Evaluation Of Construction Project Time And Cost Control Based On Earned Value And Crash Project Method (A case study on the construction project of the State Junior High School 1 Surabaya)

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Abstract

Project development and how to control time and costs in the construction project of a public junior high school 1 Surabaya. This research was conducted with the aim of knowing and comparing the amount of duration and cost after acceleration by using the alternative Earned Value Analysis. The case study in this research takes the construction project of a public junior high school 1 Surabaya which is located in Surabaya. The data needed in this study include the S curve, recapitulation of project cost calculations, a list of budget plans (RAB), and a list of unit wage prices for workers. The research method used is to design network planning, calculate the cost variance and variance schedule for each activity that changes due to changes in the duration of implementation, acceleration of work duration, and determination of the optimum cost and duration due to the application of the Earned Value Analysis method. For the calculation of the variance Schedule on week 34 shows a positive result of Rp. 109,550,470. For the calculation of the cost variance from week 34 shows -Rp. 2,488,159. For the calculation of Estimate at completion (EAC) on week 34 of Rp. 6,663,998,229. For the calculation of Estimate temporary schedule, the evaluation week 34 experienced a delay of 53 days from the original schedule. So the work completion time is 233 calendar days

Keywords: cost and schedule, Earned Value Engineering

1. Introduction

The concept of earned value is one of the tools used in project management that integrates cost and time. The concept of earned value presents three dimensions, namely the physical completion of the project (the percent complete) which reflects the cost absorption plan (budgeted cost), the actual cost that has been incurred or what is known as actual is called the earned value. Of the three dimensions, with the concept of earned value, it can be linked between cost performance and time derived from calculating the variance of cost and time (Fleming and Koppelman, 1994). Earned Value is able to present performance reporting, budget and remaining cost as well. The drawback is that the presentation is not graphic and is certainly not liked by practitioners in general. Lukas, (2008) there are four reasons why Earned Value analysis is not carried out, namely: undocumented requirements, incomplete requirements, not used or accepted WBS (Work Breakdown Structure), incomplete WBS.

The purpose of this research is how to implement EVA (Earned Value Analysis) in estimating the final time of project completion for each week, whether for 34 weeks of implementation is in accordance with the initial plan of the project schedule. In addition, to find out the project is experiencing delays and experiencing costs greater or less than the project budget plan.

2. Research Methodology

Data obtained from PT. Mitra Karya Mandiri Jaya in the form of primary and secondary data. The method used in this research is descriptive qualitative research that describes the conditions of the project by analyzing existing data. Data analysis used analytical and descriptive methods. Analysis means that existing data are processed in such a way as to produce a conclusive conclusion. Meanwhile, the meaning of descriptive is to describe the problems that already exist or appear. The Concept of Value Results (Earned Value Analysis) examines the trend of schedule variants and cost variants over a period of time during the project. However, this study will only discuss time variants.

2.1 Research Flowchart

The following is a research methodology flow chart.
3. Discussion And Analysis

In accordance with the background of the writing of this final project, the concept of earned value is one of the tools used in project management that integrates cost and time. The concept of earned value presents three dimensions, namely the physical completion of the project (the percent complete), which reflects the cost absorption plan (budgeted cost), the actual costs that have been incurred or what is called the actual called earned value. So in writing this thesis, the author will take into account the concept of the value of the results in the construction of a project for junior high school 1 Surabaya.

3.1 Earned Value Analysis

Calculation of Variance Analysis and Result Value Concept, Using Microsoft Excel. PV (Planned value) and EV (Earned value) are calculated using data from weekly reports. The project for the construction of a state junior high school 1 surabaya was carried out within 34 weeks with a contract value of Rp. 6,661,509,141.00. There are 34 weekly reports which are reported every week for 34 weeks. One of the reports in the weekly report is work weight, namely the weight of the plan and the weight of work implementation. Planner weight and work execution weight function to determine the progress of project work.
3.2 Calculation of Earned Value Analysis

After knowing what earned value analysis is, the next step is to start the calculation steps using Microsoft Excel and primary and secondary data such as budget plans and time schedules that have been obtained from the Surabaya 1 Public Junior High School project. So one example of calculations from Earned Value analysis.

3.3 Budget Cost Of Work Schedule (BCWS)

The project's budget corresponds to an inventory of activities calculated based on a percentage of total costs, according to 34 weeks of field data. BCWS is calculated using the formula 2.1, namely: Result Value = (% completion) x (Budget).

