System Analysis Project Control Using Earned Value Method in Project Apartment at Summarecon Serpong

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Abstract: System effective project controls needed to provide the earliest possible warning when there is a deviation from the cost and time so that appropriate remedial action can be quickly taken before the deviation is large enough. With the control of the cost and time it is expected to be unknown factors that cause irregularities in the implementation of the project in order to take steps in anticipation for the implementation of the project remains in accordance with the initial planning.

In this experiment, as the yield value method of cost analysis tools on the project apartment M-Town Signature Summarecon Serpong. The earned value method is one method that can be used in monitoring and controlling the activities of the project. This method has three main indicators, namely Budget Cost of Work performed (BCWP), Budget Cost of Work Scheduled (BCWS), The Actual Cost of Work performed (ACWP).

These results indicate that the results of the analysis with the Earned Value Method value of Cost Performance Index (CPI) at 1:22 and the Schedule Performance Index (SPI) worth of 1:13. This study also shows the results of the Estimate to complete (ETC) Rp 129,173,457,392.74 and Estimate at Completion (EAC) of Rp. 344,779,430,331.74. This result is lower than the contract value of Rp. This study also found 420,000,054,037.73 Time Estimate (TE) as a reference for the rest of the project completion time is as long as 119 weeks. These two weeks faster than they should 134 weeks.

Keywords: Control, Earned Value, Cost, Time

1. Introduction

The project management phases consist of planning, organizing, implementing, and controlling / monitoring of the limited resources that man, money, material, machine, and a method for achieving project goals and objectives of cost, quality, time, and safety. So that construction projects are progressing as planned is necessary to control the process [1].

Based on the results of investigations on the site, the realization is always inconsistent with the planning. Therefore, it takes a re-evaluation of plans made to find out what the cause of the realization in different field of planning. The results of these evaluations are useful for subsequent construction projects as information and comparison so that the continuous planning and scheduling with actual realization in the field. One of the way to keep in accordance with the implementation plan is doing the control.

Effective project control system is needed to provide the earliest possible warning when there is a deviation from the cost and time so that appropriate remedial action can be quickly taken before the deviation is large enough. The concept of “Earned Value” is one of the tools used in the projects that integrate the control of cost and time. This method can provide information about the progress of the project within a certain period. So we use three indicators of cost, is the Budgeted Cost of Work Schedule (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP). It will obtain the Cost Variance (CV) and Scheduled Variance (SV) and the Cost Performance Index (CPI), and Scheduled Performance Index (SPI). Variants of the overall project can also be shown by illustrating the S curve, BCWS, BCWP, and ACWP. Then from the calculation and based on the S curve can be analyzed which will provide an overview of project performance, namely the achievement of the schedule and the budget. Based on current performance reporting can be estimated costs and time required to complete the project.

2. Problem Identification

Based on the background that has been stated above, the author identifies the problem as follows:

1. The importance of knowing the performance of the ongoing project has the irregularities or not in terms of cost and time.
2. The existence of various factors on the results of project performance in terms of cost and time.
3. **Problem Formulation**
   From the background that has the writer explained before, it can be formulated issues to be discussed are:
   1. How do the results of the project's performance in terms of cost and time by using earned value?
   2. What are the factors that cause results of performance of the project in terms of cost and time after analyzed?
   3. How large is the forecast cost and time to complete the project?

4. **Research Objectives**
   The intent and purpose of this study was to answer the problem formulation studied, namely:
   1. Identification and analysis of the concept of Earned Value Method in the control system to determine the performance results project based costs and time.
   2. Identification factors that cause results after analysis of project performance Earned Value Method.
   3. Knowing forecasts for the cost and time to complete the project.

5. **Research Benefit**
   - Expected writing of this research may provide additional references regarding the discourse and project management, especially with regard to the project cost control.
   - The results of this research paper can be an input or historical data that can be used for future projects as an effort to control costs in the field.
   - The results of this paper can be input for further research.

