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Risk Management of Reclamation Works Using CPM Method Based on Green Construction for The Patimban Port Project Phase 1-2

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ABSTRACT

Reclamation works employing the Cement Pipe Mixing (CPM) method in the Phase 1–2 Patimban Port Project involve environmental risks that may affect water quality, material efficiency, ecosystems, project cost, and schedule. This study aims to identify environmental risks, develop Green Construction-based risk treatments, and evaluate their implications for the Work Breakdown Structure (WBS), project schedule, cost, and implementation feasibility compared with the existing CPM approach. A mixed-methods approach based on ISO 31000:2018 was employed through stakeholder identification, identification of 30 environmental risks, development of a risk register, determination of mitigation measures, and formulation of a Green WBS, Green Schedule, and Green Cost. The analysis also compares the resulting Delta Cost and Cost of Risk. The findings indicate that the most significant risks occur during the Dredging and Pipe Mixing stages, with marine water quality representing the largest risk category at 33%. The integration of Green Construction introduces preventive controls, including silt curtains, real-time turbidity monitoring, leak detection, material loss control, emission monitoring, and waste management, without altering the fundamental CPM construction method. The main finding shows that project duration increases from 164 to 175 days, while cost increases from IDR 680.124 billion to IDR 684.304 billion. The resulting Delta Cost is IDR 4.18 billion, equivalent to 0.61% of the baseline cost, compared with an estimated Risk Treatment cost of IDR 8.065 billion. Thus, Green Construction is considered economically feasible on an indicative basis, as the additional mitigation cost is lower than the estimated risk-treatment consequence. The integrated framework also strengthens environmental risk control and supports the principles of SDGs 9, 12, 13, and 14.

Keywords: Green Construction; Cement Pipe Mixing; Risk Management; Cost Of Risk

INTRODUCTION

Ports play a strategic role in supporting national economic growth and international trade logistics by serving as multimodal transportation nodes, goods distribution centers, and connections between maritime and terrestrial transport modes (Triatmodjo, 2009; Republic of Indonesia, 2008). In Indonesia's national infrastructure development agenda, Patimban Port, located in Subang Regency, West Java, stands as a designated National Strategic Project (PSN) designed to expand logistics capacity and enhance supply chain efficiency through the construction of container terminals and offshore reclamation areas (Japan International Cooperation Agency [JICA], 2017).

Technically, the seabed morphology at the site is dominated by soft marine clay layers characterized by extremely low shear strength (c_u), high compressibility, and low permeability. Consequently, unconditioned dredged soil requires specialized ground improvement technology before it can meet structural requirements for reclamation fill (Kitazume & Terashi, 2013).

To overcome these geotechnical constraints efficiently, the Cement Pipe Mixing (CPM) method was deployed in Package 6 (Container Terminal No. 2) of Patimban Port Phase 1–2. CPM is an innovative soil improvement technology that recycles soft marine clay dredged during basin excavation by blending it with hydraulic binders (slag cement slurry) directly inside floating pipeline networks via high-energy turbulent flow ($Re > Re_{cr}$) (Dong, 2023; Kitazume, 2016). The stabilized soil produced is directly placed into the reclamation containment area up to the target design elevation (LWS) above the underlying Cement Deep Mixing (CDM) foundation columns (Penta-Ocean Construction, 2022). CPM integrates dredging, mixing, material transport, and stable fill placement into an efficient operational sequence, eliminating the need for land-based borrow aggregate imports and long consolidation waiting periods (JICA, 2017; Kitazume & Terashi, 2013).

Despite these technical and material reuse benefits, large-scale offshore reclamation operations pose substantial environmental risks to coastal marine ecosystems and nearby communities. Dredging activities, material transport, high-pressure slurry mixing, placing operations, and fleet machinery operations generate suspended sediment plumes (Total Suspended Solids / TSS), elevate marine turbidity, and introduce risks of slurry leakage, cement washout, greenhouse gas (GHG) emissions, and hazardous waste streams (Kusuma, 2020; Setianingrum, 2018). Furthermore, coastal reclamation can create socio-economic interest friction among governmental authorities, project contractors, local fishing associations, and coastal communities regarding marine space utilization (Pratiwi et al., 2020).

