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ANALYSIS OF COST AND TIME CONTROL WITH EARNED VALUE METHOD USING MICROSOFT PROJECT 2010 (CASE STUDY: RIVER NORMALIZATION AND DRYDRYING WORKS SPREAD IN THE CITY OF BANJARMASIN (MUARA SUNGAI BUAYA))

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ABSTRACT

The Crocodile River is one of the tributaries of the Andai River in Banjarmasin, serving as a means of transportation for the surrounding community and as a means of distributing water to larger rivers during high rainfall. The normalization and dredging work of rivers spread across the city of Banjarmasin (Estuary of the Buaya River) is expected to provide a level of service and comfort for those who carry out daily activities in the environment near the river so that the people of Banjarmasin can carry out their activities again and do not experience problems such as drought during the dry season and floods. During the rainy season.

In interviews with the contractors, the project for normalization and dredging of rivers spread across Banjarmasin could be completed without delay, even though the duration of the work was quite short. With this research, I use the earned value method with the help of the Microsoft Project 2010 program to evaluate the project completion time and the total cost incurred on the project.

After the Normalization and Dredging work of the Banjarmasin Crocodile Estuary or during the 5th week, there was a difference in time and cost in the realization and planning. In the 5th week, the CV value of the job is Rp 68,657.00- and the SV value is Rp 42,132,333,36-. This means that the realization of the work is going faster than planned and the budget spent is less than planned. From week 1 to week 5, the SPI and CPI values are >1. This means that the Normalization and Dredging work of the Banjarmasin Crocodile Estuary was carried out with good performance and was completed faster than planned, and. The work was carried out at a lower cost or more efficient.

Keywords: Earned Value, Microsoft Project 2010, SV, CV, SPI, CPI

1. INTRODUCTION

Background

The Crocodile River is one of the tributaries of the Andai River in Banjarmasin, serving as a means of transportation for the surrounding community and as a means of distributing water to larger rivers during high rainfall. Based on observations seen over time, the rivers in Banjarmasin are getting smaller, and during the dry season, the water looks very dry, and it looks like there is no water flow. One of the rivers in Banjarmasin is the crocodile river. Due to the shrubs and sago palm trees that grow around the river which causes the rivers in Banjarmasin get smaller and drier as if there is no water flow. However, during the rainy season, rivers can overflow and cannot accommodate the overall water discharge.

Normalization and dredging works were carried out for the scattered rivers in Banjarmasin (Estuary of the Buaya River). In this project, it is hoped that the people of Banjarmasin who live near the river can carry out their activities again and not experience problems such as drought during the dry season and flooding during the rainy season.

In implementing a project, it is very rare to find a project that goes exactly as planned. Generally experience delays, both time and work progress. However, in interviews with contractors, the project for normalization and dredging of rivers spread across Banjarmasin could be completed without delay despite having a fairly short duration of work. With this research, I use the earned value method with the help of the Microsoft Project 2010 program to review the performance of project implementation and evaluate the control of project completion time and costs and the total costs incurred on the project so that the value of the time difference and the cost of the plan with the results can be determined.

2. STUDY OF THEORY

2.1. Concept of Earned Value Analysis

The concept of Earned Value is the concept of calculating the number of costs according to the budget according to the work that has been completed/implemented. When viewed from the amount of work completed, it means that this concept measures the number of work units that have been

completed at a time when assessed based on the amount of budget provided for the work.

2.1.2 Analysis of Earned Value Indicators

- **Planned Value (PV)**

Also known as BCWS (Budgeted Cost of Work Scheduled).

PV = % (bobot rencana) x Rp (Nilai Kontrak sebelum PPN)

- **Earned Value (EV)**

Also known as BCWP (Budgeted Cost of Work Performed).

EV = % (bobot realisasi) x Rp (Nilai Kontrak sebelum PPN)

- **Actual Cost (AC)**

Also known as ACWP (Actual Cost of Work Performed), this actual cost consists of:

a. Direct costs include materials, labor costs, and work equipment.
b. Indirect costs
   - Overhead costs in the office and in the field include taxes, operational costs, and non-operational costs.

2.1.3. Analysis of Variance

- **Schedule Variance (SV)**

SV = EV − PV atau SV = BCWP − BCWS

a. Negative (-) = Late from schedule
b. Zero (0) = On Time
c. Positive (+) = Faster than Schedule

- **Cost Variance (CV)**

CV = EV-AC or CV = BCWP-ACWP

a. Negative (-) = Cost Overrun (Cost above Plan)
b. Zero (0) = According to Cost
c. Positive (+) = Cost Underrun (Cost under Plan)

2.1.4. Performance Index Analysis

- **Schedule Performance Index or SPI (Schedule Performance Index)**

SPI = EV/PV atau SPI = BCWP/BCWS

Where,

SPI = 1: project on time

SPI > 1: faster projects

SPI < 1: late project

- **Cost Performance Index or CPI (Cost Performance Index)**

CPI = EV/AC or CPI = BCWP/ACWP

Where,

CPI = 1 : costs as planned

CPI > 1 : less cost/saving

CPI < 1 : higher cost/wasteful

In general, the use of earned value concept in project performance appraisal is explained in Figure 2.2.

