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EARNED VALUE MANAGEMENT SYSTEM FOR EVALUATING PROJECT PERFORMANCE

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Abstract---*The project management is becoming a well-known and popular science to engineers to make project planning and controlling effectively in compliance with clients' contractual requirements. Successful projects was indicated by achievement of meeting project requirement and specification and be completed on schedule and within budget. To gain a successful project, an effective project control approached must be designed, developed, and implemented to provide insight into how to finish project with timely and within budget. It is believed that Earned Value Management System (EVMS) able to control project effectively, on account of it integrate Scope, Schedule, and Cost of the Project. EVMS can obtain early warning and predict the outcome of projects. If our projects didn't meet certain requirements and specifications, we will know earlier before we continue our project. The main key metrics of EVMS are Planned Value (PV), Earned Value (EV), and Actual Cost (AC), and Budgeted at Completion (BAC). Finally, this paper described the concept and application of EVMS to control project performance in order to project be completed on schedule and within budget.*

Keywords---*scope, time, cost, earned value*

I. INTRODUCTION

As we know that US Defense Department has developed Earned Value Management System (EVMS) concept as tool of project control, meanwhile Project Management Institute (PMI) stated that EVMS as a tool for evaluating project performance. EVMS has been used for evaluating project performance, not only for government project but also for industry project. EVMS originated late in the 1960s as a financial management tool to control defenseacquisition projects (Marco and Timur, 2013). We know that EVMS is a methodology that integrates scope, cost and time. As we know that scope, time, and cost management are at the heart of successful project management. It is believed that EVMS can help projects meet their specification under circumstances. Beside that, EVMS is one of well-known powerful and effective approach utilized recently in managing complex projects. It has ability to show project progress by combining of Scope, Schedule, and Cost. Gupta (2014) stated that EVMS provide guideline for a company to control management system. Besides that, EVMS can also provide early warning and predict the outcome of projects. EVMS can monitor and control the cost, quality, schedule and risk of projects effectively (Khesal *et al*., 2019). If our projects didn't meet certain requirements and specifications, we will know earlier before we continue our project.

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Projects doesn't always run well, sometime may be appeared many problems, i.e. cost overrun or behind schedule, which it has bad impact to overall project. EVMS helps us to forecast accurately how to finish our projects. EVMS identifies project performance value based on "work in progress" to know about work in the future. We believe that EVMS is more effective than traditional one in evaluating project performance. EVMS integrated scope, cost, and time against project baseline to evaluate project performance. Meanwhile, the traditional one focused on planned expenditure and actual cost.

II. OBJECTIVE OF EVMS

According to Gupta (2014) there are five objectives of EVMS as follow.

1. Elaborate a specific statements of work
2. Comparing between progress of work and baseline plan
3. Measure a performance of schedule and cost
4. Provide information for management to make decision about project
5. Provide managers a practical information to make effective decision making

III. KEY EVMS METRICS

Gupta (2014), Busye and Vanhoucke (2010) stated that EVMS provides a few key metrics i.e. Planned Value (PV), Earned Value (EV), Actual Cost (AC), and Budgeted at Completion (BAC). Following explanation will be delivered to provide briefly insight into about key element metrics of EVMS.

1. Planned Value (PV) can be defined as the budgets for work scheduled that must be accomplished in certain time period.
2. Earned Value (EV) can be define as the budgeted cost that must be paid address to the work that has been finished or completed.
3. Actual Cost (AC) can be defined as the actual cost incurred for the completed work in certain time period.
4. Budget At Completion (BAC) can be define as total allocated budgets for a project

IV. PERFORMANCE MEASURE

There are two types of performance to measure variance, namely Cost Variance (CV) and Schedule Variance (SV). These variances indicate the differences between actual project progress and its baseline, in monetary term. As we know that CV give us information about the completed work cost compare to planned cost. We measured CV by calculating the difference between earned value and actual cost. Besides that, SV give us information about the completed work compared to planned schedule. We measured SV by by calculating the difference between the earned value and the planned value.

Other types of project performance measurement method are Cost Performance Index (CPI) and Schedule Performance Index (SPI). These indices provide us information about project performance. CPI indicates the cost efficiency of

executing work; meanwhile SPI indicates time effectiveness of executing work. Following Table explained project performance based on CV, SV, CPI, and SPI (Table 1).

