

ANALYSIS OF DELAY FACTORS IN THE TANJUNG SEMARANG FLAT CONSTRUCTION PROJECT USING THE SCHEDULE PERFORMANCE INDEX (SPI)

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INFO ARTIKEL	ABSTRAK
Diterima: 16 Juni 2026 Direvisi: 30 Juli 2026 Disetujui: 30 Agustus 2026 Tersedia Daring: 29 September 2026 Kata Kunci: <i>Keterlambatan Proyek; Schedule Performance Index; Earned Value; Planned Value; Kinerja Waktu; Proyek Konstruksi.</i>	Keterlambatan merupakan salah satu permasalahan yang sering terjadi dalam pelaksanaan proyek konstruksi dan dapat memengaruhi pencapaian target waktu yang telah direncanakan. Penelitian ini bertujuan untuk menganalisis kinerja waktu proyek dan mengidentifikasi faktor-faktor yang berkaitan dengan keterlambatan pada Proyek Pembangunan Flat Tanjung Semarang menggunakan indikator Schedule Performance Index (SPI). Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan data sekunder berupa jadwal waktu proyek atau kurva S, laporan harian, laporan mingguan, laporan bulanan, risalah rapat, dan site instruction. Kinerja waktu proyek dianalisis dengan membandingkan Earned Value (EV) dengan Planned Value (PV) untuk memperoleh nilai SPI, sedangkan faktor-faktor yang berkaitan dengan keterlambatan diidentifikasi melalui analisis dokumen proyek pada periode dengan nilai SPI kurang dari 1. Hasil penelitian menunjukkan bahwa nilai SPI berada di bawah 1 pada minggu ke-12 sampai ke-15 dan minggu ke-30 sampai ke-64. Pada minggu ke-12 sampai ke-15, nilai SPI berada pada rentang 0,81–0,86, sedangkan pada minggu ke-30 sampai ke-64 berada pada rentang 0,75–0,98. Berdasarkan analisis dokumen proyek, teridentifikasi beberapa faktor yang berkaitan dengan periode kinerja jadwal di bawah rencana, yaitu kekurangan tenaga kerja, kondisi cuaca, tingginya muka air tanah yang menyebabkan genangan dan kebocoran pada area basement, perubahan desain dan spesifikasi material, akumulasi pekerjaan yang tertunda, serta kendala perizinan pada pekerjaan deep well. Kontribusi penelitian ini terletak pada penggabungan identifikasi kinerja jadwal secara kuantitatif melalui SPI dengan analisis dokumen proyek untuk mengidentifikasi faktor-faktor yang berkaitan dengan periode keterlambatan. Pendekatan tersebut dapat menjadi dasar evaluasi kinerja waktu proyek serta mendukung perencanaan, pengawasan, dan pengendalian waktu pada proyek konstruksi sejenis.

ABSTRACT
Keywords: <i>Project Delay; Schedule Performance Index; Earned Value; Planned Value; Time Performance; Construction Project.</i> <i>Delays are one of the issues that frequently occur in the implementation of construction projects and can affect the achievement of planned time targets. This study aims to analyze project time performance and identify factors related to delays in the Tanjung Semarang Flat Construction Project using the Schedule Performance Index (SPI) as an indicator. This study uses a quantitative descriptive approach with secondary data in the form of the project time schedule or S-curve, daily reports, weekly reports, monthly reports, meeting minutes, and site instructions. Project time performance was analyzed by comparing Earned Value (EV) with Planned Value (PV) to obtain the SPI value, while the factors related to delays were identified through project document analysis for the periods in which the SPI value was less than 1. The results show that the SPI value was below 1 in weeks 12 to 15 and weeks 30 to 64. In weeks 12 to 15, the SPI value</i>

ranged from 0.81 to 0.86, while in weeks 30 to 64 it ranged from 0.75 to 0.98. Based on the project document analysis, several factors related to the periods of below-plan schedule performance were identified, namely labor shortages, weather conditions, high groundwater levels that caused waterlogging and leakage in the basement area, changes in design and material specifications, the accumulation of delayed work, and permit constraints for the deep well work. The contribution of this study lies in combining the quantitative identification of schedule performance through SPI with project document analysis to identify factors related to periods of delay. This approach can serve as a basis for evaluating project time performance and support time planning, supervision, and control in similar construction projects.

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1. INTRODUCTION

Flats, or vertical housing, are a form of construction development that is increasingly being developed in Indonesia as an effort to address land limitations in urban areas while optimizing space utilization. According to the Kamus Besar Bahasa Indonesia (KBBI), a flat is defined as a residence equipped with a living room, bedroom, bathroom, and kitchen. This type of housing is generally arranged in rows or side by side on each floor within a multistory building (Rahadian et al., 2024).

Multistory building projects such as flat construction have a high level of complexity and specific characteristics, such as staged work, the need for intensive coordination, and high interdependency between work items, so that a delay in one activity can affect other work (Rakasyiwi et al., 2022). According to Callahan et al. (1992), delay occurs when a construction project activity experiences an extension of time, or is not carried out according to the expected plan. Also according to Ahuja et al. (1994), delay is stated to be the main cause of claims. In construction claim matters, Ervianto (2023) states that delay is a portion of implementation time that cannot be utilized according to plan, thereby causing subsequent activities to be postponed or unable to be completed exactly according to the planned schedule.

