Volume 4, No. 5 May 2025 - (xx-xx)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Cost and Time Analysis in the Construction of the Probolinggo – Banyuwangi Toll Road Package 3

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ABSTRACT:
Project delays and cost overruns are common challenges in large-scale infrastructure projects, such as the construction of the Probolinggo–Banyuwangi Toll Road Package 3. As of July 2024, the project experienced a negative deviation of -7.44% between planned and actual progress, signaling performance inefficiencies that could lead to significant financial implications. This study aims to analyze the project's time and cost performance using the Earned Value Method (EVM), an integrated approach that evaluates three key indicators: Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP). By calculating Schedule Performance Index (SPI), Estimate Temporary Schedule (ETS), Estimate at Schedule (EAS), Estimate to Complete (ETC), and Estimate at Completion (EAC), the analysis revealed that the project is delayed by 131 days beyond the planned 728-day schedule. The estimated total cost for on-time completion is IDR 4.61 trillion, while the cost for delayed completion is IDR 4.40 trillion, inclusive of penalties. These findings underscore the importance of early detection and proactive management of time and cost deviations. The study provides strategic insights for improving scheduling accuracy and cost control in future toll road projects.

Keywords: *earned value method, time performance, and cost performance*

INTRODUCTION

Infrastructure includes all basic structures and facilities, both physical and social, that support various operational activities of the community and the company (Al Shawabkeh et al., 2022; Nocera & Gardoni, 2018; Vitri & Herman, 2019). Examples of physical infrastructure include roads, bridges, electricity supply, irrigation, and other facilities such as airports, ports, and clean water treatment systems (Roy, 2023; Vujović & Macura, 2014). Social infrastructure, on the other hand, includes facilities such as schools and hospitals that are necessary for the welfare of the community (Bala, 2021; Grum & Kobal

Grum, 2020; Kasapa & Gyan, 2023; Yhee et al., 2021). Infrastructure serves as a basic necessity that forms a structural system to support the public and private sectors, allowing the economy to run efficiently (Hammami et al., 2006; Lin, 2011). In addition, infrastructure also facilitates the smooth distribution of goods and services. For example, a good road will facilitate the delivery of raw materials to factories and the distribution of goods to the market (Buckley, 2009). Infrastructure can also include aspects of information technology and communication channels that support social and business interactions. In a broader sense, infrastructure is the provider of the facilities and support necessary to support systems and services within a city, country, or organization. Thus, infrastructure plays a major role in supporting the smooth running of processes and activities in various sectors (Abualoush et al., 2018; Das, 2024).

Toll roads are a form of infrastructure that aims to improve connectivity and the economy of a region. The toll road is designed to shorten the distance and reduce travel time between two locations. The objectives of toll road construction include smoothing traffic flow in developing areas, supporting the distribution of goods and services to encourage economic growth, creating equitable distribution of development results and justice, and reducing the burden of government funding through contributions from road users. The benefits of toll roads are also quite significant, such as supporting regional development and economic growth, increasing mobility and accessibility for people and goods, and providing benefits to users in the form of savings in Vehicle Operating Costs (BOK) and travel time compared to using non-toll roads. In addition, business entities that build and manage toll roads earn a return on investment through revenue from toll tariffs, the sustainability of which depends on the certainty and application of such tariffs.

Indonesia has many islands, including the island of Java, which is the 13th largest island in the world and has the most populous population with nearly 170 million people. Many cities in Java, such as Probolinggo and Banyuwangi, are experiencing rapid progress in the industrial sector supported by improved transportation infrastructure. The construction of the Probolinggo-Banyuwangi Toll Road is a government step to strengthen connectivity in East Java, connecting Probolinggo with Banyuwangi, the gateway to Bali. This toll road is expected to accelerate the distribution of goods and services, reduce congestion on the main route, and support regional economic growth. In addition, this infrastructure will increase access to tourist destinations in Banyuwangi, attract more tourists, and improve people's quality of life with better access to health services, education, and employment. Involving government and private partnerships, the project is also expected to encourage further investment and infrastructure development.

Project completion time is an important factor in the successful execution of a project. Various factors, such as implementation methods, allocation of human resources (HR), and estimation of the right material schedule, greatly affect the duration of the project. In recent years, the construction industry has become increasingly competitive, with contractors trying to find ways to complete projects successfully. However, problems such as cost overruns and delays are common. Therefore, an effective construction management system is needed to control productivity and costs. During the implementation, obstacles often arise that are not in accordance with the plan. Careful planning is very important to achieve efficiency and effectiveness in the use of resources, as well as being a guideline to achieve the goals that have been set. To prevent bigger problems and ensure that the project runs as planned, monitoring and

implementation control measures are needed. One of the methods that can be used is the concept of earned value, which is useful for evaluating work performance and increasing effectiveness in monitoring project activities (Pratiwi, 2018; Wahab, 2019; Stone, 2021; Muniroh et al., 2021; Satrio, 2021).

The earned value method is a project management approach that assesses project performance based on cost and time by comparing the planned budget and schedule with the realization in the field. This method provides estimation and early warning of potential problems, allowing for timely corrective action. Earned value integrates three key elements of a project: scope, time, and cost, and generates a cost performance index (CPI) and schedule performance index (SPI) to assess cost and time appropriateness. Its implementation allows project managers to clearly see planning, execution, and actual costs (Sri Mahapatni et al., 2022).

The earned value method in an integrated system is able to provide an accurate estimate of potential project performance issues, making it an important component in project management. This approach is very effective for controlling project performance because it can monitor the cost and time aspects needed to complete the project, while reducing the risk of financial loss for the implementing contractor (Ganjar, 2022). The analysis of project performance with the concept of earned value is based on three main indicators, namely Actual Cost of Work Performed (ACWP), Budgeted Cost of Work Performed (BCWP), and Budgeted Cost of Work Scheduled (BCWS).

ACWP (Actual Cost of Work Performed) is the total actual cost incurred to carry out work in a given period of time. These costs are calculated based on the project's financial data at the time of reporting. BCWP (Budgeted Cost of Work Performed) refers to the amount of costs that are expected to be incurred for work that has been completed in a given period according to the original plan. Meanwhile, BCWS (Budgeted Cost of Work Scheduled) is the planned budget for each work package that is associated with its implementation schedule. Thus, there is a relationship between cost, schedule, and scope of work, where each part of the work has been assigned a time allocation and costs that serve as a benchmark for the implementation of the work (Ajeng, 2023).

The earned value method works in risk management by providing relevant information to anticipate problems that may arise during the implementation of the project. The data obtained from the analysis of earned value methods can be a solid basis for management in strategic decision-making, including resource reallocation or plan revision. Through the earned value method, this project can be compared with similar projects, thus providing insight into best practices and areas for further development (Sufa'atin, 2017).

As of July 21, 2024, the progress of planned work based on the S curve was recorded at 46.60%, while the actual progress of work only reached 39.16%. There was a deviation of -7.44%, which indicates that the work was delayed. To prevent cost overruns and avoid larger negative deviations, a project performance analysis is required. One of the appropriate methods to analyze this condition is the earned value method, as this method focuses on evaluating performance related to cost and time.

Several studies have evaluated project performance in construction using the Earned Value Method (EVM). Asmaroni & Setiawan (2020) applied EVM to residential building projects and found that deviations in scheduling were often due to late material delivery and labor shortages. Aditama (2021) demonstrated the method’s usefulness in tracking both time and cost deviations in hospital construction projects.

