

Measuring project performance using earned value management (EVM) in XYZ software development project

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Abstract— The project of the research is a project-based service that develops customized reporting platform for the X multi finance company. It observed at the project execution stage and focusing on the monitor and control established in the project. The percentage of the problem occur based on the interviewees is 85% experience in over schedule and 15% experience in over budget. In order to increase the efficiency of the monitoring in the company, this paper proposed a monitoring method using Earned Value Management (EVM). This paper measured the project's performance based on the last work performed after all the failure testing and errors are fixed. The research approach consists of the data collected, which are WBS, PV, EV, and AC of the project. The result of the performance measurements indicates the percentage of SV is 21% and SPI value is 0.79 showing the project is behind schedule for four weeks, while a percentage of CV is 9% over budget for the work perform and CPI value is 0.92 showing the project is over budget. The proposed suggestion is using EAC with value Rp157,802,419 to finish the work left and extend the project time for seven weeks based on the EAC calculation.

Keywords— *IT project, EVM, performance measurement, SPI, CPI*

I. INTRODUCTION

This research is focused on the measuring software development project performance in XYZ software development started on October 2017. The reason is that the company that handles the project often experience with over budget and over scheduling. The problem occurs for project-based is 85% in over schedule and 15% experience in over budget based on the interviewees. The existing method for the company's monitor and control is only a weekly meeting. The proper method for monitoring and controlling is needed, especially to keep the project on time and on budget. Unfortunately, Project Manager doesn't realize with the impact until the project is late and it's hard to cope with the problem [1]. Besides that, monitoring performance considered as one of the project success factors. [2, 3]

Monitoring is a preventive activity from over budget and behind schedule [4] that is also one of the factors why there's still a lot of projects failing. The PMI's Pulse of the Profession in 8th Global Project Management Survey [5] shows the percentage of project experienced completed within original budget, completed on time, and deemed failure in over the past five years. The project that completed within the original budget and

completed on time is decreased to 2 %, while the project that deemed failure is 15% to 16% resulting in increased. The average statistics on the failure rate of large-scale IT projects are 45% over-budgeted, 7% over-time, while those projects only provide 56% of the promised benefits [6].

In order to avoid the cost to be over budget and the schedule from over time the project needs to comply with the planned budget, time frame and performance criteria [7]. In order to perform it, the research will conduct the measurement performance using one of the project management methodologies. The research will be using Earn Value Management (EVM) methodology by compares the planned value to the actual cost as the cost performance and compares the planned schedule to the actual schedule [8]. It is a method that employs scope, cost, and schedule to measure and communicate the real physical process of a project [9]. The reason for choosing the EVM method is because the EVM provides the project an opportunity to measure performance during the life cycle of the project. It is a project management tool that is effective in managing scope creep [10]. Also by aligning the project management methodology (PMM) to a particular project is considered to be essential for project success. Many outsourced software projects fail to deliver on time, budget or do not give value to the client due to inappropriate choice of a PMM [11]. Therefore, it is a must to implement the appropriate choice of Project Management Methodology to prevent the project to experience a problem or even failure.

II. LITERATURE STUDY

2.1 Earned Value Concept

Earned value management is a fundamental of project management it is a project management technique that forms performance baseline by integrates the scope and cost baseline, along with the schedule baseline [12]. EVM monitors three key dimensions for each work package and control

2.1.1 **Planned Value (PV)** is the authorized budget plan that needs to accomplish for each of the work breakdown structure component or activity excluding from the management budget.

2.1.2 **Earned Value (EV)** used to calculate the percent of work complete expressed in terms of the budget. It defines the amount of work that has been accomplished. To determine current status and long-term performance, EV has to be monitor.

2.1.3 **Actual Cost (AC)** is the actual cost of work performed on an activity during a specific time period. It indicates the level of resources that have been expended.

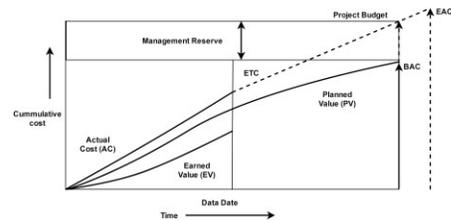


Fig.1. Planned Value, Earned Value, Actual Cost [13].

Variations also monitored from the approved baseline.

