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# Analyzing Construction Schedule Deviation Using S-Curve: A Residential Project Case

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***Abstract***

*Construction project delays are one of the main problems in the construction industry in Indonesia, especially in medium-scale housing developments. This study aims to analyze the deviation of the project implementation schedule using the S-curve evaluation method in the residential project case. The method used is a descriptive quantitative approach with a case study, based on weekly cumulative weight data from the planned and actual S-curves. The evaluation results show that until the 35th week (June 2, 2024), the actual progress of the project only reached 53.67%, compared to the plan of 59.39%, with a Schedule Performance Index (SPI) value of 0.90. The largest deviation occurred in the 35th week, which was -3.01%, and the delay trend continued cumulatively from the 29th week to the 38th week. Evaluation based on work stages showed that the most significant deviation occurred in architectural and MEP work, while structural work was relatively on schedule. The project completion projection shifted from November 11, 2024 to December 29, 2024. In response to the delay, an acceleration strategy was formulated in the form of additional manpower, extended working hours (overtime), adjustments to the weekly schedule, and consideration of change orders in the contract. This study emphasizes the importance of S-curve-based time control and the implementation of immediate corrective actions as part of adaptive project management.*

**Keywords:** Schedule deviation, s-curve, project delays, schedule performance, residential project

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## 1 INTRODUCTION

Construction projects are generally highly complex and prone to various uncertainties that can cause deviations from the planned schedule. In the context of residential development, especially cluster housing projects, delays in work completion remain a significant and presistent issue. These delay problem often increases project costs, on the one hand, inversely proportional to the level of satisfaction of project owners and end users (Agritama, Miftahul, & Titien, 2018).

One common way to further explore the progress of a project is by analyzing the S-curve. The S-curve is obtained from a graphic depiction of the amount of work accumulated over a certain period, so that a comparison can be made between the plan and the realization of project implementation. With the evaluation of the S-curve, schedule deviations can be identified quantitatively, this is very important to provide a basis for corrective actions that need to be taken by a project manager.

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For example, in a case study of subsidized housing in Malang City, an additional delay of up to 45 days from the schedule in the initial contract was identified due to weather, delays in material supply, and a small portion by inadequate skilled labor. Based on the S-curve evaluation conducted by the project supervision team, there was a significant cumulative time deviation of 15%, which automatically had an impact on rescheduling and forced overtime to be added to overcome the post-evaluation delay (Wijayanto, 2022). This study reinforces the importance of structured monitoring of project progress using visual and quantitative approaches such as the S-curve.

The problem in the study was the deviation between the planned and actual schedules in the cluster housing construction project. Although the project already had a fairly detailed baseline schedule, its implementation showed significant differences in several stages of work that affected the effectiveness of the overall project completion time.

The purpose of this study was to analyze the deviation of the project implementation schedule using the S-curve evaluation method, as well as to identify the factors causing delays that occurred during the construction process. The results of this analysis are expected to provide useful input for improving the time control system on similar construction projects in the future.

## 2 LITERATURE REVIEW

### 2.1. Schedule Management in Construction Projects

Time management is one of the key elements in construction project management. The success of a project is not only seen from the cost and quality aspects, but also from the timeliness of completion. According to Hafnidar (2021), project scheduling is needed to identify and plan construction activities so that they can be completed according to the set time target. Good scheduling allows efficient allocation of resources, work time management, and control of deviations that occur during project implementation. Failure to manage time can lead to claims, contract penalties, and even total project failure. Furthermore, project scheduling is generally prepared by considering the start and finish times of each activity that are interrelated with each other. Techniques that are often used include the Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), and S-curve. Each method has certain characteristics and objectives, but all aim to ensure that the project runs according to plan (Rizaldy, 2021).