These conditions highlight the critical necessity of applying the Green Construction approach to CPM operational management. Green Construction emphasizes resource efficiency, waste minimization, emission control, energy optimization, and ecosystem preservation during project execution without compromising structural quality or safety (Glavinich, 2008; Ervianto, 2012; Peginusa et al., 2024). In CPM works, these principles are operationalized through binder dosage optimization, material loss control, fuel tracking, emission monitoring, slurry collection, and marine water quality protection (Dahana et al., 2024).

However, implementing Green Construction interventions incurs additional capital expenditures ($Cost_{GC}$) due to monitoring equipment procurement, specialized environmental labor, testing, and waste management. Evaluating its feasibility requires factoring in regional cost dynamics via the Construction Cost Index (IKK) (Central Statistics Agency [BPS], 2025) and operational expenditure structures (Siddiq & Ashad, 2022). Rather than assessing sustainability interventions purely as an added cost burden, project management frameworks like ISO 31000:2018 and the PMBOK Guide emphasize evaluating proactive risk treatments against potential unmitigated risk event exposures ($Risk_{exposure}$) (ISO, 2018; PMI, 2017, 2021).

While literature exists on CPM geotechnical mechanics (Kitazume, 2016; Dong, 2023) and general green construction indicators (Farida et al., 2019), a critical research gap remains in systematically operationalizing risk management into a Work Breakdown Structure (WBS) and evaluating the economic trade-offs between direct Green Construction investment ($Cost_{GC}$) and quantified risk handling exposure ($Cost_{risk}$) for marine CPM reclamation (Zed, 2003; Fatimah, 2013).

Therefore, this study aims to:

1. Identify and map technical, environmental, and operational stakeholders and risks associated with CPM reclamation works at Patimban Port.
2. Formulate a Green Construction-based risk management framework by establishing structured risk treatments and transforming them into additional WBS work packages (Green WBS).
3. Evaluate the quantitative impacts of Green Construction on project scope, schedule (Critical Path Method), and total project cost.
4. Assess the economic feasibility ($Cost_{GC}$ vs. $Risk_{exposure}$) and sustainability contributions of integrating Green Construction into offshore reclamation.

RESEARCH METHODS

This study utilized a mixed-methods research design combining qualitative risk identification and quantitative schedule/cost modeling, adhering to ISO 31000:2018 Risk Management Guidelines and PMBOK (6th/7th Edition) standards (ISO, 2018; PMI, 2017, 2021).

Project Site and Data Collection

Secondary project data were retrieved from Package 6 (Container Terminal No. 2) bid documents, JICA detailed design reports, and baseline engineering studies (Syimah, 2025; JICA, 2017). Site parameters were established as follows:

1. Location: Patimban Village, Subang Regency, West Java ($06°14'$S, $107°54'$E).
2. Oceanographic Conditions: Mixed dominant semi-diurnal tide (Formzahl $F = 0.91$--1.49, tidal range 109.55 cm); mean significant wave height $H_s = 0.65$ m (operability threshold $H_{crit} \geq 1.0$ m exceeded 8.4% of the time); mean wind speed $V_w = 4.2$ m/s (threshold $V_{crit} \geq 10$ m/s exceeded 4.1% of the time) (Syimah, 2025).
3. Geotechnical Conditions: Soft marine clay upper layer (elevation -12.0 m to -24.0 m LWS, undrained shear strength $c_u < 15$ kPa) extracted as CPM feedstock; underlying stiff clay layers ($c_u \geq 60$ kPa, N-SPT > 20) supporting Cement Deep Mixing (CDM) foundation columns.