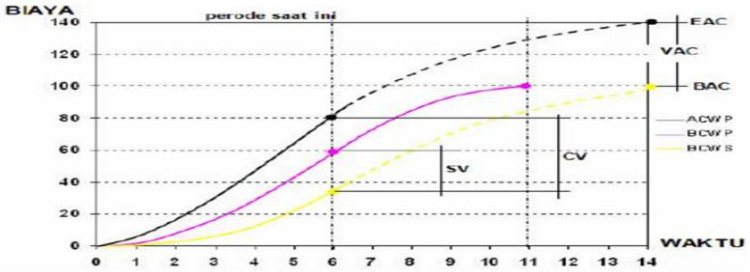


Figure 2.2 Graph of Earned Value S Curve

2.2. Definition and benefits of Microsoft Project 2010

Microsoft Project, also known as MS Project, is a program capable of managing project data. Microsoft Project 2010 is part of Microsoft Office Professional 2010, which can be easily integrated into Microsoft Exel and Visio programs.

2.3. Using Microsoft Project 2010

Steps in using Microsoft Project 2010:

- **Run and fill in project data on Microsoft Project 2010**

Click the ***Start*** menu > click ***All Programs*** > Click ***Microsoft Office Project*** 2010

- **Entering project data**

Ribbon project, click icon ***project information***> Click ***start date***> select the project startdate, and the date will appear in the star date box > Click ***Ok***

- **Setting the project calendar**

Ribbon project group ***properties,*** click ***change working time*** Please select one of the days with specific working hours > In the section ***Exception tab,*** enter a name on the first line below ***Name*** and Click ***Start*** > Press button ***Details*** to provide details of the working hours. In the Details section, if the nature is repetitive, we can add details to the section ***Recurrence Pattern*** that is *daily, weekly, monthly, yearly.* In the Range of Ruccurence again specify how long this exception ends or chooses after how many times it has occurred.

- **Create a new calendar**

Ribbon Project group ***Properties*** click icon ***Change Working Time*** > Press the button ***Create New Calendar***, name calendar > ***Create New Base*** *Calendar* create a new calendar base or Copy from an existing calendar> choose ***Work Weeks tab*** > Select ***Default*** on ***Table*** and press button ***details*** on the right.

- **Enter activities and their duration**

Views, click ***Gantt Chart*** > In the ***Field Task Name***, enter the name of the activity and the duration of the process > Inside ***Field Duration***, input the length of each activity and the abbreviation for the duration time unit, the abbreviation used is *months* = mo, *weeks* = w, *days* = d, *hours* = h, and *minutes* = m >Press ***Enter***.

- **Determine the start and end of activities**

View, click ***Gantt Chart >*** In the ***Field Task Name,*** select two or more activities to connect > ***Task***, click ***Task Link*** (or ***Toolbar*** shaped like a chain). FS ***(Finish to Start)***, FF ***(Finish to Finish)***, SS ***(Start to Start)***, and SF ***(Start to Finish)***.

- **Lag time and lead time**

Inside ***Filed Task Name*** Click the activity you want to add ***Lead*** or Lag time, select Task Information > Click ***Predecessors Tab*** > Inside Column ***lag*** type how long the delay is as the time duration > Click ***Ok***.

- **Manage Project resources Manage workforce resources**

Views, click ***Resource Sheet*** > From the menu ***views,*** Click ***Table*** and click ***Entry*** > In the ***Resource Name field,*** type the name of the resource and its detailed information > type name ***group*** in the ***Group Field*** to enter resources >In the ***field Type*** specify resource type, ***Work Resources*** (person or equipment) to be ***Work***, ***resource materials*** become material, ***Cost Resources*** Becomes ***Cost*** > For each ***Work Resources*** type Number of available resource Units > For each ***Material***

Resources, type inside ***field Label Material***, for the unit's measurement > For ***Cost Resources***, the cost will be entered directly at the time of allocating ***resources*** this on an activity.