Similarly, Mahapatni et al. (2022) emphasized EVM's strength in integrating cost and schedule analysis for infrastructure projects.

Asmoro et al. (2024) analyzed the use of EVM in educational facility construction and showed that early detection of cost overruns and delays can prevent long-term budget inefficiencies. Meanwhile, Johari & Islami (2022) studied the implementation of EVM in offshore projects and highlighted the importance of real-time reporting in minimizing deviation. Indramanik et al. (2022) further contributed by focusing on classroom building construction, illustrating how EVM supports corrective decision-making and resource reallocation.

Despite its wide application, many EVM studies center around vertical building construction and neglect large-scale infrastructure projects like toll roads. Purnomo & Prisilia (2019) stressed the lack of detailed cost forecasting in government transportation projects. The present study fills this gap by using EVM on a major toll road construction, specifically analyzing Schedule Performance Index (SPI), Estimated at Completion (EAC), and cost deviation forecasts.

Although EVM has been widely applied in construction project performance analysis, most prior studies focus on vertical structures or small-scale infrastructure, with minimal attention to its application in long-distance toll road development involving complex geotechnical and logistical components. Additionally, few studies provide a comprehensive projection of both time and cost implications of project delays using SPI, ETS, and EAC metrics simultaneously. This study addresses these gaps through an in-depth analysis of the Probolinggo–Banyuwangi Toll Road Package 3 project.

The novelty of this research lies in its integrated use of the Earned Value Method to not only monitor but also forecast the cumulative effects of delays on both schedule and budget in a national strategic toll road project. This study uniquely combines SPI-based scheduling with direct cost modeling, producing estimates for ETS, EAS, ETC, and EAC, and projecting penalty and acceleration costs under realistic contract conditions, offering a rare insight into macro-level project planning.

This research aims to analyze project time and cost performance using the Earned Value Method for the Probolinggo–Banyuwangi Toll Road Package 3. Specifically, it evaluates project delays through SPI and estimates the additional time and financial resources required for completion using ETS and EAC indicators, enabling proactive project management and financial planning.

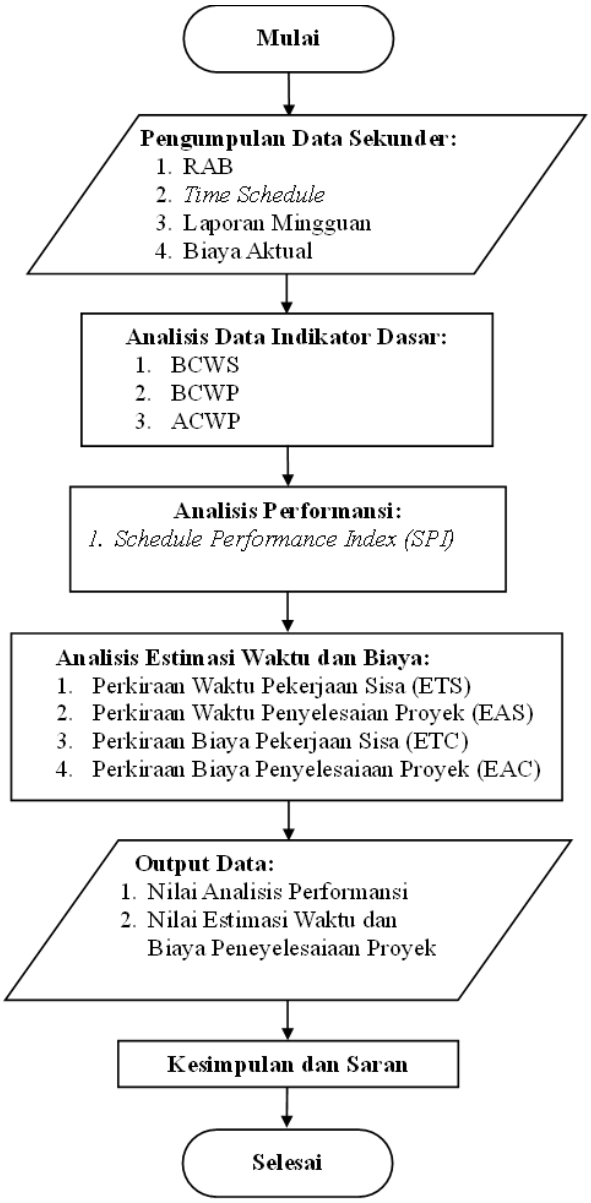
This study benefits infrastructure project managers and policymakers by providing practical tools to detect early-stage project deviations, assess financial risks, and make informed decisions on cost control, scheduling, and penalty mitigation. It also contributes academically by expanding the application of EVM to large-scale, linear infrastructure developments with strategic importance.

RESEARCH METHODS

The research employs a quantitative descriptive method using the Earned Value Method (EVM) as the primary analytical approach to assess project performance in terms of cost and time. This method integrates planning, cost estimation, and progress tracking by calculating key indicators such as Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP). The study further uses the Schedule Performance Index (SPI) to evaluate time efficiency and estimates additional time and cost requirements through metrics such

as Estimate Temporary Schedule (ETS), Estimate at Schedule (EAS), Estimate to Complete (ETC), and Estimate at Completion (EAC). This structured approach provides early insights into project deviations, enabling proactive decision-making in resource allocation, budgeting, and scheduling.

This research was carried out on the Probolinggo – Banyuwangi Toll Road Package 3 project, which stretches from Sta. 20 + 200 to Sta. 45 + 800, with a length of 25.6 km in Situbondo Regency, East Java. The data analysis technique used is an *earned value method* to evaluate project performance in terms of cost and time. The analysis begins by calculating the basic indicators of the project, namely BCWS (*Budgeted Cost of Work Scheduled*), BCWP (*Budgeted Cost of Work Performance*), and ACWP (*Actual Cost of Work Performance*). Furthermore, a performance analysis was carried out involving *the Schedule Performance Index* (SPI). After that, calculate the estimated cost and project completion time, including the estimated work time remaining (*Estimate Temporary Schedule*), total project completion time (*Estimate at Schedule*), remaining work cost (*Estimate to Complete*), and total project completion cost (*Estimate at Completion*). Based on the results of the analysis, the project's performance is evaluated to detect potential problems, which allows for early corrective actions, such as resource reallocation, budgeting, and scheduling. This approach is expected to help project managers in monitoring, managing, and controlling projects more effectively.



Gambar 1. Bagan Alur Penelitian

Sumber: Olahan Peneliti, 2024

RESULTS AND DISCUSSION

Job Data

The work data here is secondary data obtained from the project where the author will conduct research. The secondary data in question was obtained from the contractor implementing the work.

1.1.1. Gambaran Umum Proyek

1. Data Umum

   Nama Pekerjaan : Pembangunan Jalan Tol Probolinggo – Banyuwangi Paket 3

Lokasi	:	Ruas jalan Tol Probolinggo –Banyuwangi, dari ruas Paiton – Besuki, Kabupaten Situbondo, Provinsi Jawa Timur
Pemilik Proyek	:	PT. Jasa Marga Probolinggo Banyuwangi
Konsultan Pengawas	:	PT. Eskapindo Matra PT. Parama – Daksinapati – Krida (KSO)
Konsultan Perencana	:	PT. Buana Archicon
Kontraktor Pelaksana	:	PT. Pembangunan Perumahan (Persero) Tbk, PT. Wijaya Karya (Persero) Tbk, PT. Waskita Karya (Persero) Tbk (KSO).
No. Kontrak	:	021/KONTRQK/2023
Tanggal Kontrak	:	21 Pebruari 2023
No. SPMK		DU.PP.02.02.205
Tanggal SPMK		12 Juni 2023
Nilai Kontrak	:	Rp. 4.425.887.630.000,00 (include Ppn 11%)
Waktu Pelaksanaan	:	728 hari kalender
Masa Pemeliharaan	:	1.095 hari kalender (3 tahun)

2. Data Teknis Jalan

Panjang Jalan Tol	:	25,6 km
Lebar Jalan Tol	:	25,9 meter
Item Pekerjaan	:	- 12 Jembatan (Include Jembatan Besar Paiton 3); - 2 *Overpass*; - 41 Box *Underpass*; - 135 Box Culvert; - 2 Rest Area.

