

Measuring Schedule Performance of Fiber to The Home Project Using Earned Value Management

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Abstract— Fiber to the home (FTTH) is the current project that awarded by XYZ company to vendors. This project experience several months delay against the baseline. To meet the due date both parties want to give a proper corrective action toward the project. Since the project is still completing the remaining task, the project manager should perform controlling method in order the remains tasks do not deviate from current the baseline. Earn Value management has been used as a method to control the project. From EVM calculation it can be obtained that the schedule performance for this project is 0,86 which means the project is behind schedule and only progressing 86%. The deviation occur since material can't be carried out by supplier.

Keywords—Crashing Schedule, Fiber to The Home, Earned Value Management (EVM), S-Curve, Monitoring and Controlling

I. INTRODUCTION

XYZ is the largest telecommunication provider who serves fiber optic (FO) installation project in Indonesia. The type of FO project is PQR service which makes 3 features including internet services, TV cable and telephone. To fulfill the PQR service, the company wants to expands the business which called Fiber to the Home (FTTH) project.

YYY has contracted the selected vendors to carry on the project. All the vendors must perform the project all over different Indonesian area. The project started with conducting site survey to choose the desired cable path. After the selected path is met the the next activity holding the Design Review Meeting (DRM). This meeting mostly talks about the project planning approval in between two parties. If the vendor's project plan is approved by the owner, then the vendor can start doing the project.

Project cannot be separated with monitoring and controlling. This stage has many advantages such as deciding the corrective action or rework if the errors in the project may happen [1]. *Monitoring* means repeatable action to compare the actual works and the planned works based on budget, time and value. Sometime, the corrective action is needed to repair the gap/the variance of the project [2]. It aims to control the project based on its initial objective because the main objective of the project covers three aspect including cost, time and scope [3].

This project has 3 months' delay form the beginning phase. As a consequence, this research aims to monitor and control the schedule and the budget FTTH project. One of the popular method monitoring and controlling the project is *Earned Value Management* (EVM) [1]. Earned Value also called performance review, is a technique to show the future project budget, and duration based on "work in progress" data [4].

All the work in progress in each period can identify whether the project is on the initial plan or no by using the S-Curve. EVM can also estimate how long the project can be finished and how much is the total budget has been spent. EVM use three data such as *Planned Value* (PV), *Earned Value* (EV) and *Actual Cost* (AC). Planned Value means the budgeted cost. It means the budget of the project has not been incurred. Actual cost means the amount of money that has been spent for the project. it means the budget of the project has been incurred. Earn value is the budgeted cost of any work that has been performed. Thus, EVM is the effective method to see any variance happen and convert to the financial term which commonly used as the main project goal.

Study from Ashif, et.al [5]., EVM has unique purpose for vendor and owner of the project because the project can be easily monitored and evaluated regarding the money has been spent. After using the calculation of EVM, the project actually struggles from finishing the project duration and budget because the project has no good governance of monitoring and controlling the project. the forthcoming work, the remaining budget and the total actual cost can be estimated using EVM.

Based on the research by Avlijas, et.al [6], by using EVM methods, project performance can be monitored in terms of cost and the project duration against the initial plan. As mentioned earlier that monitoring & controlling project means suggest corrective action if the variance or the gap exist. The suggested corrective action may vary according to the problem. Study form Masood et al, the corrective action that used in their works is applying crashing method to accelerate the project duration [7]. Since the FTTH problem is how to meet the end project, then the best corrective action is something which is relevant to achieve the milestone project faster. However, there is a trade off when crashing is implemented for example the budget may arise or higher than the plan [8].

By using EVM method, all the progress of project performance from every period could be identify whether or not project had ran well using curve-s, besides it was also visible about how long the project could be completed and how much the cost had been expended. By using this curve-s, the planned value and earned value could be seen the difference. In addition, the analysis of monitoring and controlling could be more effective because the deviation could be seen from the key major success of this project, namely time, cost, and scope.

II. METHODOLOGY

Earned Value Management (EVM) aims to measure whether the performance value is carried out in accordance with the planned performance value, and whether the duration of the completion of the project in accordance with the planned duration. Therefore, using the EVM concept, project managers will know how well the project is performing, and if any deviation can be done immediately. There are three basic indicators that become the main reference in the performance analysis on the project based on the EVM concept [3], including:

1. **Planned Value (PV)**
The budgeted plan provided and approved at the beginning of the project. PV can be calculated by accumulating every allocated cost based on a certain period.
2. **Earned Value (EV)**
Project progress performance which convert into cost term. EV is mainly used by percentage project completion in a certain time. EV can be calculated by accumulating the value of works in every period.
3. **Actual Cost (AC)**
The amount of money has been actually spent during the project. AC can be calculated by the accumulating the actual cost in every period.