- **Allocating labor to activities**

View, choose ***Gantt Chart*** > From ***Field Task Name***, select the activity for which you want to assign resources, right-click Task information. On the tab ***Resources*** or menu ***tools, Assign Resources*** (Alt + F10) > Inside ***Field Name***, click the resource you want to place in the activity > For resources to be allocated ***part-time***, type or select a percentage less than 100% in the max. Unit ***Resource Sheet*** to indicate the percentage of work time to which resources are allocated. For more than one resource, press **CTRL** and click the resource name; for the same resource, more than one type and select percentage more than 100% > Click ***Assign***, then ***close***.

- **Do alignment**

Resources, choose ***leveling options***, and ***Resource Leveling*** will appear > On ***field leveling calculations*** choose ***automatic***, on ***the drop-down*** menu ***lock for overallocation*** choose ***day-by-day***, ***clear leveling values checkbox*** must be checked.

- **Determine the overall cost of a project.**

Ribbon Project > click the ***Project Information*** icon > Click the ***Statistics*** button located at the bottom, then a display of duration, workers, and costs will appear.

- **Using the Earned value method with Microsoft Project 2010**

View, click ***Gantt Chart*** > ***View***, click ***Table*** select ***More Tables***, select ***Earned Value***, and press the ***Apply*** button. In the ***Gantt Chart*** will appear several columns with several terms related to ***Earned Value***.

- **Microsoft project 2010 printing facility**

Ribbon project, > ***report*** **>** Select the printed report, click select > click Ok.

