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TIME ANALYSIS USING EARNED VALUE METHOD ON PRESERVATION OF SECTION 5 PANDAAN TOLL EXIT ROAD IN MALANG.

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Abstract:
The development of a country's road or toll road infrastructure can be used as a benchmark to judge a country's economic development at both macro and micro levels. The location of toll exits has a significant impact on labor absorption and the creation of new business activities.
Projects are dynamic, so contractors must adapt to changing project situations and conditions if they are to succeed in achieving optimal profits. Today's highly competitive aspects of construction planning require high levels of accuracy, efficiency, effectiveness and economy in project analysis. In the world of construction projects, there is much that can be done, including controlling costs. In cost control, efforts can be made so that the realization of costs incurred is consistent with implementation needs and is not excessive, such as efforts to limit costs, that is, to realize savings without does not reduce quantity or quality. The earned value method is used to determine the project's performance in terms of cost at a certain time, determine the project's performance in terms of progress/time at a point in time. certain, estimate the cost to complete the project after the evaluation period and estimate the cost to complete the project after the evaluation period. Project completion time after evaluation. In this study, the author performed a cost analysis using the earned value method for the conservation of Pandaan Malang Section 5 toll road. The schedule variance value is Rp1,652,192,521 with the time performance index value of 1.139743112 or SPI value > 1, meaning this project has arrived at week 17, the implementation is faster than planned. The estimated project completion date or Expected Schedule (EAS) is 278 days, 22 days faster than the total contract period of 300 days.
Keywords: Earned Value Method, Time Performance Analysis, Cost Performance Analysis, Project Control, Actual Cost Estimation.

INTRODUCTION

Projects are dynamic, so contractors must adapt to changing project situations and conditions if they want to succeed in achieving optimal profits. This requires the contractor to establish a careful planning policy to anticipate these circumstances so that the project can still be delivered without delay. With careful planning, a suitable project schedule can be prepared, based on site conditions. Project planning includes the sequence and timing of all project activities. With proper project planning, greater emphasis will be placed on coordination between contractors and problems that could adversely affect project execution can be avoided and overcome. The planning aspects of today's highly competitive construction industry are demanding in terms of accuracy, efficiency, effectiveness and economics in project analysis. In the world of construction projects, there is much that can be done, including controlling costs. In cost control, efforts can be made so that the realization of costs incurred is consistent with implementation needs and is not excessive, such as efforts to reduce costs, i.e. achieving savings without reduce quantity or quality. Therefore, when planning construction, one must use a technique that has the potential for significant success in controlling costs.

The control process of a project includes all activities included in the project life cycle, so when implementing a project, it is necessary to consider the implementation and pay attention to the project control system so that the control can take into account resources, including time, cost and performance of the project so it can be tracked. The purpose of monitoring is to ensure the project is completed according to specifications, on time, and using allocated resources.

Thus, project control is the control of resources including time control, cost control and quality control, or in other words, these three factors are often called project control factors. These control factors are important parameters for project implementation that are often associated with the project. the purpose or goal of the project. The purpose of project time and schedule control is that it must be carried out as much as possible within the specified time and completion date before the work is implemented and cost control is that project control must performed at a cost that does not exceed the project budget, while quality control results from activities or work that must meet required specifications or criteria. To increase the effectiveness of monitoring and controlling project activities, it is necessary to use a method. One of the methods to solve the above problems is to use the earned value method.

In Prservation Section 5 of the Pandaan Malang Exit Toll Road, currently under construction, there are several cost and time constraints. On this project, there are delays in schedule, which can result in cost overruns and if the job is not completed on time, late fees. Therefore, the author will use the earned value method to evaluate timeliness and cost effectiveness, for example. In which 3 (three) indicators are used: ACWP (Actual cost of work performed), BCWP (Budgeted cost of work performed) and BCWS (Budgeted cost of work Scheduled). ACWP is the actual cost of the work performed. This cost is derived from project financial or accounting data as of the reporting date (e.g. month-end), creating a record of all actual expenditures from work packages or accounting codes, including including calculation costs and other costs. ACWP is the actual amount of costs or funds used to perform work during a given period of time. BCWP shows the value of the results in terms of the value of the work performed relative to the budget allocated to do the work. When comparing ACWP figures with BCWP, it will show a comparison between the costs incurred for the work that was done and the costs that should have been incurred for this purpose. BCWS is a budget for a work package but organized and linked to implementation progress. Earned value method is a combination of cost, schedule and scope of work, where each work item has been assigned a cost analysis and schedule that can be used as a reference during execution workers' presence. so that development implementation can be consistent with the time and cost goals stated in the contract. Using the above indicators, it is possible to calculate many different factors that represent the progress and effectiveness of project implementation, such as: difference in cost and total schedule; monitor changes in deviations from standard figures; productivity and performance index; Project completion cost estimate. The earned value method (EVM) is one of the tools that can be used in project management, integrating cost, time and project performance to determine the relationship between cost performance and performance. costs and deadlines as well as the estimated costs and time required to complete the project by controlling costs and deadlines to avoid delays in the final implementation deadline. Additionally, additional costs due to delays can be optimized.

A review of similar previous research is used as a comparison in adding insight or input in reviewing research Time Analysis Using Earned Value Method on Preservation of Section 5 Pandaan Malang Exit Toll Road. The studies include:

Bridge projects play a vital role in the road network and must be maintained in good working condition. As bridges age, factors such as material durability, environmental conditions and natural disasters can cause deterioration that affects the function of the bridge. This study aims to analyze costs and time using the outcome value method in the case study of the conservation of Sembayat bridge in Gresik. The research method uses several stages such as document research stage, primary data collection (direct interviews with project supervisors), secondary data (timeline, weekly reports and budget planning) and data processing. Delay in work is one of the reasons for this cost comparison, as in the SV value of week 2, week 3, week 6, week 9 and week 10 where the SV value is negative, there is meaning working hours are not complied with. scheduled or later. The total number of planning days is 270 days with a work period of 17 weeks or 151 days. The remaining estimated completion days value considered based on data from weeks 1-17 is 190.2 days. For the Estimate All Schedule (EAS) value, which is an estimate of the total project completion time, it is 191 days. This means that the project must be completed according to planning objectives (Alfadin & Witjaksana, 2023).