Since the actual cost is a restricted data then the budget performance is not allowed to be measured. Nevertheless, it doesn't mean project performance cannot be examined, the schedule performance still has important role in monitoring and controlling the project. So, the schedule performance is the only indicator in measuring this project.

Following the EVM formula taken from PMI [1] and Nicholas & Steyn [3], there are three calculations for measuring schedule performance for instance calculating *Schedule Variance*, *Schedule Performance Index* and *forecasting the project duration*

1. **Schedule Variance (SV)**
Schedule Variance shows how much gap the the actual schedule against the schedule baseline. The formula to find SV is:

$$SV = EV - PV$$

2. **SPI (Index Performance Schedule)**
Schedule Performance Index is a ratio whether the performance of the project has a good work efficiency value so that the

project can be completed on time or even faster, or the project has poor work efficiency value that will cause a delay in project. The following formula used to calculate schedule performance is:

$$SPI = EV / PV$$

After estimating the variance and schedule performance index the following project duration can be forecasted by dividing the initial schedule by schedule performance index. Time Estimated (TE) can be used to estimate how long can the project be finished based on the work in progress.

$$TE = \frac{\text{INITIAL DURATION}}{SPI}$$

III. RESULT AND DISCUSSION

A. Work Breakdown Structure

To perform a performance analysis using EVM method, a Work Breakdown Structure (WBS) is required to inform the activity need to be done, a detail information about the activity, project activity duration, project activity predecessor, and project activity weight which indicates percentage project completion. The following is a WBS from the FTTH project which is located in Cirebon conducted by vendor. The project takes 120 calendar days as shown in Table 1.

Table 1. Work Breakdown Structure of FTTH Project

WBS No	Task Tittle	Duration
1	Preparation	
1.1	Survey	7
1.2	<i>Design Review Meeting</i>	7
1.3	Permissions	7
1.4	Order Material	7
2	Procurement Process	
2.1	Procurement Distribution Material	
2.1.1	Delivery Existing Pile Accessories	14
2.1.2	Delivery Pole Accesories	14
2.1.3	Delivery Riser Pipe	14
2.1.4	Delivery HDPE Pipe	14
2.1.5	Deliveri FO Cable	14
WBS No	Task Tittle	Duration
2.1.6	Delivery ODP	14
2.1.7	Delivery Splitter	14
2.1.8	Delivery Patch Cord	14
3	Instalation	
3.1	Existing Pile Accessories Instalation	11
3.2	Pole and Accessories Instalation	11
3.3	Pulling FO Cable	22

Table 2. Work Breakdown Structure of FTTH Project (Continued)

WBS No	Task Title	Duration
3.4	ODP Instalation	17
3.5	Splitter Instalation	17
3.6	Jointing/Termination	17
4	Closing	
4.1	Commisioning Test	3
4.2	Acceptance Test	2

B. Planned Value

After developing the WBS then the next step is creating S curve based on the Planned Value (PV). PV is used corresponding to the weight of work on WBS. The following is an S curve of the WBS by accumulating the value of weight in each period. According to Fig 1, the due date of the project takes 15 weeks and divided into 4 stages including preparation, material procurement, installation and project closing.

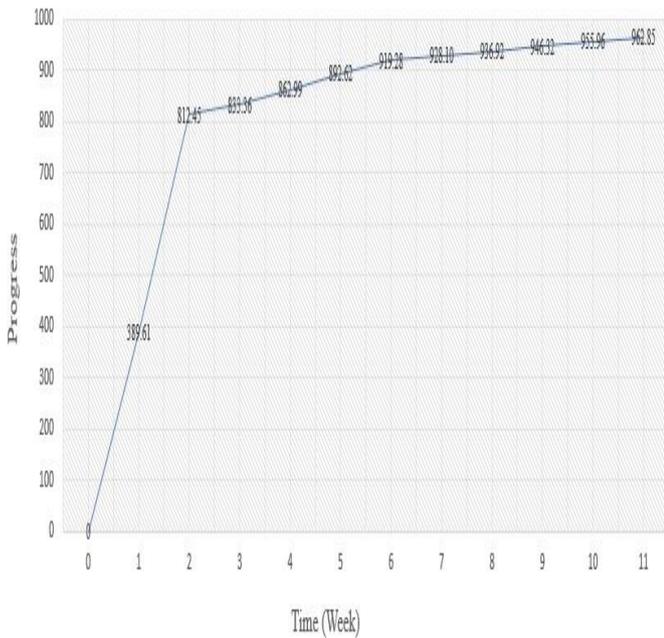


Fig. 1 S-Curve of Planned Value FTTH Project

Based on Fig. 1 about S-curve for FTTH project, it can be seen weekly plan value of the project. The observation took in weeks 11 which has 2 keys activity such as material procurement, and project installation. The weight of activity that is must be done in weekly period can be seen from the table 2.