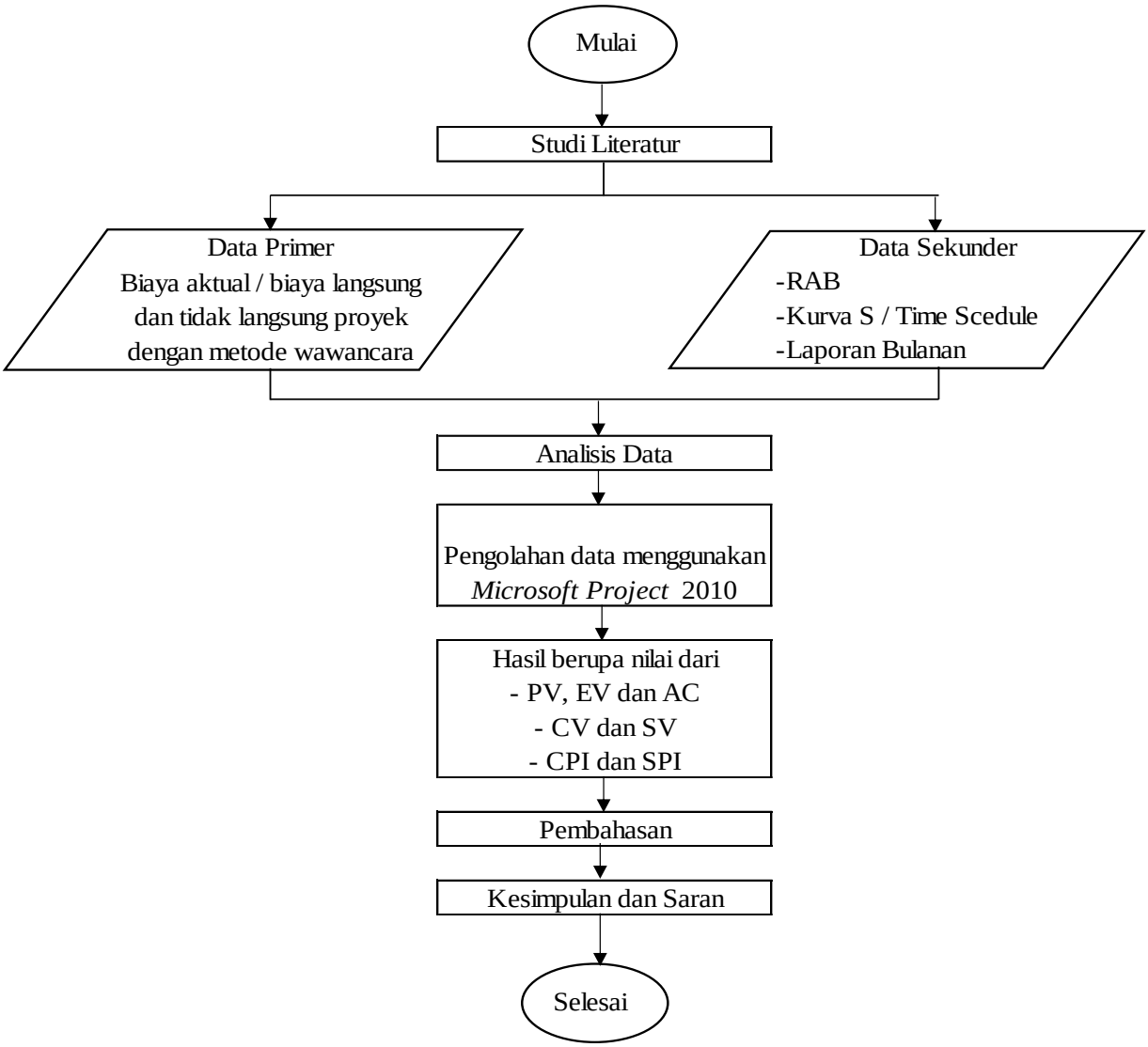
- **Save file**

File Ribbon >click icon *save*, The Save As dialog box will appear > Specify a folder location > Name the file > Specify the extension type in the Save As Type drop-down menu > Click Save.

- **Close Microsoft Project 2010**

Ribbon files > click icon exit; if the file has not been given a name, it will be given the option "yes" to name it and "No" to go straight out of *Microsoft project 2010.*

3. RESEARCH METHODOLOGY



4. RESULTS AND DISCUSSION

4.1. Project Data

a. Project general data

Job Packages : Normalization and Dredging of River Estuaries Spread in Banjarmasin City (Estuary of the Crocodile River

No Contract : 8.02/DPUPR-BS/PPK-KPWSSSB-MSBY/VIII/2019

Contract Date : August 19, 2019

Contract value : Rp. 161,505,000.00

Service Provider : CV. Pioneer Two

Completion Time : 45 Calendar Days

b. Work Item Data and Job Duration

Table 4.1 Work Item Data

Large River Channel Normalization and Dredging Works		**Duration**
Public Works	1. Administration, Documentation, and Job Reports	45 days
	2. Measurement and Drawing before and After Work	14 days
	3. Project Nameplate Making	7 days
	4. Excavator Seat	7 days
	5. Mobilization and Demobilization of Equipment	14 days
Dredging Work River	1. Cut down Plants and Plants	45 days
	2. Excavating with PC Excavator 100	45 days

4.2. Data processing

- **Develop a project schedule and cost plan in Microsoft Project 2010**

1. Enter project start date >Prepare a work calendar to determine working days and working hours.

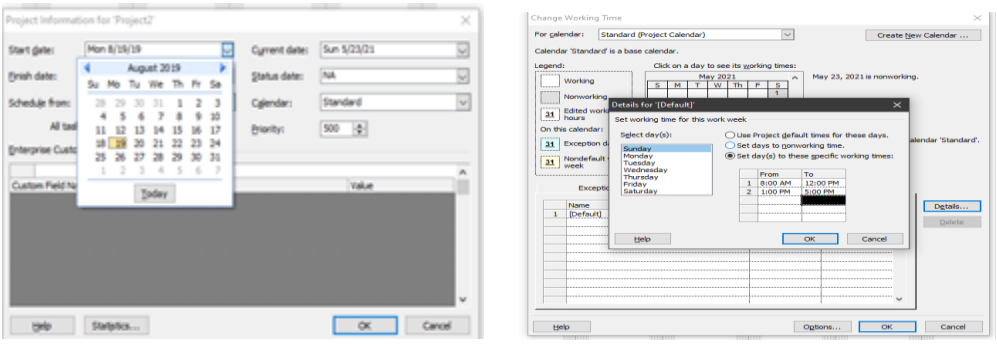


Figure 4.1 Entering project start date and Compiling work calendar

2. Entering project activity data and activity time in the column**Task Name** and **Duration**. Column **Start** and **Finish** will be filled automatically > Enter the relationship between jobs in the column **Predecessor** > Enter costs for each job.