Project control is a structured effort to establish planned standards, design information systems, compare performance with established standards, analyze potential deviations, and implement Take necessary corrective actions to ensure effective and efficient use of resources according to established objectives. Each project has a specific plan and schedule, determining project start and end times, implementation methods and resource allocation. Operational challenges often arise during project planning,

such as lack of resources, inappropriate allocations, delays, and other issues that can prevent the achievement of project goals as planned. This study uses the descriptive quantitative method, which is a research method that describes the specific conditions of the project through analyzing available data. This article will discuss Cost Variance (CV) and Schedule Variance (SV) during the development of Griya Jenggala at PT. Sarana Loka Almika, evaluated the Cost Performance Index (CPI) and Schedule Performance Index (SPI) during the development of Griya Jenggala to evaluate its effectiveness, estimated cost to completion (EAC) and the estimated time at completion (EAS) required to complete the Griya Jenggala Project, as well as provide an estimate of the potential profits or losses that may arise in connection with the Griya Jenggala Development Project. (Nastiti et al., 2023).

This study was conducted with the purpose of analyzing the cost-effectiveness of the Teuku Umar I Road Surface and Drainage Improvement Project in Tuban Regency, East Java. The earned value method is used during project execution using variables/metrics/indexes including BCWS, BCWP, ACWP, CV, SV, CPI and SPI. Based on the results of calculating the value of the progress performance index, it can be determined that the project implementation can be completed on time, although in the reporting period from week 4 to week 12, the project is delayed progress. (Sugiyanto & Kosbiamtoro, 2022).

Earned value method (EVM) is a world-renowned project management technique that focuses on monitoring project performance and timing, thereby identifying trends in execution and warning signs. alert the project manager to any deviations that may affect the project so they can take the necessary corrective measures. In this study, completed projects of a construction company in the city of Cuenca, Ecuador were evaluated. EVM is applied to projects from a database developed using people's information to reconstruct past events, current issues and key points and evaluate performance according to time. The results of this analysis are intended to determine the success of the project, and ultimately calculate the cost variance. EVM drives project stakeholders to pay attention to cost and schedule so that timely actions can be taken to optimize resources, helping to complete the project on budget and on time. In short, EVM plays an important role in comprehensive project management in terms of scope, time and cost. Additionally, there are now guidelines for applying this method as a control tool in future construction projects, (Proaño-Narváez et al., 2022)

This study aims to determine the cost and schedule variance (Cost Variance/CV and Schedule Variance/SV), to determine the performance index in terms of cost and time (Index cost performance/CPI and Schedule Performance Index/SPI) and to determine project cost and completion estimates. Earned value is one of the methods used to control project performance. The subject of this study is Mandeh 1 Tourism Access Road Development Project, South Pesisir Regency, West Sumatra Province. The method used is the descriptive analysis method which is carried out by description with the aim of finding factors, analyzing and even comparing. Data are extracted directly from the field to make it suitable for field implementation. An SPI value of 1 indicates project performance is equivalent to the planned schedule or there are no delays in the work (Harefa & Surbakti, 2021).

The earned value concept method can be used to analyze performance and provide estimates of goal achievement. In the study conducted on the construction of the trauma center and intensive care building phase IV of the RSUD DR. SOEDONO Madiun, the data collection for research documents was obtained from the implementation contractor and supervision consultant. On-time performance from the first week to the 7th week (September) was negative for (SV) meaning the work was completed late and the cost was higher than budget. While the SPI values are < 1, poor compliance with deadlines means work is behind schedule (Maulidi et al., 2021)

Project delays lead to time and cost differences. Delays occur due to the use of unnecessary materials and unskilled labor. The Tgk Muda Lamkuta Lhokseumawe Road Improvement Project is experiencing delays in Week 7 which, if not immediately anticipated, will result in time and cost discrepancies. The purpose of this study is to analyze the gap in job completion time and cost due to the 7th week delay used in Tgk. Muda Lamkuta Lhokseumawe Road Improvement Project. The methodology used under the earned value concept looks at the trend of schedule variances and cost variances over a project period. The results of calculation and analysis of performance gaps in time and cost are carried out using the obtained value method of performance indicators of project progress to the 7th week of obtaining the value of schedule variance. negative schedule (SV) is - Rp 310.585.260,84 with schedule performance index (SPI) < 1, so from the estimated completion date (EDC) calculation, the estimated project completion time was delayed by 23%, from 16 weeks to 20 weeks. It can be concluded that if the pace of work does not change and no efforts are made to improve performance, it can be expected that the project will be overscheduled in terms of time. (Ridha et al., 2020)

As development increases, the need for resources also increases. Construction works generally require financial and human resources in the form of labor, material resources, tools and methods. The availability of these resources is decreasing, which inevitably affects the performance of a job. One of the effects is the delay in providing costs and work schedules. Earned value analysis is a means or method used to measure

the amount of work actually performed on a project, specifically measuring progress and estimating costs and completion dates of project. This method is based on a key metric called earned value. is called earned value (the estimated cost of the work performed or the expected cost of doing the work). Acquisition value calculation is a cost calculation on a budget based on the work that has been performed. Review completed work at the time of appraisal against the expected budget for the project. The results of the analysis using the earned value analysis method of the project Continuous Improvement of Awang Long Road - Darmawan Road Kota Bangun Ilir Kota Bangun Village Sub-district can conclude that the work was carried out on time and effectively. The project manager's or contractor's performance was better than planned and expenditures were lower than budget estimates. (Fauzy et al., 2020)

The construction of the Trenggalek Regency Medical Office Building is a large-scale construction project. In large-scale projects, performance issues often arise. Therefore, it is necessary to control costs and schedules so that the project proceeds as planned. This study uses the earned value method to know the performance index and can estimate the cost and completion time of the work to make necessary adjustments to the project schedule. The results of the study in week 12 were Budgeted Cost of Work Schedule (BCWS) of Rp1,946,626,471.64, Budgeted Cost of Work Performed (BCWP) of Rp1,319,204,394.05, Actual Cost of Work Performed (ACWP) of Rp1,181,554,085.52. Schedule performance is delayed, Schedule Variant (SV) of Rp627,422,077.59 or Schedule Performance Index (SPI) is 0.678 < 1..(Zakariyya et al., 2020)

Good control of deadlines and costs will create favorable conditions for project implementation according to the pre-planned schedule. Therefore, planning and control are necessary to avoid any cost overruns or delays in the development project. One method of controlling project costs and time is to use the earned value concept, which uses a comparison between the value and results of what has been done in the project judgment. From the calculation results of the earned value method analysis in week 10, we obtained ACWP = Rp. 229,208,374 BCWS = Rp.,512,320,972, BCWP = Rp.254,667,780, schedule deviation value (SV) of Rp -257,653,192. This result shows that the completion progress of the project is about (-14,770%) slower than the planned progress. The estimated completion time (ECD) of this project = 34 weeks, which means the project is likely to last another 12 weeks (Arsjad & Malingkas, 2020).