Cost Adjustments and Economic Assumptions

Baseline cost calculations and unit rates were calibrated from Ministry of Transportation Regulation PM No. 78/2014 and Ministry of PUPR Regulation No. 8/2023, adjusted to 2026 economic values using:

1. Cumulative inflation multiplier factor ($F_{inf} = 1.38$) based on Bank Indonesia annual rates (2016–2025).
2. Construction Cost Index / *Indeks Kemahalan Konstruksi* (IKK) for Subang Regency ($IKK = 0.982$ or 98.20%) (BPS, 2025).
3. Heavy equipment fuel consumption formulation ($Q_{fuel} = 0.15 \times HP \times LF$) using marine industrial diesel rate of IDR 21,150/liter, and lubricant rate ($Q_{lub} = 0.003 \times HP \times LF$) using IDR 58,000/liter (PUPR, 2023).

Stakeholder Mapping and Risk Breakdown Structure (RBS)

Stakeholders ($n = 18$) were categorized across four institutional domains: Internal–Internal, Internal–External, External–Internal, and External–External. Each entity was scored on *Impact of Change* (scale 1–10) and *Level of Influence* (scale 1–10) to generate an Impact vs. Influence Matrix, dividing parties into four engagement strategies: *Manage Closely*, *Keep Satisfied*, *Keep Informed*, and *Monitor*.

Thirty ($n = 30$) environmental risks were systematically identified across five operational CPM stages: Mobilization, Dredging, Fracturing, Pipe Mixing, and Monitoring. Mitigations were formulated following the hierarchy of control and translated into additional WBS work packages (Green WBS).

Schedule and Cost Modeling

1. Volume Analysis: Total CPM reclamation volume was calculated from cross-sections C0-C0 through C6-C6 at $1{,}533{,}666.50$ m^3. Slag cement dosage was set at 95.0 kg/m^3 (theoretical demand $145{,}698.32$ tons; actual demand with 5% loss allowance $152{,}983.23$ tons).
2. Productivity & Fleet Modeling: Operational fleet modeling consisted of:
   a. 1 Grab Dredger (Harita88, 23 m^3 bucket capacity)
   b. 4 Hopper Barges ($2{,}000$ m^3 capacity, $1{,}600$ m^3 net operational load)
   c. 1 Fracturing Barge (PMI Fortuna)
   d. 1 Pumping Barge (Fujinmaru)
   e. 1 Cement Slurry Supply Barge (PM6001)
   f. 1 Placing Barge (Aura V)
   g. 6 Tugboats and 2 Anchor Boats
   h. 1,200 m HDPE floating pipeline network ($\emptyset 800$ mm)
   i. *Total production required 296 complete operational cycles.*
3. Network Scheduling: Network diagrams were modeled in Microsoft Project using Finish-to-Start (FS), Start-to-Start (SS), and Finish-to-Finish (FF) precedence relationships with lead/lag constraints to determine the project Critical Path.
4. Cost Framework: Direct and indirect costs were modeled by integrating baseline unit prices, green intervention overheads ($Cost_{GC}$), and probabilistic risk event exposures ($Risk_{exposure} = \sum P_i \times I_i$), enabling comparative cost-benefit evaluation between conventional baseline execution and Green Construction integration.

RESULTS AND DISCUSSION

Stakeholder Identification and Environmental Risk Mapping

The stakeholder evaluation mapped 42 entities across the project ecosystem. The *Manage Closely* group ($n = 11$ parties) comprises key decision-makers including JO WIKA–PTPP–Toa Corporation, Project Director, Project Manager, Construction Manager, HSE Department, QA/QC, Green Team, Commitment Making Officer (PPK), Directorate General of Sea Transportation, Ministry of Transportation, and Subang DLH. The *Keep Satisfied* group includes Virama Karya (Supervision Consultant), Yodya Karya (Design Consultant), KSOP Patimban, and Material Testing Labs, while local fishermen associations, community groups, and NGOs reside in the *Keep Informed* quadrant. Risk identification established 30 specific environmental risks across the five CPM operational sequences that presented in Table 1.

