

Earned Value Management (EVM) on Controlling the Implementation of the Road Construction Project

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Abstract- Road infrastructure development projects that are being developed in East Indonesia, one of which is located on the district of West Southeast Maluku in Maluku province. Deviation from the time of execution, on project to improve the Trans Yamdena Tumbur road on West Southeast Maluku District in 2013 the background of this study, which aims to determine the results of the performance of the project and the cause of the deviation as well as how to control. Evaluation of the performance time and cost in this study as well as control were analyzed using Earned Value Management (EVM) concept. The results evaluation showed that there are deviations from the schedule of implementation resulting in delayed projects in total for approximately 14 working days. This is caused by the redesign process of planning for one week at the 1st week which result in decreased performance on 2nd week. While the reduction in the number of workers began at 12th week, resulting in decreased performance at 13th week until the completion of the project. Control of the deviation of project time can be done by accelerating time to redesign at 1st week and increase the amount of labor as before began at 12th week. Based on the results of the control, the project is estimated to be completed in its entirety for approximately 14 weeks or faster 2 weeks of 16-week duration of the plan. Thus it is estimated the actual cost savings may occur in aggregate approximately 10.55% of the actual cost that has been realized. It becomes recommendations to implementing similar projects with project site approximately the same in the implementation of road projects in the future.

Keywords— Earned Value Management (EVM), Deviation Implementation Schedule, Control

I. Introduction

The successful implementation of an infrastructure project of road infrastructure in particular is how its output as planned either in physical form as well as the readiness to operate as they are functional. Construction of road infrastructure and the development of eastern Indonesia, especially in the Moluccas become a government priority this year and next year. Completion of the implementation of road construction in this area are often not in accordance with the planning, this can be caused by several things that can be controlled or not controlled by the project management, Road improvements in the area of West Southeast Maluku, especially on the Trans Yamdena - Tumbur in 2013 is one of the government programs to accelerate development in the region.

In a previous study conducted by Tayl (2014), only evaluates the performance of the project over a period of two months in which there are deviations from the plan period. This can have an impact on the cost of which has been planned. Therefore it is necessary to do research on the causes of the deviation so it can be given a solution how to control it.

II. Road Construction Project Implementation and Control Methods

The construction of the road as required by technical specifications, should be conducted in accordance sequence or stages of work right so the work is more effective and can increase the efficiency of the implementation, it is likely to reduce construction costs and can finish all the work on time. The construction of roads is generally based on the flowchart (flow chart) corresponding technical demands, the types and kinds of work in sequence to achieve the overall goal of project completion. In the course of its implementation are small activities that are part of the main activities which should be implemented at the same time. In addition, the use of equipment in accordance with the correct method, as well as mastery of detail throughout the equipment used to optimize the use of such equipment in order to increase production.

A. Road Improvement of the Trans Yamdena Tumbur

Construction of road improvements in the area of West Southeast Maluku, especially on the Trans Yamdena -Tumbur in 2013 is one of the government programs to accelerate development in the region. Research by Tayl (2014) is to evaluate the performance of the project over a period of two months. Research results show that the project is experiencing irregularities against time caused by several factors. To analyze how should the performance of the construction of the project can be realized according to plan, and based on the data irregularities that have occurred to conduct further research to determine the causes of the deviation of the time as well as how to control using EVM.

B. The delay in the implementation of development and improvement of road construction projects

Completion of the project which is slower than the time that has been planned can be caused by conditions of uncertainty both from external projects, internal projects, as well as of the parties involved. An important parameter in the implementation of the road construction project, which is often used as a target of the project is the budget, schedule, and quality. Success in carrying out the project on time, cost, and quality that has been planned is one of the most important goals for the owner and the contractor. Implementation of the project which is not in accordance with the plan, may result in project delays. Delays in project completion can result in losses for the owner and the contractor. For contractors, delays in addition can lead to cost overrun due to the increase in the project implementation time, can also lead to decline in the credibility of the contractor for the future. As for the owner, delay in operation way for the benefit of society. It can also lead to disputes and claims between the owner and the contractor.

C. Earned Value Management

In addition to planning, one of the functions that greatly affect the outcome of the project is the control function which achievement of the targets is not enough simply to the organization and leadership of a reliable and high working motivation, but the supervision and control is an integral and integrated. The purpose of monitoring and control is to monitor, assess and even held correction and guidance so that a predetermined can be accomplished in accordance with planning

One method that has been widely applied in the International company is Earned Value concept as applied to California Department of Transportation, US Department of Energy and NASA. Meanwhile, the American National Standard Institute (ANSI) has published ANSI / 748 which is a standard application of Earned Value Management System in the management of the project. These systems incorporate and link the elements of the budget, expenses, schedule, score result, the scope of work and implementing organizations, which are summarized in a procedure, with some aspects and criteria that must be met. This indicates that the Earned Value Management System is very necessary to be applied in the management of the project as an integrated activity between the policies, procedures and practices in decision making.