Project Data

The project data obtained as research materials include:

Contract Cost Budget Plan (RAB) Data

The Cost Budget Plan (RAB) is a breakdown and recapitulation of costs for each work item in the contract that has been agreed between the job owner and the executing contractor in accordance with an agreement that has legal force. In the RAB, there is an analysis of unit prices, wage lists, and material prices used to calculate *the Budgeted Cost Work Schedule* and *Budgeted Cost for Work Performed*. The following is a recapitulation table of the Cost Budget Plan.

Table 1. Cost Budget Recapitulation

No	Item Pekerjaan		Total Harga (Rp)	
1	Divisi 1	Umum	Rp	52,471,960,124.00
2	Divisi 2	Pembersihan Tempat Kerja	Rp	9,382,488,518.80
3	Divisi 3	Pembongkaran	Rp	4,612,779,971.93
4	Divisi 4	Pekerjaan Tanah	Rp	1,365,749,110,091.18
5	Divisi 5	Galian Struktur	Rp	8,371,749,663.53
6	Divisi 6	Drainase	Rp	164,529,175,140.41
7	Divisi 7	Subgrade	Rp	4,371,653,837.44
8	Divisi 8	Lapis Pondasi Agregat (Subbase)	Rp	73,002,651,177.82
9	Divisi 9	Perkerasan	Rp	514,220,953,422.68
10	Divisi 10	Struktur Beton	Rp	1,071,272,180,971.02
11	Divisi 12	Pekerjaan Lain-lain	Rp	624,779,973,922.47
12	Divisi 13	Pencahayaaan Lampu Lalu Lintas dan Pekerjaan Listrik	Rp	15,443,989,189.04
13	Divisi 14	Plaza Tol	Rp	5,737,821,993.00
14	Divisi 15	Pengalihan dan Perlindungan Utilitas yang ada	Rp	66,416,790,000.00
15	Divisi 16	Pekerjaan Fasilitas Tol dan Pekerjaan Gerbang Tol	Rp	6,914,493,105.00
Total Kontrak (belum termasuk Ppn)			**Rp**	**3,987,277,771,128.31**

Source: Processed Author based on the weekly report of PT. PP (Persero) Tbk, PT. Wika (Persero) Tbk and PT. Waskita (Persero) Tbk, 2024.

Data *Time Schedule*

The data is divided into two, including:

Project Plan Time Schedule

It is a measure of project implementation. In the *time schedule* , there is a description of the work, the volume of work, and the unit of weight (%).

Actual Project Timeline

It is a *time schedule* of the project plan but contains the progress of the work that has been carried out accompanied by information about the weight that has been carried out and what has not been carried out.

Project weekly report data

A weekly report is a report that includes the progress of work, achievements, or the weight of achievements that have been realized over the course of one week. Typically, this report contains the volume of RAB and the percentage of work items, the cumulative volume that has been completed in a week, and the obstacles faced in the project. This weekly report serves as data on job realization or *earned value*. The report also includes a backup volume containing the results of the work taken jointly between the supervisory consultant and the contractor's executor. Weekly report creation usually starts with more specific and detailed daily reports made by field implementers. This report aims to prevent disputes or differences in conditions in the field, provide indicators to monitor activities and costs that are or will be incurred, as an evaluation for the contractor team on the

progress that has been achieved, and as a report to the project owner on the progress of construction over time. This report also facilitates monitoring or monitoring of work by contractors and is one of the requirements for submitting project terms. The following is a table of weekly report recapitulations:

Tabel 2. Rekapitulasi Laporan Mingguan

No	Periode Minggu		(%) Rencana Per minggu	(%) Kumulatif Rencana Per minggu	(%) Realisasi Per minggu	(%) Kumulatif Realisasi Per minggu	Deviasi
		12 Jun 2023 - 14 Jul 2024	46.03	46.03	38.24	38.24	-7.79
1	Ke-58	15 Jul - 21 Jul	0.57	46.60	0.92	39.16	-7.44
2	Ke-59	22 Jul - 28 Jul	0.51	47.11	1.04	40.20	-6.91
3	Ke-60	29 Jul - 04 Agus	0.51	47.62	0.95	41.15	-6.47
4	Ke-61	05 Agus - 11 Agus	0.35	47.97	1.06	42.21	-5.76
5	Ke-62	12 Agus - 18 Agus	0.35	48.32	1.28	43.49	-4.83
6	Ke-63	19 Agus - 25 Agus	0.35	48.67	0.74	44.23	-4.44
7	Ke-64	26 Agus - 01 Sep	0.34	49.01	0.83	45.06	-3.95
8	Ke-65	02 Sep - 08 Sep	0.34	49.35	0.49	45.55	-3.80
9	Ke-66	09 Sep - 15 Sep	0.34	49.69	0.38	45.93	-3.76
10	Ke-67	16 Sep - 22 Sep	0.35	50.04	0.74	46.67	-3.37
11	Ke-68	23 Sep - 29 Sep	0.35	50.39	1.09	47.76	-2.63
12	Ke-69	30 Sept - 06 Okt	0.79	51.18	0.89	48.65	-2.53
13	Ke-70	07 Okt - 13 Okt	0.83	52.01	0.92	49.57	-2.44
14	Ke-71	14 Okt - 20 Okt	0.77	52.78	0.92	50.49	-2.29
15	Ke-72	21 Okt - 27 Okt	0.79	53.57	1.01	51.50	-2.07
16	Ke-73	28 Okt - 03 Nop	1.05	54.62	1.10	52.60	-2.02
17	Ke-74	04 Nop - 10 Nop	1.08	55.70	0.57	53.17	-2.53
18	Ke-75	11 Nop - 17 Nop	1.09	56.79	0.59	53.76	-3.03
19	Ke-76	18 Nop - 24 Nop	1.10	57.89	0.71	54.47	-3.42
20	Ke-77	25 Nop - 01 Des	1.10	58.99	0.65	55.12	-3.87

Sumber: Olahan Penulis berdasarkan laporan mingguan PT. PP (Persero) Tbk, PT. Wika (Persero) Tbk dan PT. Waskita (Persero) Tbk, 2024.

Calculation of BCWS, BCWP and ACWP

In this project, the application of *the Earned Value* method produces key values such as *Planned Value* (PV) or *Budgeted Cost Work Schedule* (BCWS), *Earned Value* (EV) or *Budgeted Cost Work Performed* (BCWP), and *Actual Cost* (AC) or *Actual Cost of Work Performed* (ACWP). These values are compared periodically in each phase of the project until completion. Information related to costs and values obtained throughout the project cycle is very useful for fast and coordinated project control and supervision. The method used to control costs and time in the field is time schedule, which is widely applied to construction projects. The percentage of project plans and realizations is depicted in the form of an S-curve. Based on the S-curve that shows the planning and realization of the project, the work between week 58 to week 77 indicates that the project is still

ongoing. However, the actual physical percentage (realization) of the project is smaller or delayed compared to the set plan. The earned *value analysis* was conducted in week 77.