Table 1. Risk Recapitulation across Operational CPM Stages

Stage	Number of Risks	Dominant Risk Events	Primary Impact Category
Mobilization & Setup	4	Fleet GHG emissions (R_1), fuel spills (R_2), pipeline flange leaks (R_3), hydraulic oil leaks (R_4).	Air Quality & Marine Pollution
Dredging	8	Turbidity plumes (R_5), TSS elevation (R_6), benthic smothering (R_7), nekton disturbance (R_8), dredger emissions (R_9), sediment loss (R_{10}--R_{12}).	Water Quality (27%) & Ecosystems
Fracturing	4	Mixture non-homogeneity (R_{13}), excessive water draw (R_{14}), slurry overflow (R_{15}), transfer pipeline burst (R_{16}).	Resource Efficiency & Loss
Pipe Mixing & Placing	10	Volumetric material loss (R_{17}), cement dust (R_{18}), binder overconsumption (R_{19}), floating pipe rupture (R_{20}), misplacement (R_{21}), cement washout (R_{22}--R_{26}).	Materials (33%) & Quality
Monitoring & Governance	4	Fuel logging errors (R_{27}), stack emissions over limit (R_{28}), unmanaged B3 waste (R_{29}), lost environmental records (R_{30}).	Compliance & Admin (13%)
Total	**30**		

Categorically, marine water quality (27%) and material loss control (33%) represented the highest risk concentrations, confirming that unmonitored dredging and placement directly threaten marine turbidity and coastal ecology.

Integration of Risk Mitigation into Green Construction Framework

Rather than altering the primary mechanical soil improvement sequence, risk treatments were converted into explicit work packages and embedded directly into the Work Breakdown Structure (Green WBS). This operational transformation (Risk Mitigation → Green WBS) represents a key core novelty of this research.

New work packages integrated into the scope include fuel tracking, carbon footprint auditing, silt curtain deployment, real-time turbidity telemetry logging, benthic habitat monitoring, water recycling, automated leak detection sensor checks, slurry collection, stack emission testing, B3/non-B3 waste management, and Environmental KPI Dashboards. The baseline WBS comprising 54 activities was expanded to 123 activities (+69 sustainability activities).

The Influence of Green Construction on WBS and Project Schedule

In the baseline scenario, total execution time for CPM reclamation was calculated at 164 calendar days (28 days for system mobilization/installation and 135.99 days for 296 placement cycles). Integrating Green Construction activities expanded total project duration to 175.00 days (an addition of 11.01 days or +6.71%). Mandatory sequential inspection gates (e.g., silt curtain positioning, hydrotests, and compliance sign-offs) added net critical path time. However, because continuous environmental monitoring (water quality sampling, fuel logging, emission tracking) was scheduled in parallel using Start-to-Start (SS) and Finish-to-Finish (FF) precedence logic, critical path disruption was minimized.

Table 2. Comparison of CPM Project Schedules

Schedule Parameter	Baseline CPM	Green Construction CPM	Variance (Δ)
Project Duration	164 days	175.00 days	+11.01 days (+6.71%)
Dominant Precedence	Finish-to-Start (FS)	Integrated FS, SS, FF	Parallel monitoring
Critical Path Impact	Unmitigated execution	Controlled inspection gates	Controlled path shift

This finding demonstrates that sustainability interventions do not inherently cause severe project delays when task dependencies are designed in parallel.

The Effect of Green Construction on Costs and Cost of Risk

The baseline execution cost for conventional CPM was calculated at IDR 680,124,405,827.64, dominated by slag cement material (IDR 243.81 billion), Pumping Barge operations (IDR 142.65 billion), and Cement Slurry Supply Barge operations (IDR 92.23 billion).

Direct environmental mitigation interventions ($\Delta Cost_{GC}$) required an additional investment of IDR 4,180,000,000.00, raising total Green Construction execution costs to IDR 684,304,405,827.64 (+0.61% budget increase over baseline). To evaluate economic rationality, potential unmitigated risk event consequences ($Cost_{risk}$) were quantified across the 30 identified risk items. Quantified Risk is presented in Table 3.