6. **Limitations and Scope Issues**
   Limitation and scope of the problem in this analysis is focused on the following matters:
   - This analysis only for the construction of apartment "M-Town Signature" in Serpong.
   - The analysis using earned value method.
   - In this analysis is on the contractor

7. **Literature**
   7.1 **Introduction of Project Construction**
   Project is a series of activities that are specific, to achieve a result which is special anyway. So the project is not a routine activity that is carried out continuously, but only about something a certain period only [2].
   The construction project is a project related to infrastructure development efforts of building something, which generally includes the basic work including in the field of civil engineering and architecture. Although there is rarely involves other disciplines such as industrial engineering, mechanical engineering, electrical engineering, geotechnical, landscape, and so on [3].

   As stated in the Project Management Body of Knowledge (PMBOK), the stages in the PMBOK project is divided into five groups or often referred to as the Project Management:[4]
   1. Initiating process Group
   Initiating process Group or the initiation process is a process to define a new project or a new phase in the existing project by obtaining authorization to start the project or phase.
   2. Planning Process Group
   The process consists of making a scope of the project, establish project objectives and defining the actions needed to achieve the project objectives have been determined.
   3. Executing Process Group
   This process is a process to complete the work or activities contained in the project management plan in accordance with the project specifications.
   4. Monitoring and Controlling Process Group
   The process requires a track, review, of the progress or achievement of every activity in the project performance. This process also identifies areas that change from project planning and then respond to the changes.
   5. Closing Process Group
   This process is the process of settlement of all the activity in each group process to formally close the project or phase or phases in the project.

   ![Figure 7.1 Project Management Process](Source: Institute, Project Management, 2008)

   **7.2 The concept of earned value method**
   There are three basic elements which is used in analyzing the performance of the project based on
the concept of earned value. These three elements are:

a. Budgeted Cost for Work Scheduled (BCWS) is the budget allocated by the work plan that has been developed over time. BCWS is calculated from the accumulated budget planned cost for work in a specific time period. BCWS at the end of a project (completion 100%) called Budget at Completion (BAC). BCWS is also a barometer of the performance period of the project implementation. BCWS reflect the cumulative absorption of cost plans for each of the work packages based on the sequence according to the schedule planned.

b. Actual Cost for Work Performed (ACWP) is a representation of the total expenditure incurred to complete the work within a certain period. ACWP can be cumulative performance calculation period or the amount of expenses in a given time period.

c. Budgeted Cost for Work Performed (BCWP) is the value received from the completion of work during a specific time period. BCWP is called “earned value”. BCWP is calculated based on the accumulation of jobs that have been completed. There are several ways to calculate BCWP are: Fixed formulas, weights Milestone, Milestone weights with percent complete, complete unit, percent complete, level of effort.

Earned value method is the concept of the value of the results (earned value concept) is one method that can be used in monitoring and controlling the activities of the project, so the effectiveness of these activities can be achieved. The concept of the calculation of the costs according to the budget in accordance with the work completed or underway (budgeted cost of works performed).

Three approaches are used to the concept of the value of the result:

1. The cost of the work is based on the budget work is still going on
2. Indicators ACWP, BCWP and BCWS
   \[ \text{BCWS} / \text{PV} \] is the proportion of costs that are planned to be used by an activity. Or budget cost of work scheduled to be carried out within a certain period (week or month).
   BCWP is the total actual expenses incurred during the implementation of the settlement activity. Or the realization of the cost of implementation of one or several activities in a particular period (weeks or months)
   BCWP is the percentage of the budget that should be spent in accordance with a performance that has been achieved to complete an activity. Or budget work has been carried out within a certain period (week or month)

By using three indicators (BCWS, BCWP and ACWP), are used to determine the various factors that indicate the progress and performance of the project.