C. Earned Value

After creating S curve based on PV, the following step is gathering project completion progress by vendor or EV. EV can be calculated by multiplying the percentage project

progress to PV. As shown in table 2, the project completion divided into weekly progress corresponds to PV curve.

TABLE 3. PLANNED VALUE OF FTTH PROJECT

Week	Planned Value (Rp)	Planned Value (%)
1	Rp 389,611,000.00	40.46
2	Rp 812,451,909.09	84.38
Week	Planned Value (Rp)	Planned Value (%)
3	Rp 833,360,000.00	86.55
4	Rp 862,991,000.00	89.63
5	Rp 892,622,000.00	92.71
6	Rp 919,279,705.88	95.47
7	Rp 928,097,647.06	96.39
8	Rp 936,915,588.24	97.31
9	Rp 946,322,352.94	98.28
10	Rp 955,964,647.06	99.28
11	Rp 962,852,000.00	100.00

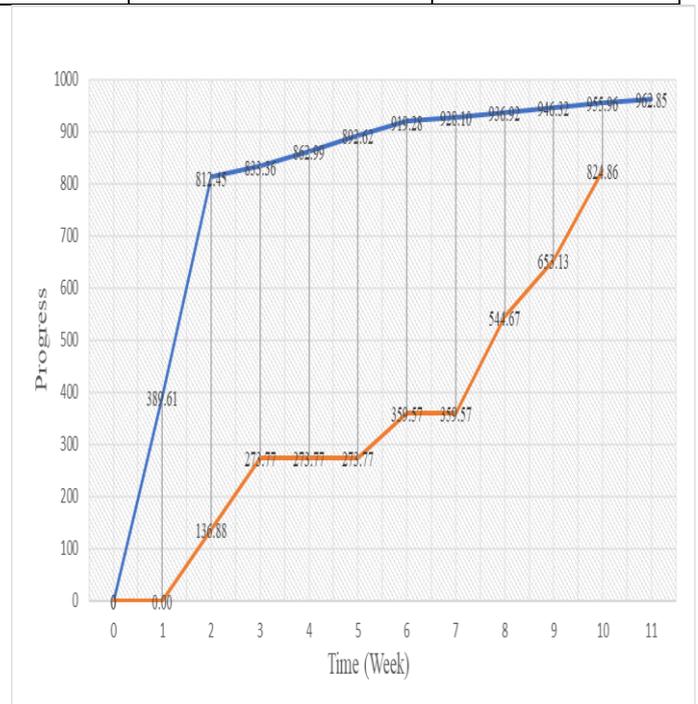


Fig. 2 S-Curve of Earned Value FTTH Project

The project seems in not good path according to the beginning week. That the actual work takes slower than the baseline (PV). The main problem behind slower progress is procurement issues. The vendor can no meet the desired date to delivery all the material. The procurement delivery is one of the critical activity which can cause delay to the project duration. Figure 2 shows the big gap or deviation of project implementation. The main reason for this cause were problem in purchase order, material delivery, material procurement, and supplier.

TABLE 4. EARNED VALUE OF FTTH PROJECT

<i>Week</i>	<i>Earned Value (Rp)</i>	<i>Earned Value (%)</i>
1	Rp -	0.00
2	Rp 136,884,500.00	14.22
3	Rp 273,769,000.00	28.43
4	Rp 273,769,000.00	28.43
5	Rp 273,769,000.00	28.43
6	Rp 359,574,000.00	37.34
7	Rp 359,574,000.00	37.34
8	Rp 544,674,000.00	56.57
9	Rp 653,127,000.00	67.83
10	Rp 824,860,000.00	85.67

Based on table 3 above, it can see the project performance done by partner begin to experience huge gap against baseline form 1st week to 10th week.

D. Schedule Variance

After calculating PV and SV, the exact number of variance can be estimated. If the SV is zero then the actual progress meets the baseline, moreover if the SV is lower than '1' or negative number then it indicated the project takes too slow than the baseline or behind schedule.