The object discussed in this study is the Tanjung Semarang Flat Construction, located at Jalan Tanjung No. 11-12, Semarang, Central Java. The flat building consists of 1 basement floor and 3 residential floors. The total building area is 4,520 m². The work period for the Tanjung Semarang Flat Construction is 450 calendar days, starting from July 24, 2023 through October 15, 2024. During the construction process, this project experienced obstacles resulting in delay. Delay occurred in the twelfth through fifteenth weeks and the thirtieth through sixty-fourth weeks. Given the delay that occurred in this project, the researchers were interested in examining the Analysis of Delay Factors in the Tanjung Semarang Flat Construction Project.

The indicator used to study the delay of the Tanjung Semarang Flat Construction Project is the Schedule Performance Index (SPI) indicator. The Schedule Performance

Index (SPI) value can indicate whether a project is running according to schedule, experiencing delay, or ahead of plan (Maromi & Indryani, 2015; Pribadi & Abduh, 2022). Through this study, the researchers hope to contribute to improving project time performance as well as to provide evaluation material for parties who will be involved in the implementation of future projects.

Previous studies have used the Earned Value method, including the Schedule Performance Index (SPI) indicator, to evaluate project time performance, such as Hayati and Lugi (2022), Maromi and Indryani (2015), and Pribadi and Abduh (2022). However, this study has a different focus because it does not only use SPI to show delay conditions, but also links the periods with an SPI value < 1 to a project document tracing to identify the factors that caused delays in each of those periods. The empirical context of this study also has specific characteristics, namely the Tanjung Semarang Flat Construction Project located at Jalan Tanjung No. 11–12 Semarang, consisting of 1 basement floor and 3 residential floors with a building area of 4,520 m² and an implementation duration of 450 calendar days. During its implementation, the project experienced delays in weeks 12 to 15 and weeks 30 to 64, which were related to labor conditions, weather, groundwater levels and flooding in the basement area, changes in design and material specifications, and permit constraints for the deep well work.

This study has two objectives which to analyze the delay performance of the Tanjung Semarang Flat Construction Project and to identify the factors causing the delay of the Tanjung Semarang Flat Construction Project.

2. METHOD

2.1 Research Methodology

This study uses a quantitative descriptive method to analyze time performance and the factors causing delays in the Tanjung Semarang Flat Construction Project. The project has an implementation duration of 450 calendar days, starting on 24 July 2023 and ending on 15 October 2024. The research stages include problem and scope determination, literature study, secondary data collection, data processing, analysis of SPI and delay factors, and the preparation of conclusions and recommendations. Secondary data were collected from project documents during the project implementation period, consisting of daily reports, weekly reports, monthly reports, meeting minutes, site instructions, and the time schedule/S-curve. Documents were selected based on their relevance to project implementation progress, particularly documents containing information on planned progress, actual progress, and conditions or events related to project delays.

2.2 Method of Schedule Performance Index (SPI) Analysis and Identification of Delay Factors

Time performance analysis was carried out by comparing Earned Value (EV) and Planned Value (PV) to obtain the Schedule Performance Index (SPI) value (Pontan, 2024; Ralahallo et al., 2024). Planned Value (PV) was obtained from the planned cumulative progress in the time schedule/S-curve, while Earned Value (EV) was

obtained from the actual cumulative progress achieved in each week of project implementation. The SPI value was calculated using the following formula:

$$SPI = EV/PV$$

The calculation was carried out for each week by comparing the actual progress represented by EV with the planned progress represented by PV. An SPI value of 1 indicates that the actual progress is in accordance with the plan, an SPI value greater than 1 indicates that the actual progress is faster than planned, while an SPI value less than 1 indicates that the actual progress is lower than the planned progress and is therefore categorized as a delay period (Hayati & Lugi, 2022). Based on these criteria, weeks with an SPI value of less than 1 were determined as delay periods and were then analyzed based on relevant project documents to identify factors related to delays (Wilanata & Waty, 2024). The documents analyzed included daily reports, weekly reports, monthly reports, meeting minutes, site instructions, and the S-curve.

2.3 Type of Research

The study uses a descriptive quantitative approach. The quantitative approach is used to analyze project progress data numerically through PV, EV, and SPI values, while the descriptive approach is used to explain the delay conditions and their causal factors based on project documents (Sugiyono, 2019).

2.4 Research Location and Object

This research was conducted on the Tanjung Semarang Flat Construction Project in Semarang City, Central Java. The project has an implementation duration of 450 calendar days, starting on 24 July 2023 and ending on 15 October 2024. The object of the research is the project work that experienced a deviation between the planned schedule and the actual implementation. The data used include the time schedule/S-curve, weekly and monthly reports, meeting minutes, and site instructions. The variables used include Planned Value (PV), Earned Value (EV), and Actual Cost (AC).

2.5 Research Instruments

The research instruments used consist of documentation sheets and calculation sheets. Documentation sheets were used to collect and record project documents, while calculation sheets were used to process PV, EV, and SPI data and analyze the research results.

