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Model Development of Time and Cost Performance Measurement Methods - Earned Value Management (EVM) With A Combination of Dynamic Uncertainty Analysis (Case Study Road Construction Project In South Sulawesi Province)

James Thoengsal
Assistant Professor of Department Civil Engineering, University of Technology Sulawesi, South Sulawesi
Correspondent Email: Architect_james@yahoo.com

ABSTRACT

In the execution cycle of a construction project often found a divergence varians especially with respect to time and costs, which in detecting the occurrence of a deviation of the project is often carried out an evaluation of the performance of the results that have been achieved both on time and cost. One method that is most frequently used in evaluating the performance of the cost and time that the methods Earned Value Management (EVM), but in the study of analysis methods EVM can be concluded that the assumptions used only linear and static the estimation of the time and cost of the project from performance has been generated just shows the estimated value of which is rigid and not dynamic, where as if the result of the estimated project cost and time performance shows one possible course. Therefore, the purpose of writing this article which is to carry out a development model of performance measurement time and cost of the project by analyzing a combination of uncertainty dymanic against time and cost of the project, which will be used in combination by entering the numbers uncertainties optimistic, enable / ideal and pessimism about the estimated time performance and future costs at the time of the evaluation process is done (Freeze time). From the study results of the analysis conducted can be formulated basic equation in the form of indicators that can be formulated to predict total project time and cost of the three conditions, namely optimistic pessimist and ideal and analysis to the level of probability methods normal distribution to predict time and totalcost of completing a project construction.

Keywords: Time, Cost, EVM, Dynamic, Performance, Uncertainly

INTRODUCTION

One of the most frequently used methods in evaluating cost and time performance is the Earned Value Management (EVM) method. The performance that has been generated only shows the estimated value that is rigid and not dynamic, where it seems as if the results of the estimated cost and time performance of the project show only one possibility. It should be noted that in the construction project implementation cycle, the uncertainty factor is something that needs to be taken into account considering the nature of the project which is constantly changing/dynamic. Due to the weakness of the EVM method, the purpose of this study is to develop a project time and cost performance measurement model by conducting a sweet combination of uncertainty analysis on project time and cost, which will be combined by entering optimistic uncertainty numbers, possible and pessimistic about the estimation of future time and cost performance during the

evaluation process (Freeze Time). Based on the description of the background above, it is necessary to conduct a research and development of the basic model of EVM performance evaluation with the aim of adding an analysis of the combination of uncertainty to the possibilities that can occur during the implementation of a dynamic construction project. Some of the main issues that will be discussed in this paper are how to determine the standard standard for the optimistic Optimistic Earned Value (EV-O) and Pesimistic Eraned Value (EV-P) pessimism in the process of evaluating construction project performance, how the uncertainty value affects the estimated time performance. and project costs in using the EVM method application and how the simulation results of Earned Value Management (EVM) model development with the addition of dynamic uncertainty combination analysis in each period will be evaluated.

Traditionally, project success was measured by the parameters on time, cost and quality. Scheduling is the allocation of available time to carry out each job in order to complete a project until optimal results are achieved by considering existing limitations (Levy, 2002). Good time planning must be accompanied by good time control too, so that the planned time can be maintained during the project journey so that project time can be achieved (Budisuanda, 2011). The Earned Value method is "almost inaudible" because the Earned Value method looks simple, but its implementation in project management is not easy and quite complex. [8]

METHOD

Research Type

This research uses development quantitative research methods. Where quantitative research is one type of research that is more systematic, structured, specific, and well planned well from the beginning to get to a conclusion. Quantitative research places more emphasis on the numbers that make it up become more detailed and clearer. In addition, the use of tables, graphs and diagrams makes it easier to read.

Research Time and Location Research

The time referred to in this study is the overall time of the course of the research related to data collection during the research. The time needed for researchers to collect research data is about 7 weeks, starting from March 12, 2019 to April 25, 2019. The research location in question is where the researcher gets research data for this final project. The researcher conducted research on the Construction Project for Construction of the Infrastructure, Facilities, and Utilities (PSU) for Public Housing Area II in the Aryamas Residence Housing, Kab. Takalar, Prov. South Sulawesi. Specifically on 8 road sections, namely 1 section in Block C, 3 sections in Block D, and 4 sections in Block E in Takalar, South Sulawesi, Indonesia.