Perhitungan Planned Value (PV) atau Budgeted Cost Work Schedule (BCWS)

Budgeted Cost Work Schedule (BCWS) is a cost budget that is allocated in accordance with a work plan that has been prepared and arranged based on time. In this project, the total contract value that includes VAT is Rp. 4,425,887,630,000.00. To calculate PV or BCWS, this value is obtained by multiplying the percentage of the work completion plan by the Cost Budget Plan (RAB) using the following formula:

PV atau BCWS = (% rencana) x (RAB)

Perhitungan PV atau BCWS pada minggu ke-58 yaitu :
PV atau BCWS = (0.57%) x (Rp 3.987.277.771.128,31)
PV atau BCWS = Rp 22.727.483.295,43
Untuk perhitungan minggu selanjutnya dapat dapat dilakukan dengan cara yang sama seperti perhitungan diatas, dilihat pada tabel 3 berikut ini:

Tabel 3. Nilai *Planned Value* atau *Budgeted Cost Work Schedule*

No	Periode Minggu	(%) Rencana Per minggu	(%) Kumulatif Rencana Per minggu	PV atau BCWS (Mingguan)	PV atau BCWS (Kumulatif)
a	b	c	d	e = c x RAB	f = d x RAB
		46,03	46,03	Rp 1.835.343.958.050,36	Rp 1.835.343.958.050,36
1	Ke-58	0,57	46,60	Rp 22.727.483.295,43	Rp 1.858.071.441.345,79
2	Ke-59	0,51	47,11	Rp 20.335.116.632,75	Rp 1.878.406.557.978,55
3	Ke-60	0,51	47,62	Rp 20.335.116.632,75	Rp 1.898.741.674.611,30
4	Ke-61	0,35	47,97	Rp 13.955.472.198,95	Rp 1.912.697.146.810,25
5	Ke-62	0,35	48,32	Rp 13.955.472.198,95	Rp 1.926.652.619.009,20
6	Ke-63	0,35	48,67	Rp 13.955.472.198,95	Rp 1.940.608.091.208,15
7	Ke-64	0,34	49,01	Rp 13.556.744.421,84	Rp 1.954.164.835.629,99
8	Ke-65	0,34	49,35	Rp 13.556.744.421,84	Rp 1.967.721.580.051,82
9	Ke-66	0,34	49,69	Rp 13.556.744.421,84	Rp 1.981.278.324.473,66
10	Ke-67	0,35	50,04	Rp 13.955.472.198,95	Rp 1.995.233.796.672,61
11	Ke-68	0,35	50,39	Rp 13.955.472.198,95	Rp 2.009.189.268.871,56
12	Ke-69	0,79	51,18	Rp 31.499.494.391,91	Rp 2.040.688.763.263,47
13	Ke-70	0,83	52,01	Rp 33.094.405.500,37	Rp 2.073.783.168.763,83
14	Ke-71	0,77	52,78	Rp 30.702.038.837,69	Rp 2.104.485.207.601,52
15	Ke-72	0,79	53,57	Rp 31.499.494.391,91	Rp 2.135.984.701.993,44
16	Ke-73	1,05	54,62	Rp 41.866.416.596,85	Rp 2.177.851.118.590,28
17	Ke-74	1,08	55,70	Rp 43.062.599.928,19	Rp 2.220.913.718.518,47
18	Ke-75	1,09	56,79	Rp 43.461.327.705,30	Rp 2.264.375.046.223,77
19	Ke-76	1,10	57,89	Rp 43.860.055.482,41	Rp 2.308.235.101.706,18
20	Ke-77	1,10	58,99	Rp 43.860.055.482,41	Rp 2.352.095.157.188,59

Sumber: Olahan Penulis berdasarkan laporan mingguan PT. PP (Persero) Tbk, PT. Wika (Persero) Tbk dan PT. Waskita (Persero) Tbk, 2024.

Perhitungan *Earned Value* (EV) atau Budgeted Cost Work Performed (BCWP)

Budget Cost for Work Performed (BCWP) is a value that reflects the cost that has been budgeted for work that has been completed in a certain period. This indicator is used to assess the extent of the progress of the work that has been achieved. In this project, *Earned Value* (EV) or BCWP refers to the budgeted cost for the work that has been completed. This value is calculated by multiplying the percentage of work that has been completed by the Cost Budget Plan (RAB), with the following formula:

EV atau BCWP = (% bobot realisasi) × (RAB)

Perhitungan EV atau BCWP pada minggu ke-58 yaitu :
PV atau BCWP = (0.92%) x (Rp 3.987.277.771.128,31)
PV atau BCWP = Rp 36.682.955.494,38
Untuk perhitungan minggu selanjutnya dapat dapat dilakukan dengan cara yang sama seperti perhitungan diatas, dilihat pada tabel 4 berikut ini:

Tabel 4. Nilai *Earned Value* atau *Budgeted Cost Work Performed*

No	Periode Minggu	(%) Realisasi Per minggu	(%) Kumulatif Realisasi Per minggu	EV atau BCWP (Mingguan)	EV atau BCWP (Kumulatif)
a	b	c	d	e = c x RAB	f = d x RAB
		38,24	38,24	Rp 1.524.735.019.679,47	Rp 1.524.735.019.679,47
1	Ke-58	0,92	39,16	Rp 36.682.955.494,38	Rp 1.561.417.975.173,85
2	Ke-59	1,04	40,20	Rp 41.467.688.819,73	Rp 1.602.885.663.993,58
3	Ke-60	0,95	41,15	Rp 37.879.138.825,72	Rp 1.640.764.802.819,30
4	Ke-61	1,06	42,21	Rp 42.265.144.373,96	Rp 1.683.029.947.193,26
5	Ke-62	1,28	43,49	Rp 51.037.155.470,44	Rp 1.734.067.102.663,70
6	Ke-63	0,74	44,23	Rp 29.505.855.506,35	Rp 1.763.572.958.170,05
7	Ke-64	0,83	45,06	Rp 33.094.405.500,37	Rp 1.796.667.363.670,42
8	Ke-65	0,49	45,55	Rp 19.537.661.078,53	Rp 1.816.205.024.748,95
9	Ke-66	0,38	45,93	Rp 15.151.655.530,29	Rp 1.831.356.680.279,23
10	Ke-67	0,74	46,67	Rp 29.505.855.506,35	Rp 1.860.862.535.785,58
11	Ke-68	1,09	47,76	Rp 43.461.327.705,30	Rp 1.904.323.863.490,88
12	Ke-69	0,89	48,65	Rp 35.486.772.163,04	Rp 1.939.810.635.653,92
13	Ke-70	0,92	49,57	Rp 36.682.955.494,38	Rp 1.976.493.591.148,30
14	Ke-71	0,92	50,49	Rp 36.682.955.494,38	Rp 2.013.176.546.642,68
15	Ke-72	1,01	51,50	Rp 40.271.505.488,40	Rp 2.053.448.052.131,08
16	Ke-73	1,10	52,60	Rp 43.860.055.482,41	Rp 2.097.308.107.613,49
17	Ke-74	0,57	53,17	Rp 22.727.483.295,43	Rp 2.120.035.590.908,92
18	Ke-75	0,59	53,76	Rp 23.524.938.849,66	Rp 2.143.560.529.758,58
19	Ke-76	0,71	54,47	Rp 28.309.672.175,01	Rp 2.171.870.201.933,59
20	Ke-77	0,65	55,12	Rp 25.917.305.512,33	Rp 2.197.787.507.445,93

Sumber: Olahan Penulis berdasarkan laporan mingguan PT. PP (Persero) Tbk, PT. Wika (Persero) Tbk dan PT. Waskita (Persero) Tbk, 2024.

