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Analysis of Delays and Time Acceleration Strategies in the Renovation of Grha JST Building

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ABSTRACT

Effective construction project management necessitates adherence to cost, quality, and timeline objectives. However, delays frequently challenge project success, impacting both schedule and budget. This research investigates the causes and consequences of delays within the Grha JST building renovation project, exploring mitigation strategies. Utilizing the Earned Value and Crashing methods, the study analyzes project performance to identify efficient delay management approaches. Recommendations are provided to enhance future project execution and mitigate delays effectively.

Keywords: *Construction Project Management, Project Delays, Time Acceleration, Renovation*

1. INTRODUCTION

In construction project management, the primary goals are to maintain low costs, ensure high quality, and adhere to project timelines [1]. To support these objectives, periodic reviews are necessary to reassess the success of a project and ensure that it remains on track until completion [2], [3]. Delays are a common issue in project execution, often leading to cost overruns and other detrimental impacts [4], [5]. The Grha JST Building Renovation Project has experienced delays due to several factors, including insufficient manpower, hindered material mobility, and contract change orders. This paper explores the causes and effects of these delays, as well as strategies for mitigating them.

The initial contract between the contractor and the owner stipulated that the project would be executed from May 2, 2023, to November 30, 2023. However, by the 19th week (October 15, 2023), the project had only reached 78.44% completion, falling short of the planned 82.88%, resulting in a progress deviation of -4.44%. The project is divided into four phases, with specific floors prioritized to minimize disruption to the owner's operations. Despite this planning, the movement of materials and items was delayed, causing setbacks in handing over work areas for subsequent phases. These delays have had significant implications for both the project's timeline and budget.

The contractor's scope of work covers the 3rd to 11th floors, as well as some items on the rooftop. Meanwhile, the ground floor to the 2nd floor remained operational, requiring careful management of noise and other disturbances. Throughout the project's progression, several changes have been discussed in weekly meetings involving the contractor, supervising consultant, and the owner. These changes, including alterations to layout, specifications, and room functions, have also contributed to the delays. Effective communication and coordination among all parties are crucial to managing these changes and mitigating their impacts.

Given these circumstances, this research aims to review the delays in the Grha JST Building Renovation Project to control costs and time. The study employs Earned Value and Crashing methods to analyze and address the project's time and cost management issues. The Earned Value method helps in assessing the project's performance by comparing the planned progress with the

actual progress. The Crashing method focuses on accelerating project activities to meet deadlines, even if it increases costs. By applying these methods, the research seeks to provide solutions for managing delays effectively.

The findings are expected to provide valuable insights into preventing delays and managing their impacts effectively. This research will help construction managers and stakeholders understand the importance of regular project reviews and proactive management strategies. It will also highlight the need for flexibility and adaptability in handling project changes and unforeseen challenges. The insights gained from this study can be applied to other construction projects facing similar issues. Ultimately, the goal is to enhance the efficiency and success of construction project management practices.

2. LITERATURE REVIEW

The construction industry is heavily regulated, with various laws and standards guiding the processes involved [6]–[8]. One significant regulation is Peraturan Pemerintah Nomor 16 Tahun 2021 about Building Construction, which defines renovation as activities aimed at improving severely damaged buildings, with or without changing the building's function, covering aspects such as architecture, structure, and utilities. This regulation ensures that renovation projects adhere to specific standards, maintaining safety and structural integrity.

Another critical regulation is Peraturan Pemerintah Nomor 20 Tahun 2020 about Construction Services, which outlines the requirements for supervision activities in construction projects. Supervision aims to ensure technical and contractual compliance, and it is the responsibility of the service user or appointed party to conduct this supervision. The regulation also emphasizes the need for construction consultancy services to have the necessary competencies and to act on behalf of the service user as per the contract agreement.

Peraturan Menteri Pekerjaan Umum No. 45/PRT/M/2007 provides technical guidelines for the construction of state buildings, defining a building as a physical structure that is partially or entirely above or below ground and serves various human activities, including residential, religious, business, social, cultural, and special functions. The regulation also covers state buildings, which are constructed for official purposes using state funds, and the processes involved in their procurement, whether through new construction, purchase, donation, exchange, or other means.