Example of Calculation of BCWS on week 1 is as follows:
% Weight of the week 1 = 0.02%
Contract Value = Rp. 6,232,056,155.00
So that:
BCWS = (% completion) x (Budget).
= 0.020% x Rp. 6,232,056,155,00
= Rp. 1,558,014.00

| WEEK | % PROFESION | CONTRACT VALUE    | PV    | PV KOM (Rp.) |
|------|-------------|-------------------|-------|--------------|
| 1    | 0.03%       | Rp 6,232,056,155 | Rp    | 1,558,014    |
| 2    | 0.28%       | Rp 6,232,056,155 | Rp    | 17,387,437   |
| 3    | 1.51%       | Rp 6,232,056,155 | Rp    | 94,291,010   |

| WEEK | % PROFESION | CONTRACT VALUE    | EV    | EV KOM (Rp.) |
|------|-------------|-------------------|-------|--------------|
| 1    | 0.00%       | Rp 6,232,056,155 | Rp    | 211,890      |
| 2    | 0.03%       | Rp 6,232,056,155 | Rp    | 1,869,617    |
| 3    | 0.03%       | Rp 6,232,056,155 | Rp    | 2,118,899    |

3.4 Budget Cost Of Work Performance (BCWP)

The yield value is the budgeted cost of the work completed by the executor, BCWP using the formula 2.1. Result Value = (% completion) x (Budget).

Example of Calculation of BCWP in week 1 is as follows:
% Implementation weight week 1 = 0.0034%
Contract Value = Rp. 6,232,056,155.00
So that:
BCWP = (% completion) x (Budget).
= 0.0034% x Rp. 6,232,056,155.00
= Rp. 211,890.00

| WEEK | % PROFESION | CONTRACT VALUE    | EV    | EV KOM (Rp.) |
|------|-------------|-------------------|-------|--------------|
| 1    | 0.00%       | Rp 6,232,056,155 | Rp    | 211,890      |
| 2    | 0.03%       | Rp 6,232,056,155 | Rp    | 1,869,617    |
| 3    | 0.03%       | Rp 6,232,056,155 | Rp    | 2,118,899    |

3.5 Schedule Varians (SV)

The schedule variance is calculated using Equation 2.3. Schedule Variance (SV) = EV - PV or SV = BCWP - BCWS

Example of calculating SV at week 1 is as follows:
Value of Week 1 BCWP = Rp. 211,890
1st Week BCWS Value = Rp. 1,558,014.04
So that:
Schedule Variance (SV) = EV (BCWP) - PV (BCWS)
= Rp. 211,890 - Rp. 1,558,014.04
= Rp. -1,346,124.13

The results of the calculation at week 1 show negative results, so that at week 1 it is delayed.
### 3.6 Cost Variances (CV)

The schedule variance is calculated using Equation 2.3. Cost Variance (CV) = EV - AV or SV = BCWP - ACWP.

Example of CV calculation in week 1 is as follows:
- Value of Week 1 BCWP = Rp. 211,890
- ACWP Value Week 1 = Rp. 209,000.00

So that:
- Cost Variance (CV) = EV (BCWP) - AV (ACWP)
  = Rp. 211,890.00 - Rp. 209,000.00
  = Rp. 2,890.91

Calculation results on week 1 show positive results, so that on week 1 the costs are below the plan (Cost Underrun).

### 3.7 Estimate At Completion (EAC)

The estimated total cost of project completion is calculated based on the costs that have been completed subtracted from the EAC results or using formula 2.7, namely:

\[ EAC = ACWP + ETC \]

An example of calculating the EAC in week 1 is as follows:
- ACWP Value Week 1 = Rp. 209,000.00
- Week 1 ETC Value = Rp. 6,146,849,823.53

Then:
- EAC = ACWP + ETC
  = Rp. 209,000.00 + Rp. 6,146,849,823.53
  = Rp. 6,147,058,824

### 3.8 Estimate Temporary Schedule (ETS)

Based on the contract for the construction project of the Junior High School 1 Surabaya building, the project work time is 180 days. The ETS calculation uses the formula 2.8 where:

\[ ETS = (\text{remaining time}) / SPI \]

An example of calculating the ETS in week 1 is as follows:
- SPI Value Week 1 = 0.14
- Project Implementation Plan Time = 180 Days
- Finish Time = 4 Days
- Remaining Time = 180 Days - 4 Days = 176 Days

So that:
- Estimate temporary Schedule (ETS) = (Remaining Time) / SPI

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\[\text{Completed Work Time} = 180 \text{ Days} - (1294.118 \text{ days} + 4 \text{ days}) = -1118.12 \text{ days}\]