Perhitungan Actual Cost (AC) atau *Actual Cost of Work Performed* (ACWP)

Actual Cost for Work Performed (ACWP) is the total expenditure incurred to complete the work in a given period. In this project, AC or ACWP reflects the actual costs incurred to achieve the percentage of work completed, which consists of direct costs (labor and materials) and indirect costs (office and field *overhead*). Due to the limited financial data of the project owner, these costs are calculated based on assumptions. Contracts are considered a combination of construction costs and project profits, with an average profit of 10%.:

RAB = Biaya Konstruksi + (10% x RAB)
Biaya Konstruksi = RAB – (10% x RAB)
Biaya Konstruksi = Rp 3.987.277.771.128,31 – (10% x Rp 3.987.277.771.128,31) Biaya Konstruksi = Rp 3.588.549.994.015,48

Biaya konstruksi merupakan penjumlahan dari biaya langsung dan biaya tak langsung. Biaya langsung pada proyek diasumsikan 85% dari biaya konstruksi, sedangkan biaya tak langsung sebesar 15% dari biaya konstruksi

Biaya Konstruksi = Biaya Langsung + Biaya Tak Langsung
Biaya Konstruksi = (85% x Biaya Konstruksi) + (15% x Biaya Konstruksi)
Biaya Langsung = 85% x Biaya Konstruksi
Biaya Langsung = 85% x Rp 3.588.549.994.015,48
Biaya Langsung = Rp 3.050.267.494.913,16
Biaya Tak Langsung = 15% x Biaya Konstruksi
Biaya Tak Langsung = 15% x Rp 3.588.549.994.015,48
Biaya Tak Langsung = Rp 538.282.499.102,32
Biaya Tak langsung tiap minggu = Rp 538.282.499.102,32 : 104
Biaya Tak langsung tiap minggu = Rp 5.175.793.260,60

Berikut merupakan rumus ACWP untuk minggu ke-58 sesuai dengan asumsi penulis:

ACWP = (% realisasi progres x biaya langsung)+biaya tak langsung mingguan
ACWP = (0,92% x Rp 3.050.267.494.913,16) + Rp 5.175.793.260,60
ACWP = Rp 33.238.254.213,80

Untuk perhitungan *Schedule Variance* dari minggu ke-58 sampai dengan minggu ke-77 dapat dilihat pada tabel 4.5 dibawah ini :

Tabel 5. Nilai *Actual Cost* atau *Actual Cost of Work Performed*

No	Periode Minggu	(%) Realisasi Per minggu	Biaya Langsung (Mingguan)	Biaya Tak Langsung (Mingguan)	AC atau ACWP (Mingguan)	AC atau ACWP (Kumulatif)
a	b	c	d	e	f	g = e + f
		38.24	Rp 1,166,422,290,054.79	Rp295,020,215,854.16	Rp 1,461,442,505,908.95	Rp 1,461,442,505,908.95
1	Ke-58	0.92	Rp 28,062,460,953.20	Rp 5,175,793,260.60	Rp 33,238,254,213.80	Rp 1,494,680,760,122.75
2	Ke-59	1.04	Rp 31,722,781,947.10	Rp 5,175,793,260.60	Rp 36,898,575,207.70	Rp 1,531,579,335,330.45
3	Ke-60	0.95	Rp 28,977,541,201.68	Rp 5,175,793,260.60	Rp 34,153,334,462.27	Rp 1,565,732,669,792.72
4	Ke-61	1.06	Rp 32,332,835,446.08	Rp 5,175,793,260.60	Rp 37,508,628,706.68	Rp 1,603,241,298,499.40
5	Ke-62	1.28	Rp 39,043,423,934.89	Rp 5,175,793,260.60	Rp 44,219,217,195.49	Rp 1,647,460,515,694.89
6	Ke-63	0.74	Rp 22,571,979,462.36	Rp 5,175,793,260.60	Rp 27,747,772,722.96	Rp 1,675,208,288,417.84
7	Ke-64	0.83	Rp 25,317,220,207.78	Rp 5,175,793,260.60	Rp 30,493,013,468.38	Rp 1,705,701,301,886.22
8	Ke-65	0.49	Rp 14,946,310,725.07	Rp 5,175,793,260.60	Rp 20,122,103,985.67	Rp 1,725,823,405,871.90
9	Ke-66	0.38	Rp 11,591,016,480.67	Rp 5,175,793,260.60	Rp 16,766,809,741.27	Rp 1,742,590,215,613.16
10	Ke-67	0.74	Rp 22,571,979,462.36	Rp 5,175,793,260.60	Rp 27,747,772,722.96	Rp 1,770,337,988,336.12
11	Ke-68	1.09	Rp 33,247,915,694.55	Rp 5,175,793,260.60	Rp 38,423,708,955.15	Rp 1,808,761,697,291.27
12	Ke-69	0.89	Rp 27,147,380,704.73	Rp 5,175,793,260.60	Rp 32,323,173,965.33	Rp 1,841,084,871,256.60
13	Ke-70	0.92	Rp 28,062,460,953.20	Rp 5,175,793,260.60	Rp 33,238,254,213.80	Rp 1,874,323,125,470.40
14	Ke-71	0.92	Rp 28,062,460,953.20	Rp 5,175,793,260.60	Rp 33,238,254,213.80	Rp 1,907,561,379,684.20
15	Ke-72	1.01	Rp 30,807,701,698.62	Rp 5,175,793,260.60	Rp 35,983,494,959.22	Rp 1,943,544,874,643.42
16	Ke-73	1.10	Rp 33,552,942,444.04	Rp 5,175,793,260.60	Rp 38,728,735,704.64	Rp 1,982,273,610,348.07
17	Ke-74	0.57	Rp 17,386,524,721.01	Rp 5,175,793,260.60	Rp 22,562,317,981.60	Rp 2,004,835,928,329.67
18	Ke-75	0.59	Rp 17,996,578,219.99	Rp 5,175,793,260.60	Rp 23,172,371,480.59	Rp 2,028,008,299,810.26
19	Ke-76	0.71	Rp 21,656,899,213.88	Rp 5,175,793,260.60	Rp 26,832,692,474.48	Rp 2,054,840,992,284.74
20	Ke-77	0.65	Rp 19,826,738,716.94	Rp 5,175,793,260.60	Rp 25,002,531,977.53	Rp 2,079,843,524,262.28

Sumber: Olahan Penulis, 2024.