Project Time Management is a crucial aspect of construction project management, involving processes such as activity definition, sequencing, duration estimation, schedule development, and schedule control [9]. Effective time management ensures that all activities are completed within the stipulated time frame, contributing to the overall success of the project [10]. This management includes creating a Work Breakdown Structure (WBS) to organize and define the total scope of the project, ensuring that all tasks are accurately sequenced and their durations properly estimated to develop a realistic schedule [11], [12].

Cost management is another vital component, encompassing resource planning, cost estimation, budgeting, and cost control. This process ensures that a project is completed within the approved budget [13]. The earned value management (EVM) technique integrates cost and schedule performance, providing a comprehensive view of project performance by comparing the budgeted cost of work performed (BCWP), actual cost of work performed (ACWP), and budgeted cost of work

scheduled (BCWS). This approach helps in identifying variances in cost and schedule, enabling corrective actions to keep the project on track.

3. METHODS

3.1 Research Type

This study is a review research, focusing on the assessment of unresolved issues in the object of study based on the data obtained. The primary variables in this research are project delays and efforts to expedite project duration to avoid delays, which could lead to losses for all parties, especially the contractor. By understanding the type of research and the variables to be studied, it is necessary to review the project delays concerning cost and time using the Earned Value method.

3.2 Research Framework

The research framework illustrates the thought process in conducting the research activities. It begins with formulating the problem, followed by data collection, including both primary and secondary data. The collected data are then analyzed using predetermined methods, and the analysis results are discussed to derive conclusions that address the research questions.

