Analysis of Project Time Performance during Covid-19 Pandemic on the Construction of Service Building at RSUD Gianyar by using the Earned Value Method

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Abstract: Construction projects are unique because project conditions are influenced by many factors, including environmental factors. Nowadays Indonesia is currently facing an outbreak of the Covid-19 virus. Project management has an increasing important role in the current construction field. Supervision and control process are one of project management functions. In this study, we want to learn further the construction performance due to the COVID-19 pandemic on the project Sanjiwani Building of RSUD Gianyar. The method which is used to evaluate the performance of the contractor from the beginning of the construction until the time of reporting the project is by using the Earned Value method (EVM). This method provides information about Schedule Varians (SV) and Schedule Performance Index (SPI) of the project in a reporting period, provide predictive information all the time for completion of work on performance indicators in reporting period. The results show that the overall performance in terms of time can be said to be good because from the beginning to the end of reporting, the SV value is positive and SPI > 1. The total estimated project completion schedule (EAC) is 385 days, 5 days faster than the original plan.

1 INTRODUCTION

A complex construction project is a dynamic system that develops in an environment of uncertainty, and has many different but interrelated ones (W. Lipke, 2009). Project need can be effectively planned. By using project planning, the completion of the project can be done on an approved budget and on time (R. Avlijaš, 2010). Of course, without timely and continuous performance supervision, the success of the project is difficult task (S. Leu, A. Chen, 2003).

The monitoring and control of any project play an important role in time and cost management. To manage project completion on time, a fundamental support of the processes is required. Those factors also can make the completion of the project within the approved budget (S. W. Azim , J. San Crist´obal, T. M. Bienvenue 2017). The construction of the Sanjiwani Building of RSUD Gianyar was carried out to rejuvenating the building and to develop optimal services in the field of health services in Gianyar Regency. The cost of the project is Rp. 135,008,492,164.99 and the execution time is 390 calendar days.This project was carried out during the Covid-19 pandemic, of course the contruction faced many challenges such as: the uncertainity about the implementation of the project that ongoing, the implemention of restriction on social activities make activities could not be carried out optimally and the delay in disbursement project term. Besides, strict health protocols were required in this periode of this contruction. This condition certainly has the potential effect to the performance of the project implementation.

A well-known method that is able to collect and analyze a comprehensive amount of information about the progress of a project is the Earned Value Method (EVM). EVM is well known and has been the subject of further development research. A more detailed review of the literature related to EVM and its application in research has been carried out previously (Willems L. L., 2015).

By using EVM, we can find out the information of the actual implementation progress and cost of project. The indicators used also support to determine further steps in the completion of a project. When the implementation progress of the project is systematically recorded, we can calculate the final

cost and completion date of the project. If we refer to the Earned Value concept, there are three basic elements that become reference in analyzing the performance of the project. They are Planned Value (PV), Earned Value (EV), and Actual Cost (AC). PV or BCWS shows the budget for a work package that is prepared and linked to the implementation schedule. EV or BCWP is the received value of completion of work over a certain period of time. EV is calculated based on accumulation of completed work. AC is the actual cost amount of the work that has been done. In order to monitor deviations, project planned duration is needed. BCWS, BCWP, and ACWP curves are delineated in a time–cost space (Aminian V, 2016).

1.1 Research Purposes

While the purpose of this study is as follows, analyzing Earned Value indicators with the aim of knowing project performance in the form of Planned Value, Earned Value, analyzing variance in the form of Schedule Variance, performance index in the form of Schedule Performance Index, analyzing estimated completion time end of the project.

1.2 Benefit of Research

The expected benefits of this research are as material for consideration and input for companies in making decisions related to project implementation policies In addition, this research can provide information, consideration or recommendations to development implementing elements and agencies in making policies related to the implementation of construction projects during the current Covid-19 pandemic.

2 METHODOLOGY

2.1 Research Design

The construction of the Sanjiwani Building of RSUD Gianyar become the object of research. This building was carried out by BIANGLALA TIRTA, KSO. The research methods or procedures carried out in this study include literature studies, data collection in the form of primary data and secondary data. Primary data were obtained directly through direct interviews with project management to complete the secondary data. While the secondary data is data obtained indirectly from the object of research. Such as Bid

Table 1: Earned value terms.