**Schedule Variance (SV)**

is the result of reduction of BCWP with BCWS. The results of the Schedule Variance shows on the implementation of the project work. SV price equal to zero (SV = 0) when the project is completed because all of Planned Value has produced.

\[ \text{SV} = \text{BCWP} - \text{BCWS} \]

**Cost Variance (CV)**

is the result of a reduction of between BCWP with ACWP. Value Cost Variance at the end of the project will differ between BAC (Budgeted At Cost) and AC (Actual Cost) issued or used.

\[ \text{CV} = \text{BCWP} - \text{ACWP} \]

**Indexproductivity and performance**

productivity index used to determine the efficiency of resource use. Analysis of the productivity index is composed of the Schedule Performance Index (SPI) . Schedule Performance Index (SPI) is a factor in completing the work efficiency of performance can be demonstrated by a comparison between the value of the physical work has been completed (BCWP) with costs incurred expenditure plan based on the work plan (BCWS). The formula for the Schedule Performance Index are:

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

Where,

- SPI = 1: project on time
- SPI> 1: faster project
- SPI <1: project delayed

**Cost Performance Index (CPI)**

is a cost efficiency factor that has been issued can be demonstrated by comparing the value of the work that is physically resolved (EV) with the costs incurred in the same period (AC). The formula for the CPI is:

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

Where,

- CPI = 1: charges according to plan
- CPI> 1: smaller cost / saving
- CPI <1: the greater cost / wasteful

**7.3 Estimated cost of project completion**

Progress calculated based on the actual physical or BCWP budgets allocated. While the expenditure was recorded in the accounting system or ACWP. BCWP and ACWP can provide projections on the end of the project on the basis of figures from the time of reporting. Making the forecast cost or schedule is very helpful because it provides an early warning of things will happen in the future if current trends (when reporting) had no change. Thus provided an opportunity to conduct rectification.
Estimated cost for the remaining work / Estimate to complete (ETC)
That the estimated costs still to be incurred to complete the project
\[ ETC = \frac{(total\ budget\ project - BEWP)}{CPI}. \]

The estimated total cost of the project / Estimate at Completion (EAC) forecast final cost of the project is calculated at time of review

\[ EAC = ACWP + ETC \]

Estimated Time (TE)
TE is an approximate time penyelesaan project.

\[ TE = ATE + \frac{(OD - (ATE \times SPI))}{SPI} \]

Note:
- ATE(Actual Time Expensed), Time has taken
- OD (Original Duration), time project completion plan

8. Framework

The method used in this research is quantitative descriptive research that describes the condition of a particular project with data-analysis existing data. Analysis of data using analytical and descriptive methods. Analytical means that the existing data is processed such that the end result can be concluded. While the descriptive meaning is by describing the problems that already exist or appear. The concept of Value Yield (Earned Value Analysis) examines the tendency variants and variants fee schedule over a period of time during the project lasts.

9. Flow Chart of Research

Stages of research compiled authors in this study illustrated in a flowchart as follows:

**Identification of the problem**
Identify on the issue of what will be discussed with regard to time management and construction costs based on the literature and information that has been obtained.

**Literature study**
Studying of literature to be used as a study of theory in this study.

**Data Collection**
This stage is the determination of the research instrument is by using interview, including sourcing data and licensing.

**Data processing**
Data obtained in the form of information work, implementation schedule, the S curve, and report project progress.

**Data analysis**
Analyzing result data processing based on the results of research and theory. Make analysis of the relationship between the timing of the project costs, as explained following picture.
10. Place and Time of Research
The research is in one of the apartment building project named "M-TownSignature Summarecon Serpong"

General Description of Project
Project Name : M-Town Signature Summarecon Serpong
Location : Boulevard Raya Gading Serpong
Project Type : Residential (apartment)
Project Owner : KSO Summarecon Serpong
Contractor : PT. Wijaya Kusuma Contractors
Implementation Time: August 1, 2015 - February 28, 2018
Number of floors:
a. Galaxy Tower: 38 floors, one basement
b. Herald Tower: 38 floors, one basement
c. Imperial Tower: 38 floors, one basement
d. Jefferson Tower: 38 floors, one basement
Area of the building: 124,517.55 m²

11. Data Research
To support this analysis, the authors take the example as a case study that Apartment Development Project M-Town Signature Summarecon Serpong. To facilitate the necessary analysis of instrument data directly related to the project. The instrument used for this study include:
1. Scheduling apartment construction project M-Town Signature Summarecon Serpong.
2. The weekly report on the construction project apartment of M-Town Signature Summarecon Serpong.
3. Reports apartment construction project budget cost M-Town Signature Summarecon Serpong.