Table 3. Quantified Risk Handling Consequence Exposure Breakdown

Risk Consequence Component	Quantified Exposure (IDR)	Proportion (%)
Material Loss & Sediment Recovery ($\boldsymbol{C_1}$)	2,120,000,000	26.29%
Additional Monitoring, Sampling & Lab Testing ($\boldsymbol{C_2}$)	1,750,000,000	21.70%
Construction Rework & Placing Misplacement ($\boldsymbol{C_3}$)	1,600,000,000	19.84%
Environmental Response, Cleanup & Waste Handling ($\boldsymbol{C_4}$)	1,400,000,000	17.36%
Equipment Corrective Maintenance & Emission Rectification ($\boldsymbol{C_5}$)	695,000,000	8.62%
Documentation, Re-auditing & Legal Compliance ($\boldsymbol{C_6}$)	500,000,000	6.20%
Total Risk Handling Consequence Cost ($\boldsymbol{Cost_{risk}}$)	**8,065,000,000**	**100.00%**

The synthesis of project cost parameters and feasibility metrics is summarized in Table 4.

Table 4. Comparison of Baseline CPM and Green Construction Costs

Indicator / Metric	Result / Value	Economic Interpretation
Baseline Cost (C_{base})	IDR 680.124 Billion	Standard CPM execution budget
Green Construction Cost (C_{GC})	IDR 684.304 Billion	Total project cost with mitigations
Delta Cost ($\Delta Cost$)	IDR 4.180 Billion	Direct investment in green interventions (+0.61%)
Risk Handling Consequence Cost ($Cost_{risk}$)	IDR 8.065 Billion	Quantified exposure from unmitigated risk events
Total Cost of Risk ($TCOR$)	IDR 12.245 Billion	Combined direct mitigation and risk exposure value
$\Delta Cost/Cost_{risk}$ Ratio	0.518 (51.8%)	Mitigation cost is 51.8% of prevented risk exposure

Spending IDR 4.180 billion on direct Green Construction controls prevents an estimated IDR 8.065 billion in potential risk handling, cleanup, rework, and delay expenses. Because $\Delta Cost < Cost_{risk}$ (Benefit-to-Cost Ratio $= 1.93$), the implementation of Green Construction is indicatively cost-justified and economically feasible.

Comparison with Previous Research and Research Novelty

A critical review against literature confirms that previous studies evaluated these dimensions in isolation (Table 5).

Table 5. Research Position Against Previous Literature

Research	Main Focus	Similarities	Differences / Advancement in This Study
Chai Kian Hoon (2006)	Coastal reclamation environmental impact	Discusses environmental impacts	Did not integrate risks into WBS, CPM schedules, or cost models.
Kazemian & Huat (2009)	Soil improvement injection methods	Technical and cost evaluation	Did not focus on Green Construction or CPM risk management.
Pioch et al. (2011)	Green marine construction	Marine ecological integration	Did not quantify mitigation impacts on Critical Path Method or Cost of Risk.
Johansen et al. (2014)	Uncertainty management frameworks	Risk identification & response	Did not apply risk responses directly into CPM reclamation WBS.
de Vriend et al. (2014)	*Building with Nature* hydraulic infrastructure	Sustainability orientation	Did not evaluate trade-offs between Delta Cost and Cost of Risk.
JICA (2017)	Technical baseline for Patimban Port	CPM productivity & schedules	Serves as technical baseline; this study adds Green Construction & ISO 31000 risk controls.
This Study	**CPM–Green Construction–Risk Integration**		**Integrates risks, Green WBS, schedule, costs, Delta Cost, and Cost of Risk into one framework.**

Evaluation of Method, Hypothesis, and Follow-Up

The research methodology successfully resolved the problem statement by producing an integrated risk register, stakeholder matrix, Green WBS, S-curve schedule, Delta Cost, and Cost of Risk evaluation without replacing core CPM ground improvement mechanics.

The initial hypothesis stated that Green Construction would yield lower risk exposure and an economically rational Delta Cost compared to prevented risk costs. The findings confirm that risk management capacity and environmental governance were enhanced. Economically, because direct mitigation investment ($\Delta Cost =$ IDR 4.180 B) is substantially lower than prevented risk handling consequences ($Cost_{risk} =$ IDR 8.065 B), the economic feasibility hypothesis is confirmed.