According to the national industry standard in the United States (1998) is an American National Standards Institute / Electronic Industries Alliance (ANSI / EIA) 748 - A - 1998, in application of the concept of Earned Value, there are five major aspects of project management, which translated into 32 criteria. The five aspects are: 1). Organization, 2). Planning, scheduling, and budgeting, 3). Accounting system, 4). Analysis and management reports and 5). Revision and repair data.

III. Research Methods

The primary data and secondary data on one of the projects that the Government of Works Maintenance / improvement of the Trans Yamdena-Tumbur where there are deviations to schedule the execution time plan. Secondary data include contract documents and reports on implementation while the primary data are interviews with the parties directly involved in the project.

Occupation is Heaps subgrade and pavement improvement with Penetration Macadam layer along the 3 km.

The contract is dated July 13, 2013 with the duration of the project plan: \pm 120 working days / 16 weeks.

At budgeted Complete: \$102,199.79 .

Type Budget, the Special Allocation Fund (SAF) for Fiscal Year 2013.

Task Giver Department of Public Works, Mines and Energy West Southeast Molucas District and

Contractor is "X" company.

Indicator is the reference in analyzing the performance of the road project is based on Earned Value Management Concept includes three things:

- 1) Budgeted Cost for Work Scheduled (BCWS),
- 2) Actual Cost for Work Performed (ACWP) and
- 3) Budgeted Cost for Work Performed (BCWP) .

Of the three dimensions can be connected between the cost performance with time comes from

Cost calculation variant (SV) and

Schedule Varian (SV),

Cost Performance Index (CPI) and

Schedule Performance Index (SPI). (Fleming and Koppelman, 1994).

IV. Earned Value Management on Controlling the Implementation of the Road Construction Project

A. Deviations of Project Schedule

Based on secondary data, evaluation of overall performance on road projects Sp. Trans Yamdena Tumbur, deviation occurs when the implementation of the planning time. Deviations of time occurred during the 2nd week and in the period week 13 until the project is completed ie until the 18th week, so the project has been delayed in total for approximately 14 working days, or about 2 weeks of the planned time is 16 weeks (Figure1). This could have an impact on project costs, especially indirect costs. The evaluation results are shown in Table 1 below.

TABLE 1. TIME PERFORMANCE EVALUATION RESULTS

	Parameter EVM	Scheduled Planning, 120 work days /16 weeks						
		Week 1st	Week 2nd	Week 12th	Week 13th	Week 14th	Week 15th	Week 16th
	Original Date (Week)	16	16	16	16	16	16	16
	Budget At Complete (BAC)	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79
	Time used until now (Week)	1	2	12	13	14	15	16
A	Basic Parameter							
	Cummulative BCWS (Budget Cost Work Scheduled)	\$2,074.66	\$4,200.41	\$74,197.18	\$83,497.36	\$89,731.55	\$95,965.74	\$102,199.79
	Cummulative BCWP (Budget Cost Work Performed)	\$0.00	\$3,229.51	\$78,090.99	\$82,107.45	\$86,123.90	\$90,089.25	\$94,064.82
	Cummulative ACWP (Actual Cost Work Performed)	\$0.00	\$1,858.73	\$67,633.88	\$72,037.92	\$76,441.96	\$80,846.00	\$85,250.05
B	Perfomanced Varians Project							
	SV = BCWP - BCWS (Scheduled Varians)	-\$2,074.66	-\$970.90	\$3,893.81	-\$1,389.92	-\$3,607.65	-\$5,876.49	-\$8,134.97
	CV = BCWP - ACWP (Cost Varians)	\$0.00	\$1,370.78	\$10,457.12	\$10,069.52	\$9,681.93	\$9,243.24	\$8,814.77
C	Efficiency Index Perfomanced of Project							
	SPI = BCWP/BCWS (Scheduled Perfomanced Index)	0.00	0.77	1.05	0.98	0.96	0.94	0.92
	CPI = BCWP/ACWP (Cost Perfomanced Index)	0.00	1.74	1.15	1.14	1.13	1.11	1.10
D	Estimated Cost of Project Forward							
	Estimation Cost Project To Finish							
	B-ETC = (BAC-BCWP)/CPI - Budget Estimate To Complete	\$0.00	\$56,961.98	\$20,880.40	\$17,628.25	\$14,268.66	\$10,867.99	\$7,372.64
	Estimation Total Cost Project To Finish							
	B-EAC = (ACWP ⁿ + B-ETC)- Budget Estimate At Complete	\$0.00	\$58,820.71	\$88,514.28	\$89,666.17	\$90,710.62	\$91,713.99	\$92,622.69
	Varians Cost At Complete = (BAC - B-EAC)	\$0.00	\$43,379.08	\$13,685.51	\$12,533.62	\$11,489.17	\$10,485.80	\$9,577.10
E	Estimated Scheduled of Project Forward							
	Estimation Scheduled Project To Finish							
	S-ETC = (OD-Elapsed time)/SPI - (Weeks)	0.00	18.21	3.80	3.05	2.08	1.07	0.00
	Scheduled Estimate To Complete							
	Estimation Total Scheduled Project To Finish							
	S-EAC = (Elapsed time + S-ETC) - (Weeks)	0.00	20.21	15.80	16.05	16.08	16.07	16.00
	Scheduled Estimate At Complete							
	Varians Schedule At Complete (Weeks)	16	4.21	0.20	0.05	0.08	0.07	0.00