Provision	Explanation	Analisis
PV (BCWS)	Planned Value	It is a combination of cost and time or sometimes resources of time that make up characteristic of the S-curve
EV (BCWP	Earned Value	This value indicates the magnitude of the value of the work which has been settled against the amount of fees provided for complete the work
AC (ACWP)	Actual Cost	This value is the amount of the actual cost that has been used to complete a job in time certain..
Schedule Variance (SV)	$SV = BCWP - BCWS$	The SV value is a subtraction of the value of the results obtained from the project with the amount of costs that have been previously budgeted If a negative value in the schedule variance means that it is late, a zero value means that the project is according to plan and a positive value means that the project is faster than planned.
Schedule Performance Index (SPI)	$SPI = BCWP \div BCWS$	It is an index showing the efficiency of the time utilized on the project. On schedule, SPI = 1 Ahead schedule, SPI > 1 Behind schedule, SPI < 1
Estimate To Completion (ETC)	ETC $= (OD - ATE) \div SPI$	It is the estimated remaining work schedule of the project OD = *Original Duration, ATE = Actual Time Expended*
Estimate At Completion	$EAC = ATE + ETC$	It is the estimated time for completion of the project
BAC	Budget at Completion	The total cost of the project implementation plan according to its scope.

price, Schedule, Engineering Details Design, Weekly Reports, Monthly Physical Reports.

2.2 Data Analysis

To analyze the implementation of the integrated Earned Value Method (EVM) in an effective and simple way, the author uses an automated sheet for analysis of the Sanjiwani hospital construction project with a completion time of fourteen months, the results are reported on a monthly basis cut-off (Fatemeh Nouban, 2020).

The Earned Value Method is a method controls used to control project costs and schedules in an integrated manner. The method can provide information of the performance status project in a reporting period and provide cost prediction information required and the time to complete all the work based on performance indicators when reporting. The description of the indicators in the EVM is as shown in Table I.

3 RESULT AND DISCUSSION

3.1 First Section

The construction of the Sanjiwani Building of RSUD Gianyar is expected to provide support for facilities and conveniences for the Gianyar community to access health services. The construction of this project was carried out by the Bianglala Tirta Contractor, KSO with a contract value of Rp.

135,008,492,164.99 and while the implementation time is 390 calendar days or 56 weeks.

The scope of work includes Hospital building work, Landscape Works, Water Treatment Plant (WTP) and Water Feature Building Works, Medical Gas Building Works, Monument Works and Mechanical Electrical and Plumbing (MEP) Work.

Table 2: Cost recapitulation.

No	Scope	Price	%
1	Preparation	3,938,194,076.93	3.209
2	Earth Work	1,334,052,298.89	1.087
3	Hospital	89,549,814,217.11	79.96
4	Landscape	2,131,923,55458.	1.737
5	WTP	2,029,902,784.96	1.654
6	Medical Gas	307,433,118.30	0.250
7	Monument	206,036,931.55	0.168
8	MEP	23,237,626,895.00	
	Real Cost	122.734.992,877.26	
	Tax 10%	12,273,499,287.73	
	Total Price	135,008,492,162.99	

The above costs include costs for handling Covid 19 of Rp. 351,585,000.00.

3.2 Earned Value Indicator Analysis

3.2.1 BCWS (Budgeted Cost of Work Schedule)

BCWS is calculated from the accumulated cost budget that is planned for work in a certain period. Example of BCWS calculation on the implementation of the 1st month.

Table 3: Earned value data.