3. RESULT AND DISCUSSION

3.1 Analysis of Planned Progress and Actual Progress

The daily reports collected become weekly reports, and the weekly reports, once compiled, become monthly reports. The monthly report consists of documents such as: a summary of weekly progress, minutes of weekly coordination meetings, correspondence matters, and schedule monitoring and evaluation. In the process of the Tanjung Semarang Flat Construction, a planned schedule had been established by the parties involved in the project. However, in its implementation, there was a difference between the actual realized progress and the actual progress that occurred in the field, or in other words, the project experienced delay. The project performance report, covering both the planned schedule and the schedule realized in the field, is presented in Figure 1, Tanjung

Semarang Flat Construction S-Curve Report. The deviation in work progress is calculated using the formula:

$$\text{Progress deviation} = \text{Cumulative Realized Progress} - \text{Cumulative Planned Progress}$$

The progress deviation value is divided into two indicators. A negative deviation value indicates that the project progress experienced delay, while a positive deviation value indicates that the project progress ran ahead of schedule. Based on the time schedule report as shown in Figure 1, Tanjung Semarang Flat Construction S-Curve Report, a comparison figure between the actual realized progress of the work in the field and the planned progress of the work is obtained.

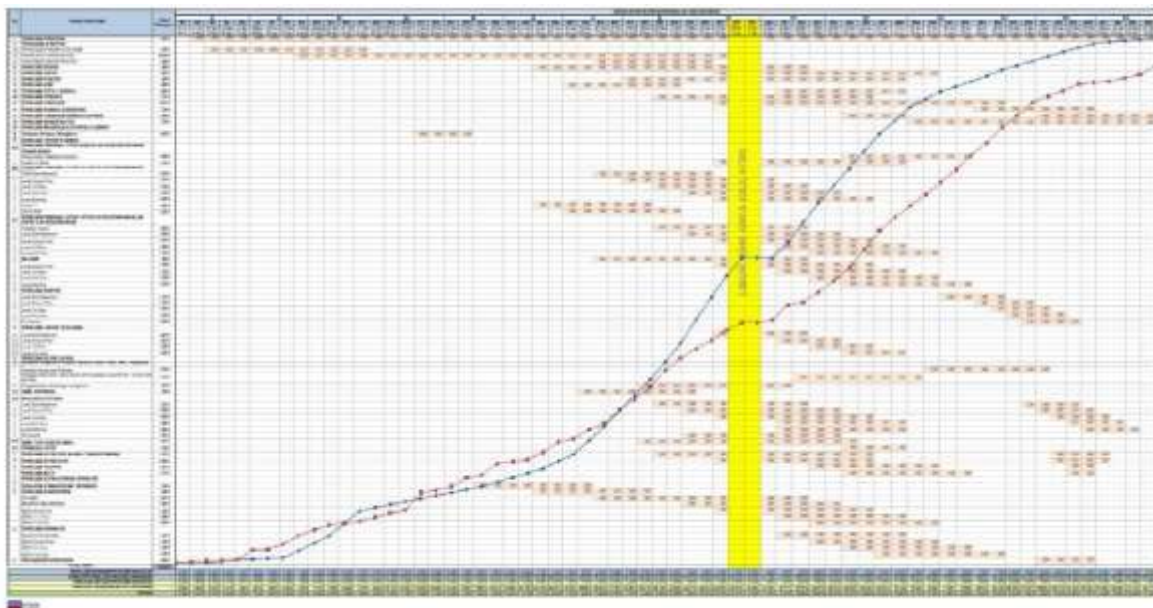


Figure 1. Tanjung Semarang Flat Construction S-Curve Report

3.2 Analysis of Schedule Performance Index (SPI)

The results of the Schedule Performance Index (SPI) calculation are used as an indicator to determine the delay of work progress within the project. The SPI calculation results and Figure 2, Schedule Performance Index Chart.