However, because probability levels before and after mitigation were not empirically measured in the field, quantitative risk score reduction remains an indicative finding. Future research should utilize empirical field telemetry (actual fuel burn rates, measured plume dispersion, exact downtime frequencies) to perform Monte Carlo probabilistic risk modeling and multi-objective optimization balancing cost, duration, carbon footprint, and marine ecosystem impact simultaneously.

CONCLUSIONS AND SUGGESTIONS

This study successfully identified 42 project stakeholders mapped into four engagement quadrants and established 30 dominant environmental risks across five Cement Pipe Mixing (CPM) operational stages, where marine water quality (27%) and material loss control (33%) represented the primary risk burdens. By integrating Green Construction principles into the operational sequence, structured preventive controls such as silt curtain deployment, real-time turbidity sensors, slurry leak detection, and stack emission logging were established without disrupting core geotechnical mixing procedures. This systematic transformation expanded the baseline Work Breakdown Structure from 54 activities to 123 activities, incorporating 69 dedicated sustainability work packages.

From a project scheduling perspective, the Green Construction scenario expanded overall execution duration from 164 days to 175 days, representing an increase of 11 days (+6.71%). This schedule variance remained well-controlled because continuous environmental monitoring tasks were scheduled in parallel using Start-to-Start (SS) and Finish-to-Finish (FF) precedence logic, avoiding severe disruptions to the critical path. Financially, direct green implementation expenditures ($\Delta Cost$) were quantified at IDR 4.180 billion, which represents a modest 0.61% addition over the IDR 680.124 billion baseline budget. Because this preventive investment is substantially lower than the quantified unmitigated risk handling consequence exposure of IDR 8.065 billion (resulting in a Total Cost of Risk of IDR 12.245 billion and a Benefit-to-Cost Ratio of 1.93), the application of Green Construction in offshore reclamation is proven to be indicatively cost-justified, economically sound, and essential for marine environmental governance.

Based on these findings, future port reclamation projects should embed Green WBS packages, environmental check-point gates, and compliance milestones directly into baseline tender documents and the Bill of Quantities (BOQ) to ensure contractual enforcement. Project execution teams are encouraged to implement advanced IoT-enabled instrumentation, such as real-time water turbidity telemetry, automated pipeline leak detection sensors, and digital fuel flow meters, to streamline continuous field data collection. Furthermore, subsequent academic research should utilize empirical field telemetry to execute quantitative probabilistic risk modeling via Monte Carlo simulations and conduct multi-objective optimization balancing project cost, construction duration, carbon footprint, and marine ecosystem preservation simultaneously.

BIBLIOGRAPHY

Badan Pusat Statistik (BPS), 2025. *Provincial and Regency/City Construction Cost Index 2025*, vol. 16. Jakarta, Indonesia: BPS.

Chapman, C. & Ward, S., 2000. Estimation and evaluation of uncertainty: a minimalist approach. *International Journal of Project Management*, 18(6), pp. 369–379.

Dahana, P. A. et al., 2024. Study on Construction Waste Management in the Construction Project of the Nurul Huda Integrated Roudlatul Ulum Building, Kudus Regency. *Indonesian Journal of Civil Engineering Study*, 1(1), pp. 26–35.

de Vriend, H. J. et al., 2014. Sustainable hydraulic engineering through building with nature. *Journal of Hydro-Environment Research*, 8(3), pp. 159–171.

Dong, L. P., 2023. *Cement Deep Mixing (CDM) and Cement Pipe Mixing (CPM) in Patimban Port Development Project*. Tokyo, Japan: Oriental Consultants Global, Tech. Rep.

Ervianto, W. I., 2012. *Selamatkan Bumi Through Green Construction*. Yogyakarta: Andi Offset.

Farida, N., Handayani, N. U. & Wibowo, M. A., 2019. Developing indicators of green construction of green supply chain management in construction industry: A literature review. *IOP Conference Series: Materials Science and Engineering*, 598, p. 012021.

Fatimah, S., 2013. Literature Study Methods in Qualitative Research. *Journal of Education Policy and Development*, 1(1), pp. 15–26.