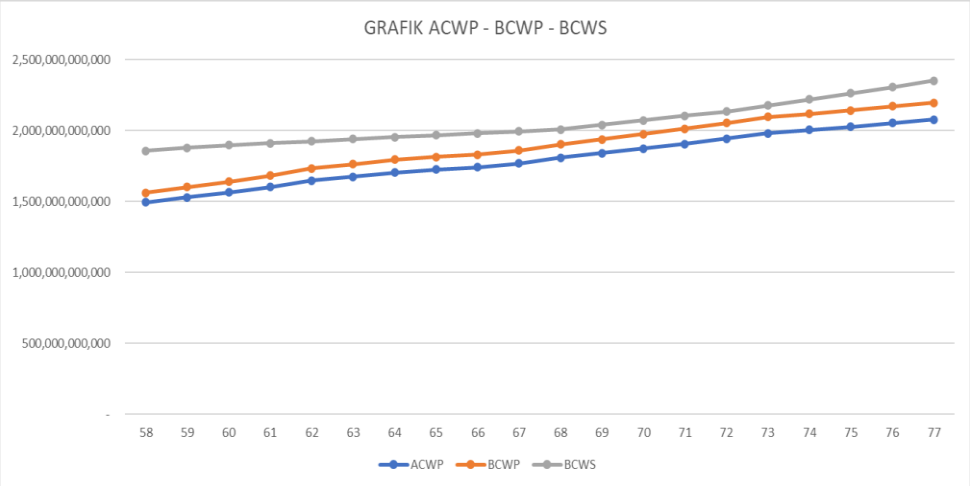
Perhitungan yang dilakukan terhadap tiga indikator dasar *Budgeted Cost Work Schedule* (BCWS), *Budgeted Cost Work Performed* (BCWP), dan *Actual Cost of Work Performed* (ACWP) dapat memberikan gambaran tentang pencapaian biaya dan waktu secara kumulatif setiap minggu, sebagaimana yang ditunjukkan dalam tabel 6 berikut.:

Tabel 6. Rekapitulasi Perhitungan BCWS, BCWP dan ACWP Kumulatif

No	Periode Minggu	PV atau BCWS (Kumulatif)	EV atau BCWP (Kumulatif)	AC atau ACWP (Kumulatif)
a	b	d	e	f
1	Ke-58	Rp1,858,071,441,345.79	Rp1,561,417,975,173.85	Rp1,494,680,760,122.75
2	Ke-59	Rp1,878,406,557,978.55	Rp1,602,885,663,993.58	Rp1,531,579,335,330.45
3	Ke-60	Rp1,898,741,674,611.30	Rp1,640,764,802,819.30	Rp1,565,732,669,792.72
4	Ke-61	Rp1,912,697,146,810.25	Rp1,683,029,947,193.26	Rp1,603,241,298,499.40
5	Ke-62	Rp1,926,652,619,009.20	Rp1,734,067,102,663.70	Rp1,647,460,515,694.89
6	Ke-63	Rp1,940,608,091,208.15	Rp1,763,572,958,170.05	Rp1,675,208,288,417.84
7	Ke-64	Rp1,954,164,835,629.99	Rp1,796,667,363,670.42	Rp1,705,701,301,886.22
8	Ke-65	Rp1,967,721,580,051.82	Rp1,816,205,024,748.95	Rp1,725,823,405,871.90
9	Ke-66	Rp1,981,278,324,473.66	Rp1,831,356,680,279.23	Rp1,742,590,215,613.16
10	Ke-67	Rp1,995,233,796,672.61	Rp1,860,862,535,785.58	Rp1,770,337,988,336.12
11	Ke-68	Rp2,009,189,268,871.56	Rp1,904,323,863,490.88	Rp1,808,761,697,291.27
12	Ke-69	Rp2,040,688,763,263.47	Rp1,939,810,635,653.92	Rp1,841,084,871,256.60
13	Ke-70	Rp2,073,783,168,763.83	Rp1,976,493,591,148.30	Rp1,874,323,125,470.40
14	Ke-71	Rp2,104,485,207,601.52	Rp2,013,176,546,642.68	Rp1,907,561,379,684.20
15	Ke-72	Rp2,135,984,701,993.44	Rp2,053,448,052,131.08	Rp1,943,544,874,643.42
16	Ke-73	Rp2,177,851,118,590.28	Rp2,097,308,107,613.49	Rp1,982,273,610,348.07
17	Ke-74	Rp2,220,913,718,518.47	Rp2,120,035,590,908.92	Rp2,004,835,928,329.67
18	Ke-75	Rp2,264,375,046,223.77	Rp2,143,560,529,758.58	Rp2,028,008,299,810.26
19	Ke-76	Rp2,308,235,101,706.18	Rp2,171,870,201,933.59	Rp2,054,840,992,284.74
20	Ke-77	Rp2,352,095,157,188.59	Rp2,197,787,507,445.93	Rp2,079,843,524,262.28

Sumber: Olahan Penulis, 2024.

Dari tabel diatas kemudian dituangkan dalam bentuk grafik sehingga diketahui dimana posisi BCWS, BCWP dan ACWP kumulatif sesuai dengan gambar grafik 3 dibawah ini:



Gambar 1. Grafik Rekapitulasi BCWS, BCWP dan ACWP Kumulatif

Sumber: Olahan Peneliti, 2024.

1.3. Perhitungan Indeks Performansi

Indeks performansi terdiri dari dua komponen, yaitu *Schedule Performance Index* (SPI) yang mengukur aspek waktu. Berikut adalah perhitungan indeks performansi untuk proyek Pembangunan Jalan Tol Probolinggo – Banyuwangi Paket 3..

1.3.1. Perhitungan Schedule Performance Index (SPI)

Schedule Performance Index (SPI) adalah rasio antara *Budget Cost for Work Performed* (BCWP) dan *Budgeted Cost Work Schedule* (BCWS). Indeks ini memberikan informasi kepada pemilik proyek mengenai efisiensi penggunaan sumber daya, sehingga bisa menjadi acuan untuk menilai kinerja atau produktivitas proyek. Perhitungan SPI dilakukan dengan rumus dibawah, dan berikut adalah contoh perhitungan kumulatif pada minggu ke-77:

$$\text{SPI} = \frac{\text{BCWP}}{\text{BCWS}}$$

$$\text{SPI} = \frac{\text{Rp } 2.197.787.507.445{,}93}{\text{Rp } 2.352.095.157.188{,}59}$$

SPI = 0,93

Untuk nilai SPI < 1, hal ini berarti pekerjaan kumulatif sampai dengan minggu ke-77 mengalami keterlambatan dari jadwal yang direncanakan. Untuk perhitungan *Schedule Performance Index* dari minggu ke-58 sampai dengan minggu ke-77 dapat dilihat pada tabel 7 dibawah ini:

Tabel 7. Rekapitulasi Nilai *Schedule Performance Index*

No	Periode Minggu	EV atau BCWP (Mingguan)	PV atau BCWS (Mingguan)	*Schedule Performance Index*	Keterangan
a	b	c	d	e = c : d	f
1	Ke-58	Rp 36,682,955,494.38	Rp 22,727,483,295.43	1.61	Lebih cepat
2	Ke-59	Rp 41,467,688,819.73	Rp 20,335,116,632.75	2.04	Lebih cepat
3	Ke-60	Rp 37,879,138,825.72	Rp 20,335,116,632.75	1.86	Lebih cepat
4	Ke-61	Rp 42,265,144,373.96	Rp 13,955,472,198.95	3.03	Lebih cepat
5	Ke-62	Rp 51,037,155,470.44	Rp 13,955,472,198.95	3.66	Lebih cepat
6	Ke-63	Rp 29,505,855,506.35	Rp 13,955,472,198.95	2.11	Lebih cepat
7	Ke-64	Rp 33,094,405,500.37	Rp 13,556,744,421.84	2.44	Lebih cepat
8	Ke-65	Rp 19,537,661,078.53	Rp 13,556,744,421.84	1.44	Lebih cepat
9	Ke-66	Rp 15,151,655,530.29	Rp 13,556,744,421.84	1.12	Lebih cepat
10	Ke-67	Rp 29,505,855,506.35	Rp 13,955,472,198.95	2.11	Lebih cepat
11	Ke-68	Rp 43,461,327,705.30	Rp 13,955,472,198.95	3.11	Lebih cepat
12	Ke-69	Rp 35,486,772,163.04	Rp 31,499,494,391.91	1.13	Lebih cepat
13	Ke-70	Rp 36,682,955,494.38	Rp 33,094,405,500.37	1.11	Lebih cepat
14	Ke-71	Rp 36,682,955,494.38	Rp 30,702,038,837.69	1.19	Lebih cepat
15	Ke-72	Rp 40,271,505,488.40	Rp 31,499,494,391.91	1.28	Lebih cepat
16	Ke-73	Rp 43,860,055,482.41	Rp 41,866,416,596.85	1.05	Lebih cepat
17	Ke-74	Rp 22,727,483,295.43	Rp 43,062,599,928.19	0.53	Terlambat
18	Ke-75	Rp 23,524,938,849.66	Rp 43,461,327,705.30	0.54	Terlambat
19	Ke-76	Rp 28,309,672,175.01	Rp 43,860,055,482.41	0.65	Terlambat
20	Ke-77	Rp 25,917,305,512.33	Rp 43,860,055,482.41	0.59	Terlambat

Sumber: Olahan Penulis, 2024.

1.4. Perhitungan Estimasi Waktu dan Biaya

The estimated time calculation aims to find out how long it takes to complete the Probolinggo – Banyuwangi Toll Road Construction project Package 3, while the cost estimation aims to find out how much costs must be incurred for the Probolinggo – Banyuwangi Toll Road Construction Package 3 project. The calculation in the estimated time consists of 2 (two) things, namely *Estimate Temporary Schedule* (ETS) and *Estimate at Schedule* (EAS), while the cost estimate also consists of 2 (two) things, namely *Estimate to Complete* (ETC) and *Estimate at Complete* (EAC).

1.4.1. Perhitungan Estimate Temporary Schedule (ETS)

Estimate Temporary Schedule is a method used in calculating the estimated time left to complete the existing work. The formula for calculating *the Estimate Temporary Schedule* uses the formula below, and for the calculation of *the Estimate Temporary Schedule* from week 58 to week 77 as shown in table 9 below:

Tabel 8. Rekapitulasi Perhitungan Nilai *Estimate Temporary Schedule*

No	Periode Minggu	*Schedule Performance Index*	Waktu Rencana	Waktu Terpakai	Waktu Sisa	*Estimate Temporary Schedule*
a	b	c	d	e	f = d - e	g = f : c
1	Ke-58	1.61	728	406	322	199.50
2	Ke-59	2.04	728	413	315	154.47
3	Ke-60	1.86	728	420	308	165.35
4	Ke-61	3.03	728	427	301	99.39
5	Ke-62	3.66	728	434	294	80.39
6	Ke-63	2.11	728	441	287	135.74
7	Ke-64	2.44	728	448	280	114.70
8	Ke-65	1.44	728	455	273	189.43
9	Ke-66	1.12	728	462	266	238.00
10	Ke-67	2.11	728	469	259	122.50
11	Ke-68	3.11	728	476	252	80.92
12	Ke-69	1.13	728	483	245	217.47
13	Ke-70	1.11	728	490	238	214.72
14	Ke-71	1.19	728	497	231	193.34
15	Ke-72	1.28	728	504	224	175.21
16	Ke-73	1.05	728	511	217	207.14
17	Ke-74	0.53	728	518	210	397.89
18	Ke-75	0.54	728	525	203	375.03
19	Ke-76	0.65	728	532	196	303.66
20	Ke-77	0.59	728	539	189	319.85

Sumber: Olahan Penulis, 2024.

Perhitungan nilai *Estimate Temporary Schedule* pada minggu ke-77 adalah sebagai berikut:

$$\text{ETS} = \frac{\text{Sisa waktu}}{\text{SPI}}$$

$$\text{ETS} = \frac{189}{0.59}$$

ETS = 319,85 dibulatkan menjadi 320 hari

1.4.2. Perhitungan Estimate at Schedule (EAS)

Estimate at Schedule merupakan metode yang digunakan untuk memperkirakan waktu penyelesaian proyek. Rumus yang digunakan untuk menghitung *Estimate at Schedule* ada dibawah ini, dan perhitungan *Estimate at Schedule* dari minggu ke-58 sampai minggu ke-77 seperti pada tabel 10 dibawah ini:

Tabel 9. Rekapitulasi Perhitungan *Estimate at Schedule*

No	Periode Minggu	*Schedule Performance Index*	Waktu Rencana	Waktu Terpakai	Waktu Sisa	*Estimate Temporary Schedule*	*Estimate at Schedule*	Selisih Waktu
a	b	c	d	e	f = d - e	g = f : c	h = e + g	i = h - d
1	Ke-58	1.61	728	406	322	199.50	605.50	(122.50)
2	Ke-59	2.04	728	413	315	154.47	567.47	(160.53)
3	Ke-60	1.86	728	420	308	165.35	585.35	(142.65)
4	Ke-61	3.03	728	427	301	99.39	526.39	(201.61)
5	Ke-62	3.66	728	434	294	80.39	514.39	(213.61)
6	Ke-63	2.11	728	441	287	135.74	576.74	(151.26)
7	Ke-64	2.44	728	448	280	114.70	562.70	(165.30)
8	Ke-65	1.44	728	455	273	189.43	644.43	(83.57)
9	Ke-66	1.12	728	462	266	238.00	700.00	(28.00)
10	Ke-67	2.11	728	469	259	122.50	591.50	(136.50)
11	Ke-68	3.11	728	476	252	80.92	556.92	(171.08)
12	Ke-69	1.13	728	483	245	217.47	700.47	(27.53)
13	Ke-70	1.11	728	490	238	214.72	704.72	(23.28)
14	Ke-71	1.19	728	497	231	193.34	690.34	(37.66)
15	Ke-72	1.28	728	504	224	175.21	679.21	(48.79)
16	Ke-73	1.05	728	511	217	207.14	718.14	(9.86)
17	Ke-74	0.53	728	518	210	397.89	915.89	187.89
18	Ke-75	0.54	728	525	203	375.03	900.03	172.03
19	Ke-76	0.65	728	532	196	303.66	835.66	107.66
20	Ke-77	0.59	728	539	189	319.85	858.85	130.85

Sumber: Olahan Penulis, 2024.

Perhitungan nilai *Estimate at Schedule* pada minggu ke-77 adalah sebagai berikut:

EAS = Waktu terpakai + ETS

EAS = 539 + 319,85

EAS = 858,85 hari dibulatkan menjadi 859 hari

Dari hasil perhitungan *Estimate Temporary Schedule* dan *Estimate at Schedule* didapat bahwa untuk penyelesaian pekerjaan membutuhkan waktu yang lebih lama dari waktu yang dijadwalkan yaitu selama 131 hari.