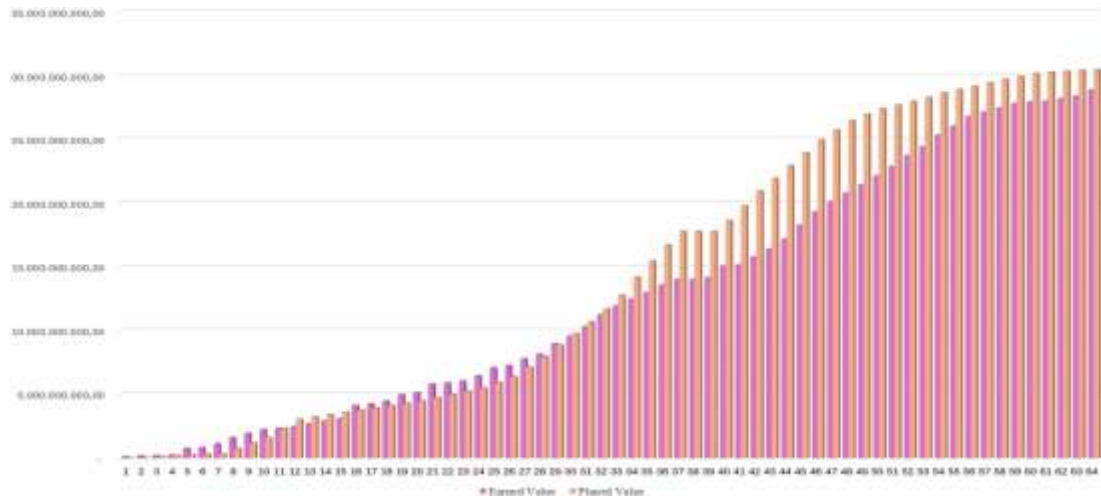


Figure 2. Schedule Performance Index Chart

Figure 2, Schedule Performance Index Chart, shows the chart between the EV and PV values. In accordance with the formula that SPI is a comparison between EV and PV. The chart shows that in several weeks the PV value is greater than the EV value; if the PV value is greater than EV, then the resulting SPI value will certainly be less than one, which is an indicator that at those times project performance was slower than planned. In accordance with the results of the Schedule Performance Index (SPI) analysis and Chart 2 above, it can be seen that the change occurred from week 12 through week 64. In weeks 12 through 15 (October 9–November 5, 2023), the SPI values were, respectively, 0.81, 0.83, 0.85, and 0.86. Subsequently, in weeks 30 through 40 (February 12–April 28, 2024), the SPI value declined from 0.98 to 0.81. The decline continued in weeks 41 through 44 (April 29–May 26, 2024), with respective values of 0.77, 0.75, 0.75, and 0.75. After that, the SPI value gradually increased again from 0.76 in week 45 until it reached 0.93 in week 59 (May 27–September 8, 2024). In weeks 60 through 64 (September 9–October 15, 2024), the SPI value was relatively stable in the range of 0.92 to 0.95, with respective values of 0.93, 0.92, 0.93, 0.93, and 0.95.

To present the development of time performance more systematically, a summary of the SPI values, schedule performance status, and documented delay factors is presented in Table 1.

Table 1. PV, EV, SPI, Schedule Status, and Delay Factors of the Project

Week	PV (%)	EV (%)	SPI	Schedule status	Documented delay factors
12	9.94	8.04	0.81	Delayed	Labor shortage
13	10.64	8.79	0.83	Delayed	Labor shortage
14	11.22	9.56	0.85	Delayed	Labor shortage
15	11.79	10.19	0.86	Delayed	Labor shortage
16	12.36	13.53	1.09	Faster	Work acceleration
30	32.05	31.35	0.98	Delayed	Labor and weather
31	35.11	33.80	0.96	Delayed	Rain, high groundwater level, and basement waterlogging

32	38.36	36.91	0.96	Delayed	Rain, high groundwater level, and basement waterlogging
33	41.97	39.14	0.93	Delayed	Rain, high groundwater level, and basement waterlogging
34	46.52	40.94	0.88	Delayed	Rain, high groundwater level, and basement waterlogging
35	50.77	42.57	0.84	Delayed	Basement waterlogging and accumulation of delayed work
36	54.85	44.53	0.81	Delayed	Basement waterlogging and accumulation of delayed work
37	58.32	45.95	0.79	Delayed	Basement waterlogging and accumulation of delayed work
38	58.32	45.95	0.79	Delayed	Basement waterlogging and canopy design changes
39	58.32	48.40	0.80	Delayed	Basement waterlogging and canopy design changes
40	61.16	49.35	0.81	Delayed	Groundwater leakage in the basement and GWT
41	64.99	49.77	0.77	Delayed	Groundwater leakage in the basement and GWT
42	68.75	51.79	0.75	Delayed	Groundwater leakage in the basement and GWT
43	72.04	53.79	0.75	Delayed	Groundwater leakage in the basement and GWT
44	75.32	56.39	0.75	Delayed	Accumulation of delayed work
45	78.62	59.92	0.76	Delayed	Accumulation of delayed work
46	81.88	63.38	0.77	Delayed	Accumulation of delayed work
47	84.43	65.95	0.78	Delayed	Accumulation of delayed work
48	86.98	68.14	0.78	Delayed	Accumulation of delayed work
49	88.51	70.34	0.79	Delayed	Accumulation of delayed work
50	89.98	72.64	0.81	Delayed	Accumulation of delayed work
51	90.91	75.05	0.83	Delayed	Accumulation of delayed work
52	91.83	77.88	0.85	Delayed	Accumulation of delayed work
53	92.89	80.13	0.86	Delayed	Accumulation of delayed work
54	94.10	83.13	0.88	Delayed	Accumulation of delayed work
55	94.90	85.39	0.90	Delayed	Accumulation of delayed work
56	95.72	87.87	0.92	Delayed	Accumulation of delayed work
57	96.65	89.13	0.92	Delayed	Reduction in the number of workers
58	97.53	90.13	0.92	Delayed	Reduction in the number of workers
59	98.29	91.34	0.93	Delayed	Reduction in the number of workers
60	99.02	91.65	0.93	Delayed	Reduction in the number of workers
61	99.37	91.88	0.92	Delayed	Work shortfall due to changes in specifications/design
62	99.61	92.50	0.93	Delayed	Work shortfall due to changes in specifications/design
63	99.79	93.17	0.93	Delayed	Work shortfall due to changes in specifications/design
64	100.00	94.77	0.95	Delayed	Work shortfall due to changes in specifications/design

Based on Table 1, the project time performance shows two main patterns of delay. In weeks 12 to 15, the SPI ranged from 0.81 to 0.86 and then increased to 1.09 in week

16. This condition is consistent with the labor analysis, which shows a delay due to labor shortages in that period.

Delays reappeared starting in week 30. The SPI value of 0.98 in week 30 then decreased to reach its lowest value of 0.75 in weeks 42, 43, and 44. After that, the SPI increased gradually but remained below 1 until week 64. This pattern shows that although progress increased during the final period of the project, the actual performance was not able to catch up with the cumulative plan.