Types Data Research

Primary data in this study is in the form of observations of researchers at the project site, then Secondary data in the form of Budget Plan (RAB) / Budget Plan Implementation (RAP), Schedule / (S Curve), Detailed Engineering Design (DED), Weekly Reports.

Analysis Method Research

The method in writing this article review is carried out by conducting a basic development analysis of the Earned Value Management (EVM) method then performing a simulation of the development of the EVM model based on several weaknesses in the Classical EVM method, namely by modifying the basic parameters of EVM with dynamic uncertainty analysis, starting from the stages:

- Determination of Optimistic and Pessimistic Standard Earned Value
- Formulate Scheduled Variance (SV) and Cost (CV).
- Formulate Cost Performance Index (CPI) and Time (SPI)
- Formulate Cost Estimate Complete
- Formulate Scheduled Estimated Complete
- Uncertainty Analysis of Time and Total Cost Estimates using the analysis method of the gauss distribution/normal distribution.

The stages of analyzing the uncertainty equation are the Budget –Estimate to Complete (ETC)/ Budget-Estimate At Complete (EAT) and Scheduled – Estimate To Complete (ETC)/ Scheduled-Estimate At Complete EAC parameters. This is done by finding the probabilistic value from table Z of the normal distribution. and simulation of equations is carried out to determine estimates from historical data on actual costs and project implementation times that have been realized.

FINDING AND DISCUSSION

Based on the results of the simulation modeling of the concept of developing an Earned Value Management (EVM) time and cost performance measurement method, it can be done systematically and theoretically the derivative equations of EVM in the form of determining the basic parameters of EVM in the form of optimistic, ideal and pessimistic EV/BCWP values based on assumptions and predictions Initially, the derivative equations can be made in the form of optimistic, ideal and pessimistic time and cost variance equations and continued with the project time and cost performance index equations. Determination of Standard Earned Value Optimistic and Pessimistic

- BCWP (EV)- Optimistic
- BCWP (EV) – Ideal
- BCWP (EV) – Pessimistic

Time Variance Scheduled (SV) and Cost (CV)
Scheduled Variance Equation:

VS –Optimistic = (BCWP –Optimistic - BCWS)……..(1)
VS –Ideal = (BCWP –Ideal - BCWS)……..(2)
VS –Pessimistic = (BCWP –Pessimistic - BCWS)……..(3)

Cost Variance - VC –Optimistic = (BCWP –Optimistic - ACWP)……..(4)
VC –Ideal = (BCWP –Ideal - ACWP)……..(5)
VC –Pessimistic = (BCWP –Pessimistic - ACWP)……..(6)

Cost Performance Index (CPI) and Time (SPI) Equation:
CPI – Optimistic = BCWP-Optimistic/ ACWP)……..(7)
CPI- Ideal = BCWP-Ideal / ACWP……..(8)
CPI- Pessimistic = BCWP-Optimistic/ ACWP) ……..(9)
SPI – Optimistic = BCWP-Optimistik/ BCWS) ……..(10)
SPI- Ideal = BCWP-Ideal / BCW……..(11)
SPI- Pessimistic = BCWP-Optimistic/ BCWS) ……..(12)

To find out the projected value of the estimated cost and time based on the initial assumptions of the EVM parameters, an equation can be derived in determining the probabilistic value of the cost and time of implementation of a project, with the following equation derivativ.

Uncertainty Analysis of Time and Total Cost Estimates The value of the estimate of project time and cost equations based on optimistic, ideal and pessimistic basic assumptions can be done in combination using the adoption of the application of optimistic and pessimistic time analysis development model methods Program Evaluation Review Technique (PERT) can be seen at Figure 1.