Pekanbaru Toll Road Development Project - Dumai Section 2 (Province 9+500 - District 33+600) is expected to be completed within 32 months with a contract value of Rp 1,774,796,909,000. (including 10% VAT) so that the purchase price is Rp. 1,613,451,735,809.5 Before controlling, it is necessary to know in advance the effectiveness of the project's implementation. The purpose of this study is to determine the performance of the Pekanbaru - Dumai section 2 toll road construction project in terms of time and cost at the time of review, from July 2018 to February 2019. The method used in this study is the earned value method that combines the factors of cost, time, and physical performance of the work. Data obtained from the project includes implementation progress, monthly reports and actual project costs, then analyze costs, progress, variances and performance indicators. Analysis results in February 2019 show that the implementation time is slower than the plan shown by the value SPI = 0,478. The estimated implementation period of 69 months (Nufah et al., 2019).

Large and small scale projects are implemented to meet the growing facilities and infrastructure of the community. When implementing the Pelantaran - Parenggean - Tumbang Sangai Road Improvement Project (multi-year contract), it is necessary to know the duration and cost of project implementation. Therefore, this study aims to determine project performance in terms of time, cost, and project completion forecast. We hope that this study will be useful as an early measure of project control through measuring project duration and cost effectiveness. Data analysis was used using Earned Value Analysis (EVA) with Microsoft Project 2013 software as the analysis tool. The data collection process is carried out for project owners, consultants and contractors along with direct identification of the project location. According to the results of analysis using the EVA method, the value of Actual Cost of Work Performed (ACWP) value (IDR 21,674,400,000.00) < Budgeted Cost of Work Performed (BCWP) (IDR 22,484,516,144.00).In terms of implementation time, the value of Budget cost of work performed (BCWP) (IDR 22,484,516,144.00) > Budget cost of work scheduled (BCWS) (IDR 22,212,645,911 .00) indicates that Project implementation is faster than the planned schedule with a positive Schedule Variance Value (SV) (+IDR 271,870,233.00) and Scheduled Performance Index (SPI) > 1. The final project completion time achieved was 574 days (Pratama et al., 2019).

Toll road infrastructure development is a type of construction project with a complex scope of work, long implementation time and requiring a lot of funding. Project performance monitoring techniques are needed in a consistent and integrated manner so that project performance does not fall below expected performance. The earned value concept is one of the appropriate methods used to monitor project performance. This study aims to apply the earned value concept to the Kayuagung-Palembang-Betung (Kapalbetung) Toll Road construction project, part of the Trans-Sumatra Toll Road Network Development Plan. Supervision of project implementation by earned value is carried out from the beginning of the project until the end of the 15th month of project implementation. The results of this study indicate that until the end

of the 15th month, project schedule performance did not well as indicated by the SPI value of 0.97. This study shows that applying the earned value concept to a case study project can provide a comprehensive overview of project performance status (Susanti et al., 2019).

RESEARCH METHOD

The earned value method is a budgeting concept based on work performed (Budgeted cost of work performed). This concept measures the number of units of work completed at a given time as evaluated against the budgeted amount for the work. For this reason, it is possible to know the relationship between what is achieved materially and how much of the budget has been spent. Calculation and data processing were carried out using Microsoft Excel software, using secondary data from Pandaan Malang Exit Toll Road Conservation Project of Section 5.

The data used in this study includes secondary data which is a certain amount of information or facts obtained indirectly, especially from literary research, specifically in the form of some information or certain events through studying books, documents, magazines, laws and regulations, and reports, etc. related to the problem under study will be obtained from many different data sources by taking notes or citing data sources previously processed by relevant agencies.

The secondary data of this study includes scientific assessments of previous research, related report data, relevant government regulations, budget plans for road conservation projects on Section 5 of the Pandaan Malang Exit Toll Road obtained from BBPJN III East Java - Bali, progress for the road conservation project Section 5 of the Pandaan Malang Exit Toll Road obtained from BBPJN III East Java - Bali, progress weekly until week 17 of Road Conservation Project on Section 5 of Pandaan Malang Exit Toll Road retrieved from BBPJN III Jatim - Bali , HSPK Malang Regency, SSH East Java Province, Construction Cost Estimation Guide for public works and public housing.

Data Analysis Technique

1. Schedule and Cost Analysis
   a. Planned Value/PV (Budgeted Cost of Work Schedule/ BCWS)
      PV = Progress Plan * BAC (1)
      The budgeted cost of planned work (BCWS) is the cost allocated based on the work plan that has been established over time. BCWS is calculated from the total expected cost of the project over a certain period of time. The BCWS at project completion is called Budget at Completion (BAC). It can be said that BCWS is the budget for a work package associated with implementation progress. So it's a combination of cost, schedule and scope of work. In traditional management, BCWS is called the planning S-curve, which is an S-curve created before work is performed.
   b. Earned Value/EV (Budgeted Cost of Work Performed / BCWP)
      EV = Realisation progress * BAC (2)
      The budgeted cost of work performed (BCWP) is the value received from completing work within a certain period of time. BCWP is what we call earned value. In traditional management, BCWP is called the performance S-curve, which is an S-curve created based on the work performed during a certain period of time..
   c. Actual Cost/AC (Actual Cost of Work Performed/ACWP)
      AC = Direct Cost + Indirect Cost (3)
      - Direct costs in this study are assumed based on secondary data obtained from weekly progress data for quantity estimation, while for price estimation, estimates are taken from Malang City HSPK and Nearest City/District HSPK, East Java Province HSPK, East Java Province SSH
      - Indirect costs in this study are assumed to be 15% of direct costs, according to the construction cost estimation guidelines public and public housing by 2022.
2. Variance Analysis
   SV = EV – PV (4)
   A schedule variance is the difference between the work that can be done and the work that is scheduled.
   A positive value for the schedule variance indicates that during that period, more work was completed than planned. In other words, some parts of the work were completed faster than expected.
3. Performance Index Analysis
   SPI = EV / PV (5)
   The progress performance index is a comparison between the completion of field work and the work plan within a certain period of time. An SPI value greater than 1 shows good performance and work performed beyond planned goals.