### 2.2. S-Curve as a Project's Schedule Evaluation Tool

The S-curve is a visual aid widely used in construction projects to monitor the progress of work over time. This curve illustrates the relationship between implementation time and work value (both in terms of physical volume weight and cost). In general, the S-curve consists of

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three main lines, namely the planned, actual, and deviation curves. By comparing the actual curve to the planned curve, it can be seen whether the project is ahead of schedule, on schedule, or delayed.

According to Putra (2023), the S-curve is effective for evaluating the suitability between the plan and the realization of project implementation, as well as identifying points of deviation that have the potential to become obstacles. Through S-curve analysis, project managers can make quick decisions to address delays or schedule mismatches that occur. One of the advantages of the S-curve is its ability to provide a comprehensive picture of project progress, especially when combined with the Earned Value Management (EVM) method. With this approach, project managers can assess time and cost performance simultaneously (Wibowo & Adji, 2021).

### 2.3. Factors Causing Schedule Deviation. In Construction Projects

Deviation from project schedules is a common problem in the construction industry. Based on research by Agritama et al. (2019), the causes of construction project delays generally come from internal and external factors. Internal factors include ineffective project management, lack of coordination between related parties, and delays in procurement of materials and labor. While external factors include weather conditions, design changes from the project owner, delays in licensing, and socio-political conditions at the project location.

A study by Santoso and Hidayat (2020) also stated that inaccuracies in initial planning are one of the main causes of deviations. This shows the importance of comprehensive planning and flexibility in project implementation, in order to anticipate and mitigate the risk of delays. In the context of residential projects, schedule deviations are often influenced by the large number of parallel jobs on housing units, limited labor in the field, and delays in ordering special materials (such as frames, ceramics, or precast concrete panels).

## 3 RESEARCH METHOD

### 3.1 Research Design and Location

This study examines residential housing development projects in the Tangerang, Banten area, and uses a descriptive quantitative approach. The purpose of this study is to examine the deviation of the construction project implementation schedule through a comparison of actual and planned S-curves. One of the projects analyzed is the construction of a number of middle-class housing units that will begin in 2024.

### 3.2 Data Collection Techniques and Instruments

Data were collected through three main techniques: (1) documentation, in the form of time schedule data and weekly physical progress of the project, including planned and actual S-curves; (2) semi-structured interviews, with the project implementation team to explore

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the causes of schedule deviations; (3) field observations, to verify the conformity of actual progress to the S-curve report.

The main research instrument is the S-curve developed from the project time schedule. The creation and analysis of the curve were carried out using Microsoft Excel software. This instrument is used to visualize project progress and identify differences between planned and actual schedules.

### 3.3 Data Analysis and Validation

The analysis begins by compiling the planned and actual S-curves; calculating the deviation difference in weekly units and percentage of work weight; categorizing deviations into acceleration and delay; then ending with interpreting the results in the form of graphs and tables. Data validation is carried out through source triangulation, by comparing the results of documentation, interviews and observations. In addition, a peer checking method is used with professionals to review the suitability of the analysis results.

## 4 RESULT AND DISCUSSION

Medium-scale construction projects such as housing developments include structures, architecture, and mechanical electrical piping (MEP) installations. The project started on October 9, 2023 and is scheduled to be completed on November 11, 2024. The project will last for 57 weeks. In implementing the project, the implementation team uses an S-curve evaluation approach, both for the plan, actual, and estimated completion. However, based on the evaluation results up to the 35th week (June 2, 2024), there was a deviation between the planned and actual progress. The actual progress only reached 53.67%, lower than the planned weight of 59.39%, which indicates a delay in the overall work.

The data on the S-curve on June 2, 2024 shows the cumulative weight: (a) Planned Value of 59,39%; (b) Earned Value of 53,67%; (c) Schedule Performance Index of 0, which means less than <1 indicates the project is delayed. The overall deviation is -5.72% which indicates that the actual progress of the project is 5.72% behind the planned schedule.