Tabel 1: Description of Project Performance Indicators

Time Effectiveness	Cost Efficiency	Descriptions
SV positive	CV positive	Time: ahead of schedule project
SPI more than one	CPI more than one	Cost: under budget project
SV positive	CV equal to zero	Time: ahead of schedule project
SPI more than one	CPI equal to one	Cost: on budget project
SV positive	CV negative	Time: ahead of schedule project
SPI more than one	CPI less than one	Cost: over budget project
SV equal to zero	CV positive	Time: on schedule project
SPI equal to one	CPI more than one	Cost: under budget project
SV equal to zero	CV equal to zero	Time: on schedule project
SPI equal to one	CPI equal to one	Cost: on budget project
SV equal to zero	CV negative	Time: on schedule project
SPI equal to one	CPI less than one	Cost: over budget project
SV negative	CV positive	Time: behind schedule project
SPI less than one	CPI more than one	Cost: under budget project
SV negative	CV equal to zero	Time: behind schedule project
SPI less than one	CPI equal to one	Cost: on budget project
SV negative	CV negative	Time: behind schedule project
SPI less than one	CPI less than one	Cost: over budget project
The formulas of SV and CV are:		The formulas of SPI and CPI are:
CV = EV – AC		CPI = EV/AC
SV = EV – PV		SPI = EV/PV

V. COST FORECASTING

We present cost estimation to predict project cost in the future i.e. estimate at completion (EAC). To forecast of EAC is not only consider the budget at completion (BAC) based on project performance, but also involve projection of project in the future based on current performance and other knowledge availability at the time of forecast. PMI (2011) stated that forecast of EAC usually based on actual cost for work complete and plus an estimate to complete (ETC) the remaining work. There are three type approaches to calculate the EAC, namely:

1. EAC is equal to AC plus (BAC – EV).

   Forecast of EAC based on the actual costs and prediction of ETC for the future work that will be accomplished at the budgeted rate
2. EAC is ratio between BAC and CPI, so EAC = BAC/CPI

   Forecast of EAC based on the budgeted rate at the present of CPI

3. EAC is equal to AC plus [(BAC – EV) / (CPI × SPI)]

Forecast of EAC based on the actual costs on the budgeted rate and considering both SPI and CPI factors

Estimation of ETC can be determined after we found the calculation of EAC. As we explained before that ETC is the expected remaining cost to complete the project. It is not talk about the overall project expected budget (that's the EAC), but it is talk about the expenditure from now to the end of the project. Besides that it does not include what has already been spent. The final formula to estimate ETC was provided as follows:

ETC is equal to EAC - AC

According to PMBOK (2013), the relationship between key EVMS Metrics, Performance Measure and Cost Forecasting is depicted in Figure 1.