Table 1 Element Assessment Earned Value

No	Indicator	Varian	Value	Performance	Value	Assessment
1	Schedule	SV	+	SPI	>1	Ahead of schedule
		SV	0	SPI	=1	On schedule
		SV	-	SPI	<1	Behind Schedule

4.Time Estimation at the End of Work

Schedule forecasts are useful because they provide an early warning of what is likely to happen in the future, if trends at the time of reporting do not change. If the remaining work is assumed to be performing as it was at the time of reporting, then the cost forecast for the remaining work

a. Estimate to Schedule (ETS).
   ETS = remaining time / SPI (6)
b. Estimate at Schedule (EAS).
   EAS = Time Completed + ETS (7)

RESULT AND DISCUSSION

1. Planned Value (BCWS)
   Planned Value (BCWS) = % Progress Planned x Contract Value (BAC)
   PV 1st Week = 0,059% x Rp. 46.447.201.153
   PV 1st Week = Rp. 27.246.395

Table 2 Nilai Planned Value (

Contract Value (BAC) = Rp. 46.447.201.153 PV (BCWS) = % Progress Planned x Contract Value (BAC)			
Week	**Progress Planned (%)**	**Cummulative Progress Planned (%)**	***PV (BCWS)***
1	0,059%	0,059%	Rp 27.246.395
2	0,049%	0,107%	Rp 49.792.790
3	0,049%	0,156%	Rp 72.339.186
4	0,089%	0,245%	Rp 113.737.301
5	0,160%	0,405%	Rp 187.970.416
6	0,143%	0,548%	Rp 254.397.671
7	0,143%	0,691%	Rp 320.824.927
8	0,433%	1,124%	Rp 522.047.042
9	0,432%	1,556%	Rp 722.644.158
10	0,413%	1,969%	Rp 914.689.645
11	3,481%	5,450%	Rp 2.531.449.130
12	3,484%	8,934%	Rp 4.149.769.365
13	3,304%	12,238%	Rp 5.684.429.388
14	3,304%	15,543%	Rp 7.219.089.410
15	3,304%	18,847%	Rp 8.753.749.433
16	3,304%	22,151%	Rp 10.288.409.455
17	3,304%	25,455%	Rp 11.823.069.478

Source: Analysis Results, 2023

The planned value is calculated as a percentage of the planned weight multiplied by the contract value (BAC). Contract value (BAC) is Rp 46.447.201.153. In week 17, the cumulative proportion of the

plan was 25.455%. From this weight, it can be calculated that the planned value (PV) or budget cost of work planned is Rp 11,823,069,478.

2. Earned Value (BCWP)
   Earned Value (BCWP) = % Progress Realisation x Contract Value (BAC)
   EV 1st Week = 0,046% x Rp. 46.447.201.153
   EV 1st Week = Rp. 21.365.713

Table 3 Nilai Earned Value (

Contract Value (BAC) = Rp. 46.447.201.153 EV (BCWP) = %Progress Realisation x Nilai Kontrak (BAC)			
Week	**Progress Realisation (%)**	**Cummulative Progress Realisation (%)**	***EV (BCWP)***
1	0,046%	0,046%	Rp 21.365.713
2	0,000%	0,046%	Rp 21.365.713
3	0,016%	0,062%	Rp 28.797.265
4	0,044%	0,106%	Rp 49.234.033
5	0,011%	0,117%	Rp 54.343.225
6	0,218%	0,335%	Rp 155.598.124
7	1,130%	1,465%	Rp 680.451.497
8	1,495%	2,960%	Rp 1.374.837.154
9	1,167%	4,127%	Rp 1.916.875.992
10	1,315%	5,442%	Rp 2.527.656.687
11	2,531%	7,973%	Rp 3.703.235.348
12	3,331%	11,304%	Rp 5.250.391.618
13	3,594%	14,898%	Rp 6.919.704.028
14	3,244%	18,142%	Rp 8.426.451.233
15	3,367%	21,509%	Rp 9.990.328.496
16	3,145%	24,654%	Rp 11.451.092.972
17	4,358%	29,012%	Rp 13.475.261.999

Source: Analysis Results, 2023

Earned value is calculated as a percentage of the merit weight multiplied by the contract value (BAC). Contract value (BAC) is Rp 46.447.201.153. In week 17, the cumulative performance ratio was 29.012%. From this weighting, it can be calculated that the value of the earned value (EV) or budgeted cost to carry out the work is Rp 13,475,261,999.

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3. Actual Cost (ACWP)
   AC = Direct Cost + Indirect Cost
   AC 1st Week = Direct Cost 1st Week + Indirect Cost 1st Week
   Direct costs in this study were assumed based on secondary data obtained from weekly progress data for quantity estimation, while for price estimation, estimates were obtained from HSPK Malang City, the neighboring city/area of HSPK and East Java province of SSH.
   Indirect costs in this study are assumed to be 15% of direct costs, in accordance with the guidance on estimating construction of public works and public housing in 2022.

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Indirect costs in this study are assumed to be 15% of direct costs, in accordance with the guidance on estimating construction of public works and public housing in 2022.

AC = Direct Cost + Indirect Cost		
Week	**AC (ACWP)**	**AC (ACWP) Kumulatif**
1	Rp23.907.619	Rp23.907.619
2	Rp-	Rp23.907.619
3	Rp8.625.000	Rp32.532.619
4	Rp23.194.120	Rp55.726.739
5	Rp6.148.475	Rp61.875.214
6	Rp114.658.449	Rp176.533.663
7	Rp594.044.170	Rp770.577.834
8	Rp763.030.562	Rp1.533.608.395
9	Rp589.284.199	Rp2.122.892.594
10	Rp677.225.691	Rp2.800.118.285
11	Rp1.333.179.993	Rp4.133.298.278
12	Rp1.749.381.236	Rp5.882.679.514
13	Rp1.892.383.410	Rp7.775.062.924
14	Rp1.708.958.085	Rp9.484.021.009
15	Rp1.775.375.473	Rp11.259.396.482
16	Rp1.658.101.982	Rp12.917.498.463
17	Rp2.301.989.176	Rp15.219.487.639

(Source: Analysis Results, 2023)

In week 17, it can be seen that the actual cost value (AC) is Rp. 2,301,989,176.While the cumulative actual cost (AC) value is Rp. . 15,219,487,639. Cumulative will be used as data in subsequent analysis.