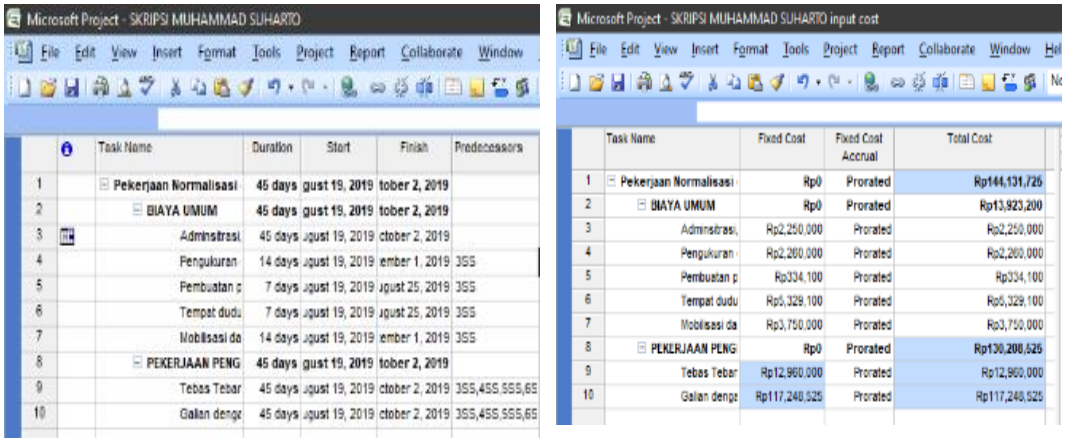


Figure 4.2 Compilation of Work (Task) and Filling in Total Cost

3. Save the schedule and cost plans as baseline.

   Click menu**Tools > Tracking > Set baseline**

- **Field Actualization (Tracking)**

1. Enter update date > Enter actual data in a field in **Gantt Chart View** and Task **Usage**. **Then click View > Table: Tracking** > Adding a row on the right **Task**

Usage, choose **Style details**. Put in **Actual Work <Show>**, **Actual Overtime Work <Show>**, **Actual Cost <Show>**, **OK.**

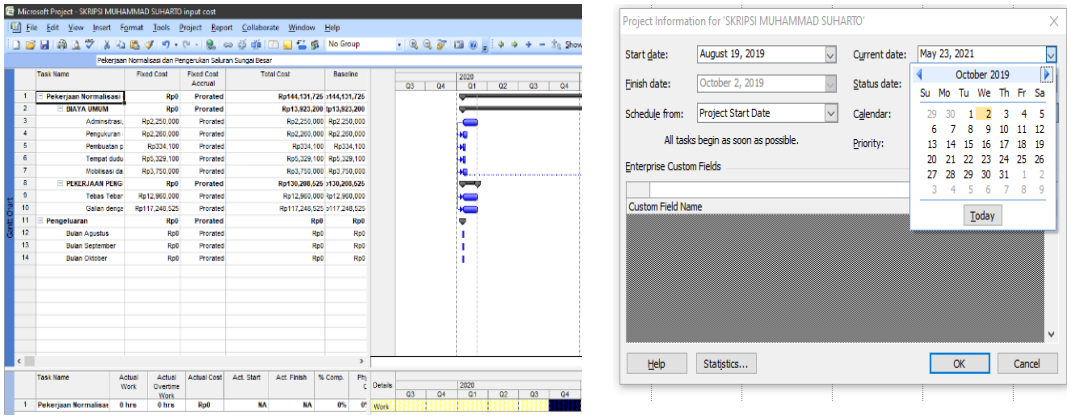


Figure 4.3 Gantt Chart View, Task Usage, and Fill in the updated date

2. Carry out the process *updating*.

   Example of filling:

   5th week for the period September 16 to September 20, 2019)

   a. Add tasks **Expenditure** on column **Task Name** with sub tasks **August, September** > click ***Resources Sheet*** on the Viewbar. Then fill in the type of resource, including the price of labor per day and material per unit in the column **Std Rate.** For hourly labor overtime pay in column **ovt Rate**. See Figure 4.4.

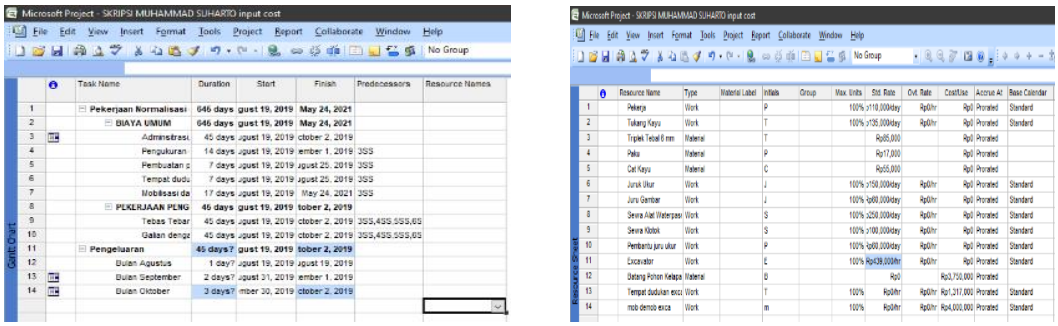


Figure 4.4 Adding Task Name and Resources

   b. Assign *resources*, Double click on *sub task* to be filled *resources*, so that a dialog box appears **Task Information**, then choose ***Resources***nya > Fills the number of resources on the line **actual work**.

   In the amount of material entered in one day, labor hours included in one day, tools included are also working hours for tools in one day. The Actual Cost value is obtained when entering usage data in the ***Task Usage*** table

section. This is entered so that we know the materials and labor used every day during the work period.