12. Data Collection
Project data on the work of M-Town apartment Signature Summarecon Serpong until week 82 (eighty two) are as follows:

BCWP, BCWS and BCWP ACWP is the value of Rp. 262,644,787,707, - then the value ACWP Rp. 215,605,972,939, - and BCWS value of Rp. 232,988,192,693, -

The implementation was done 82 weeks (574 days) for a total period of work of 134 weeks (938 days) so that the remaining construction period is 52 weeks (364 days).

13. Data Analysis
Once the data required all collected then will do data analysis to determine the condition of the project. The analysis of these data are as follows:
1. Analysis of variance per work schedule and cost variance.
2. Analysis of grade point performance by the cost and time of implementation of the project.
3. The final calculation of costs and the remainder of the project duration.

14. Analysis of variance schedule and variant costs
14.1 Analysis of variance schedule on preparatory work
From the values obtained that the value of BCWP is above BCWS meaning in this work is more steady progress and growing the value of the cumulative value SV with the results at week 82 are as follows:

\[ SV = Rp\ 36,792,004,733 - Rp\ 24,775,803,187.59 \]
\[ = Rp\ 12,016,201,546.02 \]

From the above calculation can be seen that up to 82 weeks SV value on the preparatory work to be positive with a number of Rp.12,016,201,546.02 which means that the progress of preparatory work is happening faster than planned.

14.2 Analysis of variance on the work schedule structure
From the values obtained until week 82 that the structure work is progressing on schedule at SV values which can be seen also from the graph where the values approaching BCWP BCWS values at week 82. This means that the value of progress this work run more faster than the value of the progress of the plan. One example of the calculation of the value of SV in week 82 of the work structure is as follows:

\[ SV = Rp\ 156,647,525,540.07 - Rp\ 150,488,734,905.04 \]
\[ = Rp\ 15,158,790,635.03 \]

From the above calculation can be seen that up to 82 weeks on the job structure value SV is positive in the amount of 158,790,635.03 which means that the employment structure has a progress faster than planned.

14.3 Analysis of variance on the work schedule architecture
From the values obtained that up to 82 work weeks of architects has increased continuously on a weekly basis. But along the way, at week 52 to weeks 66 had experienced keterlamabatan job. One example of the calculation of the value of SV in week 82 of the architectural work is as follows:

\[ SV = Rp\ 74,631,328,155.6 - Rp\ 56,346,224,334.29 \]
\[ = Rp\ 18,285,103,821.38 \]
From the above calculation can be seen that until week 82 SV value in architectural work is positive in the amount of Rp 18,285,103,821.38 which means that the work of the architect has a progress faster than planned. The weekly analysis results can be seen from the table below.

14.4 Analysis of variance on the work schedule of infrastructure

From the values obtained until week 82 that the infrastructure work has an SV value is negative. That means in this work progress occurring value smaller than the value of a progress plan also means that infrastructure work is happening more slowly than planned. One example of the calculation of the value of SV in week 82 of the work structure is as follows:

\[
SV = Rp573,929,277.61 - USD 1,377,490,266.26 = -Rp 803,500,988.65
\]

From the above calculation can be seen that through week 82 value SV in the infrastructure work is negative in the amount of Rp. 803,500,988.65, which means that the infrastructure work has a slower progress than planned. The weekly analysis results can be seen from the table below.