The factors documented during this period include labor and weather in week 30, basement waterlogging due to rainfall and high groundwater levels in weeks 31 to 34, accumulation of delayed work and canopy design changes in weeks 35 to 39, and groundwater leakage in the basement and GWT in weeks 40 to 43. Furthermore, weeks 44 to 56 were affected by the accumulation of previously delayed work, while weeks 57 to 60 were related to the reduction in the number of workers.

The SPI values described above are depicted in Figure 3, Chart of SPI Values for Weeks 12 through 15, and Figure 4, Chart of SPI Values for Weeks 30 through 64.



Figure 3. Chart of SPI Values for Weeks 12 through 15

Figure 3 shows an increase in the SPI value from week 12 through week 15, although in week 15 the SPI value was still below one. Following the delay that occurred in week 12, the contractor immediately carried out acceleration measures to raise field work progress by conducting an evaluation of the conditions in the field. However, the acceleration carried out could not rise significantly because the SPI value in week 12 was considerably below one, at 0.81. In week 13, the SPI value increased to 0.83, followed by week 14 at 0.85, then in week 15 it rose to 0.86, and finally the SPI value in week 16 was above one, at 1.09. This means that the field work had returned to being ahead of plan.

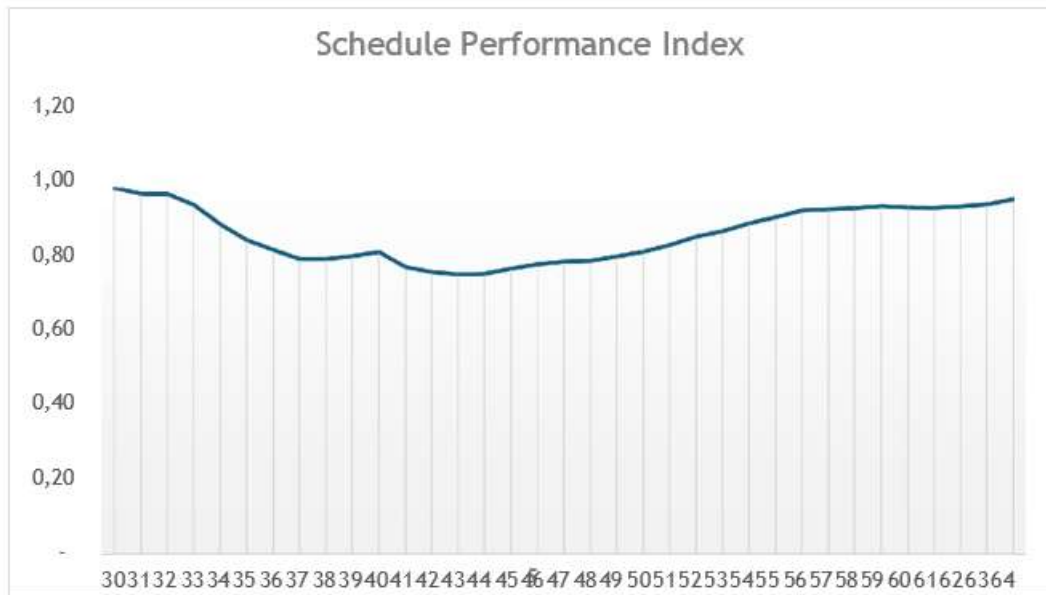


Figure 4. Chart of SPI Values for Weeks 30 through 64

Figure 4 shows that the SPI value from week 30 through week 64 was below one, meaning that work progress from week 30 through week 64 experienced delay. Week 30 had an SPI value of 0.98 and continued to decline until the final week, week 64, when the SPI value reached was 0.95. The above analysis results explain that this project remained delayed through the end of the contract period.

3.3 Discussion of Delay Causal Factors

The delay that occurred in the Tanjung Semarang Flat Construction Project can already be seen from the existing S-curve report and is confirmed by the SPI calculation results obtained, which are below 1 for periods with an SPI value < 1 . The discussion of the factors causing the delay in the Tanjung Semarang Flat Construction was conducted based on existing data such as: daily reports, weekly reports, monthly reports, and meeting minutes. The discussion of the delay causal factors is as follows.

The delay that occurred in weeks 12 through 15 was caused by an insufficient number of workers in the field (Khairani & Supriyadi, 2021; V. Nabut et al., 2021). This can be seen in the Month III and Month IV Reports. The deviation in work progress began to decline starting from week 11, although in that week the progress value was not yet negative. The negative progress deviation occurred in weeks 12 through 15, evidenced by an SPI value below 1, then the work progress deviation turned positive again in week 16, also evidenced by an SPI value above 1. Analysis of the number of workers was conducted from week 11 through week 16.

The basis of weekly progress that had already begun to decline in week 11 could have served as a basis for evaluation by adding workers to avoid delay in weeks 12 through 15. The analysis of the number of workers can be seen in Table 2, Table of Worker Count Analysis for Weeks 11 through 16.