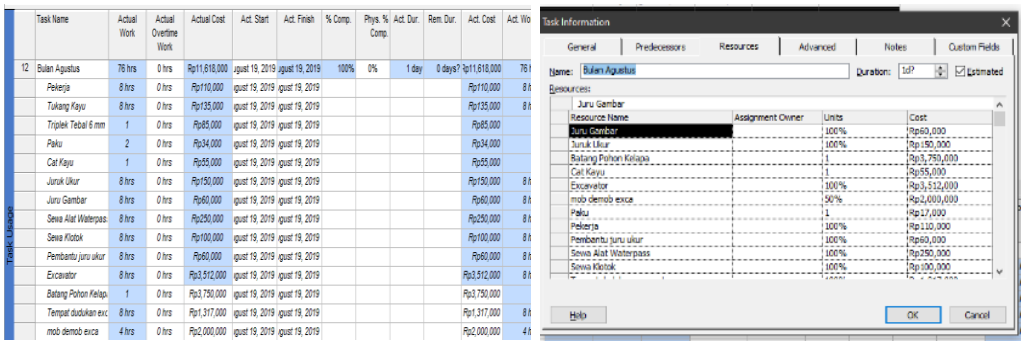


Figure 4.5 Filling in the number of resources and assigning Resources for each subtask.

3. Entering indirect project costs

   In this project, the Work Start Order (SPMK) was issued on August 19, 2019.

   Total construction cost = IDR 122.511.966.08

   Indirect costs = 15% x Rp 122.511.966.08

   = IDR 18,376,794.91

   Indirect costs per day = IDR 471,905,832.00/ 45 days

   = IDR 408,373.00

   Enter indirect costs in the ***Resources Sheet*** > assign them to the project ***summary task*** > ***Task Usage*** enter 1d under Act. Work for each day from 19 August to 02 October 2019. See the display in Figure 4.6 and Figure 4.7.

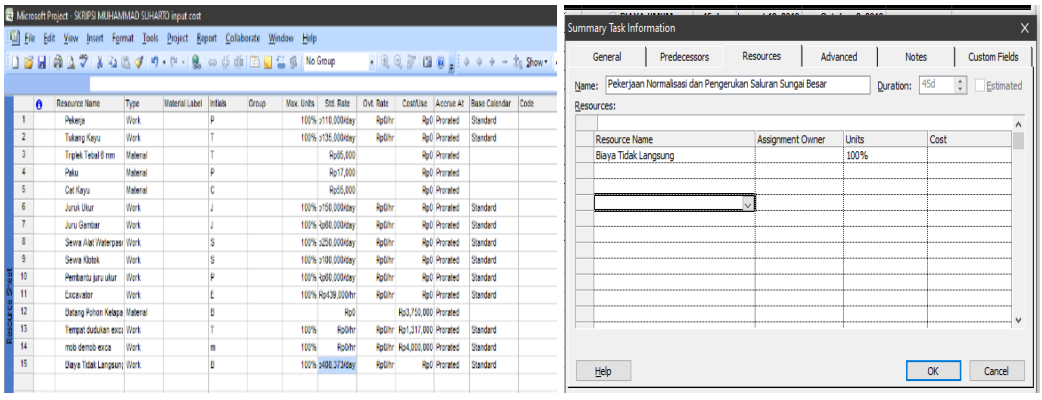
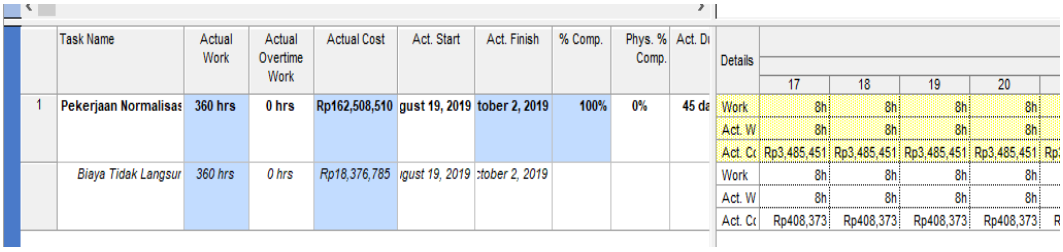


