)	8.183.052.640
CPI	1,13
SPI	0,67

Table 5 Calculation of Earned Value Method[39]

Data IEAC	Result
IEAC1	28.306.016.428
IEAC2	38.271.081.738
IEAC3	35.354.580.316
IEAC4	29.596.149.943

Table 6 Calculation IEAC[40]

[38] By Author
[39] By Author
[40] By Author

Data MTC	Result	Unit
MTC1	1,00	Months
MTC2	3,00	Months
MTC3	2,00	Months
MTC4	3,00	Months

Table 7 Calculation MTC[41]

Decription	Time Now Date	MTC	IECD
	Months		
IECD1	4	1,00	5,00
IECD2	4	3,00	7,00
IECD3	4	2,00	6,00
IECD4	4	3,00	7,00

Table 8 Calculation IECD[42]

Findings

Step 5 Analysis and Comparison of the Alternatives

Based on the calculation results in the previous step, several alternatives will be analyzed, along with a comparison of each.

1. Independent Estimate At Completion

   From Table 6, the smallest to the largest IEAC results compared to the Project Contract Value are as follows:

Data IEAC	Ratio to Contract Value	
IEAC1	28.306.016.428	61,82%
IEAC2	38.271.081.738	83,59%
IEAC3	35.354.580.316	77,22%
IEAC4	29.596.149.943	64,64%

Table 9 Ratio IEAC to Contract Value[43]

[41] By Author
[42] By Author
[43] By Author

From the comparison with the contract value, good results were obtained for the Bidder.

2. Independent Estimate Completion Date

From Table 8, the smallest to the largest IECD results compared to the duration of the work are as follows:

Description	Time Now Date	MTC	IECD
	Months		
IECD1	4	1,00	5,00
IECD2	4	3,00	7,00
IECD3	4	2,00	6,00
IECD4	4	3,00	7,00

Table 10 Ratio IECD to Contract Duration[44]

3. SPI, CPI & S-Curve Analysis

The SPI and CPI values are displayed again.

Period	M1	M2	M3	M4
SPI	1,07	1,09	0,61	0,67
CPI	0,90	1,36	0,83	1,13

Table 11 SPI & CPI Value every month[45]

The S-Curve is shown as follows:

[44] By Author
[45] By Author

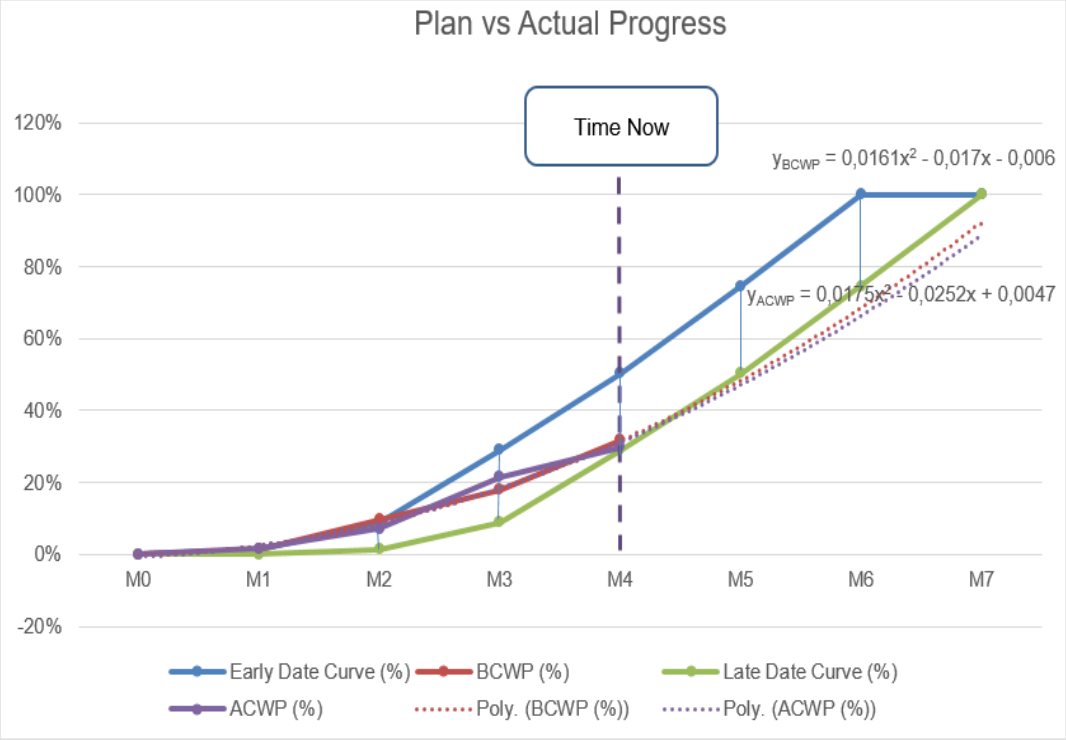


Figure 8 S-Curve Project up to Months 4[46]