Table 2. Table of Worker Count Analysis for Weeks 11 through 16

Week	Period	Work Progress		Deviation	SPI	Total Workers (persons)
		Cum. Planned	Cum. Realized			
11	Oct. 2, 2023 – Oct. 8, 2023	7.61%	7.68%	0.07%	1.01	122
12	Oct. 9, 2023 – Oct. 15, 2023	9.94%	8.04%	-1.90%	0.81	172
13	Oct. 16, 2023 – Oct. 22, 2023	10.64%	8.79%	-1.85%	0.83	219
14	Oct. 23, 2023 – Oct. 29, 2023	11.22%	9.56%	-1.66%	0.85	313
15	Oct. 30, 2023 – Nov. 5, 2023	11.79%	10.19%	-1.60%	0.86	342
16	Nov. 6, 2023 – Nov. 12, 2023	12.36%	13.53%	1.16%	1.09	372

The factor causing the delay in week 30 was analyzed based on the Month VII Report. The report shows that the factors causing the delay were labor and weather. The number of workers working in week 30 declined from the previous weeks, weeks 28 and 29. Worker count data can be seen in Table 2. Weather was an external factor that contributed to the delay in work progress (Megawati & Lirawati, 2021; Syakhertra et al., 2025). According to the daily reports, a fairly high intensity of rainfall occurred in January and February 2024. Rainfall report data is presented in Figure 5, Rainfall Report.

Analysis of the number of workers on the project can be seen in Table 3, Table of Worker Count Analysis for Weeks 28 through 30.

Table 3. Table of Worker Count Analysis for Weeks 28 through 30

Week	Period	Work Progress		Deviation	SPI	Total Workers (persons)
		Cum. Planned	Cum. Realized			
28	Jan. 29, 2024 – Feb. 4, 2024	26.16%	26.68%	0.52%	1.02	448
29	Feb. 5, 2024 – Feb. 11, 2024	29.10%	29.39%	0.29%	1.01	321
30	Feb. 12, 2024 – Feb. 17, 2024	32.05%	31.35%	-0.70%	0.98	252

The rainfall report can be seen in Figure 5, Month VII Rainfall Report. The report shows fairly high rainfall in January and February 2024. There were approximately 15 days in one month with rainfall. The high rainfall hindered the work process in the field, particularly when rain fell over a fairly extended period.

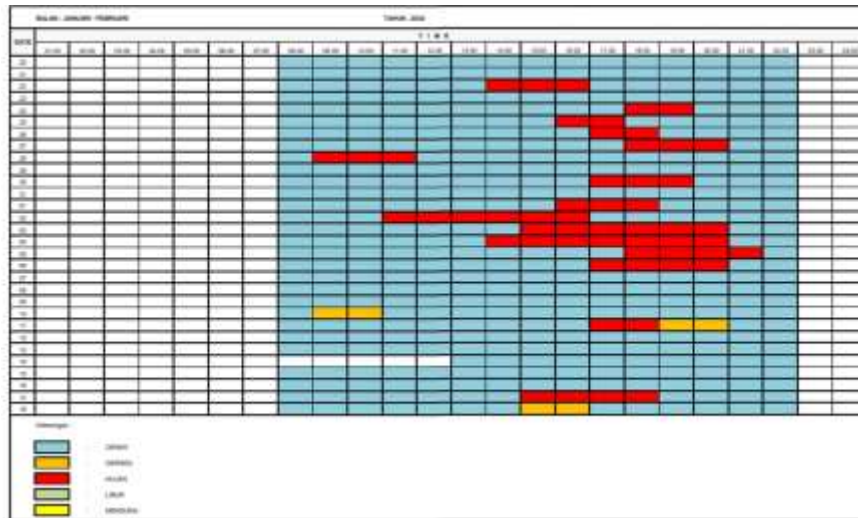


Figure 5. Month VII Rainfall Report

In addition to the factors above, other obstacles occurred in the field, including a change in generator set power capacity because the planned generator power was insufficient to lift the fire pump capacity of 75 kW, and the presence of material that had already been discontinued and was no longer produced, requiring a search for an alternative replacement material that had to first be approved (Thina et al., 2025).

The reports for weeks 31 through 34 are contained in a single monthly report, namely the Month VIII report, for the period February 19, 2024 through March 19, 2024. A summary of work progress in Month VIII is attached in Table 4, Table of Work Progress for Weeks 31 through 34.

Table 4. Table of Work Progress for Weeks 31 through 34

No.	Month Week Period	FEBRUARY 2024 – MARCH 2024			
		31 19-25	32 26-03	33 04-10	34 11-17
1.	Cumulative Planned	35.11%	38.36%	41.97%	46.52%
2.	Cumulative Realized	33.84%	36.91%	39.14%	41.19%
3.	Deviation	-1.27%	-1.45%	-2.83%	-5.33%

The monthly report indicates that the primary factor causing the delay at that time was pooled water in the basement due to rainwater. Flooding occurred in the basement due to the high rainfall combined with the fairly high groundwater level at the project site.

Work progress for weeks 35 through 39, for the period March 20, 2024 through April 18, 2024, is contained in a single monthly report, namely the Month IX Report. The weekly work progress summary report is presented in Table 5, Table of Work Progress for Weeks 35 through 39.