Figure 4.6 Indirect Costs on Resources Sheet and Task Summary



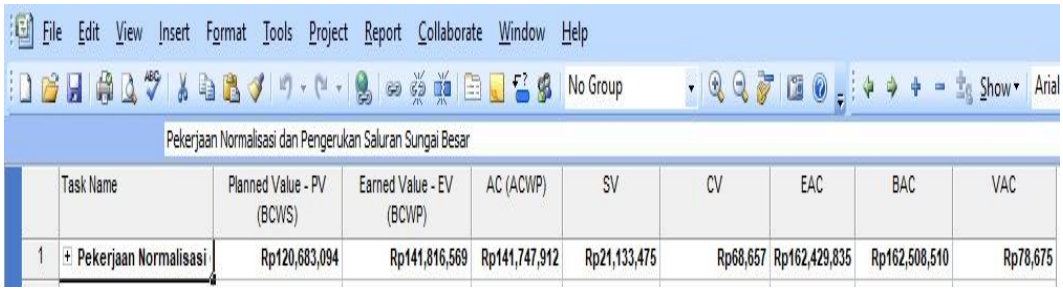
	Task Name	Actual Work	Actual Overtime Work	Actual Cost	Act. Start	Act. Finish	% Comp.	Phys. % Comp.	Act. Di
1	Pekerjaan Normalisas	360 hrs	0 hrs	Rp162,508,510	gust 19, 2019	tober 2, 2019	100%	0%	45 da
	Biaya Tidak Langsur	360 hrs	0 hrs	Rp18,376,785	igust 19, 2019	:tober 2, 2019			

Details	17	18	19	20
Work	8h	8h	8h	8h
Act. W	8h	8h	8h	8h
Act. Cc	Rp3,485,451	Rp3,485,451	Rp3,485,451	Rp3,485,451
Work	8h	8h	8h	8h
Act. W	8h	8h	8h	8h
Act. Cc	Rp408,373	Rp408,373	Rp408,373	Rp408,373

Figure 4.7 Charging indirect costs on task usage

4. Viewing the result value concept indicator

   In the ***Gantt Chart View***, select the **view** menu > **Table** > **More Tables** > **Earned Value**. The following table displays the calculation results in Table 4.2.



	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC
1	Pekerjaan Normalisasi	Rp120,683,094	Rp141,816,569	Rp141,747,912	Rp21,133,475	Rp68,657	Rp162,429,835	Rp162,508,510	Rp78,675

Table 4.2 Recapitulation of Concept Value Indicators for Results at week 5

4.3. Data analysis

The calculations for each week can be seen in Table 4.3 to Table 4.9 below

Table 4.3 Recapitulation of Planned Value / PV. Calculations

Minggu ke -		Bobot Rencana Kemajuan Pekerjaan	Bobot Kumulatif Rencana Kemajuan Pekerjaan	Planned Value
1	Rp120.683.094,00	21,33	21,33	25.741.703,95
2		15,32	36,65	44.230.353,95
3		15,32	51,97	62.719.003,95
4		15,32	67,29	81.207.653,95
5		15,31	82,60	99.684.235,64
6		17,40	100,00	120.683.094,00

Table 4.4 Recapitulation of Earned Value / EV . Calculation

Minggu ke -		Bobot Realisasi Kemajuan Pekerjaan	Bobot Kumulatif Realisasi Kemajuan Pekerjaan	Earned Value
1	Rp141.816.569,00	21,33	21,33	30.249.474,17
2		22,19	43,52	61.718.570,83
3		25,87	69,39	98.406.517,23
4		26,84	96,23	136.470.084,35
5		3,77	100,00	141.816.569,00

Table 4.5 Recapitulation of Actual Cost / AC . Calculations

Minggu ke -		Bobot Realisasi Kemajuan Pekerjaan	Bobot Kumulatif Realisasi Kemajuan Pekerjaan	Actual Cost Kumulatif
1	Rp141.747.912,00	21,33	21,33	30.234.829,63
2		22,19	43,52	61.688.691,30
3		25,87	69,39	98.358.876,14
4		26,84	96,23	136.404.015,72
5		3,77	100,00	141.747.912,00

Table 4.6 Recapitulation of Cost Variance Calculation / CV

Minggu ke -	Earned Value	Actual Cost	CV
1	30.249.474,17	30.234.829,63	14.644,54
2	61.718.570,83	61.688.691,30	29.879,53
3	98.406.517,23	98.358.876,14	47.641,09
4	136.470.084,35	136.404.015,72	66.068,63
5	141.816.569,00	141.747.912,00	68.657,00

Table 4.7 Recapitulation of Schedule Variant Calculations / SV

Minggu ke -	Earned Value	Planned Value	SV
1	30.249.474,17	25.741.703,95	4.507.770,22
2	61.718.570,83	44.230.353,95	17.488.216,88
3	98.406.517,23	62.719.003,95	35.687.513,28
4	136.470.084,35	81.207.653,95	55.262.430,40
5	141.816.569,00	99.684.235,64	42.132.333,36