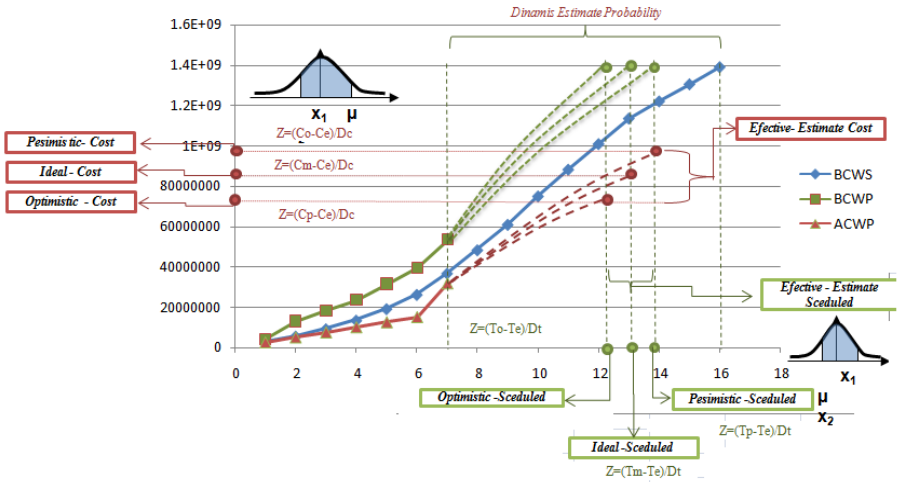
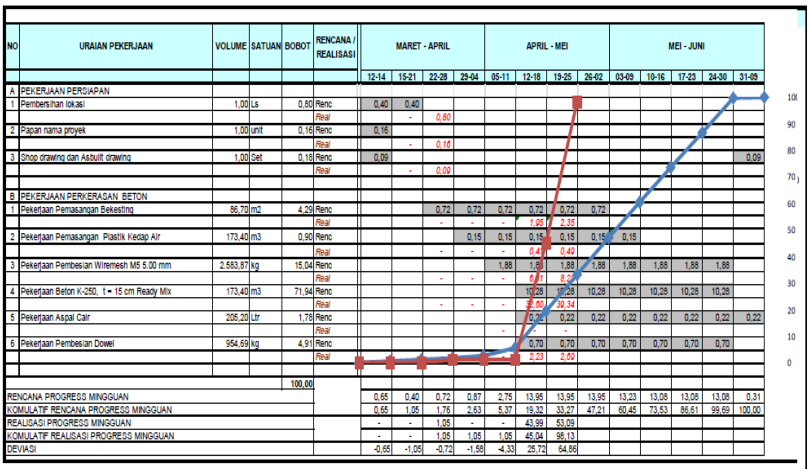


Figure 1. Development Model -Earned Value Management Method

Simulation model at example case project with recapitulation of the total price of the Concrete Road Construction Project for Infrastructure, Facilities and Utilities (PSU) for Region II Public Houses at Aryamas Residence Housing, Takalar Regency, South Sulawesi Province. Details of the time plan and the actual time of the project can be seen from the following Figure 2.



NO	URAIAN PEKERJAAN	VOLUME	SATUAN	BOBOT	RENCANA / REALISASI	MARET - APRIL				APRIL - MEI				MEI - JUNI				
						12-14	15-21	22-28	29-04	05-11	12-18	19-25	26-02	03-09	10-16	17-23	24-30	31-09
A	PEKERJAAN PERSIAPAN																	
1	Pembersihan lokasi	1,00	Ls	0,80	Renc	0,40	0,40											
					Real		-	0,80										
2	Papan nama proyek	1,00	unit	0,16	Renc	0,16												
					Real		-	0,16										
3	Shop drawing dan Asbuilt drawing	1,00	Set	0,18	Renc	0,09												0,09
					Real		-	0,09										
B	PEKERJAAN PERKERASAN BETON																	
1	Pekerjaan Pemasangan Bekesting	86,70	m2	4,29	Renc			0,72	0,72	0,72	0,72	0,72	0,72					
					Real			-	-	-	1,05	2,35						
2	Pekerjaan Pemasangan Plastik Kedap Air	173,40	m3	0,90	Renc				0,15	0,15	0,15	0,15	0,15	0,15				
					Real			-	-	-	0,40	0,40						
3	Pekerjaan Pembesian Wiremesh M5 5.00 mm	2.583,87	kg	15,04	Renc					1,88	1,88	1,88	1,88	1,88	1,88	1,88	1,88	
					Real			-	-	-	0,01	8,20						
4	Pekerjaan Beton K-250, t = 15 cm Ready Mix	173,40	m3	71,94	Renc						10,28	10,28	10,28	10,28	10,28	10,28	10,29	10,28
					Real			-	-	-	30,50	30,34						
5	Pekerjaan Aspal Cair	205,20	Ltr	1,78	Renc						0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
					Real					-	-	-						
6	Pekerjaan Pembesian Dowel	954,69	kg	4,91	Renc						0,70	0,70	0,70	0,70	0,70	0,70	0,70	
					Real						2,23	2,69						
				100,00														
RENCANA PROGRESS MINGGUAN						0,65	0,40	0,72	0,87	2,75	13,95	13,95	13,95	13,23	13,08	13,08	13,08	0,31
KOMULATIF RENCANA PROGRESS MINGGUAN						0,65	1,05	1,76	2,63	5,37	19,32	33,27	47,21	60,45	73,53	86,61	99,69	100,00
REALISASI PROGRESS MINGGUAN						-	-	1,05	-	-	43,99	53,09						
KOMULATIF REALISASI PROGRESS MINGGUAN						-	-	1,05	1,05	1,05	45,04	98,13						
DEVIASI						-0,65	-1,05	-0,72	-1,58	-4,33	25,72	64,86						

