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Standard Operating Procedures for Tugboat Clearance and Service Enhancement at Jepara Port

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Abstract. *Background: Clearance in and clearance out procedures are critical components of port operations that directly affect service quality, vessel turnaround time, and port sustainability. Jepara Port, as a regional hub, faces challenges in implementing effective clearance procedures for tugboats, notably TB. Bintang Harbour 4009, operated by PT. Sinar Bintang Samudera. Original value: Prior research has extensively examined container terminal performance and green port policies, but limited studies address tugboat clearance processes in smaller regional ports, despite their strategic role in supporting larger maritime logistics chains and sustainable port development frameworks. Objectives: This research investigates the clearance in/out procedures at Jepara Port, analyzes their influence on service quality, and evaluates whether adherence to SOPs can enhance efficiency and sustainability within the context of integrated maritime policy frameworks. Methodology: A qualitative descriptive approach was employed, using semi-structured interviews, questionnaires, direct observations, and document analysis. Data were analyzed through thematic analysis, cross-group comparisons, and narrative synthesis, incorporating sustainability assessment frameworks. Results: Findings revealed that while SOPs exist, their implementation is hindered by documentation errors, inconsistent inter-agency coordination, and partial digitalization. These issues contribute to prolonged clearance times and reduced compliance rates. However, improvements in first-time-right documentation and single-channel digital communication were shown to significantly enhance clearance performance and environmental outcomes. Conclusions: Clearance procedures are more than administrative requirements; they are strategic levers for port service quality, sustainability, and maritime vocational education. Strengthening these procedures can improve efficiency, reduce emissions, enhance port resilience, and support sustainable maritime development goals.*

Keywords: *Jepara Port; Maritime Sustainability; Port Resilience; Service Quality; SOP; Tugboat Clearance*.

1. INTRODUCTION

The maritime industry plays a pivotal role in global economic development, with ports serving as the critical nodes of international trade and transportation. Within this system, clearance procedures—both in and out—are essential for the efficient functioning of port operations and sustainable maritime development. These processes regulate vessel entry and departure, ensuring compliance with safety, security, and administrative requirements while contributing to broader sustainability objectives (Caldeirinha et al., 2024; Zhou et al., 2024).

Despite being viewed as routine, the clearance process has profound implications for vessel turnaround time, port competitiveness, environmental performance, and sustainability outcomes. Tugboats, while auxiliary in nature, are integral to these operations as they enable larger vessels to berth, maneuver, and depart efficiently while minimizing environmental impact through optimized movements (Du et al., 2023). For ports like Jepara in Indonesia,

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tugboat clearance procedures are central to service quality, operational reliability, and sustainable port development.

Inefficiencies in clearance procedures have long been recognized as systemic obstacles in port performance and sustainability achievement. According to Qi, Wang, and Zheng (2022), paperwork-intensive procedures often create delays, raising costs for shipping companies and reducing port competitiveness while increasing vessel idle time and associated emissions. Similarly, Zhou et al. (2024) emphasize that administrative efficiency is as critical as infrastructure in sustaining port performance and achieving green port objectives. Kim et al. (2021) further highlight that port resilience depends significantly on efficient operational procedures and stakeholder coordination.

The integration of sustainable practices into port operations has become increasingly important, with environmental considerations now forming a core component of port management strategies (Liao & Lee, 2023). Digital transformation initiatives, as discussed by recent research on port automation and digitalization, demonstrate the potential for technology-enhanced clearance procedures to improve both efficiency and environmental outcomes (Kim et al., 2022). However, in developing maritime regions, these inefficiencies are magnified due to resource limitations, fragmented digital adoption, and inconsistent coordination between port stakeholders.

Jepara Port provides an illustrative case where tugboat clearance processes can determine whether vessels experience timely service or costly delays, directly impacting both operational efficiency and environmental performance. The port's strategic position within Indonesia's maritime network makes it a critical case study for understanding how clearance procedures affect regional maritime logistics and sustainability goals (Paridaens & Notteboom, 2021).