TABLE 5. SCHEDULE VARIANCE OF FTTH PROJECT

<i>Week</i>	<i>Planned Value (%)</i>	<i>Earned Value (%)</i>	<i>Schedule Variance (%)</i>	<i>Information</i>
1	40.46	0.00	-0.40	<i>Behind Schedule</i>
2	84.38	14.22	-0.70	<i>Behind Schedule</i>
3	86.55	28.43	-0.58	<i>Behind Schedule</i>
4	89.63	28.43	-0.61	<i>Behind Schedule</i>
5	92.71	28.43	-0.64	<i>Behind Schedule</i>
6	95.47	37.34	-0.58	<i>Behind Schedule</i>
7	96.39	37.34	-0.59	<i>Behind Schedule</i>
8	97.31	56.57	-0.41	<i>Behind Schedule</i>
9	98.28	67.83	-0.30	<i>Behind Schedule</i>
10	99.28	85.67	-0.14	<i>Behind Schedule</i>
11	100.00			

E. Schedule Performance Index

SPI aims to measure whether the performance of a vendor stay in a good position or not. The result of SPI can be proceed to the corrective action if the result bad. If SPI is lower than '1' then the project manager must pay attention to

this activity because it means the schedule is underrun. However, if the SPI is greater that '1' then it means the project is faster than baseline.

TABLE 6. SCHEDULE PERFORMANCE INDEX OF FTTH PROJECT

<i>Week</i>	<i>Planned Value (%)</i>	<i>Earned Value (%)</i>	<i>Schedule Performance Index</i>	<i>Information</i>
1	40.46	0.00	0.00	<i>Behind Schedule</i>
2	84.38	14.22	0.17	<i>Behind Schedule</i>
3	86.55	28.43	0.33	<i>Behind Schedule</i>
4	89.63	28.43	0.32	<i>Behind Schedule</i>
5	92.71	28.43	0.31	<i>Behind Schedule</i>
6	95.47	37.34	0.39	<i>Behind Schedule</i>
7	96.39	37.34	0.39	<i>Behind Schedule</i>
8	97.31	56.57	0.58	<i>Behind Schedule</i>
9	98.28	67.83	0.69	<i>Behind Schedule</i>
10	99.28	85.67	0.86	<i>Behind Schedule</i>
11	100.00			

F. Time Estimate

Project cannot be separated with threat that may jeopardize the project objective. The threat may have an impact toward the project which is sometimes unpredictable. in EVM concept, the project duration can be estimated so that the project manager can anticipated which action must be prepared or decided. After calculating SPI and SV, the project stays on bad position that will lead to delay. Any delay will cause the over budget. The current accumulative SPI is 0.86 which indicates the project only progress 86% than the baseline. The project completion can be forecasted based on the current progress (week 11). According to Table 6, the project is longer than the planning up to 13 weeks form the baseline The project will be finished in weeks 13.

TABLE 7. TIME ESTIMATE OF FTTH PROJECT

Planning Duration	11	Week
Duration Used	19	Week
Remaining Duration	1	Week
Estimate Complete Duration	13	Week

IV. ANALYSIS

Performance analysis using earn value management can help the project team to monitor project performance, whether the project stays in a good position (meet the baseline) or not. Based on the results of EVM method, the vendor experienced deviations in project completion time. The procurement issue such as material purchase orders, difficulties in licensing, availability of materials, and labor are factor that makes the project longer. So, in this case, the remaining work will be crashed or shortened to avoid the schedule deviation get worse.

The project manager should revise the schedule issue since the project will face the similar experience later. PM should make sure all the materials are set up before the project begins or divide the project into 2 different vendors for instance a vendor who supplies the material and a vendor who installs the material.

Therefore, the result of SV value on the 10th week is - 0.14, it means the project made deviation of time, and SPI value in 10th week is 0.86, it reflected the project performance was not accordance with the plan. By using EVM analysis, it could be predicted that project would be able to be completed on the 13th week. In the other hand, the project experiences delay.

V. CONCLUSION

Form the Schedule Variance calculation project is behind schedule and also indicate that the actual budget will get higher than baseline. From SPI calculation obtained 0.86 which means the project only progressing 86% against the plan. Form forecasting calculation, the project will be finished longer from 11 weeks to 13 weeks.

Crashing may have been chosen as the corrective action but it will make the actual cost get bigger. In this case, if cost is not the problem to vendor then crashing will be best option, however if the cost is limited then another option will be better than crashing such as fast racking, smoothing technique. However, it doesn't mean they are safe to be implemented they also have risk such as rework so by investigating the characteristic of each option is really recommended before apply the method.

Choosing the right activity that will be shortened is tricky, every crash-cost should be estimated firstly then choose which activity that has the least cost. Every activity in crashing method should be critical so calculating the float every activity is urgently needed. Some scheduling software can accommodate the calculation such as Microsoft Project. This research is mainly focus on the schedule performance then for future works the budget performance can be interesting topic to be studied as long as the data is sharable.

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