After conducting an analysis on every job can be concluded for a total value of SV in the entire work can be seen from Table 1 of the following:

<table>
<thead>
<tr>
<th>No</th>
<th>work</th>
<th>Schedule variants Values Week 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preparation</td>
<td>Rp12,297,601,582.22</td>
</tr>
<tr>
<td>2</td>
<td>Structure</td>
<td>Rp158,790,635.03</td>
</tr>
<tr>
<td>3</td>
<td>Architect</td>
<td>Rp18,285,103,821.38</td>
</tr>
<tr>
<td>4</td>
<td>Infrastructure</td>
<td>-Rp803,500,988.65</td>
</tr>
<tr>
<td></td>
<td>total Variant</td>
<td>Rp299,937,995,049.98</td>
</tr>
</tbody>
</table>

Source (Data Processing Results)

The total variance pda entire job is Rp 299,937,995,049.98, it means at this project contractor is accelerating the progress of actual value rather than progress direncankaan. Although in their infrastructure work has been delayed, but it can be covered by an acceleration in other jobs.

15. Variant Analysis Cost

Cost Variant can be calculated from the actual progress penguruanngan reduced costs on actual costs is out on the project.

From the results of the value obtained from the table and the picture above can be seen that up to a week to 82 CV positive. That means you benefit financially experienced contractor on this project because actual expenditure is less than the cost of the actual progress of the project. Although in a few weeks there is a sizeable outlay, but it can be arranged so that at week 82 the value of fixed costs resulting variant is positive One example calculation CV values at week 82 of all jobs are as follows:

\[
CV = \frac{Rp262,644,787,707.05 - Rp215,605,972,939.00}{Rp262,644,787,707.05} = Rp 47,038,814,768.05
\]

From the above calculation can be seen that through week 82 CV values on the project is positive with the amount of Rp 47,038,814,768.05 which means that this project has the advantage that the actual cost is less than the actual progress of the field.

15.1 Analysis of the index performance and project implementation time.

On the research value of the CPI and SPI can be calculated by the formula for the results of the SPI and CPI values at week 26 in the project are:

\[
CPI = \frac{Rp215,605,972,939.00}{Rp262,644,787,707.05} = 1.22
\]

\[
SPI = \frac{Rp232,988,192,693.28}{Rp262,644,787,707.05} = 1.13
\]

CPI at week 82 had a value of more than 1 is 1.22, which means the cash flow of the project experienced the situation is stable and experiencing savings in project expenditures. As for the comparison of the value of the SPI and CPI on the project can be seen from Figure 15.1 below:

![CPI VS SPI](image_url)

Figure 15.1 Grafik Comparison Values vs. SPI CPI at Whole Works
In Figure 15.1 can be explained comparison of CPI and SPI on the project. In the early weeks of the CPI shows that the chart is below a value of 1 means the contractor expenditures take more than the planned expenditure is paid to the value of SPI ore than 1. This means that at the time of big spending contractors can produce progress fairly large value too. After a few weeks until week 82 SPI and CPI value is above 1 means that jobs are a stable performance in terms of both expenditure and in terms of the progress of the work produced.

16. The final calculation of costs and the remainder of the project implementation

The results of the calculation and analysis on the value of Estimate to Complete (ETC) and values Estimate at Complete and Time Estimate on Apartments project M-Town Signature Summarecon Serpong at weeks 82 is as follows:

\[
\text{ETC} = \frac{420,000,054,037.73 - 262,644,787,707.053}{2} = \text{Rp} 129,173,457,392.74
\]

\[
\text{EAC} = \text{Rp} 215,605,972,939 + \text{Rp} 129,173,457,392.74 = \text{Rp} 344,779,430.33
\]

\[
\text{TE} = -82 + ((134 -1.13) 1.13) = 119 \text{ weeks}
\]

As for the recapitulation of the analysis of the value of the EAC, ETC and TC can be seen from the following table:

17. Analysis of results Data processing

Data processing is divided into two parts: an analysis based on time and analysis based on cost.