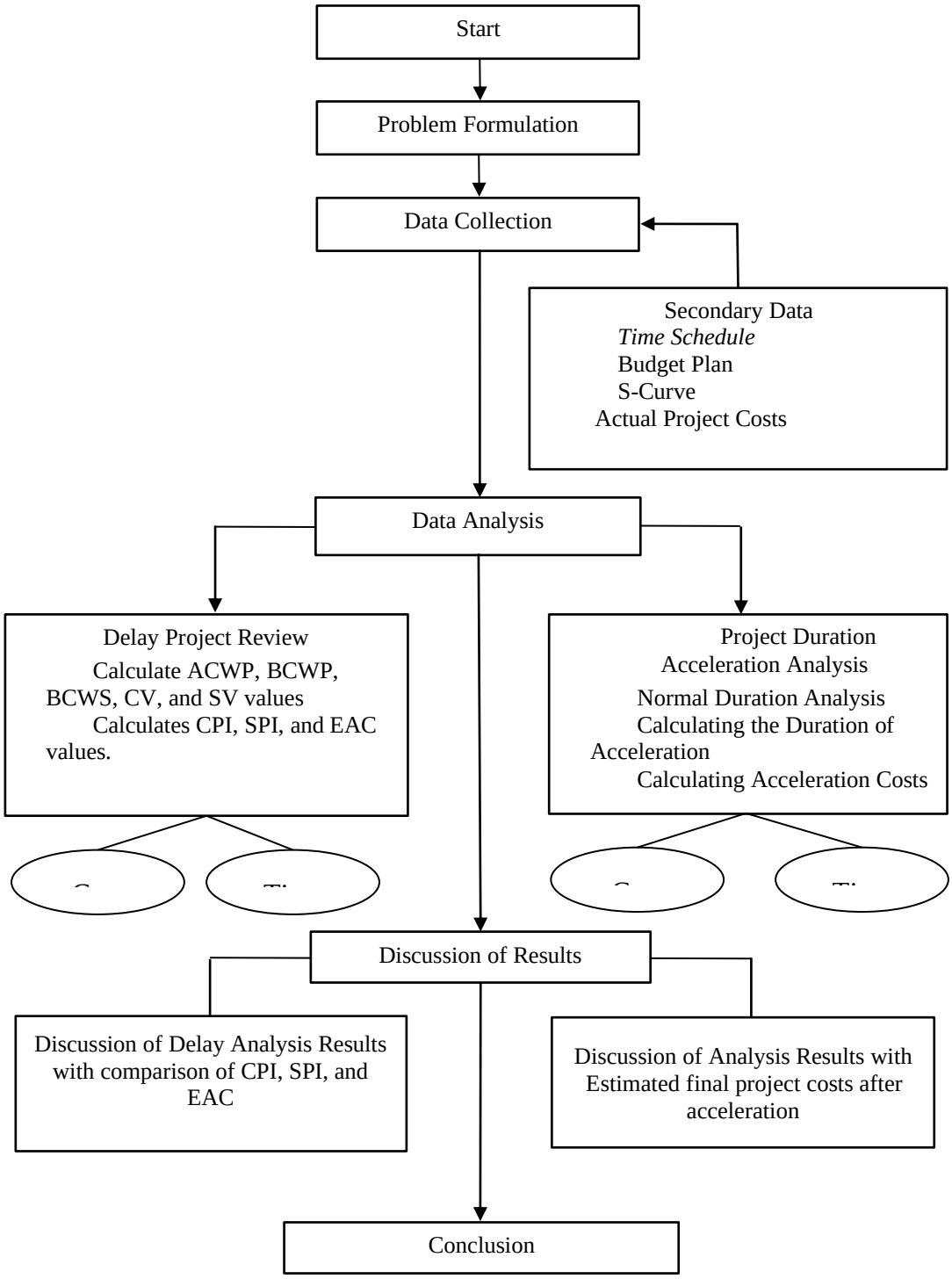


Figure 1. Research Framework
Source: Own Mapping, 2024

3.3 Data Collection Methods

The data used in this research are solely secondary data, which include:

1. Time schedule.
2. Budget plan (RAB).
3. S-curve.
4. Actual project costs.

These data will be requested from the Construction Management or Contractor.

3.4 Data Analysis Methods

The data analysis in this study is divided into two main areas: review of delays using Earned Value Management and identifying factors contributing to delays. The detailed processes are as follows:

1. Analysis of Delays using Earned Value Method
   a. Manually calculate BCWP (Budgeted Cost of Work Performed) and BCWS (Budgeted Cost of Work Scheduled) and compare them to ACWP (Actual Cost of Work Performed).
   b. Calculate Cost Variance (CV) and Schedule Variance (SV) from the comparisons.
   c. Determine the Schedule Performance Index (SPI) and Cost Performance Index (CPI).
   d. Estimate the project completion cost (EAC) and time (EAS).
2. Project Duration Acceleration Analysis
   a. Identify critical path activities for analysis.
   b. Calculate the crashing duration.
   c. Estimate Direct and Indirect Costs.
   d. Calculate the total projected cost after acceleration.

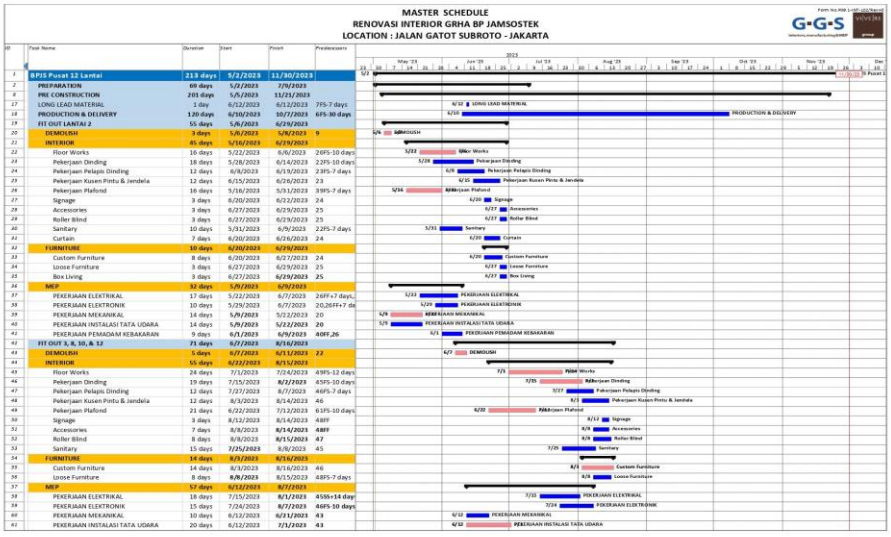
4. RESULTS AND DISCUSSION

4.1 Research Data

This secondary data was obtained from sources who acted as contractors for the renovation of the Grha JST building, consisting of Schedule, S-Curve Resume, RAB, and Actual Weekly Costs:

1. Time Schedule

Time Schedule can be used to determine the duration of work on each activity. In this project, the schedule is divided into 4 phases, according to the schedule depicted in the following figure:



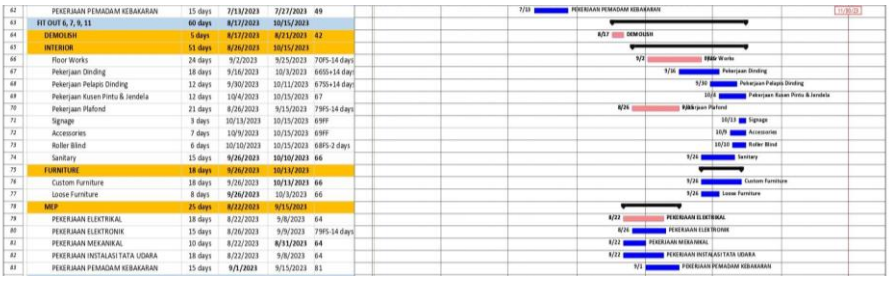


Figure 2. Schedxule Pre Construction, Phase of 1-3

Source: Contractor

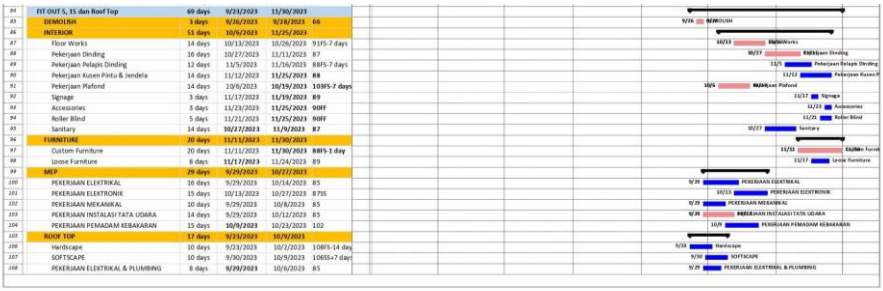


Figure 3. Schedule Pre COnstruction, Phase of 4

Source: Contractor

2. S-Curve

The large S-Curve in the second attachment is used to calculate the value of BCWP and BCWS which contains planned and actual weekly progress as well as the difference between them.

Table 1. Resume of S-Curve

Week	Date	Plane 1	Actual	Deviation
			B	C
1	2-May-2023	0,09	0,14	0,05
2	8-May-2023	0,30	0,21	-0,09
3	15-May-2023	0,73	1,34	0,61
4	22-May-2023	1,97	1,50	-0,47
5	29-May-2023	3,18	2,55	-0,63
6	5-Jun-2023	4,57	2,65	-1,92
7	12-Jun-2023	6,00	3,55	-2,45
8	19-Jun-2023	8,60	5,50	-3,10
9	26-Jun-2023	12,88	6,90	-5,98
10	3-Jul-2023	14,60	10,11	-4,49
11	10-Jul-2023	17,71	12,22	-5,49
12	17-Jul-2023	20,11	16,23	-3,88
13	24-Jul-2023	23,65	18,75	-4,90
14	31-Jul-2023	28,77	23,30	-5,47
15	7-Aug-2023	36,00	28,23	-7,77
16	14-Aug-2023	42,19	32,40	-9,79
17	21-Aug-2023	44,74	36,70	-8,04

18	28-Aug-2023	48,14	40,80	-7,34
19	4-Sep-2023	50,81	45,70	-5,11
20	11-Sep-2023	53,17	51,80	-1,37
21	18-Sep-2023	55,31	58,23	2,92
22	25-Sep-2023	65,08	66,93	1,85
23	2-Oct-2023	75,91	73,20	-2,71
24	9-Oct-2023	82,88	78,44	-4,44
25	16-Oct-2023	84,77		
26	23-Oct-2023	86,65		
27	30-Oct-2023	88,06		
28	6-Nov-2023	91,05		
29	13-Nov-2023	95,48		
30	20-Nov-2023	99,12		
31	30-Nov-2023	100,00		

Source: Contractor

3. Budget Plan

This Cost Budget Plan (RAB) is used to calculate BCWP and BCWS in calculations using the Earned Value method, the data summary is as follows:

Table 2. Budget Plan

NO	DESKRIPSI	NILAI
	JST 12 LANTAI	**40.741.890.746**
1	INTERIOR WORKS	21.194.198.960
1.1	PREPARATION	226.075.391
1.2	PROJECT COST	140.000.000
1.3	DEMOLITION WORKS	231.000.000
1.4	WALL WORKS	6.705.129.204
1.5	FLOOR WORKS	5.618.818.763
1.6	CEILING WORKS	3.435.665.516
1.7	DOOR AND WINDOW WORKS	3.415.098.769
1.8	SANITARY FIXTURES	755.567.315
1.10	HARDSCAPE	600.153.351
1.11	SOFTSCAPE	18.190.652