B. Cause of occurrence Deviations Project Schedule

Causes delay in project based on primary data collected in Table 2 below:

TABLE 2. CAUSES DELAY

No	Week to	Causes of deviation	Scope of work	Proposed Control
1.	2nd	Process redesign	Embankment	Accelerate or process redesign before the project is implemented so as not to hamper the implementation process that has been planned. On this analysis conducted for one week accelerated the shift time to redesign.
2.	13th	Lessening of manpower, the number of workers who have competence very limited, and late allocation of material and equipment	Primecoat / tackcoat and Macadam Penetration	Adding the amount of manpower began at week 12, while increasing the number of labor force is directly proportional to the addition of indirect costs. Procurement of materials and equipment must be on schedule plan

c. Control of the time and cost of the project

Adding manpower, starting week 12th based on the analysis as follows:

TABLE 3. ANALYSIS OF PRODUCTIVITY OF MANPOWER (MP) AT MACADAM PENETRATION

Analysis of Productivity of manpower at Macadam Penetration

1	The volume of the items Late Work	=	302.83	m3
2	The total duration of which has been delayed	=	7	week
3	The total number of manpower earlier in the week 12th until 18th	=	20	(MP)
4	Manpower productivity	=	43.26	m3/week
		=	7.21	m3/day
		=	0.36	MP
5	The total duration of the estimated after controlling	=	3.00	week
6	Time for 1 manpower	=	840	day
7	Plan to increase the total number of manpower	=	46.6	MP/day
		=	47	MP/day
8	The actual number of MP began weeks 12th	=	20	MP
	Salary of MP	=	\$ 4,412	MP
9	Schedule Control			
	The total number of manpower weeks 12th	=	47.00	MP
10	Actual Cost : The addition of MP costs	=	\$119.12	day
	The addition of MP costs	=	\$714.71	week
	The addition of equipment costs	=	\$2,202.02	week
	TOTAL	=	\$2,916.73	week

Table 4. COST CALCULATION RESULTS BEFORE AND AFTER CONTROL

Parameter	Before Control	After Control
ACWP	\$ 94,058.13	\$ 84,134
Saving (%)	-	10.55
Profit (%)	7.97	17.67

D. Results Control of Time and Cost Performance Project

Control is done by using EVM, beginning at week 2nd and at week 12th until the project can be completed. Results of the evaluation time control at week 2th clearly visible performance of the project time better and increase of performance has been realized previously, where the index performance when SPI and cost CPI > 1 and estimate the approximate time is much faster around 8 weeks to the actual cost more lower than the cost of the plan.