### 4.1 Weekly Progress Deviation

Based on Figure 1 the S curve and weekly deviations that occurred, the largest deviation on the S curve occurred in the 35th week, which was -3.01%. The percentage those who experienced a deviation in implementation in the field experienced significant obstacles in that period. Each week in the deviation range occurred consecutively from the 30th week to the 38th week without any significant recovery week.

From the recapitulation of actual weight realization in stages 1-4, namely the structural work stage, it has reached 47.58% of the total deviation in 60% of the total project. Then in stages 5-7, the deviation was quite significant, with a deviation of -5.85% in stage 5 and a

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deviation of -13.74% in stage 6, and a deviation of -10.16% in stage 7. In stages 8 and 10, the actual finishing and handover stages have not been realized. Based on the evaluation obtained in the final phase of the evaluation time. Various factors that cause construction project delays have been widely disclosed in detail in the literature review.

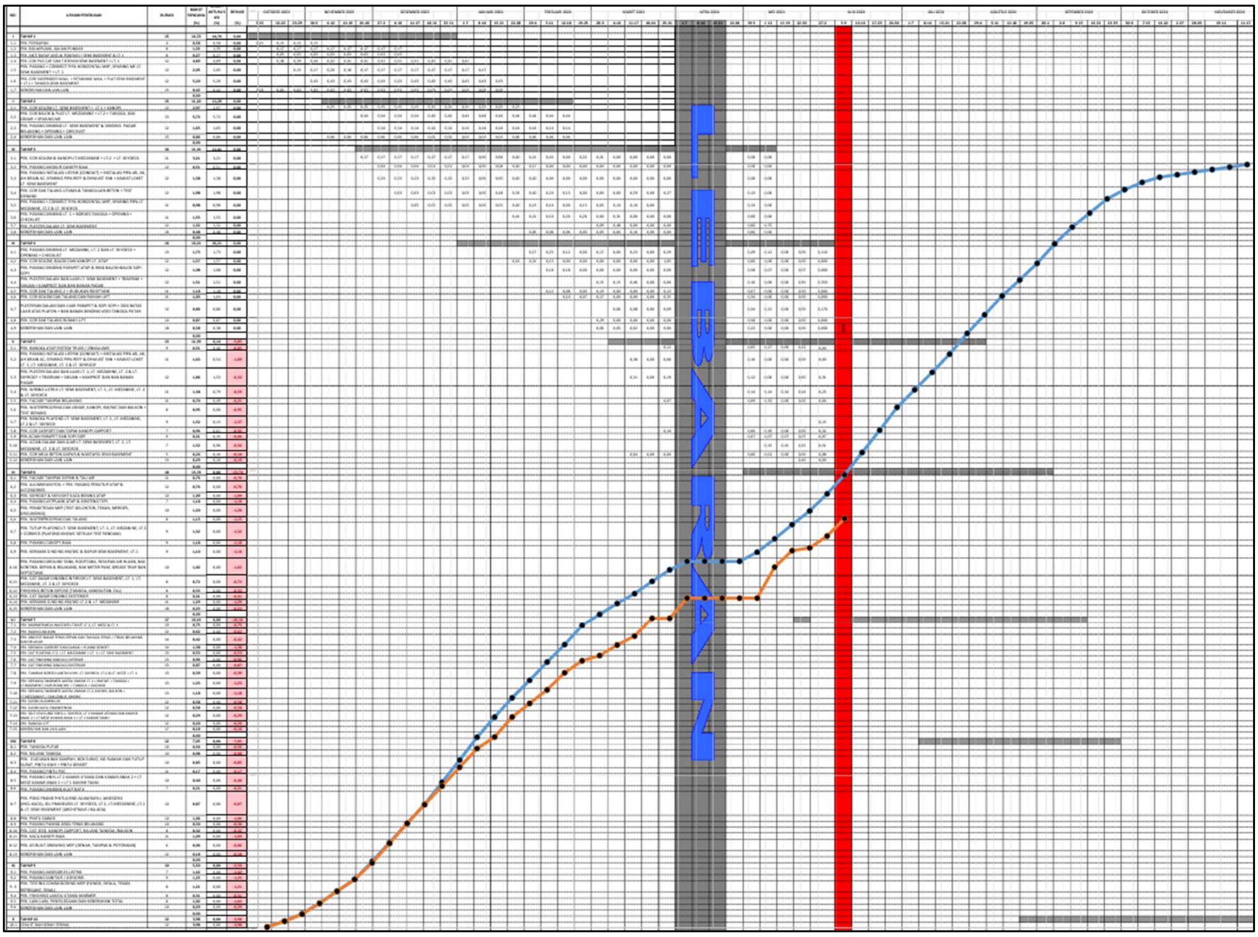

**Figure 1. Schedule Plan**

According to Lestari, Simanjuntak, and Kurniawan (2022), several reasons for responses as the dominant causes of construction project delays emphasized that weekly progress deviations can be caused by internal and external factors, such as:

a. Delays in decision making

   Project owners can lose money if they do not make decisions or pay contractors or vendors on time. Inaccurate payments have a direct impact on project implementation and delayed material procurement. Situations like this can lead to ongoing weekly progress deviations (Syakhertra et al., 2025).

b. Limited availability of skilled labor

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Delays are largely due to the number of workers who have special expertise in construction, especially in architectural and MEP work. According to Puppisari (2020), the lack of experienced employees extends the implementation time of the work and disrupts the overall project process. In medium-scale projects such as cluster housing, there are several problems. One of them is the difficulty in obtaining the right materials and in accordance with technical needs. Puspitasari (2020) said that the lack of material supply affects the level of work progress.

c. Changes in project scope or design revisions

   Design changes proposed by the project owner during the construction process can lead to changes in planning, rework, and revisions to schedules and budgets. This is one of the main factors causing delays in housing projects in Indonesia, according to Rizal et al. (2024).