	INTERIOR - LABOR , OVERHEAD ETC (Site Management Cost)	48.500.000
2	OTHER FURNITURE	6.463.992.900
2	OTHER FURNITURE	6.463.992.900
3	FURNITURE CUSTOM	4.430.366.861
3.1	FURNITURE CUSTOM	4.220.186.861
3.2	DELIVERY	83.700.000
3.3	INSTALL	126.480.000
4	FURNITURE LOOSE	1.378.075.953
4.1	FURNITURE LOOSE	1.312.975.953
4.2	DELIVERY	26.040.000
4.3	INSTALL	39.060.000
5	MEP	5.391.803.572
5.2	ELECTRICAL WORKS	3.618.191.272
5.3	MECHANICAL WORKS	1.737.612.300
5.3	LABOR COSTS	36.000.000
6	OTHERS	1.883.452.500
6.1	WORKSTATION	1.883.452.500

4. Actual Weekly Project Expenditure Costs

The actual expenditure costs for the Grha JST building renovation project were obtained from PT Gema Graha Sarana Tbk, which will be used as the ACWP value, the data is as follows:

Table 3. Actual Weekly Expenditure

Week	Date	Assigned Cost	%
1	2-May-2023	450.091.532	1,10%
2	8-May-2023	458.334.649	1,12%
3	15-May-2023	482.386.753	1,18%
4	22-May-2023	777.109.143	1,91%
5	29-May-2023	1.378.983.641	3,38%
6	5-Jun-2023	3.101.206.272	7,61%
7	12-Jun-2023	5.270.621.905	12,94%
8	19-Jun-2023	6.846.697.172	16,81%
9	26-Jun-2023	7.493.814.158	18,39%
10	3-Jul-2023	8.982.131.765	22,05%
11	10-Jul-2023	10.445.683.259	25,64%
12	17-Jul-2023	12.488.521.288	30,65%
13	24-Jul-2023	14.091.951.983	34,59%
14	31-Jul-2023	16.195.699.861	39,75%
15	7-Aug-2023	17.676.298.231	43,39%
16	14-Aug-2023	19.994.018.604	49,07%
17	21-Aug-2023	22.333.784.894	54,82%
18	28-Aug-2023	23.164.633.813	56,86%
19	4-Sep-2023	23.614.575.768	57,96%
20	11-Sep-2023	25.633.949.449	62,92%
21	18-Sep-2023	26.223.353.864	64,36%
22	25-Sep-2023	27.996.106.971	68,72%
23	2-Oct-2023	28.913.112.951	70,97%
24	9-Oct-2023	29.653.429.212	72,78%
25	16-Oct-2023		
26	23-Oct-2023		
27	30-Oct-2023		
28	6-Nov-2023		

29	13-Nov-2023		
30	20-Nov-2023		
31	30-Nov-2023		

3.4 Data Analysis

Table 4. Project Delay Analysis Results

Indicator	Value
BCWS	Rp 33.766.879.050
BCWP	Rp 31.957.939.101
ACWP	Rp 29.653.429.212
CPI	1,08
ETC	Rp 8.150.534.597
EAC	Rp 2.937.926.937
SPI	0,95
Rest of Day	59
ETS	63
EAS	217 (late 4 days)

Source: Data Analysis, 2024

The table above provides a detailed analysis of the project delay, focusing on various performance indicators. The Budgeted Cost of Work Scheduled (BCWS) stands at Rp 33.766.879.050, while the Budgeted Cost of Work Performed (BCWP) is Rp 31.957.939.101, indicating a discrepancy between planned and actual progress. The Actual Cost of Work Performed (ACWP) amounts to Rp 29.653.429.212. The Cost Performance Index (CPI) is calculated at 1,08, suggesting that the project is cost-efficient with actual costs being less than planned. The Estimate to Complete (ETC) is Rp 8.150.534.597, and the Estimate at Completion (EAC) is Rp 2.937.926.937, highlighting a potential profit margin upon project completion. The Schedule Performance Index (SPI) is 0,95, indicating slight schedule inefficiency. With 59 days remaining, the Estimate Temporary Schedule (ETS) is 63 days, leading to an overall Estimate at Completion (EAS) of 217 days, which means the project will be completed 4 days later than initially planned.