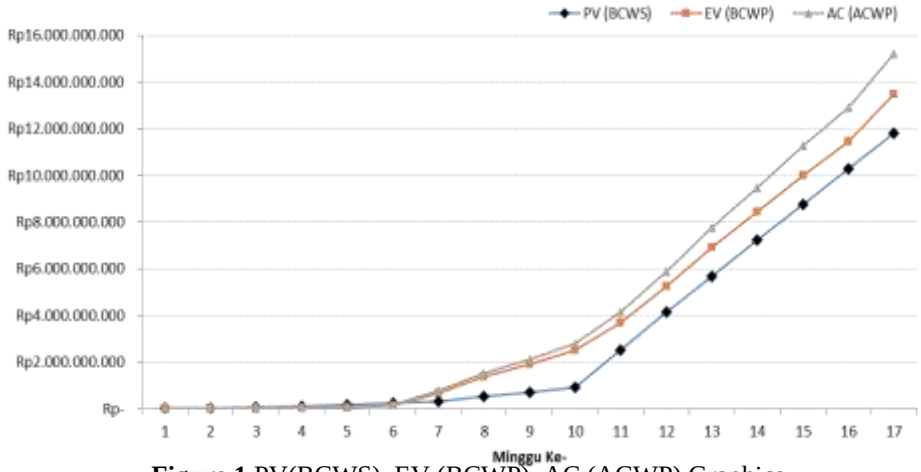


Figure 1 PV(BCWS), EV (BCWP), AC (ACWP) Graphics

Figure 1. shows that the EV value (BCWP) after week 6 increased compared to the PV value (BCWS). Figure 1 shows this data with schedule variation, where the latter value is used to determine the schedule performance index (SPI)

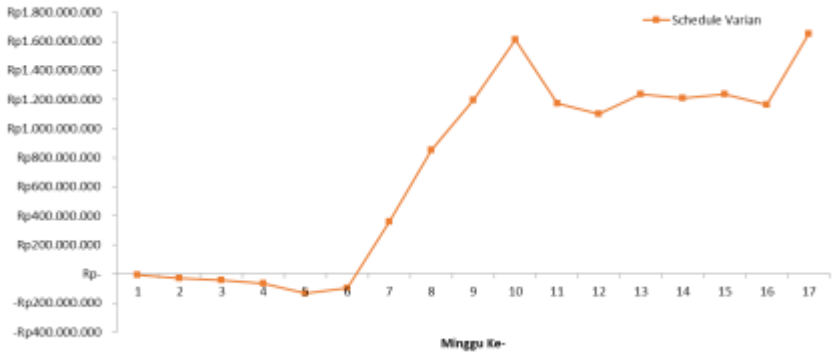
4. Schedule Variance (SV)
   SV = EV – PV
   SV 1st Week = EV 1st Week – PV 1st Week
   SV 1st Week = Rp21.365.713- Rp27.246.395
   SV 1st Week = -Rp5.880.683

Table 5 Schedule Varians (SV)

SV = EV - PV				
Week	***PV***	***EV***	***SV***	**Keterangan**
1	Rp27.246.395	Rp21.365.713	-Rp5.880.683	Behind Schedule
2	Rp49.792.790	Rp21.365.713	-Rp28.427.078	Behind Schedule
3	Rp72.339.186	Rp28.797.265	-Rp43.541.921	Behind Schedule
4	Rp113.737.301	Rp49.234.033	-Rp64.503.268	Behind Schedule
5	Rp187.970.416	Rp54.343.225	-Rp133.627.191	Behind Schedule
6	Rp254.397.671	Rp155.598.124	-Rp98.799.547	Behind Schedule
7	Rp320.824.927	Rp680.451.497	Rp359.626.570	On Schedule
8	Rp522.047.042	Rp1.374.837.154	Rp852.790.112	On Schedule
9	Rp722.644.158	Rp1.916.875.992	Rp1.194.231.834	On Schedule
10	Rp914.689.645	Rp2.527.656.687	Rp1.612.967.041	On Schedule
11	Rp2.531.449.130	Rp3.703.235.348	Rp1.171.786.218	On Schedule
12	Rp4.149.769.365	Rp5.250.391.618	Rp1.100.622.253	On Schedule
13	Rp5.684.429.388	Rp6.919.704.028	Rp1.235.274.640	On Schedule
14	Rp7.219.089.410	Rp8.426.451.233	Rp1.207.361.823	On Schedule
15	Rp8.753.749.433	Rp9.990.328.496	Rp1.236.579.063	On Schedule
16	Rp10.288.409.455	Rp11.451.092.972	Rp1.162.683.517	On Schedule
17	Rp11.823.069.478	Rp13.475.261.999	Rp1.652.192.521	On Schedule

Source: Analysis Results, 2023

From Table 5, it can be seen that in week 17, the value of the schedule variation is positive, meaning the project can be completed on time according to schedule. In week 17, the positive value of the schedule variation (+) amounts to Rp 1,652,192,521.



Source: Analysis Results, 2023

Figure 2 Schedule Varian (SV) Graphics

Figure **2** is a histogram of Table 5 showing that in week 17, the value of Schedule Variant is positive, meaning that this project can be completed on time according to schedule.