17.1 Analysis of the data processing time

data from previously known that for the overall project work has a positive value on the SV and has a performance index of more than one, which means the project is progressing actual progress compared to the plan. But in the SV processing per job was found that the infrastructure work suffered a setback on the actual progress compared to the plan. It can be seen from the SV negative. This can result in delays in the completion of structural work if there is no improvement on the performance side. From weekly analyzes on infrastructure works can be seen that the delay occurred because of several factors:

a. land for infrastructure work not yet ready to be done
b. yet their specialized workers for infrastructure
c. orders Delayed material infrastructure

Further factors that accelerate projects going on preparatory work. This was due to the progress that has been stable operations every week and the acceleration of the procurement of equipment and K3 requirements.

17.2 Analysis of the data processing costs

The expenditure does not always equal or stable on a weekly basis. Because the actual expenditure every week is different depending on the needs of that week. The factors that influence the variance in the financing was well worth the negative or positive value is:

1. The administrative fees beginning of the project and the cost of PO material
2. order is a great material for stock material
3. financial order in less material

The contract value for this project is Rp 420,000,054,037.73 while expenditure actual on week 82 was Rp 215,605,972,939. From the results of this processing we can see that actually at week 82 experienced contractor profit of Rp 47,038,814,768.05 at week 26 due to spending less than the progress obtained. If the contractor is able to maintain its performance in cost and more effective in spending the end of the project the contractor will spend Rp 129,173,672,998.71 clear Nili is smaller than the value of the project contract. However, because the project is still running so it is still too early to say the future actual contractor would cost less than the value of the contract. Need for monitoring and further study to determine the value of the final cost to be incurred contractor whether to remain effective or will be swelling of the expenditure.

18. Conclusion

After doing research on project control methods Earned Value Method in project implementation apartment M-Town Signature Summarecon Serpong then that can be summed up as follows:

1. On the implementation of development projects loft apartments M-Town Signature Summarecon Serpong which has a project value of Rp 420,000,054,037.73 up at week 82 performance results occur on the project in which the value of schedule performance index (SPI) at 1:13 and had a schedule variance (SV) of Rp 29,656,595,013.71. Furthermore, the project has an index value of cost performance achievement (CPI), which occurs in this project is worth the 1:22 and the cost variance (CV) of Rp 47,038,814,768.05. Expenditures fluctuated so that the expenditure is sometimes larger or
smaller than a plan on a weekly basis. The expenditure occurred at week 82 were worth Rp.113,110,368,434.19 because the contractor did order the material is quite large and the smallest expenditure occurred in Week 1 that is worth Rp.325,564,046.84 because the work has not been fully effective at the beginning of the project. But in general, the project has accumulated a stable cash flow and is followed by the index stable construction schedule also without any delay on the overall workmanship.

2. The estimated value of expenses to complete until completion of the project / Estimate to Completion is Rp 129,173,457,392.74 so that the total of the cost of the ETC plus the cost of which has been out and is required for completion of the project is Rp. 344,779,430,331.74. This value is smaller than the total value of projects Rp.420,000,054,037.73 so that the contractor predicted a profit of Rp.75,220,623,705.99 Likewise, the estimated completion time that happened project where the project is accelerating progress on the contractor performed the initial weeks that occur after the completion time is calculated takes as long as 119 weeks, which means the project can be resolved faster 2 weeks of the planned schedule for 134 weeks.

3. Work affecting the delay in the project are the infrastructure works with a value of SV - Rp.803,500,988.65, with a performance index of 0.42 and the estimated completion time of 130 weeks of the scheduled 54 weeks in infrastructure construction. The factors that affect delays in infrastructure work are:
   1. land for infrastructure work not yet ready to be done
   2. yet their specialized workers for infrastructure
   3. Delayed order material infrastructure
      While the work affecting the acceleration of the project is in the preparatory work to the value of SV Rp 12,016,201,546.02, then the value of the index 1:48 and estimates completion of work for 88 weeks of the scheduled namely 130 weeks. And factors affecting it are:
      a. Progress operations have stabilized weekly
      b. Acceleration on procurement of equipment and the need K3

19. Suggestions
   At the time of the study, the authors put forward some suggestions on the research results that occur are as follows:

20. References