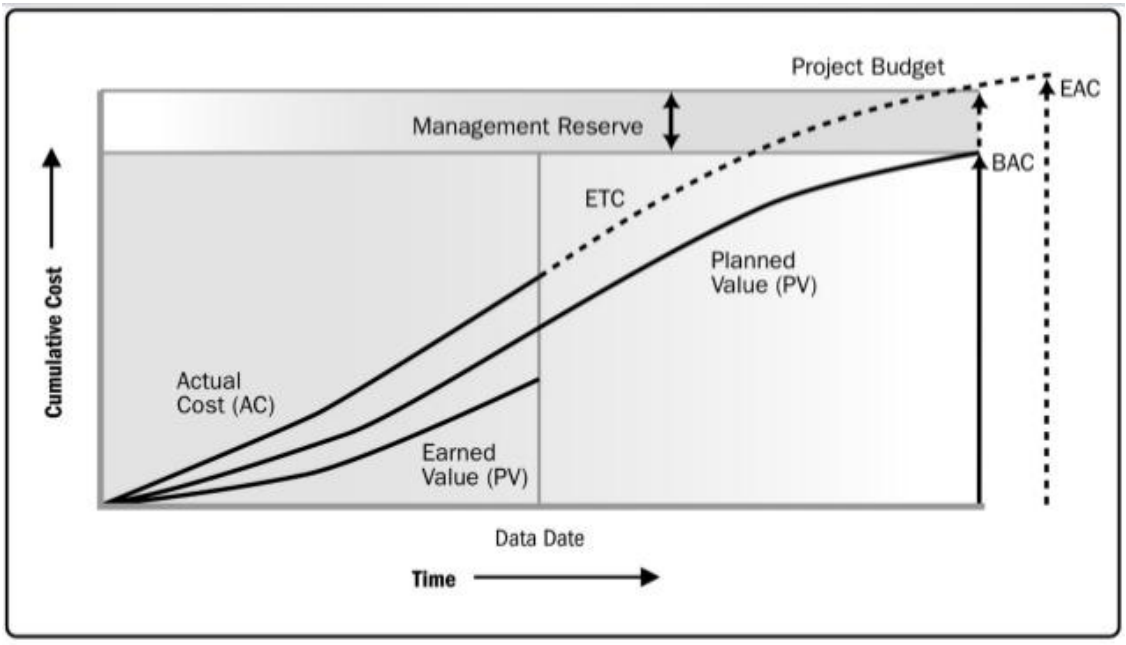

Figure 1: Earned Value Management System

Following table explained the summary of EVMS terminology and their interpretation (Table 2.)

Tabel 2: Interpretation of EVMS Term

EVMS Terms	Description	Interpretation
PV	Planned Value	Value of the work planned that has to be done
EV	Earned Value	Value of the work actually that has to be accomplished
AC	Actual Cost	Actual cost that incurred
SV	Schedule Variance	The differences between EV and PV
CV	Cost Variance	The differences between EV and AC

BAC	Budgeted at Completion	The budget for the total project accomplished
CPI	Cost Performance Index	The ratio between EV and AC
SPI	Schedule Performance Index	The ratio between EV and PV
EAC	Estimate at Completion	Expected total cost of completing all work
ETC	Estimate to Completion	Expected cost to finish all remaining project work

VI. CASE STUDY

Case study was taken to explain how EVMS concept implemented. We are planning project of software development. In the first stage, we identify scope of the project i.e. planning, development, and release. Second stage, we compose work breakdown structure (WBS) of the project. Third stage, we calculate BAC of this projects that calculated from WBS cost. Forth stage, we track progress all work by placing percentage of finish work. Fifth stage, as final stage, we analyze project performance by EVMS methodology.

Following Figure 2 indicates the project tracking of software development. We try to analyze at the end of the date 6. The budget for the total project is around $695, and now progress of overall project achieved 42%. Many tasks have finished indicated by 100% progress. Only test build task just achieve only 25%. Earned value analysis developed to evaluate the project performance on certain date. The result is shown in Table 3 below.

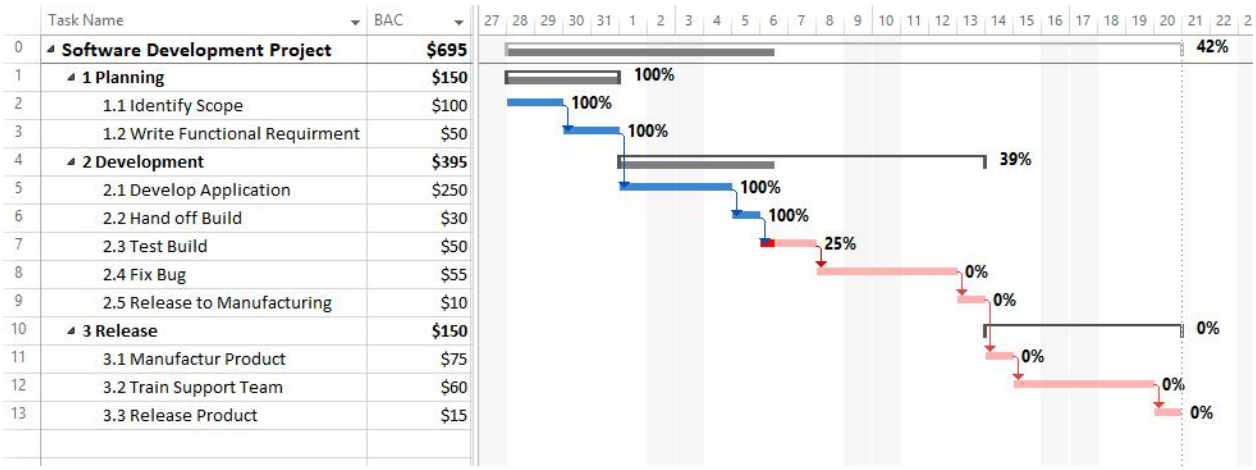

Figure 2: Case Study Example

According to Table 3, we get conclusion that at the end of 6 project of software development is effective but not efficient, on account of this project on schedule but over budget. We calculate that the value of CV was -$77.10 and CPI was 0.27. What does CPI of 0.27 mean?. At this point, the project of software development is over budget. Actually, we get only 27 cents worth of work for every dollar that we are spent. The forecasting of EAC was $2,536 and the value of ETC was around $1,471. Based on current performance, we need $2,536 to finish all work of project and $1,471 to finish remaining work of project.