5. Schedule Performance Index (SPI)

$$SPI = \frac{EV}{PV}$$

$$SPI\ 1^{st}\ Week = \frac{EV\ 1st\ Week}{PV\ 1st\ Week}$$

$$SPI\ 1^{st}\ Week = \frac{Rp21.365.713}{Rp27.246.395}$$

$$SPI\ 1^{st}\ Week = 0{,}784166579$$

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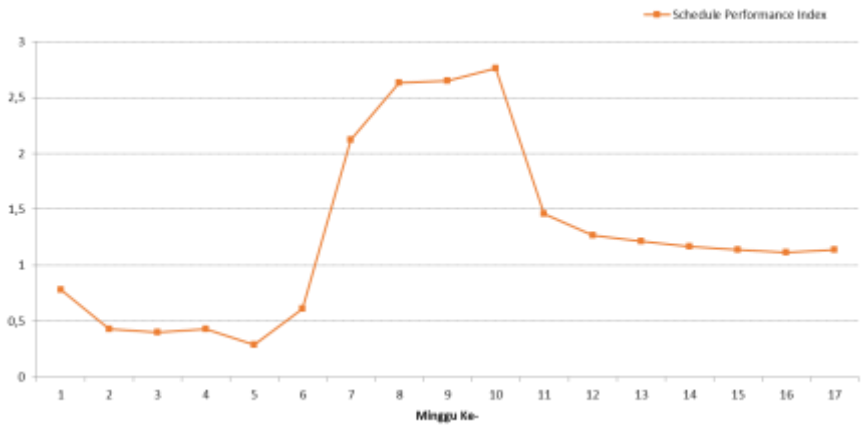
SPI = EV / PV				
Week	***PV***	***EV***	***SPI***	**Description**
1	Rp27.246.395	Rp21.365.713	0,784166579	Behind Schedule
2	Rp49.792.790	Rp21.365.713	0,429092492	Behind Schedule
3	Rp72.339.186	Rp28.797.265	0,398086659	Behind Schedule
4	Rp113.737.301	Rp49.234.033	0,432874992	Behind Schedule
5	Rp187.970.416	Rp54.343.225	0,289105203	Behind Schedule
6	Rp254.397.671	Rp155.598.124	0,611633444	Behind Schedule
7	Rp320.824.927	Rp680.451.497	2,120943358	Faster Schedule
8	Rp522.047.042	Rp1.374.837.154	2,633550319	Faster Schedule
9	Rp722.644.158	Rp1.916.875.992	2,652586299	Faster Schedule
10	Rp914.689.645	Rp2.527.656.687	2,763403631	Faster Schedule
11	Rp2.531.449.130	Rp3.703.235.348	1,462891473	Faster Schedule
12	Rp4.149.769.365	Rp5.250.391.618	1,265224921	Faster Schedule
13	Rp5.684.429.388	Rp6.919.704.028	1,217308468	Faster Schedule
14	Rp7.219.089.410	Rp8.426.451.233	1,167245722	Faster Schedule
15	Rp8.753.749.433	Rp9.990.328.496	1,141262789	Faster Schedule
16	Rp10.288.409.455	Rp11.451.092.972	1,113009063	Faster Schedule
17	Rp11.823.069.478	Rp13.475.261.999	1,139743112	Faster Schedule

Source: Analysis Results, 2023

From Table 6 it can be seen that in week 17, the SPI value is 1.139743112 or SPI value > 1, meaning this project is ahead of schedule



Source: Analysis Results, 2023

Figure 3 Schedule Performance Index (SPI) Graphics

Figure 3 is the histogram of Table 6. It can be seen that 9 in Week 17 Schedule Performance Index > 1 means this project is ahead of schedule.

6. Estimate To Schedule (ETS)
   Time Left = Implementation Time – Usage Time\
   Time Left 1st Week = Implementation Time 1st Week – Usage Time 1st Week
   Time Left 1st Week = 300 – 7
   Time Left 1st Week = 293 Days

Table 7***Table*** 7

Time Left (ETS) = Implementation Time – Usage Time			
Week	**Implementation Time**	**Usage Time**	**Time Left**
1	300	7	293
2	300	14	286
3	300	21	279
4	300	28	272
5	300	35	265
6	300	42	258
7	300	49	251
8	300	56	244
9	300	63	237
10	300	70	230
11	300	77	223
12	300	84	216
13	300	91	209
14	300	98	202
15	300	105	195
16	300	112	188
17	300	119	181

Source: Analysis Results, 2023

In Table 7, the analysis results show that, at week 17, the remaining project implementation time is 181 days or 26 weeks. When the total number of project implementation days under the contract is 300 days or 43 weeks.

$ETS = \frac{Time\ Left}{SPI}$

ETS 1st Week $= \frac{Time\ Left\ 1st\ Week}{SPI\ \text{1st Week}}$

ETS 1st Week $= \frac{293}{0{,}784166579}$

ETS 1st Week = 374

ETS = Time Left / SPI			
Week-	**SPI**	**Time Left**	**ETS**
1	0,784166579	293	374
2	0,429092492	286	667
3	0,398086659	279	701
4	0,432874992	272	628
5	0,289105203	265	917
6	0,611633444	258	422
7	2,120943358	251	118
8	2,633550319	244	93
9	2,652586299	237	89
10	2,763403631	230	83
11	1,462891473	223	152
12	1,265224921	216	171
13	1,217308468	209	172
14	1,167245722	202	173
15	1,141262789	195	171
16	1,113009063	188	169
17	1,139743112	181	159

Source: Analysis Results, 2023

At , Table 8, the analysis results show that at week 17, the estimated progress or time to complete the project is 159 days or 23 weeks. When the total number of project implementation days under the contract is 300 days or 43 weeks.

7. Estimate At Schedule (EAS)

   $EAS = ETS$ + Usage Time

   EAS 1st Week = ETS 1st Week + Usage Time 1st Week

   EAS 1st Week = 374 + 7

   EAS 1st Week = 381

Week	*ETS*	Usage Time	*EAS*
1	374	7	381
2	667	14	681
3	701	21	722
4	628	28	656

Week	*ETS*	Usage Time	*EAS*
5	917	35	952
6	422	42	464
7	118	49	167
8	93	56	149
9	89	63	152
10	83	70	153
11	152	77	229
12	171	84	255
13	172	91	263
14	173	98	271
15	171	105	276
16	169	112	281
17	159	119	278

Source: Analysis Results, 2023

In , Table 9, the analysis results show that at week 17, the estimated schedule (EAS) is 278 days or 40 weeks. When the total number of project implementation days under the contract is 300 days or 43 weeks. So this project is expected to be completed on schedule and faster than 22 days or 3 weeks.

CONCLUSION

Performance over time of the Pandaan Malang Exit Toll Road Conservation Project of Season 5 in Week 17 of the Schedule Variation (SV) value of Rp 1,652,192,521, with Schedule Performance Index (SPI) is 1.139743112. This means that in week 17, the Progress Performance Index (SPI) was >1, the project accelerated compared to the expected progress. The final estimated value of the project or cost estimate (EAC) is Rp 52,459,284,569, while the contract value of the project is Rp 46,447,201,153. Week 17 analysis of the estimated project completion time/ Estimate To Schedule (ETS) is 278 days, with a contract performance period of 300 days, meaning the project has accelerated by 22 days or 3 weeks compared to contract progress.

Proposed further research, To analyze actual costs, it is necessary to obtain primary data in the form of project budget plans from the contractor so that the analysis results can be more accurate. Further cost-effectiveness analysis can be done using the earned value method to preserve the toll road out of Pandaan Malang Section 5 in relation to the incremental contract value. A cost-effectiveness analysis can be performed to conserve the Pandaan Malang Exit Toll Road, Section 5, using other project control methods.