Months	% Plan	% Actual	BCWS		BCWP	
			This Month	*Cumulative*	*This Month*	*Cumulative*
1	1.52	1.85	1,871,531,986.14	1,871,531,986.14	2,278207,951.54	2,278,207,951.53
2	10.94	10.64	13,429,466,193.12	15,300,998,179.26	13,061,672,981.62	15,339,880,933.16
3	14.98	14.98	18,393,730,209.84	33,694,728,389.10	18,386,182,791.93	33,726,063,725.09
4	14.65	29.57	17,982,840,298.72	51,677,568,687.82	36,293,324,930.02	70,019,388,655.12
5	20.75	5.85	25,477,219,805.57	77,154,788,493.39	7,189,301,776.09	77,208,690,431.21
6	6.43	6.42	7,903,903,451.01	85,058,691,944.40	7,889,336,555.24	85,098,026,986.46
7	5.89	5.93	7,238,833,035.36	92,297,524,979.76	7,289,839,076.44	92,387,866,062.90
8	5.35	5.87	6,572,359,561.74	98,869,884,541.50	7,204701,416.87	99,592,567479.78
9	5.30	5.87	6,514,234,211.80	105,384,118,753.31	6,617,399,901.87	106,209,967,381.65
10	5.28	7.11	4,822,085,916,37	110,206,204,669.67	8,714,184,483.64	114,924,151,865.29
11	3.90		6,417,106,982.29	116,623,311,651.97		
12	2.55		3,134,985,440.61	119,758,297,092.58		
13	1.77		2,184,622,698.91	121,942,919,791.49		
14	0.96		791,988,502.85	122,734,992,727.34		

$$BCWS = BAC \times \% \text{ plan} \qquad (1)$$

$$= 122{,}734{,}992{,}727.34 \times 1.52\%$$
$$= Rp.\ 1{,}871{,}531{,}986.14$$

3.2.2 BCWP (Budgeted Cost of Work Performanced)

The value of this BCWP is calculated based on the accumulated work that has been completed by the contractor in each current month.

Example of BCWP calculation in the 1st month.

$$BCWP = BAC \times \% \text{ Actual progress} \qquad (2)$$

$$= 122{,}734{,}992{,}727.34 \times 1.85\%$$
$$= Rp2{,}278{,}207{,}951{,}53$$

The following is the result of calculating the value of BCWS and BCWP in the 1st month to the 14th month, as shown in Table 3.

From the results of calculations between BCWS and BCWP which shows the cost and time of project implementation, it shows variations between values and each indicator use.
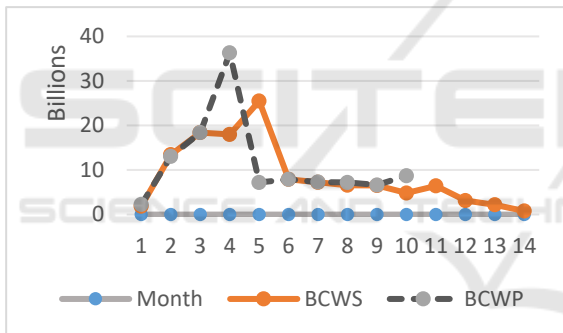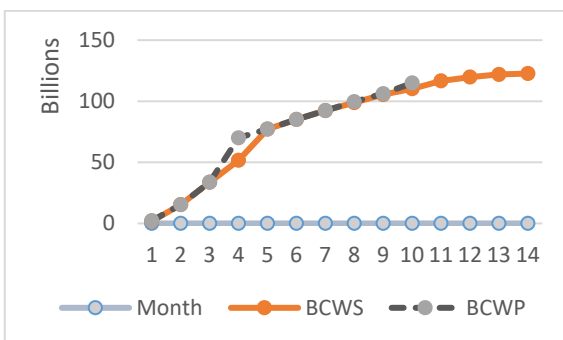

Figure 1: Graph of interaction between BCWS, BCWP.

Figure 2: Comparative graph of BCWS, BCWP.

According to the graphical interpretations of figure 1, it can be seen that the comparison of BCWS and BCWP values for each month fluctuates which shows that the BCWP value is below the BCWS

value, occurring in the 2nd to 3rd month, 5th to the 6th month and the 9th month. to the 10th month while the BCWP value is above the BCWS value occurs in the 1st month, the 4th month, 7th to 8th month, even extreme conditions occur in the 4th week this is due to MOS (Material on site) work (material on site) brought to the field for sanitary and MEP (Mechanical-Electrical and Plumbing) work.

However, the cumulative comparison of the values of BCWS and BCWP as shown in figure 2 illustrates that the evaluation of the implementation time from month 1 to month 10 shows that the BCWP value is still above BCWS.

With this value, it means that the construction of the Sanjiwani Hospital project is faster than the planned schedule (a head schedule).