Figure 2. Plans and Realization of Implementation Time for Infrastructure Concrete Road Construction Projects, Takalar Regency, South Sulawesi Province (Sources: South Sulawesi Road Project Master Scheduled 2019)

From the analysis from Figure 2 of the Cost Performance Index (CPI) at week 1 to week 7 shows (CPI > 1) better performance than planning, in the sense of spending more smaller than budget and reporting activities from oversight the field is running smoothly. b. From the analysis of the time performance index/ Schedule Performance Index (SPI) at week 1 to week 5 shows the value of (SPI < 1) in the sense that work performance is not according to schedule which was planned. in other words the project experienced lateness. While in the 6th week to the 7th week shows the value (SPI > 1) in terms of implementation performance work faster than scheduled in other words project experiencing acceleration.

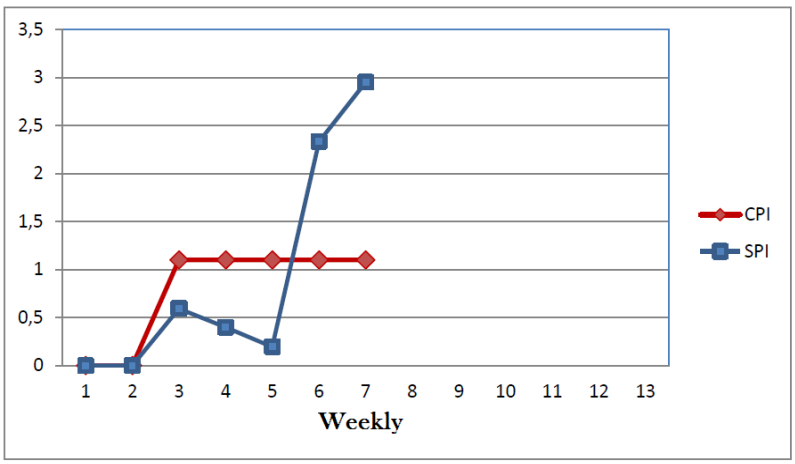


Figure 3. Graph of CPI and SPI Implementation Conditions

In the project case simulation example projection of delay/progress and Projection of Cost Overrun (Cost Above Plan)/Cost Underrun (Cost Under Plan) at the end of the Concrete Road Construction project at Aryamas Residence Housing, Kab. Takalar, South Sulawesi Province. From the cost aspect, the estimated cost for the remaining work (ETC) and the estimated total project cost (EAC) obtained an EAC value with currency unit Indonesia Rupiah (IDR), IDR. 312,087,921.25 while the BAC

or RAB value was IDR. 343,296,000.00 this means that at the end of the project later it is estimated that there will be a profit/profit of IDR. 31,208,078.75 (9.09% of RAB). From the aspect of time, the estimated time to work remaining (ETS) is 2 weeks. Estimated total project time (EAS) calculation is (time spent + ETS) 7 + 2 = 9 weeks, total planning time is 13 weeks. This means the project performance is running 4 weeks faster than the initial plan time can seen at figure 4.