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REFERENCES

1. AACE® International Recommended Practice. (n.d.). *Cost Engineering Terminology*. Retrieved November 15, 2023, from https://library.aacei.org/terminology/welcome.shtml
2. Abd. Rahman Rasidin, Muh. Nashir T., & Hendro Widarto. (2022). Studi Kelayakan Pembangunan Jalan Lingkar Tengah Kota Parepare. *Jurnal Karajata Engineering*, *2*(1), 19–25.
3. https://doi.org/10.31850/karajata.v2i1.1632
4. Akbar, R. W., & Maliki, I. (2018). *Pembangunan Sistem Informasi Manajemen Sumber Daya Manusia Di Pt. Saekan Bumi Persada*. 1–10. https://elibrary.unikom.ac.id/id/eprint/414/
5. Alfadin, M. R., & Witjaksana, B. (2023). Analisis Biaya dan Waktu dengan Metode Nilai Hasil (Studi Kasus : Preservasi Jembatan Sembayat Di Gresik). *Ensiklopedia Of Journal*, *5*(4).
6. https://doi.org/https://doi.org/10.33559/eoj.v5i4.1741
7. Arifin, Z. (2017). *Modul 01 Pengantar Manajemen Proyek* (Vol. 01).
8. https://pustaka.ut.ac.id/lib/wp-content/uploads/pdfmk/MSIM4406-M1.pdf

9. Arsjad, T. T., & Malingkas, Y. G. (2020). Pengendalian Biaya Dan Waktu Pada Proyek Pembangunan Ruko Di Area Perumahan Kharisma Koka Minahasa Menggunakan Metode Konsep Nilai Hasil. *Jurnal Sipil Statik*, *8*(1), 53–64.
10. Balai Besar Pelaksanaan Jalan Nasional (BBPJN) Jawa Timur. (2022). *Dokumen Suplemen Dokumen Evaluasi Lingkungan Hidup (DELH) Pembangunan / Peningkatan Jalan Jawa Timur – 2 Exit Toll Seksi 5 Pandaan – Malang* (Issue November).
11. https://p3tb.com/uploads_file/20230216.3661.Supplement_DELH_Preservasi_Jalan_pada_Exit_Tol_Pandaan_Malang_P3TB.pdf
12. Fauzy, Y., Mochtar, B., & Marzuki, R. (2020). Analisa Biaya Dan Waktu Dengan Metode (Earned Value Analysis) Pada Lanjutan Peningkatan Jalan Awang Long – Jalan Darmawan Desa Kota Bangun Ilir Kecamatan Kota Bangun. *Kurva S Jurnal Keilmuan Dan Aplikasi Teknik Sipil*, *11*(1), 1–13. http://ejurnal.untag-smd.ac.id/index.php/TEK/article/view/5238/4984
13. Fleming, Q. W., & Koppelman, J. M. (1994). *The Essence of Evolution of Earned Value*.
14. Peraturan Gubernur Jawa Timur Nomor 33 Tahun 2022 Tentang Harga Satuan Pokok Kegiatan Pemerintah Provinsi Jawa Timur, 1 (2023).
15. https://peraturan.bpk.go.id/Download/222949/2022PERGUBJATIM033.pdf
16. Peraturan Gubernur Jawa Timur Tentang Standar Satuan Harga Barang Pemerintah Provinsi Jatim Tahun 2022, Pub. L. No. 30/2022, 31 (2023).
17. https://peraturan.bpk.go.id/Download/222888/2022PERGUBJATIM030.pdf
18. Hansen, S. (2015). *Manajemen Kontrak Konstruksi* (1st ed.). PT. Gramedia Pustaka Utama. https://scholar.google.co.id/scholar?oi=bibs&cluster=16577217016900568223&btnI=1&hl=en
19. Harefa, M. B., & Surbakti, A. A. (2021). Pengendalian Pelaksanaan Pada Proyek Jalan Dengan Earned Value Analysis. *Juitech*, *5*(2), 14–22.
20. http://www.portaluniversitasquality.ac.id:5388/Ojssystem/index.php/JUITECH/article/download/627/pdf
21. Herman, F., & Saleh, S. M. (2011). Biaya Preservasi Jalan Akibat Truk Dengan Beban Berlebih di Jalan Pesisir Timur Provinsi Aceh. *Jurnal Transportasi*, *11*(3), 219–228.
22. https://journal.unpar.ac.id/index.php/journaltransportasi/article/view/460/444
23. Maulidi, N., Huda, M., & Tjendani, H. T. (2021). Analisis Biaya dan Waktu Pada Pembangunan Gedung Trauma Center Dan Intensive Care Tahap IV RSUD Dr. Soedono Madiun dengan Metode Earned Value. *Jurnal Spesialis Teknik Sipil*, *2*(2).
24. https://jurnal.untag-sby.ac.id/index.php/JSpTS/article/view/7088/5004
25. Pedoman Penyusunan Perkiraan Biaya Pekerjaan Konstruksi Bidang Pekerjaan Umum dan Perumahan Rakyat Tahun 2022, Pub. L. No. 01/2022, Kementrian PUPR 1 (2022).
26. https://jdih.pu.go.id/internal/assets/assets/produk/PermenPUPR/2022/01/PermenPUPR1.zip
27. Nastiti, H., Suryana, D. S., Aulia, F. R. F., & Ramsyahdira, M. R. (2023). Control Analysis of the Griya Jenggala Development Project using the Earned Value Method at PT Sarana Loka Almika in Kebayoran. *Journal of Innovation and Community Engagement*, *4*(3), 174–191.
28. https://doi.org/10.28932/ice.v4i3.73
29. Nufah, Y. W., Yanti, G., & Lubis, F. (2019). Analisis Proyek Dengan Metode Earned Value Concept (Studi Kasus Pada Proyek Pembangunan Jalan Tol Ruas Pekanbaru – Dumai Seksi 2 Sta. 9+500 – 33+600). *Prosiding Seminar Nasional Cendekiawan*, *5*, 1.59.1-1.59.7.
30. https://trijurnal.lemlit.trisakti.ac.id/index.php/semnas/article/view/5740
31. Peraturan Walikota Malang nomor 10, Pub. L. No. 10/2022, Harga Satuan Pekerjaan Konstruksi 1 (2022). https://peraturan.bpk.go.id/Download/221352/Salinan Perwal No 10 Tahun 2022 Ttg Harga Satuan Pekerjaan Konstruksi.pdf
32. Peraturan Menteri Pekerjaan Umum Republik Indonesia Nomor 13/PRT/M/2011 Tentang Tata Cara Pemeliharaan Dan Penilikan Jalan, Menteri Pekerjaan Umum Republik Indonesia 1 (2011).
33. https://peraturan.bpk.go.id/Download/136608/PermenPU13-2011.pdf
34. PPK 3.6 SATKER PJN WIL III PROVINSI JAWA TIMUR BBPJN JATIM BALI. (2023). *Uraian Singkat Preservasi Jalan Pada Exit Tol Seksi 5 Pandaan Malang*. 3–5.