Table 6. Cumulative Estimate Temporary Schedule (ETS)

| WEEK | EV KOM(Rp) | EV KOM(Rp) | SPI | Plan Time | Time's up | Remaining time | ETS(Hari) |
|------|------------|------------|-----|-----------|-----------|----------------|-----------|
| 1    | Rp 211.890 | Rp 1.558.014 | 0.14 | 180 | 4 | 176 | 1294.12 |
| 2    | Rp 2.081.507 | Rp 18.945.451 | 0.11 | 180 | 11 | 169 | 1538.20 |
| 3    | Rp 4.200.406 | Rp 113.236.460 | 0.04 | 180 | 18 | 162 | 4367.27 |

The project status when reporting (monitoring baseline) in June or week 14 shows the project performance is under budget, this is indicated by the positive CV (Cost Varian) indicator of Rp. 607,955.00 on the 14th week, between the difference in the value of the results (EV / BCWP) and the actual costs incurred (AC / ACWP). Project performance from this cost aspect can also be seen from the cost performance index indicator CPI = 1.0010 > 1. Meanwhile, from the schedule aspect, it shows that project performance is delayed, this is indicated by the Schedule Variant (SV) which is negative at -Rp. 1,148,516.02000 between the difference in yield value (BCWP) and the planned budget (PV / BCWS). Project performance from this time aspect can also be seen from the schedule performance index (SPI) whose value is 0.455 < 1. As in the table below.

Table 1. Project Performance Status at Week 14

| Earned Value Method | Calculation | The calculation results | Information | $ Earned Value Graph |
|---------------------|-------------|-------------------------|-------------|----------------------|
| I. Cost Parameters  |             |                         |             |                      |
| 1. CV (Cost Variance) / Cost Variance | = BCWP - ACWP | = Rp. 958.654.955,00 - Rp. 958.047.000,00 | = Rp. 607.955 | CV > 0, Cost Under run |
| 2. Cost Performance Index (CPI) | = EV (BCWP) / CV (ACWP) | = Rp. 958.654.955,00 - Rp. 958.047.000,00 | = 1.001 | CPI > 0, Cost Under run |
| II. Time Parameters  |             |                         |             |                      |
| 1. SV (Schedule Varians) | = EV (BCWP) - PV (BCWS) | = Rp. 958.654.955,00 - Rp. 2.107.170.975,00 | = Rp. 1,148,516.020 | SV < 0, Schedule Overrun |
| 2. Schedule Performance Index (SPI) | = EV (BCWP) / PV (BCWS) | = Rp. 958.654.955,00 - Rp. 2.107.170.975,00 | = 0.455 | SV < 0, Schedule Overrun |

Table 2. Estimated Cost and Time Required to Complete the Project

| Earned Value Method | Calculation | The calculation results | Information | $ Earned Value Graph |
|---------------------|-------------|-------------------------|-------------|----------------------|
| I. Estimasi Biaya dan waktu minggu ke 14 |             |                         |             |                      |
| 1. ESTIMATE AT COMPLETION (EAC) | = ((BAC - BCWP) / CPI) + ACWP | = (Rp. 6.555.544.827 - Rp. 211.889.91) / 1,01 | = Rp. 6.550.888.179 | The estimated cost is less than the planned project budget of Rp. 6.555.544.827 |
| 2. Estimate Temporary Schedule (ETS) | = (Total time - End time) / SPI + Job Time = (180 - 7) / 0.45 + 7 | = 95 days or 13 weeks | The estimated time is faster than the project plan time, 180 days |