Table 5. Table of Work Progress for Weeks 35 through 39

No.	Month Week Period	MARCH 2024 – APRIL 2024				
		35 18-24	36 25-31	37 01-07	38 08-14	39 15-21
1.	Cumulative Planned	50.77%	54.85%	58.32%	58.32%	58.32%
2.	Cumulative Realized	42.57%	44.53%	45.95%	45.95%	48.40%

3.	Deviation	-8.20%	-10.31%	-12.37%	-12.37%	-11.92%
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The factor causing the delay in Month IX was that the basement flooding had still not been resolved, resulting in an increasing accumulation of work that could not be carried out, including GWT (Ground Water Tank) work, pump work, hydrant work, and pump room construction work.

In addition, another contributing factor was a change in the canopy design (Syakhertra et al., 2025; Widyawati, 2026). Month IX also included Eid al-Fitr, which resulted in work being on holiday in weeks 38 and 39. According to the proposed planned schedule, work was on holiday during those weeks; however, the contractor attempted to make up for lost progress by implementing a worker holiday for one week, namely week 38, with the purpose of catching up on the lagging progress. The issue described in the monthly report was a change to the large canopy and the pedestrian canopy frame.

In the Month X Report, covering weeks 40 through 43 over the interval April 19, 2024 through May 18, 2024, a progress summary is presented in Table 6, Table of Work Progress for Weeks 40 through 43.

Table 6. Table of Work Progress for Weeks 40 through 43

No.	Month Week Period	APRIL 2024 – MAY 2024			
		40 22-28	41 29-05	42 06-12	43 13-19
1.	Cumulative Planned	61.16%	64.99%	68.75%	72.04%
2.	Cumulative Realized	49.35%	49.77%	51.79%	53.79%
3.	Deviation	-11.81%	-15.22%	-16.96%	-18.25%

Referring to Figure 4, Chart of SPI Values for Weeks 30 through 64, it is explained that the lowest SPI value occurred in weeks 42 through 43, with respective SPI values of 0.75. In terms of progress deviation, Table 6 shows that the work progress deviation was at week 43 with a deviation value of -18.25%. The primary issue in this monthly report was continued groundwater leakage in the basement and GWT area, resulting in delayed work.

Work progress for weeks 44 through 47 is contained in the Month XI Report, covering the period May 19, 2024 through June 17, 2024. The progress report for Month XI is presented in Table 7, Table of Work Progress for Weeks 44 through 47.

Table 7. Table of Work Progress for Weeks 44 through 47

No.	Month Week Period	MAY 2024 – JUNE 2024			
		44 20-26	45 27-02	46 03-09	47 10-16
1.	Cumulative Planned	75.32%	78.62%	81.88%	84.43%
2.	Cumulative Realized	56.39%	59.92%	63.38%	65.95%
3.	Deviation	-18.94%	-18.70%	-18.50%	-18.49%

The increasingly larger work progress value that occurred in Month XI represents the accumulation of work progress that could not be carried out due to obstacles that occurred in the field in the previous month. The highest peak deviation in work progress

was in week 44, with a deviation of -18.94%. In subsequent weeks, work progress showed improvement, marked by a decreasing progress deviation value. The progress deviation in week 45 was -18.70%, in week 46 the deviation was -18.50%, and the deviation in week 47 was -18.49%.

The Month XII progress report, covering weeks 48 through 53, from April 19, 2024 through May 18, 2024, is attached in Table 8, Table of Work Progress for Weeks 48 through 52.

Table 8. Table of Work Progress for Weeks 48 through 52

No.	Month Week Period	JUNE 2024 - JULY 2024				
		48 17-23	49 24-30	50 01-07	51 08-14	52 15-21
1.	Cumulative Planned	86.98%	88.51%	89.98%	90.91%	91.83%
2.	Cumulative Realized	68.14%	70.38%	72.64%	75.05%	77.91%
3.	Deviation	-18.85%	-18.13%	-17.33%	-15.85%	-13.92%

Table 8 shows a decrease in the work progress deviation that occurred in that month. The monthly report began with week 48, with a still-high progress deviation of -18.85%; however, in week 49, the progress deviation had already begun to show improvement, marked by a further reduction in progress deviation to -18.13%. Progress in the field continued to improve, until in week 52 the work progress deviation dropped substantially further, to -13.92%.

Progress for weeks 53 through 56, for the period July 18, 2024 through August 16, 2024, is included in the Month XIII report. Work progress is shown in Table 9, Table of Work Progress for Weeks 53 through 56.

Table 9. Table of Work Progress for Weeks 53 through 56

No.	Month Week Period	JULY - AUGUST 2024			
		53 22-28	54 29-04	55 05-11	56 12-18
1.	Cumulative Planned	92.89%	94.10%	94.90%	95.72%
2.	Cumulative Realized	80.13%	83.13%	85.38%	87.87%
3.	Deviation	-12.76%	-10.97%	-9.51%	-7.85%

In the work progress report, the deviation that occurred continued to decrease, meaning that field progress had begun to accelerate fairly significantly, although the deviation value was still negative. The Month XIV Report consists of the accumulated progress for weeks 57 through 60, over the interval from August 17, 2024 through September 15, 2024. Work progress is shown in Table 10, Table of Work Progress for Weeks 57 through 60.