2.1.4 **Schedule Variance (SV)** is the difference between Earned Value and Planned Value to show the project is ahead or behind the planned delivery date of it is baseline schedule. It is a metric to measure the schedule performance on a project. The equation is EV minus PV.

2.1.5 **Cost Variance (CV)** is the difference between Earned Value and Actual Cost to indicate the relationship of physical performance to the costs spent. CV will be the difference between the budget at completion (BAC) and the actual amount spent at the end of the project. It is a metric to measure the cost performance on a

project. The equation is EV minus AC.

- 2.1.6 **The schedule performance index (SPI)** shows how efficient the project in time consumption expressed as the ratio of earned value to planned value. The SPI measures all project work includes the critical path performance to determine whether the project will be ahead or behind planned date.

The equation is a ratio of the EV to the PV with the result explanation [10] :

- If SPI value < 1.0, indicates the work performed less than planned;
- If SPI value > 1.0, indicates the work performed more than planned.

- 2.1.7 **The cost performance index (CPI)** shows how efficient the project in budgeted resources expense expressed as the ratio of earned value to actual cost. The CPI is the most important EVM metric because it measures the cost efficiency for the work completed and for determining project status.

The equation is a ratio of the EV and the AC with the result explanation [10] :

- If CPI value < 1.0, indicates a cost overrun for work to complete;
- If CPI value > 1.0, indicates a cost underrun for work to complete.

Forecasting will determine the necessary action based on past and present data.

- 2.1.8 **Estimate to Complete (ETC)** is a forecasting technique to calculate how much the remaining work will cost.
- 2.1.9 **Estimate at Completion (EAC)** is a forecasting technique to calculate the expected total cost until the work finish.
- 2.1.10 **To-Complete Performance Index (TCPI)** compares the remaining work and the remaining budget. It determines how efficient the resources need to achieve on the remaining work to meet the Budget at Completion

(BAC) or Estimate at Completion (EAC).

III. RELATED WORK

Cedergren & Larsson [14] conducted the research on senior managers in product development software to evaluate the performance to show whether the performance measurement has been effective. The research used the journal approach by observed the project from senior managers' view to collect the data needed through interviews.

Pajares & López-Paredes [15] analyzed the project monitoring using EVM for control cost and schedule. The difference with the paper is the journal integrates EVM with risk management method to create new metrics. The research used the journal approach by using EVM for control cost and schedule as the chosen method for the paper.

Warburton [16] only used CPI and SPI to create an earned value model that is performed on the software project and uses a PNR labor rate profile. While the research did not use PNR labor rate profile, but the research used the journal approach by calculated the CPI and SPI to determine the efficiency of the schedule and cost performed.

Mishakova, Vakhrushkina, Murgul, & Sazonova [17] used two methods, EVM and PERT for project construction control. While the paper did not use PERT method for project control and only use EVM method for project control as the chosen method of the research.

Abdi, Taghipour, & Khamooshi [18] developed an EVM model for monitoring and control of the environmental performance of greenhouse gas emissions projects during the project execution as well as this paper. This paper used EVM method to monitor and control performance during the project execution. The only difference is the journal is a green-based project, while the project of the researcher is a software development project.

Czarnigowska [19] used EVM method and earned schedule method to do project control while this paper only using EVM method for project control without using earned schedule as the chosen method.

IV. RESULT AND ANALYSIS

4.1 Performance Measurement

Performance measurements include the calculated CV, SV, CPI and SPI values. The values are calculated based on the variance analysis and the work performance index.

TABLE I. SUMMARY OF PERFORMANCE MEASUREMENT

Schedule		Cost	
SV	-Rp 23,891,129	CV	-Rp 7,802,419
SV%	-21.34	CV%	-8.86
SPI	0.787	CPI	0.92

Based on the schedule variance calculation, the work with the amount of Rp111,935,484 should be completed at week 15th, however, only Rp88,044,355 of work has been actually done. It means the project is Rp23,891,129 or 21.34% behind schedule and the project need to do 21.34% work to be on track with the planned schedule. The performance index showed that in the 15th week the Schedule Performance Index (SPI) is 0.78 it indicates that work is being accomplished at 78% of the planned rate. A value of less than 1.0 indicates less work is being accomplished than was planned. [10]

TABLE II. PERFORMANCE INDEX

No	Task	Work completed	SPI
1	Master module	100%	1
2	Fee dealer module	100%	1
3	Credit administration module	100%	1
4	Individual debtors module	100%	1
5	Business entity debtors module	100%	1
6	Credit module	70%	0.7
7	Other facilities	100%	1

TABLE II. PERFORMANCE INDEX (cont.)

	module		
8	Credit joint account module	80%	0.8
9	Assurance module	75%	0.75

XYZ software development project has indicated activities that causing the project to be delayed was because the activities haven't been completed. There are three activities with different percentage completed of work.