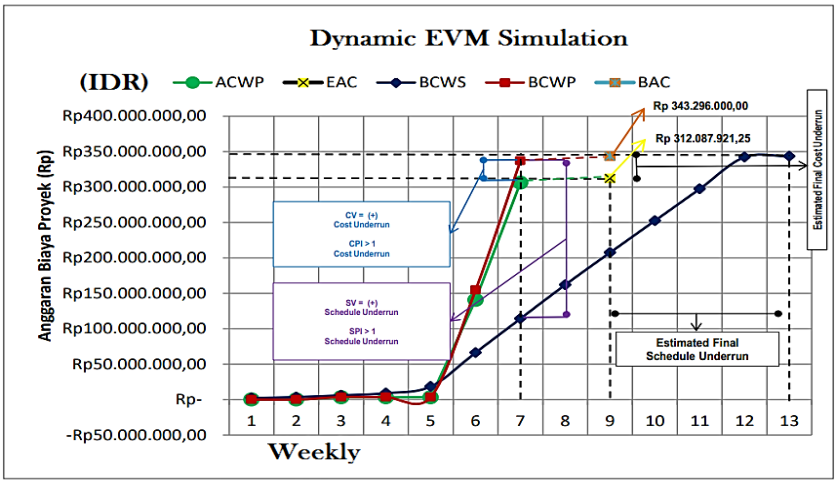


Figure 4. Graph of Time-Based and Forecast Schedule (EAS) and Cost (EAC) Estimates at the End of the Project Simulation

From the results of the application of the result value method, it is known that the results of the review in the 7th week obtained BCWS = IDR. 114,207,599.16; BCWP = IDR. 336,878,761.28; ACWP = IDR 306,254,055.74; Analysis of the Cost Performance Index (CPI) at week 7 shows (CPI > 1) performance is better than planning, while the Schedule Performance Index (SPI) shows a value (SPI > 1) in terms of performance. faster than scheduled and it can be seen that the estimated final project cost / Estimate At Complete (EAC) is IDR. 312,087,921.25 with a planned budget of IDR. 343,296,000.00. From the calculation of the estimated total project time / Estimate All Schedule (EAS) is 9 weeks, the total planning time is 13 weeks. This means the project performance simulation running 4 weeks faster than the initial plan time.

The probability value of uncertainty in the ETC/EAC equation can be calculated by collecting historical data on project time and costs that have actually been realized and then analyzed with a standard deviation value based on the actual time and cost of events that have occurred next theoretically using the Gaussian distribution equation/normal distribution. the value of the coefficient - Z can be obtained which is a parameter in determining the probability value of the estimated time and cost of the project. Seen in the graph below, it shows that there are differences in the basic parameters between the Classical EVM model and the EVM model that can be developed by adding the parameter estimate of uncertainty in probability to the project time and cost based on the estimates to be predicted at the end of the completion of a construction project which is presented with a

quantitative value. the total budget and project duration along with the probability value of the possibility of achieving these estimates at the end of the completion of a project.

CONCLUSION

The results basically, results of the application of the result value method, it is known that the results of the review in the 7th week obtained BCWS = IDR. 114,207,599.16; BCWP = IDR. 336,878,761.28; ACWP = IDR 306,254,055.74; Analysis of the Cost Performance Index (CPI) at week 7 shows (CPI > 1) performance is better than planning, while the Schedule Performance Index (SPI) shows a value (SPI > 1) in terms of performance. faster than scheduled and it can be seen that the estimated final project cost / Estimate At Complete (EAC) is IDR. 312,087,921.25 with a planned budget of IDR. 343,296,000.00. From the calculation of the estimated total project time / Estimate All Schedule (EAS) is 9 weeks, the total planning time is 13 weeks, it is necessary to measure the cost and time control of construction projects to measure project performance against deviations that occur. Earned Value is one of the methods used to measure the cost and time performance of an integrated project. In its implementation, the Earned Value method has weaknesses, including: cost and time predictions are deterministic, linear and do not involve an element of uncertainty, use units of value, require a complete management system, do not provide information on the probability of project results objectives, and do not take into account project quality. By identifying the lack of Earned Value, it is hoped that it can be used as consideration for making a better construction project performance measurement model and a higher level of accuracy, so that it can provide an early warning of cost overruns and construction project delays and can be the basis for research. advanced in applying in case examples of ongoing construction projects and seeing their influence in the control process of a project.

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