Tabel 3: Calculation of Project Performance

Task Name	BAC	% Complete	PV	EV	AC	SV	CV	SPI	CPI	EAC	ETC
Software Development Project	**$695**	**42%**	**$291.90**	**$291.90**	**$1,065**	**$0.00**	**($773.10)**	**1**	**0.27**	**$2,536**	**$1,471**
Planning	**$150**	**100%**	**$150**	**$150**	**$200**	**$0.00**	**($50)**	**1**	**0.75**	**$200**	**$0**
Identify Scope	$100	100%	$100	$100	$125	$0.00	($25)	1	0.80	$125	$0
Write Functional Requirment	$50	100%	$50	$50	$50	$0.00	$0.00	1	1.00	$50	$0
Development	**$395**	**39%**	**$154.05**	**$154.05**	**$345**	**$0.00**	**($190.95)**	**1**	**0.45**	**$885**	**$540**
Develop Application	$250	100%	$250	$250	$300	$0.00	($50)	1	0.83	$300	$0
Hand off Build	$30	100%	$30	$30	$30	$0.00	$0	1	1.00	$30	$0
Test Build	$50	25%	$12.50	$12.50	$15	$0.00	($2.50)	1	0.83	$60	$45
Fix Bug	$55	0%	$0	$0	$0						
Release to Manufacturing	$10	0%	$0	$0	$0						
Release	**$150**	**0%**	**$0**	**$0**	**$0**						
Manufactur Product	$75	0%	$0	$0	$0						
Train Support Team	$60	0%	$0	$0	$0						
Release Product	$15	0%	$0	$0	$0						

VII. CONCLUSION

Project performance must be evaluated every gradual time to know how what we should do if we found the project progress unsuitable with planning. Well-known evaluation approach is EVMS, on account of EVMS not only could measure project performance of time and cost, but also we could estimate what time must be provided to finish project and how much cost must be incurred to finish total work and remaining work. It is believed that EVMS as systematic approach to find variances in projects based on the comparison of worked performed and work planned. In the other word, EVMS can be used as early warning system to identify project problem occurred. Estimation of time and cost that must be provided to finish project give us certainty to manage project better on schedule and budget.

REFERENCES

[1] A Guide to the Project Management Body of Knowledge, (PMBOK® Guide) Fifth Edition, (2013), Project Management Institute.

[2] Fleming, Q. W and Koppelman, J. M. (2010). Earned value project management (4th ed). PA, Newton Square: Project Management Institute.

[3] Gupta, R. (2014), "Earned Value Management System", International Journal of Emerging Engineering Research and Technology, Vol. 2 Issue 4, PP 160-165.

[4] Khesal, T., Abbas, S., Mohammad, K., Masoud, R.G., Roya, S. (2019), "Integrated Cost, Quality, Risk and schedule Control Through Earnedvalue Management (EVM)", Journal of Engineering, Designand Technology, Vol. 17 No. 1, pp. 183-203.

[5] Marco, A.D. and Timur, M. (2013), "Earned Value-Based Performance Monitoring Offacility Construction Projects", Journal of Facilities Management, Vol. 11 No. 1, PP. 69-80.

[6] Petrenko, Y.; Vechkinzova, E.; Antonov, V. 2019. Transition from the industrial clusters to the smart specialization of the regions in Kazakhstan, Insights into Regional Development 1(2): 118-128. https://doi.org/10.9770/ird.2019.1.2(3)

[7] Masood, O.; Tvaronavičienė, M.; Javaria, K. 2019. Impact of oil prices on stock return: evidence from G7 countries, Insights into Regional Development 1(2): 129-137. https://doi.org/10.9770/ird.2019.1.2(4)