d. Delays in material supply and logistics

   Inefficient material supply chains and logistical constraints can slow down the availability of building materials in the field. This has a direct impact on construction delays, especially in the architectural and finishing stages (Mardiaman, 2023).

e. Unfavorable weather conditions

   External factors such as heavy rain, extreme weather, or environmental conditions around the project often cause delays in outdoor activities, especially structural and utility work. Puspitasari's study (2020) shows that this is one of the factors that causes housing projects to be delayed

f. Lack of coordination

   Related Parties Miscommunication between the main contractor, subcontractor, supervising consultant, and project owner disrupts field implementation. According to Syakhertra et al. (2025), poor coordination is an important component in the accumulation of project time deviations.

In the context of this project, significant deviations at the architectural and MEP stages were most likely caused by a combination of these factors.

### 4.2 S-Curve Analysis in Completion Estimation

The estimated completion S-curve provides a realistic picture of the project's possible completion time based on the actual progress trend and the time performance achieved up to the evaluation week. Based on the graph and data analyzed on Fig 2, the project completion which was originally planned to be completed on November 11, 2024 is now projected to be delayed to December 29, 2024, indicating a delay of around 7 weeks from the planned schedule. This decrease in project time performance is reflected in the Schedule Performance Index (SPI) value of 0.90, which means that of all the work that should have been completed

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according to plan, only 90% was achieved at that time. SPI <1 is an indicator that the project is experiencing a time deviation and corrective action needs to be taken to avoid further delays.

Cumulative data shows that until the 35th week (June 2, 2024), the actual progress of the project has only reached 53.67%, while the planned progress should be at 59.39%, resulting in a cumulative deviation of -5.72%. The worst weekly deviation occurred in week 35 at -3.01%, and there was no significant catch-up week until week 38. This means that the delay is progressive and has not been resolved. The identified critical period, namely between weeks 29 and 38, shows a continuous downward trend in performance.

