Evaluation of cost and time control in Lhokseumawe City improvement project using earned value method (Case Study Street Alue Raya-Line Pipa)

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Abstract. The purpose of this study is to evaluate the amount of cost and use of time that has been used in the Improvement Project Street Alue Raya-Line Pipa Lhokseumawe City. The method that used in this study is the concept of yield value (earned value analysis) review trends in schedule variants and cost variants for a period during the project. By doing this earned value study method, evaluating the completion of the project with BPWP = IDR. 864.310.464,06, BCWS = IDR. 393.436.638,08, and ACWP = IDR. 591.235.630,69, in terms of cost variance (CV) > 0 with cost performance index (CPI) > 1 so that is obtained project completion cost (EAC) 68% of a budget plan that is IDR. 2.037.182.494,70, while from the schedule aspects the project is decreasing in time by 47% of plan or 16 weeks to be 9,45 weeks indicated value SPI > 1.

1. Introduction

To be able to determine the success of the project, therefore it is necessary to have a good scheduling and cost control in writing this Final Project is evaluating the implementation of the Street Alue Raya-Line Pipa Improvement Project, which has a contract value IDR 2.978.000.000, - funded by the Government of Lhokseumawe City with a road width of 5 meters, 1 meter of road shoulder and 1.057 meters of road length with the completion time of 0f 120 calendar days. Based on the background above, the formulation of the problem that the authors examine in this Final Project is whether the completion cost on the Street Alue Raya-Line Pipa Improvement Project is in accordance with the planned or loss cost, and how to predict or estimate the time and cost of the completing project work and the completing project until the project is finish on time.

According to reference [1], “the actual measurement of the work done can be used as input data in project control”. The way is by calculating the volume of each activity, then the weight is made in the percentage cumulative of cost in the form of an S curve. S curve also obtained from the cumulative weight of work as a percentage of the cost per item divided by the total project budget, with the data in the control report format.
According to reference [1], to facilitate project control, project management should have a reference as the target and objectives. Therefore, the indicators of the project’s final objectives must be displayed and taken into account during project implementation. The indicators that are usually being the target of achieving final project objectives are performance of cost, quality, and time.

To monitor project, finance a project cash flow indicator is needed to show the plan and actual use of cost in the project time period, as below:

![Figure 1. Cash flow](image)

In the picture above, there are two actual project cash flow conditions in which the condition of Figure 1a with positive cash flow, where the project’s position benefits, while Figure 1b with negative cash flow where the project’s position suffered a loss. To get the curve as above the y-axis is made which shows the cumulative cost plotted throughout the duration of the project to form an S curve.

Whereas to monitor the progress of cash flow, baseline monitoring is made in every period of payment of term or adjusted for special conditions.

According to reference [2], earned value concept is a concept of calculating the amount of cost, according to the budget and according to the work that has been completed or implemented. When viewed from the number of jobs completed, it means that this concept measures the amount of work units that have been complete, at a time if it is judged based on the amount of the budget which provided for the work. The result value is the budgeted cost of the work completed. Calculate the result value, the following formula is used:

\[
\text{Result Value} = (% \text{ Settlement}) \times (\text{Actual budget})
\]

According to Iman reference [2], in the result value concept using 3 indicators/parameter to analyze work achievement and make estimates of target achievement. That are:

1. **BCWS (Budgeted Cost Work Schedule)** is a budget value of a work package combined that is integrated from the cost, schedule, and scope of work with the implementation schedule;

   \[
   \text{BCWS} = \text{Total Budget Plan} \times \% \text{ Setlement (Plan)}
   \]

2. **BCWP (Budgeted Cost Work Performed)** is result value or earned value from the point of view of the value of completed work on the budget provided to carry out the work;

   \[
   \text{BCWP} = \text{Total budget plan} \times \% \text{ Setlement (Realization)}
   \]