TABLE 5. RESULTS CONTROL OF TIME AND COST PERFORMANCE PROJECT

	Parameter EVM	Scheduled				
		Week 1	Week 2	Week 12	Week 13	Week 14
	Original Date (Week)	16	16	16	16	16
	Budget At Complete (BAC)	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79	\$102,199.79
	Time used until now (Week)	1	2	12	13	14
A	Basic Parameter					
	Cummulative BCWS (Budget Cost Work Scheduled)	\$2,074.66	\$4,200.41	\$74,197.18	\$83,497.36	\$89,731.55
	Cummulative BCWP (Budget Cost Work Performed)	\$3,229.51	\$9,668.24	\$93,451.62	\$101,218.81	\$102,199.79
	Cummulative ACWP (Actual Cost Work Performed)	\$1,858.73	\$3,717.47	\$69,492.61	\$74,611.52	\$79,730.43
B	Perfomanced Varians Project					
	SV = BCWP - BCWS (Scheduled Varians)	\$1,154.86	\$5,467.82	\$19,254.44	\$17,721.44	\$12,468.24
	CV = BCWP - ACWP (Cost Varians)	\$1,370.78	\$5,950.77	\$23,959.01	\$26,607.28	\$22,469.36
C	Efficiency Index Perfomanced of Project					
	SPI = BCWP/BCWS (Scheduled Perfomanced Index)	\$1.56	\$2.30	\$1.26	\$1.21	\$1.14
	CPI = BCWP/ACWP (Cost Perfomanced Index)	\$0.00	\$2.60	\$1.34	\$1.36	\$1.28
D	Estimated Cost of Project Forward					
	Estimation Cost Project To Finish					
	B-ETC = (BAC - BCWP)/CPI - Budget Estimate To Complete	\$0.00	\$35,578.69	\$6,505.32	\$723.11	\$0.00
	Estimation Total Cost Project To Finish					
	B-EAC = (ACWP + B-ETC) - Budget Estimate At Complete	\$0.00	\$39,296.16	\$75,997.94	\$75,334.64	\$79,730.43
	Varians Cost At Complete = (BAC - B-EAC)	\$0.00	\$62,903.63	\$26,201.85	\$26,865.15	\$22,469.36

TABLE 5. CONTINUATION....

	Parameter EVM	Scheduled				
E	Estimated Scheduled of Project Forward					
	Estimation Scheduled Project To Finish					
	S-ETC = (OD- Waktu Terpakai)/SPI - (Weeks)	0.00	6.08	3.18	2.47	1.76
	Scheduled Estimate To Complete					
	Estimation Total Scheduled Project To Finish					
	S-EAC = (Waktu Terpakai + S-ETC) - (Weeks)	0.00	8.08	15.18	15.47	15.76
	Scheduled Estimate At Complete					
	Varians Schedule At Complete (Weeks)	16	7.92	0.82	0.53	0.24

Results of the performance control the time and cost of the overall project with methods of Earned Value Management (EVM) is shown in Figure 1.

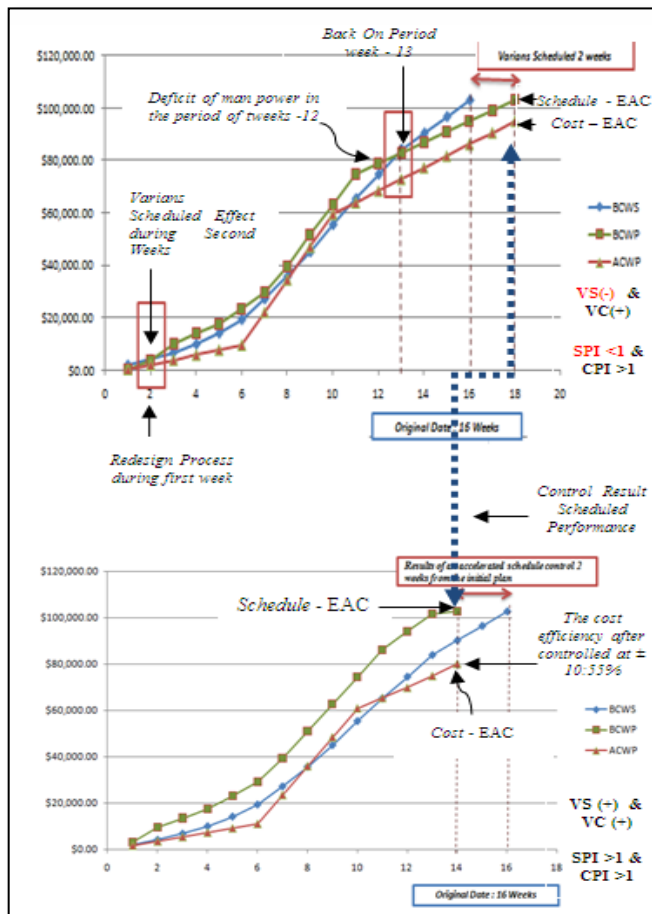


Figure 1. Results Comparison Project Time and Costs Performance Before And After Controlled With EVM Method

v. Recommendation

The contractors should use evaluation methods Earned Value Management (EVM) in controlling the performance of the project since early so that they can determine how much the performance in terms of time and or cost and also be aware of irregularities that have and will occur during the life cycle project.

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Earned Value Management is a technique and method of cost and schedule control who used to measure the performance of integrated cost and schedule that can quickly reveal deviation. In practice, Earned Value Management incorporate and link the elements of the budget, expenses, schedule, score result, the scope of work and implementing organizations