35. https://lpse.pu.go.id/eproc4/dl/b070fae498f37e56181275810d2b0d2b360631800f75dfeace99b3f9729040e323518417a8f8bc12284b9507a8e0133c957265cb391927718ca34459e5ee45b3f4552532dde04724189ccb8bc67ec0304ceea7a78e683f47b2cff8ca7d4e557569da8d910c60f0201d7d48c2027d066
36. Pratama, F., Waluyo, R., & Puspasari, V. H. (2019). Analisis Kinerja Proyek Peningkatan Jalan Pelantaran-Parenggean-Tumbang Sangai Dengan Metode Earned Value. *Oktober*, *3*(1), 1–10.
37. https://e-journal.upr.ac.id/index.php/JT/article/view/1325/1109
38. Proaño-Narváez, M., Flores-Vázquez, C., Vásquez Quiroz, P., & Avila-Calle, M. (2022). Earned Value Method (EVM) for Construction Projects: Current Application and Future Projections. *Buildings*, *12*(3), 301. https://doi.org/10.3390/buildings12030301
39. Project Management Institute. (2017). A Guide to The Project Management Body of Knowledge. In Inc. The Project Management Institu l.), *Project Management Institute, Inc.* (6th ed., Vol. 2, Issue 1). Project Management Institute.
40. Ridha, R., Syarwan, & Supardin. (2020). Analisis Waktu dan Biaya Proyek Peningkatan Jalan Tgk. Muda Lamukta Lhokseumawe dengan Metode Earned Value. *Jurnal Sipil Sains Terapan*, *03*(2), 1–75.
41. https://e-jurnal.pnl.ac.id/JSST/article/view/3105/2565
42. Ritz, G. J. (1994). *Total Construction Project Management* (Vol. 2013).
43. Surat Edaran Nomor 09/SE/Db/2021 tentang Perencanaan dan Pemrograman Pekerjaan Preservasi Jaringan Jalan (Bagian Dari Manajemen Aset Prasarana Jalan), Surat Edaran Dirjen Bina Marga 2021 1 (2021).
44. https://binamarga.pu.go.id/index.php/peraturan/dokumen/surat-edaran-nomor-09sedb2021-tentang-perencanaan-dan-pemrograman-pekerjaan-preservasi-jaringan-jalan-bagian-dari-manajemen-aset-prasarana-jalan
45. Sidiq, A. P., & Johari, G. J. (2022). Analisis Penerapan Earned Value Terhadap Manajemen Waktu dan Biaya pada Proyek Jembatan Cibuni. *Jurnal Konstruksi*, *20*(1), 139–150.
46. https://doi.org/10.33364/konstruksi/v.20-1.1036
47. Soeharto, I. (1999). Manajemen Proyek (Dari Konseptual Sampai Operasional). In *Penerbit Erlangga* (2nd ed., Vol. 1). Penerbit Erlangga.
48. Soemardi, B. W., Wirahadikusumah, R. D., Abduh, M., & Pujoartanto, N. (2006). Konsep Earned Value untuk Pengelolaan Proyek Konstruksi. *Institut Teknologi Bandung*, 1–13.
49. https://www.academia.edu/2979947/Konsep_Earned_Value_untuk_Pengelolaan_Proyek_Konstruksi
50. Sugiyanto, S., & Kosbiamtoro, A. (2022). Analisis Kinerja Biaya Pada Proyek Rehabilitasi Drainase Dan Trotoar Jalan Teuku Umar Paket I Dengan Metode Earned Value. *Jurnal Litbang Sukowati : Media Penelitian Dan Pengembangan*, *5*(2), 126–141. https://doi.org/10.32630/sukowati.v5i2.320
51. Susanti, B., Melisah, M., & Juliantina, I. (2019). Penerapan Konsep Earned Value Pada Proyek Konstruksi Jalan Tol (Studi Kasus Ruas Jalan Tol Kayuagung - Palembang -Betung). *Jurnal Rekayasa Sipil (JRS-Unand)*, *15*(1), 12. https://doi.org/10.25077/jrs.15.1.12-20.2019
52. Tangtobing, R. F. F., & Waty, M. (2023). Penerapan Metode Earned Value Dan Earned Schedule Pelaksanaan Proyek Rumah Sakit X Di Bandung. *JMTS: Jurnal Mitra Teknik Sipil*, *6*(2), 237–248. https://doi.org/10.24912/jmts.v6i2.22251
53. Tenggara, M. A. P., Agustin, I. W., & Hariyani, S. (2021). Kinerja Jalan Di Kota Surabaya Berdasarkan Tingkat Pelayanan Jalan. *Planning for Urban Region and Environment*, *10*(3), 119–128. https://purejournal.ub.ac.id/index.php/pure/article/view/194/149
54. Widiasanti, I., & Lenggogeni. (2013). Manajemen Konstruksi. In P. Latifah (Ed.), *Remaja Rosdakarya*. PT Remaja Rosdakarya.
55. Zakariyya, B., Ridwan, A., & Suwarno, S. (2020). Analisis Biaya Dan Jadwal Proyek Pembangunan Gedung Dinas Kesehatan Kabupaten Trenggalek Dengan Metode Earned Value. *Jurnal Manajemen Teknologi & Teknik Sipil*, *3*(2), 362. https://doi.org/10.30737/jurmateks.v3i2.1197
56. Zanuardi, A., & Suprayitno, H. (2018). Analisa Karakteristik Kecelakaan Lalu Lintas di Jalan Ahmad Yani Surabaya melalui Pendekatan Knowledge Discovery in Database. *Jurnal Manejemen Aset Infrastruktur & Fasilitas*, *2*(1), 45–55. https://doi.org/10.12962/j26151847.v2i1.3767