1.4.3. Perhitungan Estimate to Complete (ETC)

Estimate to Complete merupakan pedoman dalam menghitung nilai yang dapat digunakan untuk mengembangkan laporan kinerja. Perhitungan *Estimate to Complete* menggunakan rumus sebagai berikut:

$$\text{ETC} = \frac{\text{BAC} - \text{BCWP}}{\text{CPI}}$$

$$\text{ETC} = \frac{\text{Rp } 3.987.277.771.128{,}31 - \text{Rp } 2.197.787.507.445{,}93}{1{,}06}$$

ETC = Rp 1.805.072.033.970,52

1.4.4. Perhitungan Estimate at Complete (EAC)

Estimate at Complete merupakan perkiraan biaya total yang dibutuhkan sampai akhir proyek yang diperoleh dari biaya aktual (*Actual Cost*) ditambah dengan *Estimate to Complete*. Perhitungan *Estimate at Complete* menggunakan rumus sebagai berikut:

EAC = ACWP + ETC

EAC = Rp 2.079.843.524.262,28 + Rp 1.805.072.033.970,52

EAC = Rp 3.884.915.558.232,80

Apabila pelaksana pekerjaan diminta untuk menyelesaikan pekerjaan tepat waktu sesuai jadwal yang telah ditentukan pada awal kontrak, maka biaya yang dibutuhkan untuk mengejar keterlambatan progres pekerjaan yaitu:

Tabel 10. Rekapitulasi Rencana Progres Penyelesaian Proyek

No	Periode Minggu	(%) Rencana Per minggu	(%) Realisasi Per minggu	EV atau BCWP (Mingguan)	PV atau BCWS (Mingguan)	*Schedule Performance Index*
a	b	c	d	e	f	g = f : e
1	Ke-77	1.10	0.65	Rp 43,860,055,482.41	Rp 25,917,305,512.33	0.59
2	Ke-78	1.72	1.02	Rp 68,581,177,663.41	Rp 40,525,241,346.56	0.59
3	Ke-79	1.77	1.05	Rp 70,574,816,548.97	Rp 41,703,300,688.03	0.59
4	Ke-80	1.53	0.90	Rp 61,005,349,898.26	Rp 36,048,615,848.97	0.59
5	Ke-81	1.30	0.77	Rp 51,834,611,024.67	Rp 30,629,542,878.21	0.59
6	Ke-82	1.31	0.77	Rp 52,233,338,801.78	Rp 30,865,154,746.51	0.59
7	Ke-83	2.09	1.24	Rp 83,334,105,416.58	Rp 49,242,880,473.43	0.59
8	Ke-84	1.72	1.02	Rp 68,581,177,663.41	Rp 40,525,241,346.56	0.59
9	Ke-85	1.90	1.12	Rp 75,758,277,651.44	Rp 44,766,254,975.85	0.59
10	Ke-86	2.21	1.31	Rp 88,118,838,741.94	Rp 52,070,222,892.96	0.59
11	Ke-87	1.93	1.14	Rp 76,954,460,982.78	Rp 45,473,090,580.73	0.59
12	Ke-88	1.70	1.00	Rp 67,783,722,109.18	Rp 40,054,017,609.97	0.59
13	Ke-89	2.02	1.19	Rp 80,543,010,976.79	Rp 47,593,597,395.38	0.59
14	Ke-90	1.94	1.15	Rp 77,353,188,759.89	Rp 45,708,702,449.03	0.59
15	Ke-91	2.01	1.19	Rp 80,144,283,199.68	Rp 47,357,985,527.08	0.59
16	Ke-92	2.01	1.19	Rp 80,144,283,199.68	Rp 47,357,985,527.08	0.59
17	Ke-93	1.47	0.87	Rp 58,612,983,235.59	Rp 34,634,944,639.21	0.59
18	Ke-94	0.00	0.00	Rp -	Rp -	-
19	Ke-95	0.00	0.00	Rp -	Rp -	-
20	Ke-96	1.48	0.87	Rp 59,011,711,012.70	Rp 34,870,556,507.50	0.59
21	Ke-97	1.47	0.87	Rp 58,612,983,235.59	Rp 34,634,944,639.21	0.59
22	Ke-98	1.81	1.07	Rp 72,169,727,657.42	Rp 42,645,748,161.20	0.59
23	Ke-99	1.81	1.07	Rp 72,169,727,657.42	Rp 42,645,748,161.20	0.59
24	Ke-100	1.88	1.11	Rp 74,960,822,097.21	Rp 44,295,031,239.26	0.59
25	Ke-101	1.01	0.60	Rp 40,271,505,488.40	Rp 23,796,798,697.69	0.59
26	Ke-102	1.05	0.62	Rp 41,866,416,596.85	Rp 24,739,246,170.86	0.59
27	Ke-103	1.07	0.63	Rp 42,663,872,151.07	Rp 25,210,469,907.45	0.59
28	Ke-104	0.80	0.47	Rp 31,898,222,169.03	Rp 18,848,949,463.52	0.59

Sumber: Olahan Penulis, 2024.

Berdasarkan tabel 11 diatas maka pada minggu ke-104 total progres realisasi pekerjaan sebesar 79,35% dan progres yang belum terselesaikan sebesar 20,65%, sehingga rencana biaya yang dibutuhkan untuk menyelesaikan peoyek tersebut adalah :

Biaya Langsung = progres sisa x total biaya langsung
Biaya Langsung = 20,65% x Rp 3.050.267.494.913,16
Biaya Langsung = Rp 629.783.183.733,82
Biaya Tak Langsung = jumlah hari keterlambatan x biaya tak langsung perhari
Biaya Tak Langsung = 131 x Rp 739.399.037,23
Biaya Tak Langsung = Rp 96.861.273.876,93
Biaya Konstruksi = Biaya Langsung + Biaya Tak Langsung
Biaya Konstruksi = Rp Rp 629.783.183.733,82 + Rp 96.861.273.876,93
Biaya Konstruksi = Rp 726.644.457.610,75
Total biaya proyek = EAC + Biaya Konstruksi
Total biaya proyek = Rp 3.884.915.558.232,80 + Rp 726.644.457.610,75
Total biaya proyek = Rp 4.611.560.015.843,55

Sehingga total biaya yang dikeluarkan untuk mengejar keterlambatan agar proyek selesai sesuai dengan jadwal pada kontrak awal sebesar Rp 4.611.560.015.843,55.

Apabila pelaksana pekerjaan harus membayar denda keterlambatan selama 131 hari, maka total biaya yang harus dikeluarkan sebesar sebagai berikut:

Denda = (1/1000) x jumlah hari keterlambatan x nilai kontrak
Denda = (1/1000) x 131 x Rp 3.987.277.771.128,31
Denda = Rp 522.333.388.017,81
Total biaya proyek = EAC + Denda
Total biaya proyek = Rp 3.884.915.558.232,80 + Rp 522.333.388.017,81
Total biaya proyek = Rp 4.407.248.946.250,61

Sehingga total biaya yang dikeluarkan untuk menyelesaikan proyek beserta denda yang harus dibayar oleh pelaksana pekerjaan kepada pemilik pekerjaan sebesar Rp 4.407.248.946.250,61.

CONCLUSION

Based on the analysis conducted, it is concluded that the estimated time required to complete the Probolinggo–Banyuwangi Toll Road Package 3 project is 859 days, which is 131 days longer than the originally planned schedule. In terms of costs, completing the project on time would require an estimated total of Rp 4,611,560,015,843.55, including acceleration efforts, while completing it with the delay would result in a total cost of Rp 4,407,248,946,250.61, inclusive of penalties. These findings highlight the significant financial impact of project delays and underscore the importance of proactive schedule and cost control. For future researchers, it is recommended to explore predictive modeling techniques using real-time data integration and risk-based scheduling to enhance early warning systems and improve the accuracy of time and cost forecasting in large-scale infrastructure projects.

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