Table 10. Table of Work Progress for Weeks 57 through 60

No.	Month Week Period	AUGUST - SEPTEMBER 2024			
		57 19-25	58 26-01	59 02-08	60 09-15
1.	Cumulative Planned	96.65%	97.53%	98.29%	99.02%

2.	Cumulative Realized	90.10%	90.13%	91.34%	91.65%
3.	Deviation	-6.55%	-7.41%	-6.95%	-7.37%

The progress deviation in week 57 had a value of -6.55%, an improvement from the previous week; however, in week 58 the progress deviation fell to -7.41%. Similarly, the progress deviation in week 59 was -6.95%, followed by a decline in the progress deviation in week 60 to -7.37%. The factor causing the decline in progress deviation at that time was a reduction in the number of workers in the field, which caused the progress deviation to decline again.

Table 11. Table of Work Progress for Weeks 61 through 64

No.	Month	SEPTEMBER – OCTOBER 2024			
	Week	61	62	63	64
	Period	16-22	23-29	30-06	07-15
1.	Cumulative Planned	99.37%	99.61%	99.79%	100%
2.	Cumulative Realized	91.88%	92.50%	93.17%	94.77%
3.	Deviation	-7.49%	-7.10%	-6.63%	-5.23%

In Table 11, the work progress appears to have gone well, as indicated by the decreasing progress deviation. However, the work progress did not reach 100% at the end of the project because there were some reduced works whose weights could not be accounted for. This condition is related not only to administrative aspects, but also indicates adjustments to the scope and specifications of the work during project implementation. Work reductions can affect project performance because changes in work scope require adjustments to the sequence and volume of the planned work. In addition, work that was previously delayed can accumulate and affect the implementation of work in the following periods. In the Tanjung Semarang Flat Construction Project, the site instruction recapitulation shows changes in the form of additional and reduced works, changes in material specifications, and changes in design or work location. Therefore, the decrease in progress deviation at the end of the project indicates better execution of the ongoing work, but it does not imply that all planned work remained within the final project scope.

These findings are consistent with previous studies showing that construction project delays can be related to various interacting factors, including labor, materials, weather conditions, and changes in work implementation (Megawati & Lirawati, 2020; Khairani & Supriyadi, 2021; Nabut et al., 2021). In the Tanjung Semarang Flat Construction Project, the interaction between factors is seen in the work that was delayed and accumulated from previous periods, while design and specification changes led to adjustments to the work that had to be carried out. As a result, the impact of a delay does not only occur in the period when the problem arises, but can continue and affect work in the following periods. Therefore, project time performance needs to be viewed not only based on progress in a particular week, but also by considering changes in work scope and the accumulation of work that previously experienced delays.

A site instruction is an official instruction given by an authorized party, such as the owner, supervision consultant, or construction management, to the contractor to carry out an adjustment to a work item. In this project, several changes listed in the site instruction recapitulation are specific to project conditions, such as changes related to site conditions, work requirements, and the provisions applicable to the deep well work. However, other factors such as design or specification changes, labor availability, weather conditions, material availability, and the accumulation of delayed work are factors that may also occur in other flat or apartment construction projects. Therefore, although the specific characteristics and causes may differ in each project, the pattern of interaction between work changes, delayed work, and time performance has the potential to be found in building construction projects with similar characteristics.

5. CONCLUSION

Based on the results of the study on the Analysis of Delay Factors in the Tanjung Semarang Flat Construction Project Using the Schedule Performance Index (SPI), it can be concluded that the project time performance shows periods of below-plan performance. Based on the calculation of the Schedule Performance Index (SPI), the SPI value was below one in weeks 12 to 15 and weeks 30 to 64. This condition shows that work progress in those periods was slower than the planned progress. Therefore, SPI can be used to identify the periods in which schedule performance was below plan, but it does not directly show the factors that caused the delays.

The results of the analysis of daily reports, weekly reports, monthly reports, meeting minutes, and site instructions in the periods with an SPI value < 1 show that the factors related to delays can be systematically grouped as follows: (1) labor shortages or reductions in the number of workers, especially in weeks 12 to 15 and weeks 57 to 60; (2) weather conditions and high rainfall; (3) site conditions in the form of high groundwater levels, waterlogging, flooding, and groundwater leakage in the basement area and GWT; (4) changes in work design and specifications, including canopy design changes and material specification changes; (5) material availability, including discontinued materials that required replacement and adjustment; (6) accumulation of delayed work due to constraints in previous periods, especially in weeks 44 to 56; and (7) permit constraints for the deep well work that caused changes in work items. Therefore, the results of the study show that the identification of schedule performance periods through SPI needs to be complemented by project document analysis to obtain evidence regarding the factors related to the occurrence of delays.

To minimize the risk of project delays, the contractor is advised to prepare a master schedule that includes labor and material schedules, provide pumps with adequate capacity during periods of high rainfall, and apply appropriate dewatering methods in areas with high groundwater levels. The planning consultant is advised to carry out more detailed planning and design, including identifying permit requirements, calculating electrical power capacity and material requirements, and checking material availability with suppliers to avoid the use of materials that are no longer in production. These steps

are expected to reduce the risk of work changes, delays in material procurement, and obstacles in project implementation.

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