Table 5. Duration Acceleration Analysis Results (Crashing)

Task	Normal Duration (days)	Daily Productivity (m^2/day)	Hourly Productivity (m^2/hour)	Crash Duration (days)	Normal Cost (Rp)	Crash Cost (Rp)
Hollow Ceiling Frame	7	133.22	16.65	6	1,157,841	926,272.80

Gypsum Ceiling Installation	14	66.61	8.33	11	147,321.63	117,857.30
Statuario Marble Installation	14	27.28	3.47	11	2,896,715	2,317,372
Total Duration	35			28		

Source: Data Analysis, 2024

The project task analysis table provides a detailed comparison between the normal and crash durations, daily productivity, hourly productivity, and associated costs for three key tasks: hollow ceiling frame installation, gypsum ceiling installation, and Statuario marble installation. The normal duration for the hollow ceiling frame installation is 7 days with a daily productivity of 133.22 m²/day and an hourly productivity of 16.65 m²/hour. The crash duration for this task reduces to 6 days, with the normal cost being Rp 1,157,841 and the crash cost being Rp 926,272.80. The gypsum ceiling installation, which normally takes 14 days with a daily productivity of 66.61 m²/day and an hourly productivity of 8.33 m²/hour, is reduced to 11 days under the crash scenario. The normal cost for this task is Rp 147,321.63, while the crash cost is Rp 117,857.30. Similarly, the Statuario marble installation, with a normal duration of 14 days and a daily productivity of 27.78 m²/day (3.47 m²/hour), is also reduced to 11 days when crashed. The normal cost for this task is Rp 2,896,715 and the crash cost is Rp 2,317,372. In total, the normal duration for all tasks is 35 days, which is reduced to 28 days under the crash scenario, highlighting the efficiency gained and the cost implications of accelerating the project timeline.

Discussion

The project delay analysis reveals important insights into the current state of project performance and the potential impacts of implementing crash durations. The BCWS (Budgeted Cost of Work Scheduled) value of Rp 33,766,879,050 indicates the planned expenditure up to the 24th week. However, the BCWP (Budgeted Cost of Work Performed) is Rp 31,957,939,101, showing a slight deviation from the planned value, indicating that the work performed is lagging behind the schedule. Additionally, the ACWP (Actual Cost of Work Performed) is Rp 29,653,429,212, which is lower than both BCWS and BCWP, suggesting cost efficiency in the work completed so far.

The Cost Performance Index (CPI) of 1.08 indicates that the project is performing well in terms of cost, as a CPI greater than 1 suggests cost efficiency. This means that for every Rp 1 spent, the project is earning Rp 1.08 worth of work. On the other hand, the Schedule Performance Index (SPI) is 0.95, indicating that the project is behind schedule as the SPI is less than 1. This translates to the project earning only 95% of the value planned for the work scheduled. The SPI value correlates with the delay, necessitating further analysis and corrective measures to bring the project back on track.

Implementing crash durations, as analyzed, involves reducing the task durations by increasing productivity through additional working hours or resources. For instance, the hollow ceiling frame installation's duration was reduced from 7 days to 6 days, and the cost implications showed a decrease in the normal cost. Similarly, the gypsum ceiling installation and Statuario marble installation saw reduced durations from 14 days to 11 days each. This crash implementation not only aims to shorten the project timeline but also presents a financial consideration, as the crash costs are lower than the normal costs, indicating potential savings and efficiency improvements.

The analysis indicates that while the project is cost-efficient, it faces schedule delays that can be mitigated through effective crash management strategies. The reduction in task durations

demonstrates the feasibility of meeting project deadlines by enhancing productivity. This approach, however, must be carefully balanced against the associated costs and the potential impact on resource allocation and project quality. Regular monitoring and adaptive project management techniques are essential to ensure that the project remains on track and within budget, ultimately achieving the desired project outcomes.

CONCLUSION

Based on the research findings, it can be concluded that using the Earned Value method, the renovation project of Grha JST building experienced a delay of 4 days, with an estimated completion date of December 4, 2023. Despite the delay, there is a potential cost savings amounting to Rp2,937,926,937, indicating efficiency in budget management. Furthermore, applying the Crashing method allowed the project to be accelerated by 7 days, albeit with additional overtime costs totaling Rp62,716,380. After factoring in estimated savings, the overall potential project gain is projected at Rp2,769,466,568. Recommendations for future research include considering the use of overtime not only on critical activities but also on non-critical tasks to optimize project execution time comprehensively.

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