1. Credit module the planned duration was 15 days, but the actual duration was ongoing for only 12 days with the work completed for 70%
2. Assurance module the planned duration was 18 days, but the actual duration was ongoing for only 15 days with the work completed for 80%
3. Credit joint account module the planned duration was 3 days, the actual duration was ongoing for 3 days but, the work completed was only 75%.

The other activities were indicated causing the project to be delayed for 15 weeks of work with the detail of delayed working days.

1. Master module late for 4 days work
2. Fee dealer module late for 4 days work
3. Credit administration module late for 11 days work
4. Individual debtors' module late for 5 days work
5. Business entity debtor's module late for 4 days work

Besides, having to deal with schedule overrun the XYZ software development also encountered over budget. The cost was over budget from 2% and increased to 9% for the last four weeks. The amount of cost spent was not equal to the work value performed. The project was over budget for Rp7,802,419. There are three activities that caused the project to be over budget.

1. Credit module activity

The activity of create credit master should be done at week 12th, instead, this activity finished on week 13th. The activity of create sub menu (form) should be done for 100% for six days work, instead, the activity is done for 80% and being held to work credit joint account module activity. This is causing the project to be 6% over budget from the work performed.

2. Credit joint module activity

The activity should include the configuration with credit module, testing, release, review, but since the credit module hasn't finished the activity it needs to be held at this point. This is what causing the project to be 6% over budget for the work performed at week 13th.

3. Assurance module activity

The activity of create assurance master should be done at week 14th, instead, this activity finished on week 15th. The activity of create sub menu (form) should be done started at week 14th, instead, this activity started at week 15th with the work done for 80% in four days work. This is what causing the project to be 9% over budget for the work performed.

4.2 Root Problem

The following figure is a cause-and-effect diagram that consists responsible factors that caused the XYZ software project development to encounter the schedule overrun.

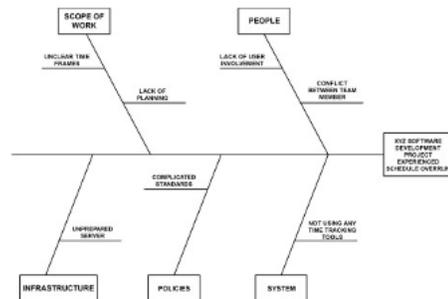


Fig. 2. Cause-effect diagram

Figure 2 shows there are responsible factors that caused the project to be delayed. These factors were qualitative based on the data gathered.

1. Unclear time frames
2. Lack of planning
3. Lack of user involvement
4. Conflict between team member
5. Not using any time tracking tools
6. Complicated standards
Unprepared server

4.3 Forecasting

The ETC is the expected total cost need for the remaining work. There are ten activities that haven't been finish. Based on the calculation the cost for the remaining work for ten activities will be Rp61,955,645.-.

The EAC is the expected cost needed until the project work finish. Based on the calculation the expected total cost for the work to finish is Rp157,802,419.- for 30 weeks estimate completion time for the project. It has 7 weeks additional time than the original estimated completion time which is 23 weeks, and it also has Rp7,802,419.- additional cost in order to finish the rest of the project work.

The project has spent Rp95,846,774 as the actual value with the actual duration 15 weeks. The project has another 15 weeks in order to finish the project with budget left is Rp61,955,645. The project estimated to complete at week 30th, but based on the activities that have been divided and adjusted to the required time and budget allocation, the project estimated to be complete at week 27th and only need five weeks additional time in order to overtake the work left behind, but the other three weeks could be a saving time to prevent the project to be behind schedule again.

