EVALUASI KINERJA WAKTU PROYEK DINDING PENAHAN TANAH BERBASIS SIMULASI MONTE CARLO DENGAN VARIABEL RISIKO CURAH HUJAN (STUDI KASUS: PANDANARAN AVENUE, SEMARANG)

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ABSTRACT

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Title	:	Time Performance Evaluation of Retaining Wall Projects Using Monte Carlo Simulation with Rainfall Risk Variables (Case Study: Pandanaran Avenue, Semarang)
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Conventional deterministic scheduling is less adaptive in managing climate uncertainty. This research aims to evaluate the time performance and structural stability of Retaining Walls (RW) at Pandanaran Avenue, Semarang, using a quantitative approach based on Monte Carlo Simulation. Geotechnical parameters were identified through laboratory testing, while weather risks were derived from GPM-IMERG satellite data (2005–2024) using the Weibull method to establish a Triangular Distribution across 10,000 simulation iterations.

Laboratory results classified the excavated soil as medium-plasticity Silty Clays (c = 18 kPa, φ = 32.74°, PI = 8,23%). Based on SNI 8460:2017 calculations, the Type C RW was declared stable, whereas Types A and B were unstable, requiring foundation base widening to 2,400 mm and 3,800 mm, respectively. Schedule analysis shows that the initial plan of 77 working days shifted to a simulation average of 106 days (+37.7%). At a 90% confidence level (P90), the recommended safe duration is 122 days.

The actual physical realization in the field reached 142 days, exceeding the simulation's pessimistic limit (136 days). This gap proves that the cumulative delay was not only triggered by hydrometeorological constraints but also by other factors such as internal operational inefficiencies of labor and heavy equipment. This study recommends implementing a scientific time buffer as a foundation for project delay risk mitigation.

Keywords : *Retaining Wall, Monte Carlo Simulation, Probabilistic Scheduling, Rainfall Risk, Time Buffer.*

ABSTRAK

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Program Studi	:	Rekayasa Infrastruktur & Lingkungan
Judul	:	Evaluasi Kinerja Waktu Proyek Dinding Penahan Tanah Berbasis Simulasi Monte Carlo dengan Variabel Risiko Curah Hujan (Studi Kasus: Pandanaran Avenue, Semarang)
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Penjadwalan deterministik konvensional kurang adaptif dalam mengatasi ketidakpastian iklim. Penelitian ini bertujuan mengevaluasi kinerja waktu dan stabilitas struktur Dinding Penahan Tanah (DPT) di Pandanaran Avenue, Semarang, menggunakan pendekatan kuantitatif berbasis Simulasi Monte Carlo. Parameter geoteknik diidentifikasi melalui uji laboratorium, sementara risiko cuaca diturunkan dari data satelit GPM-IMERG (2005–2024) dengan metode Weibull untuk membentuk Distribusi Triangular dalam 10.000 iterasi simulasi.

Hasil laboratorium mengklasifikasikan tanah galian sebagai Lempung Berlanau berplastisitas medium (c = 18 kPa, φ = 32,74°, IP = 8,23%). Berdasarkan perhitungan SNI 8460:2017, DPT Tipe C dinyatakan stabil, sedangkan Tipe A dan B tidak stabil sehingga memerlukan pelebaran dasar fondasi masing-masing menjadi 2.400 mm dan 3.800 mm. Analisis penjadwalan menunjukkan rencana awal 77 hari kerja bergeser menjadi rata-rata hasil simulasi 106 hari (+37,7%). Pada tingkat kepercayaan 90% (P90), durasi aman yang direkomendasikan adalah 122 hari.

Realisasi fisik aktual di lapangan mencapai 142 hari, melampaui batas pesimis simulasi (136 hari). Kesenjangan ini membuktikan bahwa keterlambatan kumulatif tidak hanya dipicu kendala hidrometeorologi, melainkan oleh faktor lain seperti inefisiensi operasional internal tenaga kerja dan alat berat. Penelitian ini merekomendasikan penerapan cadangan waktu ilmiah (scientific time buffer) sebagai landasan mitigasi risiko penundaan proyek.

Kata kunci : Dinding Penahan Tanah, Simulasi Monte Carlo, Penjadwalan Probabilistik, Risiko Curah Hujan, Time Buffer.