Glavinich, T. E., 2008. *Contractor's Guide to Green Building Construction: Management, Project Delivery, Documentation, and Risk Reduction*. Hoboken, NJ: John Wiley & Sons.

International Organization for Standardization (ISO), 2018. *ISO 31000:2018 Risk Management — Guidelines*. Geneva, Switzerland: ISO.

Japan International Cooperation Agency (JICA), 2017. *Preparatory Survey on Patimban Port Development Project: Final Report*. Tokyo, Japan: JICA.

Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR), 2021. *Peraturan Menteri PUPR Nomor 9 Tahun 2021 tentang Pedoman Penyelenggaraan Konstruksi Berkelanjutan*. Jakarta: Kementerian PUPR.

Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR), 2023. *Peraturan Menteri PUPR Nomor 8 Tahun 2023 tentang Pedoman Penyusunan Perkiraan Biaya Pekerjaan Konstruksi Bidang Pekerjaan Umum dan Perumahan Rakyat*. Jakarta: Kementerian PUPR.

Kementerian Perhubungan, 2014. *Peraturan Menteri Perhubungan Nomor PM 78 Tahun 2014 tentang Standar Biaya di Lingkungan Kementerian Perhubungan*. Jakarta: Kementerian Perhubungan.

Kitazume, M., 2016. Ground improvement by cement mixing for port and harbor structures. *Geotechnical Engineering Journal of the SEAGS & AGSSEA*, 47(4), pp. 1–12.

Kitazume, M. & Terashi, M., 2013. *The Deep Mixing Method*. London, UK: CRC Press.

Kusuma, 2020. Distribution of Water Quality in the North Coast of Jakarta 2020. *Journal of Fisheries and Marine Technology*, 11(2), pp. 149–159.

Peginusa, S. S. et al., 2024. Bibliometric analysis for the development of research related to green construction. In *Proceedings of the National Seminar on Vocational Superior Applied Products*, 1(1), pp. 281–289.

Penta-Ocean Construction Co., Ltd., 2022. *Technical Method Statement: Cement Pipe Mixing (CPM) Method for Reclamation*. Tokyo: Penta-Ocean Construction.

Pioch, S. et al., 2011. Green marine construction. *Ecological Engineering*, 37(12), pp. 1950–1958.

Pratiwi, A., Harini, I. S. & Adi, D. P., 2020. Analysis of Transnationalism in Global Capitalism: A Case Study of the Rejection of the Reclamation of Benoa Bay in Nusa Bali. *Adz Dzahab: Journal of Islamic Economics and Business*, 5(1), pp. 10–21.

Project Management Institute (PMI), 2017. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 6th ed. Pennsylvania, USA: PMI.

Project Management Institute (PMI), 2021. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 7th ed. Pennsylvania, USA: PMI.

Republic of Indonesia, 2008. *Law Number 17 of 2008 concerning Shipping*. Jakarta: State Secretariat.

Setianingrum, 2018. Marine and Coastal Resources Sustainability Index at the Reclamation Site of Benoa Bay, Bali. *National Journal of Marine Science*, 13(3), pp. 121–136.

Siddiq, R. & Ashad, H., 2022. A Study of Passenger Fare Costs and Vehicle Operations on Public Interest in Using Mamminasata Buses in Makassar City. *Journal of Construction: Engineering, Infrastructure and Science*, 1(9), pp. 12–23.

Syimah, N. J., 2025. *Perencanaan Manajemen Proyek Konstruksi Terminal Peti Kemas No. 2 Pelabuhan Patimban Tahap 1-2 Paket 6*. Master's Thesis, Institut Teknologi Bandung, Indonesia.

Tah, J. H. M. & Carr, V., 2000. Information modelling for a construction project risk management system. *Advances in Engineering Software*, 31(8-9), pp. 509–521.

Triatmodjo, B., 2009. *Port Planning*. Yogyakarta, Indonesia: Beta Offset.

Zed, M., 2003. *Literature Research Methods*. Jakarta, Indonesia: Yayasan Obor Indonesia.