3. **ACWP (Actual cost Work Performed)** is the sum of the actual from the production or the funds used to execute the job in the timeline of a particular;

   \[
   \text{ACWP} = \% \text{ of the arrangement (realization)}
   \]

By using the 3 indicators above, able to count various factors that indicate the progress and performance of the implementation of the project such as:
Cost Variance (CV) is the difference between the value in the earn after finishing the job packets with the cost of the actual happened during the implementation of the project. The formula to calculate the variation cost is:

\[ CV = BCWP - ACWP \]

Schedule Variance (SV) is the difference between the value in the earn after finishing the job packets with the estimated value for a packet of job. The formula to calculate the Schedule Variance is:

\[ SV = BCWP - BCWS \]

Schedule performance index (SPI) is a comparison between the result value and jobs in the planned. Schedule Performance Index can be calculated by using the formula:

\[ SPI = \frac{BCWP}{BCWS} \]

Cost Performance Index (CPI) is the comparison between the result value with a cost that realized. Cost Performance Index (CPI) can be calculated by using the formula:

\[ CPI = \frac{BCWP}{ACWP} \]

From the parameters above, it could be predictable that the total cost of the implementation at the end of the project (EAC) by using the formula:

\[ EAC = \left\{ \frac{(BAC - BCWP)}{(CPI \times SPI)} \right\} + ACWP \]

Then the Variant Arrangement Cost (VAC) between the cost of execution and estimated using the formula as follows:

\[ VAC = BAC - EAC \]

Information:
- BAC = the approximate value of the overall employment (without tax)
- EAC = predicting the final estimate of the implementation (without tax)
- VAC = difference estimate between the plan and the implementation

According to reference [1], with calculating some index as above will be seen that the project will be later or faster and the cost should be removed will be more or less from the estimated. Then the progress of the project to the next to be predicted in the following way: Estimated Completion Date, \( ECD = \frac{(the \ rest \ of \ the \ time)}{SPI} + time \ applies \), Percentage of slowing/acceleration = 100\% - ECD/schedule plan x 100\%, Estimated at Completion, \( EAC = \frac{waste \ estimates}{CPI + ACWP} = (total \ cost - BCWP) / CPI + ACWP \).

The percentage cost of the addition / decline of the cost of actual against estimated cost = 100\% - EAC/total cost x 100\%. Earned Value = BCWP (the cost of the solution volume of employment in the period of certain).

From the third case of the indicators that can be counted on Monitoring Baseline that has been determined. Until the value that founded shows the project progress in that period and the project progress from the cost side and the time for finishing at the time of the next.
2. Methodology

In this method, the first stage is an overview of the library which got from the books and the material available in e-book that related with the restraint of the cost and the time for implementing the project. Earned value method is a concept for calculating the scale fee, which according to estimates correspond the jobs that has been implemented.

According to reference [3], “earned value method is a concept that integrating the context between the cost and the time and project performance by determining the value of money for every part of it”. The base concept of the value of the result can be used for analyzing the performance and make the arrangement of target achievement. Indicators that used for cost analysis are ACWP, BCWP, BCWS, CV and SV with Estimated Completion Date (ECD) and (EAD).

3. Results and Discussion

This case study is done in the project for upgrading the road of Alue Raya – pipeline and it has the value of the contract for IDR 2,978,000,000.- which the source of funds from the Government of Lhokseumawe City. As a result, from the calculation of BCWS, BCWP and ACWP are as follows:

| Week | BCWP       | BCWS       | ACWP       |
|------|------------|------------|------------|
| 1st  | IDR 13,864,704.61 | IDR 1,600,728.13 | IDR 10,816,327.02 |
| 2nd  | IDR 115,434,420.13 | IDR 37,509,154.92 | IDR 93,694,396.27 |
| 3rd  | IDR 154,464,059.96 | IDR 204,364,587.82 | IDR 136,944,200.55 |
| 4th  | IDR 864,310,464.06 | IDR 393,436,638.08 | IDR 591,235,630.69 |

3.1. Integrated Variant Analysis

As for the results of the calculation of integrated variant which includes Cost Variant, Schedule Variant, Cost Performance Index, and Schedule Performance Index are shown in Table 1 and 2, respectively.