Period	M0	M1	M2	M3	M4	M5	M6	M7
Plan (%)	0%	1,38%	7,42%	20,18%	21,22%	24,31%	25,49%	0%
Actual (%)	0%	1,47%	8,26%	8,19%	13,75%			
Early Date Curve (%)	0%	1,38%	8,80%	28,98%	50,20%	74,51%	100,00%	100,00%
Late Date Curve (%)	0%	0,00%	1,38%	8,80%	28,98%	50,20%	74,51%	100,00%
BCWP (%)	0%	1,47%	9,73%	17,92%	31,67%			
ACWP (%)	0%	1,64%	7,07%	21,44%	29,86%			

Table 12 Plan vs. Actual Progress[47]

[46] By Author
[47] By Author

SPI Value	Implication
> 1.00	FAVORABLE - The effort on average is being accomplished at a faster rate than planned
= 1.00	ON TRACK - The effort on average is performing to plan
< 1.00	UNFAVORABLE - The effort on average is being accomplished at a slower rate than planned

Figure 9 SPI Value[48]

CPI Value	Implication
> 1.00	FAVORABLE - The effort on average is being accomplished more efficiently than planned
= 1.00	ON TRACK - The effort on average is being accomplished at the planned efficiency
< 1.00	UNFAVORABLE - The effort on average is being accomplished less efficiently than planned

Figure 10 CPI Value[49]

Analysis was performed for SPI, CPI, and S-Curve.

A. First-Month Analysis

Table 11 obtained SPI 1.07 and CPI 0.90. This shows that the Bidder is ahead of schedule and costs are overrun. As for the S-Curve, Actual Progress is 1,47%, and Planned Progress is 1,38%; in the first month, progress is still ahead of schedule, which aligns with the SPI value.

B. Second-Month Analysis

Table 11 obtained SPI 1.09 and CPI 1.36. This shows that the Bidder is ahead of schedule and costs are underrun. As for the S-Curve, Actual Progress is 9.73%, and Planned Progress is 8.80%; in the second month, progress is still ahead of schedule, which aligns with the SPI value.

C. Third-Month Analysis

Table 11 obtained SPI 0.61 and CPI 0.83. This shows that the Bidder is delayed in schedule, and costs are overrun. As for the S-Curve, Actual Progress is 17.92%, and Planned Progress is 28.98%; it shows that in the third-month progress is a delay in the schedule, which is in line with the SPI value.

[48] NDIA, A Guide to Managing Programs Using Predictive Measures, page 6, March 26, 2021, Revision 3.
[49] NDIA, A Guide to Managing Programs Using Predictive Measures, page 40, March 26, 2021, Revision 3.

D. Fourth-Month Analysis

Table 11 obtained SPI 0.67 and CPI 1.13. This shows that the Bidder is ahead of schedule and costs are overrun. As for the S-Curve, Actual Progress is 31,67%, and Planned Progress is 50.20%; in the fourth month, progress is delayed in the schedule, which is in line with the SPI value.

From the analysis results obtained, the following information:

1. From the third month, a delayed schedule has been described.
2. The bidder must re-baseline based on the data in order for the work to be executed in accordance with the contract.
3. Intensive monitoring using the EVM analysis every week to track the progress.
4. The Cost Performance Index for this work tends to improve.

Step 6 Selection of the Preferred Alternatives

Based on the analysis and comparison in step 5, the result should be considered the most considerable delay. In this case, the IECD 2 and IECD 4 calculations were obtained using these calculations with an estimated completion duration of 7 months.

Step 7 Performance Monitoring and Post-Evaluation of Results

From the results obtained, several things were obtained as follows:

1. Compare the IEAC and IECD calculations for each month.
2. Earned Value Management for the Company is an early warning system to monitor and control project costs and duration as planned continuously. This system helps detect when something undesirable happens and quickly takes the necessary action.

Conclusion

In this paper, the Author sought or was seeking answers to the following questions:

1. Why should we use the earned value method?

"One of the fundamental requirements of any good project management system is the ability to determine the accurate status of a project. Otherwise, the development of a plan loses its value

since there is no way to accurately assess how closely the plan is being followed or monitor the results of corrective action. Earned value is an effective way to do so."[50]

2. What are the challenges of using the earned value method in carrying out the work?

The three principles that govern the earned value technique are planned value, earned value, and actual cost. These three requirements must be consistently followed and thoroughly monitored in order to guarantee that the project complies with the stipulated contract.

3. What are the advantages for Pertamina by implementing EVM?

The Advantages for Pertamina are:

1. Gets accurate planning from Bidder.
2. Be able to monitor progress regularly based on planned value from bidders and detect project conditions early on with a record that the reports received have been appropriately validated.
3. Able to immediately make the necessary repairs to complete the job.

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