Figure 2.
Table 7. Value Of Actual Cost For Work Performance Every Week

| WEEK | BCWS     | BCWP     | ACWP     |
|------|----------|----------|----------|
| 1    | Rp 1.558,014 | Rp 211,890 | Rp 209,000 |
| 2    | Rp 18.945,451 | Rp 2,081,507 | Rp 2,030,000 |
| 3    | Rp 113,236,460 | Rp 4,200,406 | Rp 4,143,000 |
| 4    | Rp 408,694,866 | Rp 19,278,159 | Rp 19,445,000 |
| 5    | Rp 651,840,023 | Rp 65,822,527 | Rp 66,081,000 |
| 6    | Rp 791,145,351 | Rp 80,703,614 | Rp 80,935,000 |
| 7    | Rp 993,449,464 | Rp 175,988,458 | Rp 176,218,000 |
| 8    | Rp 1,200,408,014 | Rp 246,067,232 | Rp 246,293,000 |
| 9    | Rp 1,374,457,730 | Rp 322,767,107 | Rp 322,804,000 |
| 10   | Rp 1,438,702,069 | Rp 454,433,558 | Rp 454,279,000 |
| 11   | Rp 1,670,833,911 | Rp 455,844,667 | Rp 455,268,000 |
| 12   | Rp 2,107,107,975 | Rp 455,844,667 | Rp 455,268,000 |
| 13   | Rp 2,107,107,975 | Rp 455,844,667 | Rp 455,268,000 |
| 14   | Rp 2,107,107,975 | Rp 455,844,667 | Rp 455,268,000 |
| 15   | Rp 2,563,043,562 | Rp 1,039,943,711 | Rp 1,039,205,000 |
| 16   | Rp 2,876,070,828 | Rp 1,392,632,022 | Rp 1,310,682,000 |
| 17   | Rp 3,123,149,312 | Rp 1,569,631,733 | Rp 1,487,499,000 |
| 18   | Rp 3,414,674,391 | Rp 1,853,486,824 | Rp 1,771,653,000 |
| 19   | Rp 3,695,645,045 | Rp 2,322,863,833 | Rp 2,241,291,000 |
| 20   | Rp 4,069,453,385 | Rp 2,339,908,250 | Rp 2,258,052,000 |
| 21   | Rp 4,523,020,355 | Rp 2,701,774,324 | Rp 2,619,695,000 |
| 22   | Rp 5,115,248,274 | Rp 2,761,429,782 | Rp 2,679,267,000 |
| 23   | Rp 5,768,770,538 | Rp 2,870,251,826 | Rp 2,788,374,000 |
| 24   | Rp 6,312,487,426 | Rp 3,751,317,051 | Rp 3,669,182,000 |
| 25   | Rp 6,529,475,960 | Rp 4,088,272,055 | Rp 4,006,331,000 |
| 26   | Rp 6,549,142,594 | Rp 4,376,716,028 | Rp 4,294,822,000 |
| 27   | Rp 6,549,470,371 | Rp 4,534,704,658 | Rp 4,452,711,000 |
| 28   | Rp 6,549,470,371 | Rp 4,861,170,790 | Rp 4,778,992,000 |
| 29   | Rp 6,549,470,371 | Rp 5,004,081,668 | Rp 4,921,707,000 |
| 30   | Rp 6,549,470,371 | Rp 5,361,358,861 | Rp 5,279,196,000 |
| 31   | Rp 6,549,470,371 | Rp 5,667,122,130 | Rp 5,669,944,000 |
| 32   | Rp 6,549,470,371 | Rp 6,419,872,663 | Rp 6,422,912,000 |
| 33   | Rp 6,549,470,371 | Rp 6,421,871,116 | Rp 6,424,623,000 |
| 34   | Rp 6,549,470,371 | Rp 6,659,020,841 | Rp 6,661,509,000 |
4. Conclusions And Suggestions

4.1 Conclusion

Based on the analysis of the calculations that have been done, the things that can be concluded from this study are:

1. Earned Value Analysis can predict the cost and time of project completion well and can predict early in each reporting period if there is a deviation in cost and implementation time.

2. Evaluation of the Schedule variance at week 1 shows a negative result of - Rp. 1,346,124 So that at week 1 there was a delay. Whereas at week 34 shows a positive result of Rp. 109,550,470 so that at week 34 experienced a speed.

3. Evaluation of Cost Variance at week 1 shows a positive result of Rp. 2,890 So that in week 1 experience lower costs. While at week 34 it shows - Rp. 2,488,159 so that at week 34 so it costs above budget

4. Cost Evaluation
   • Budget plan for building rehabilitation construction type B2 (SMP Negeri 1 Surabaya) is Rp. 6,661,509,000 (six billion six hundred sixty-one million five hundred and nine thousand rupiah)
   • Estimate at completion (EAC) cost at week 34 is Rp. 6,663,998,229

5. Evaluation of Time
   • The planned construction time for type B2 (SMP Negeri 1 Surabaya) is 180 calendar days
   • Estimate time of project completion or Estimate temporary schedule which is influenced by the implementation of project work. In the evaluation week 34 experienced a delay of 53 days from the original schedule. So the work completion time is 233 calendar days

6. Value of Results (Earned value) in this evaluation is the project work is delayed and costs higher than the budget

4.2 SUGGESTION

1. In the next research, acceleration can be done using the Crashing method, Earned Value Analysis, and can be compared using the Microsoft Project program so that the comparison between the three methods can be seen.

2. For subsequent research, other methods can be used so that comparisons can be made to accelerate and cost a project.

3. Subsequent research can carry out regular checks so that you can find out the duration of the project in order to know the changes in data precisely and accurately.

References

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