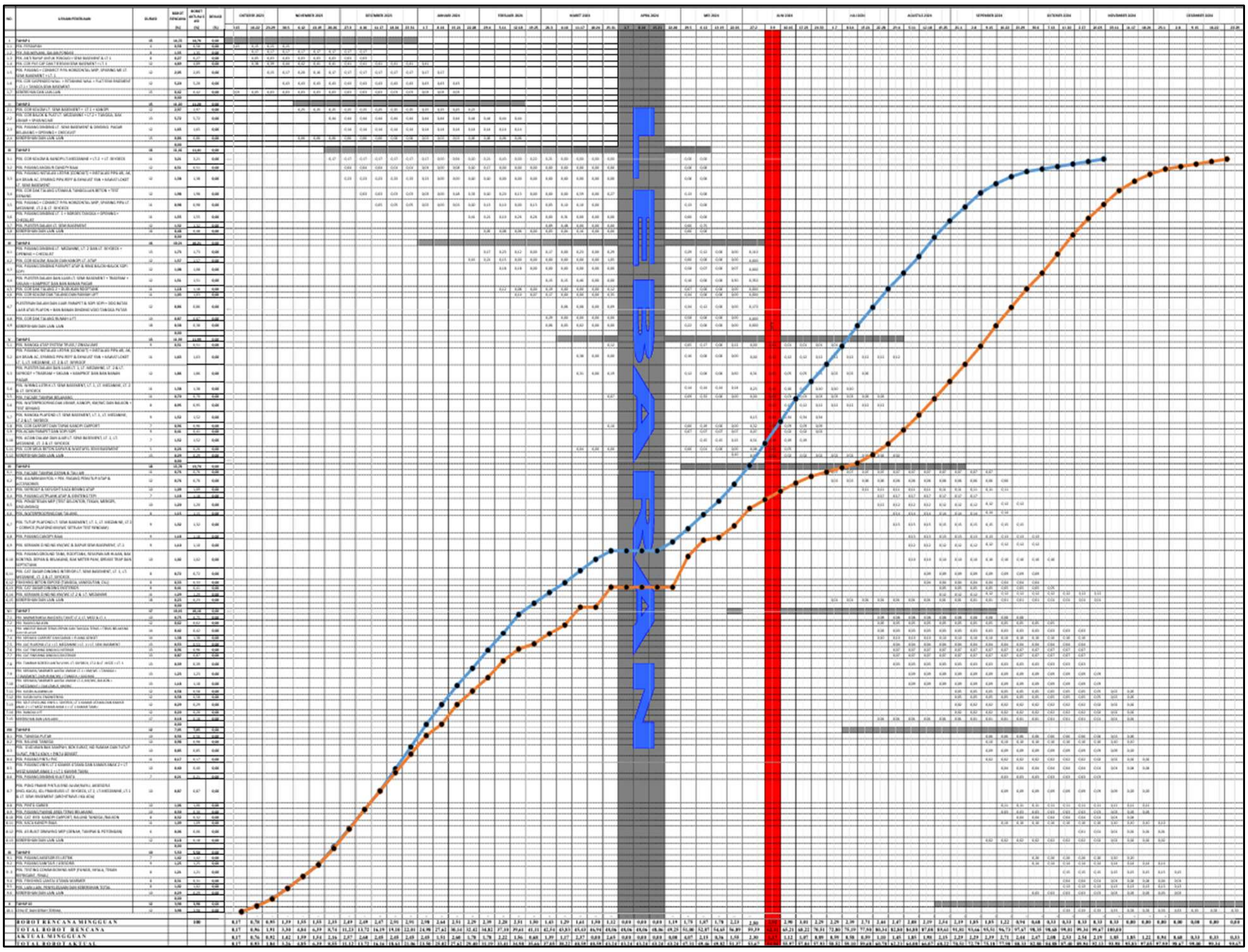


**Figure 2. Schedule Estimated Completion**

When reviewed based on the work phase, the most significant delays occurred in:

i. Stage 5–7, is architectural and MEP works, with the following deviations
ii. Stage 5: -5,85%
iii. Stage 6: -13,74%
iv. Stage 7: -10,16%

The delay in this work is believed to be caused by several factors:

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a. The accumulation of cross-disciplinary activities (MEP and architectural work) that are not carried out in parallel;
b. A limited number of skilled workers for specialized installations;
c. Non-conformity or delays in the delivery of finishing materials and installation equipment;
d. Weak coordination among technical sections of the project on site.