3.2.3 Schedule Variance (SV)

The variance in the schedule or Schedule Variance (SV) occurs because there is a difference between the plan and the realization of the time required for project implementation which is reviewed in terms of periodic physical progress.
Examples of calculations as follows:
For work in the first month

$$SV = BCWP - BCWS \qquad (3)$$

BCWP = Rp. 2,278,207,951.53
BCWS = Rp. 1,871,531,986.14
SV = Rp 2,278,207,951.53 – Rp 1,871,531,986.14
    = Rp 406,675,965.40

Figure 3, below shows a graph of the results of calculating the value of SV on project implementation from month 1 to month 10.
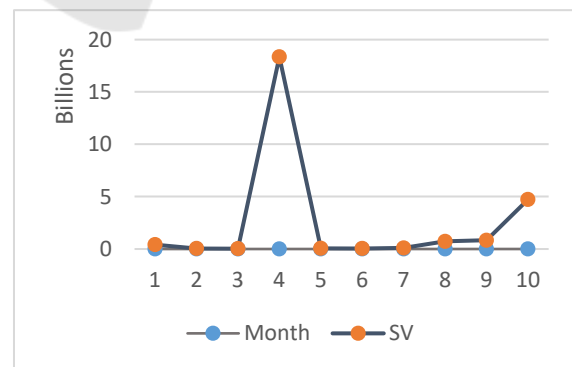

Figure 3: Monthly Schedule Variance (SV) analysis.

Based on Figure 3 above, it can be seen that the Schedule Variant (SV) from month 1 to month 10 is positive indicating that the implementation time is running faster than planned.

3.2.4 Schedule Performance Index (SPI)

SPI (Schedule Performed Index) is a number of numbers used for reviewing the achievements made in comparison with the planned target in that time. In project time control, the schedule performance index which shows that the SPI value is less than one means that the work performance is not as expected because it cannot meet the planned targets.

When the performance index numbers are reviewed further, the following will be seen: If the performance index number is less than one, it means that the work performance is not as expected because it is unable to achieve the planned work target. If the performance index is more than one, it means that the work performance is better than planned.

The greater the Schedule Performed Index (SPI) value of number 1, it indicates that the greater the deviation from the project to its initial planning or costs

Even if the value is too high, this means that the work performance of the project is very good, but it is necessary to conduct an assessment because whether it is possible that the planning carried out may not be realistic or not in accordance with the reality in the field.

Example of calculation as follows:

For jobs in the First month

$$SPI = BCWP : BCWS \qquad (4)$$

BCWP = Rp 2,278,207,951.53
BCWS = Rp 1,871,531,986.14
SPI   = 1.217

Furthermore, the results of calculating the SPI value for each month can be seen in the graph below.

Table 4: Schedule performance index.

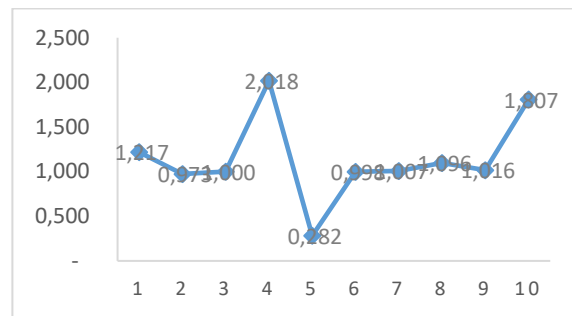| Month	BCWS	BCWP	SPI
1.	1,871,531,986	2,278207,951	1.21
2.	13,429,466,193	13,061,672,981	0.97
3.	18,393,730,209	18,386,182,791	0.99
4.	17,982,840,298	36,293,324,930	2.10
5.	25,477,219,805	7,189,301,776	0.28
6.	7,903,903,451	7,889,336,555	0.99
7.	7,238,833,035	7,289,839,076	1.00
8.	6,572,359,561	7,204701,416	1.09
9	6,514,234,211	6,617,399,901	1.02
10	4,822,085,916	8,714,184,483	1.80

Figure 4: Analysis of SPI monthly.

From Figure 4 and the calculation of the monthly Schedule Performance Index (SPI) in this Gianyar hospital project, the biggest delay occurred in the 5th month with an SPI value < 1 (0.282). While the biggest acceleration in this project occurred in the 4th month with an SPI value > 1 (2.018).