Table 4.8 Recapitulation of Calculation of Cost Performance Index / CPI

Minggu ke -	Earned Value	Actual Cost	CPI
1	30.249.474,17	30.234.829,63	1,0005
2	61.718.570,83	61.688.691,30	1,0005
3	98.406.517,23	98.358.876,14	1,0005
4	136.470.084,35	136.404.015,72	1,0005
5	141.816.569,00	141.747.912,00	1,0005

Table 4.9 Recapitulation of Time Performance Index Calculation / SPI

Minggu ke -	Earned Value	Planned Value	SPI
1	30.249.474,17	25.741.703,95	1,18
2	61.718.570,83	44.230.353,95	1,40
3	98.406.517,23	62.719.003,95	1,57
4	136.470.084,35	81.207.653,95	1,68
5	141.816.569,00	99.684.235,64	1,42

The indicators for the concept of yield value can be seen in the graph of Figure 4.16, and the values can be seen in Table 4.10 so that it can be seen whether or not there are deviations from the plan.

Figure 4.16 Indicators of the concept of yield value

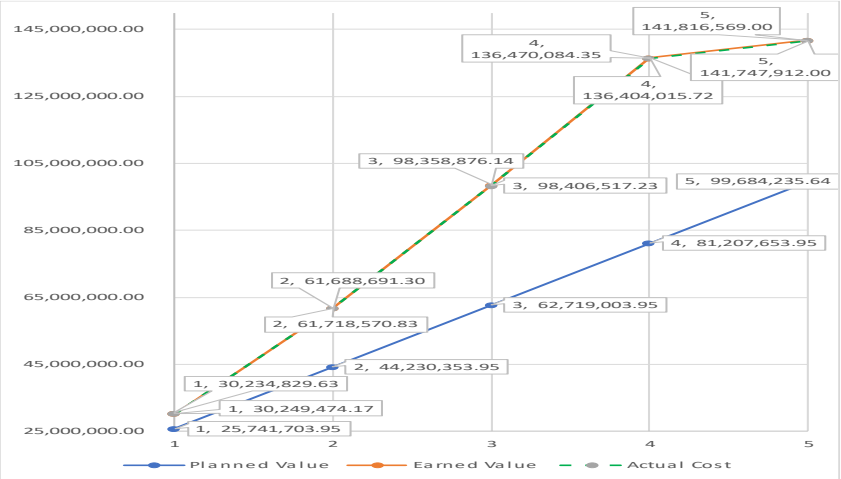


Table 4.10 Concept Indicator Value Result Value

Minggu ke-	Planned Value	Earned Value	Actual Cost
1	25.741.703,95	30.249.474,17	30.234.829,63
2	44.230.353,95	61.718.570,83	61.688.691,30
3	62.719.003,95	98.406.517,23	98.358.876,72
4	81.207.653,95	136.470.084,35	136.404.015,72
5	99.684.235,64	141.816.569,00	141.747.912,00

In the graph in Figure 4.16 and the value in Table 4.10, it can be seen that in the 1st to 5th week, the EV value is higher than the PV value. This shows that the implementation or realization of the work is faster than planned. In the 1st to 5th week, the ACWP and EV values seem to coincide because the difference in values is small, but it can be seen in the calculation table that the ACWP value is smaller than the EV value. It can be concluded that the costs incurred are less than the budget

5. CLOSING

Conclusion

Based on the results of the discussion, it can be concluded as follows:

1. From week 1 to week 5, the SPI (Schedule Performance Index) value is >1. This means that the Normalization and Dredging work of the Banjarmasin Crocodile Estuary was carried out with good performance and was completed faster than planned. Then from a cost point of view, the work from week 1 to week 5 has a value of >1. This means that the Normalization and Dredging of the Banjarmasin Crocodile Estuary will be carried out at a smaller or more efficient cost.

2. Normalization and Dredging Work of Banjarmasin Crocodile Estuary from week 1 to week 5, the EV value is higher than the PV value, which indicates that the work is carried out faster than planned. Then from week 1 to week 5, the ACWP value is lower than EV, so it can be concluded that the costs incurred are smaller than planned.
3. After the Normalization and Dredging work of the Banjarmasin Crocodile Estuary or during the 5th week, there was a difference in time and cost in the realization and planning. In the 5th week, the CV (Cost Variance) value of the job is Rp 68,657.00- and the SV (Schedule Variance) value is Rp 42,132,333,36-. This means that the realization of the work is going faster than planned and the budget spent is less than planned.

Suggestion

1. Making relationships between jobs in Microsoft Project 2007 should be done carefully to obtain accurate analysis results.
2. Implementing of a project, it is necessary to detail the material, tool, labor, and subcontractor requirements for each work item so that its use is more efficient and it can be seen what types of work are profitable/disadvantaging.

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