3.2. Cost and Time Performance Productivity Index

Estimated Completion Date (ECD) calculations up to 4th week are carried out by calculating the remaining time divided by SPI and added to the time spent, then ECD = ((16-4) / 2.20) + 4 = 9.4. Percentage of delay/acceleration = (100% - 9.45) / (16 x 100%) = -0.53%.

Estimated at Completion (EAC) calculation up to the 4th week is carried out by calculating the total cost minus BCWP and then dividing SPI and adding ACWP, then EAC = (IDR 2,978,098,842.48
- IDR 864,310,464.06) / 1,05 + IDR 591,235,630.69 = IDR 2,037,182,494.70. The percentage decrease in actual costs = \((100\% - IDR\ 2,839,660,065.00) / (IDR\ 2,978,098,842.48 \times 100\%) = -95\%.

| Week | BCWP       | BCWS        | ACWP           | CV     | SV        |
|------|------------|-------------|----------------|--------|-----------|
| 1st  | IDR13,864,704.61 | IDR1,600,728.13 | IDR10,816,327.02 | IDR3,048,377.59 | IDR12,263,976.48 |
| 2nd  | IDR115,434,420.13 | IDR37,509,154.92 | IDR93,694,396.27 | IDR21,740,023.86 | IDR77,925,265.21 |
| 3rd  | IDR154,464,059.96 | IDR204,364,587.82 | IDR136,944,200.55 | IDR17,519,859.41 | IDR49,900,527.85 |
| 4th  | IDR864,310,464.06 | IDR393,436,638.08 | IDR591,235,630.69 | IDR273,074,833.38 | IDR470,873,825.98 |

| Week | BCWP       | BCWS        | ACWP           | CV     | SV        |
|------|------------|-------------|----------------|--------|-----------|
| 1st  | IDR13,864,704.61 | IDR1,600,728.13 | IDR10,816,327.02 | 1.28   | 8.66      |
| 2nd  | IDR115,434,420.13 | IDR37,509,154.92 | IDR93,694,396.27 | 1.23   | 3.08      |
| 3rd  | IDR154,464,059.96 | IDR204,364,587.82 | IDR136,944,200.55 | 1.13   | 0.76      |
| 4th  | IDR864,310,464.06 | IDR393,436,638.08 | IDR591,235,630.69 | 1.46   | 2.20      |

3.3. Graph of Cost and Time Performance

Cost and time predictions of enhancement projects on Alue Raya-Line Pipa street, shows that plans and actual usage costs in the project time period, are as follows.

![Graph of Cost and Time Performance](image-url)

Figure 3. Prediction of time and cost of project completion graph until the end of week 16th
4. Conclusion

The results of calculations and analysis using the earned value method in the enhancement project on Alue Raya - Line Pipa street in Lhokseumawe City are:

1. The value of the completion the final project implementation is obtained from the value until the 4th week is BCWP (Budgeted Cost Work Performed) IDR 864,310,464.06, BCWS (Budgeted Cost Work Schedule) IDR 393,436,638.08, and ACWP (Actual Cost Work Performed) IDR 591,235,630.69.

2. Indicator of variant cost (CV) up to 4th week, which is positive is IDR 273,456,424 or from the cost performance index value (CPI) = 1.46> 1, schedule variant indicator (SPI) = 2.20> 1, so that with SV and CV (+) showing that the work done faster than the schedule with the cost lower than the budget, with SPI> 1 shows that the work has accelerated and CPI> 1 then shows good cost performance with no waste.

3. Indicators of cost and time performance, productivity, with ECD = 9.45 weeks faster than the time of planned work for 16 weeks and EAC = IDR 2,037,182,494.70. Reduced from the planned budget of IDR 2,978,098,842.48

References

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