The estimated S-curve indicates that although the project is currently in the mid-phase, the existing deviation may have significant implications for the overall project duration. In the context of project management, this trend can be categorized as an early warning signal, which requires corrective actions in the form of:

a. Reallocation of resources (labor, equipment, and overtime) to critical path activities;
b. Readjustment of the weekly work schedule, considering the need for acceleration;
c. Stricter evaluation and supervision of MEP vendors and material suppliers;
d. Strengthening cross-team coordination, especially between the structural, architectural, and installation teams.

If this deviation is not addressed, the estimated final completion date may not only extend beyond the end of December 2024, but also lead to additional cost implications and contract penalties, depending on the time clauses stipulated in the work contract.

### 4.3 Review of Acceleration Plan and Strategy

In response to the project delays identified through the S-Curve analysis and the Schedule Performance Index (SPI) value of 0.90, an acceleration strategy is needed to get the project back on track. This acceleration strategy includes the following approaches :

a. Increase in the number of workers

Increasing the number of workers by 1.5 to 2 times, especially in structural and finishing work, can accelerate the completion of delayed work. A study by Messah et al. (2023) showed that adding workers can significantly reduce project duration, although it has an impact on increasing project costs.

b. Extension of working hours

Working overtime until 20:00–21:00 allows for faster completion of work. However, it should be noted that overtime can increase labor costs and potentially reduce productivity if not managed properly. Research by Fardila and Adwayah (2021) emphasizes the importance of effective management in implementing overtime to avoid negative impacts on project costs and quality.

c. Weekly schedule adjustment and intensive evaluation

Conducting weekly schedule adjustments and intensive evaluation of priority work items helps in quickly identifying and addressing obstacles. This approach is in line with project

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management principles that emphasize the importance of tight monitoring and control to ensure the project stays on track.

d. Change order considerations in contracts

Making contract changes (Change Order) to adjust the implementation time can provide flexibility in rearranging schedules and resources. However, it should be noted that Change Orders can have legal and financial implications, so they must be managed carefully. According to Putri et al. (2022), Change Orders that are not managed properly can increase project costs and time.

## 5 CONCLUSION

This study aims to analyze the deviation of the implementation schedule of the Cluster housing development project using the S-curve evaluation method. The evaluation results show that until the 35th week (June 2, 2024), the project experienced a delay with actual progress of 53.67%, lower than the planned progress of 59.39%. The cumulative deviation of -5.72% reflects a decline in project time performance, as further evidenced by a Schedule Performance Index (SPI) of 0.90. The most significant deviation in progress occurred in the 35th week, with the highest weekly deviation of -3.01%. The critical period lasted from the 29th week to the 38th week without any significant progress in recovery. Evaluation based on work stages showed that the largest delay occurred in architectural and MEP work (stages 5–7), while structural work was relatively according to plan. The estimated S-curve shows that the project is projected to be 7 weeks behind schedule, with an estimated completion date of December 29, 2024. The factors causing the delay are dominated by design changes, delays in material procurement, lack of skilled labor, and poor coordination between parties. As a follow-up, the recovery plan includes additional manpower, overtime, weekly schedule evaluation, and the possibility of implementing change orders. This strategy is in line with the principles of project management that emphasize the need for immediate corrective action when the project shows time performance below target. This research is expected to provide a real contribution in controlling housing project schedules in Indonesia and become a reference in formulating project acceleration strategies based on S-curve data.

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