TCPI compares the remaining works with the remaining budget to indicate if the project is good to go based on the how much the work and budget left. Since the project is over budget if using resource from BAC, the calculation using EAC

because it has the estimated budget needed for the remaining works to be complete.

The calculation equals to be one, it means the remaining works and the remaining budget for the project left is balance. The project is good to go continuing the work left by using the estimated budget from EAC.

V. CONCLUSION

The schedule performance of the project in the 15th week is 21% behind schedule or four weeks behind schedule. The efficiency of the schedule is 0.787 or less than one indicates the project is behind schedule. There are three activities that caused the project to be behind schedule at the predefined week where the calculation is done. The cost performance of the project in the 15th week is 9% over budget for the work performed with the Cost Variance is Rp7,802,419. The efficiency of the cost is 0.92 or less than one indicates the project is over budget. There are three activities that caused the project to be behind schedule and over budget at the predefined week where the calculation is done. There are credit module, credit joint account module, and assurance module. The actual work is Rp95,846,774 not equal with the value work perform that is Rp88,044,355. The project cost estimate to complete is Rp157,802,419.-

REFERENCES

- [1] Alvarado, C.M., Silverman, R.P. and Wilson, D.S. Assessing the performance of construction projects: implementing earned value management at the general services administration, *Journal of Facilities Management*, Vol. 3 No. 1, pp. 92-105. (2004)
- [2] Cooke-Davies, T. The real success factors on project. *International Journal of Project Management*, **20**(3), 185–190. (2002)
- [3] Jugdev, K., & Muller, R. A retrospective look at our evolving understanding of project success. *Project Management Journal*, **36**(4), 19–31. (2005)
- [4] De Marco, A. *Project Management for Facility Constructions*, (Springer, Heidelberg, 2011)
- [5] Project Management Institute (PMI). *The PMI's Pulse of the Profession 8th Global Project Management Survey: The High Cost of Low Performance*. Project Management Institute, Inc. (2016)
- [6] Bloch, M., Blumber, S., & Laartz, J. *Delivering large-scale IT projects on time, budget and value*. (McKinsey & Company, 2012)
- [7] Beleiu, I., Crisan, E., & Nistor, R. Main Factors Influencing Project Success. *Interdisciplinary Management Research XI*, 59-73. (2014)
- [8] Project Management Institute (PMI). *A guide to the Project Management Body of Knowledge (PMBOK Guide) (6th ed.)*. (Pennsylvania, Project Management Institute, Inc., 2017).
- [9] Vanhoucke, M., Vandevoorde, S., A simulation and evaluation of earned value metrics to forecast the project duration. *J. Oper. Res. Soc.* **58**(10), 1361–1374. (2007)
- [10] J. Art Gowan Richard G. Mathieu Mark B. Hey, Earned value management in a data warehouse project, *Information Management & Computer Security*, Vol. 14 Iss 1 pp. 37– 50. (2006)
- [11] Joslin, Robert & Müller, Ralf. The impact of project methodologies on project success in different contexts. (2014)
- [12] Project Management Institute (PMI). *Practice Standard for Earned Value Management*. (Pennsylvania, Project Management Institute, Inc., 2005)
- [13] Project Management Institute (PMI). *Practice Standard for Earned Value Management*. (Pennsylvania, Project Management Institute, Inc., 2011)
- [14] Cedergren, S., & Larsson, S. Evaluating performance in the development of software-intensive products. *Information and Software Technology*, 516-526. (2014)
- [15] Pajares, J., & López-Paredes, A. An extension of the EVM analysis for project monitoring: The cost control index and the schedule control index. *International journal of project management*, 615-621. (2011)
- [16] Warburton, R. D. A time-dependent earned value model for software projects. *International Journal of Project Management* **29**, 1082-1090. (2011)
- [17] Mishakova, A., Vakhrushkina, A., Murgul, V., & Sazonova, T. Project control based on a mutual application of pert and earned value management methods. *Procedia Engineering*, 1812-1817. (2016)
- [18] Abdi, A., Taghipour, S., & Khamooshi, H. A model to control environmental performance of project execution process based on greenhouse gas emissions using earned value management. *International Journal of Project Management* **36**, 397-413. (2018)
- [19] Czarnigowska, A. Earned value method as a tool for project control. *Budownictwo i Architektura* 3, 15-32. (2008)