The large SPI value in the 4th month was due to material work on site for MEP, so that the progress of the work progressed by 14.92% from the plan

However, cumulatively the calculation of the SPI value from the 1st month to the 10th month of the Gianyar Hospital project, shows that the average SPI value is slightly above 1, meaning that the project's performance is quite good or the time is slightly faster than planned as shown in Figure 5.
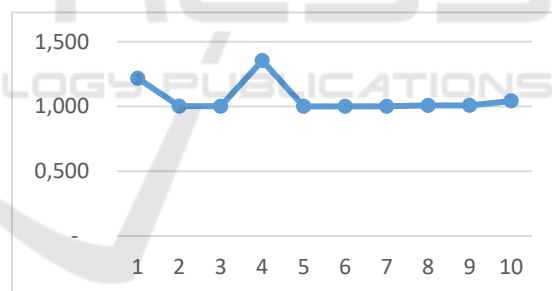

Figure 5: Analysis of SPI cumulative.

When SPI number is more than one, it illustrates that the performance of the work carried out by the contractor on the Gianyar hospital project is better than planned.

3.2.5 Estimate to Completion (ETC)

ETC represents performance against schedule assuming the same as remaining work at the time of reporting. The value of the ETC is the remaining working time of the project divided by the performance index against the schedule.

This estimated completion time is very useful for the project because it can provide an early warning

about things that will happen in the future, if the reporting of current trends does not change.

Assuming that the remaining work is guided by the fixed performance as at the time of reporting or appraisal, the estimated remaining time of work (ETC) is :

$$ETC = (OD – ATE) : SPI \qquad (5)$$

Calculation of the ETC value in the 4th month
ETC = (390 - 112)/1.355
= 205 days

3.2.6 Estimate at Completion (EAC)

The EAC value is the amount of work that has been used up to the time of reporting or appraisal plus the projected time required to complete and perfect the remaining work of the project.

Calculation of the EAC value in the 4th month

$$EAC = ATE - ATC \qquad (6)$$

= (112 - 205)
= 317 days

The following are the details of calculating the EAC value per month during the study.

Table 5: EAC value per month.

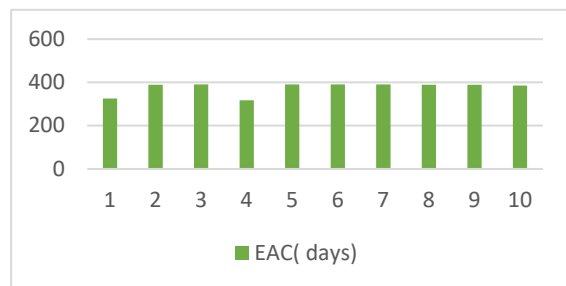| Month	OD	ATE	SPI	ETC	EAC (days)
1	390	28	1.217	297	325
2	390	56	1,003	333	389
3	390	84	1.001	306	390
4	390	112	1.355	205	317
5	390	140	1.001	250	390
6	390	168	1.000	222	390
7	390	196	1.001	194	390
8	390	224	1.007	165	389
9	390	252	1.008	137	389
10	390	273	1.043	112	385

Figure 6: Monthly EAC histogram.

Table 5 and Figure 6, above shows that the largest SPI occurred in the 4th month is 1.355 and an EAC value is 317 days, so that the project experienced accelerated completion, 73 calendar days earlier than

the schedule planned. However, in the following months the project performance decreased but was still equal to 1 so that with the same performance the project completion projection was in accordance with the plan. At the end of reporting, which is the 10th month, the project completion schedule (EAC) prediction is 385 days, which is smaller than the initial plan, which is 390 days. This shows that the project's time performance during the COVID-19 pandemic is still good because the project has accelerated by 5 calendar days.

4 CONCLUSIONS

Based on data analysis on the construction project for the construction of the Sanjiwani Gianyar Hospital Building by using the Result Value method on the evaluation of weekly report to month 10, the following conclusions were obtained:

a. Project performance in terms of time in the construction project of the Sanjiwani Hospital Gianyar Hospital as a whole can be said to be good because from the beginning to the end of reporting, the results of Schedule Variant (SV), are positive and the value of Schedule Performance Index (SPI) > 1.

b. Estimated project completion schedule (EAC) at the end of reporting is 385 days, smaller than the initial plan of 390 days. This shows that the project's time performance during the COVID19 pandemic is still good because the project has accelerated by 5 calendar days.

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