The central problem addressed in this study is the limited efficiency and inconsistency in the clearance in and clearance out procedures for tugboats at Jepara Port, specifically TB. Bintang Harbour 4009. Although SOPs exist, preliminary insights suggest gaps between formal procedures and actual practice, resulting in bottlenecks, delays, service dissatisfaction, and potential negative environmental impacts from extended vessel waiting times.

The research questions guiding this inquiry are: (1) What are the actual clearance in procedures for tugboats at Jepara Port? (2) What are the clearance out procedures and their environmental implications? (3) How do these procedures influence service quality and sustainability outcomes at the port? (4) What role do digitalization and coordination play in procedure effectiveness?

The study objectives are fourfold: to systematically document clearance procedures, to evaluate their impact on service delivery and operational performance, to assess their contribution to sustainability goals, and to propose improvements for sustainable and efficient implementation within integrated maritime policy frameworks. These objectives align with broader maritime research agendas that prioritize port governance reform, service quality improvement, sustainability integration, and resilience building (Paridaens & Notteboom, 2021; Caldas, Pedro, & Marques, 2024; Kim et al., 2021).

The significance of this study lies in its contribution to four interlinked domains. First, it informs port and shipping management by identifying clearance inefficiencies and proposing targeted solutions that enhance both operational and environmental performance. Second, it enriches maritime vocational education by providing cadets and researchers with empirical evidence of clearance processes and their sustainability implications. Third, it advances sustainability discourse by linking clearance efficiency with reduced emissions from idle vessels, improved port governance, and resilience building. Fourth, it contributes to the understanding of digital transformation in port operations and its role in achieving sustainable development goals (Mwendapole & Jin, 2021; Liao & Lee, 2023).

2. RESEARCH METHOD

This study employed a qualitative descriptive methodology, designed to capture the complex experiences and practices associated with tugboat clearance at Jepara Port while incorporating sustainability assessment frameworks. The research approach aligns with contemporary maritime research methodologies that emphasize stakeholder engagement and sustainability evaluation (Kim et al., 2021; Zhou et al., 2024).

The population of the study consisted of stakeholders directly involved in clearance procedures, including ship officers of TB. Bintang Harbour 4009, PT. Sinar Bintang Samudera operations staff, port agents, Harbor Master and KSOP officials, terminal representatives, and environmental compliance officers. These respondents were selected purposively, as they represented the individuals most knowledgeable about clearance operations and their sustainability implications. Snowball sampling further allowed participants to recommend additional informants, ensuring a diverse set of perspectives including those related to environmental management and digital transformation initiatives.

The primary instruments were semi-structured interviews, structured questionnaires, observation checklists, and sustainability assessment tools. Independent variables included SOP clarity, documentation completeness, inter-agency coordination, digital adoption levels,

and environmental compliance procedures, while dependent variables were defined as service quality, efficiency, and sustainability performance indicators.

Key performance indicators comprised: (a) Service Performance Indicator (SPI), which measured median clearance times. (b) Process Compliance Indicator (PCI), which tracked first-time-right documentation rates. (c) Environmental Impact Indicator (EII), which assessed emissions from vessel waiting times. (d) Digital Adoption Index (DAI), which measured technology integration levels. (e) Stakeholder Satisfaction Index (SSI), which evaluated service quality perceptions

Interviews explored clearance steps, bottlenecks, digitalization challenges, and sustainability considerations, while questionnaires operationalized these into measurable items on Likert scales. Observational checklists recorded timestamps and delays in clearance cycles, environmental impact indicators, and digital system utilization patterns. Supporting instruments included SOP manuals, clearance documentation, environmental management protocols, and digital system logs.

Data collection proceeded in five stages, incorporating sustainability assessment protocols. Ethical approvals and consent were secured, followed by pilot interviews to refine the instruments and validate sustainability metrics. The main phase involved 24 interviews, 35 questionnaires, eight complete clearance cycle observations, and environmental impact assessments. Supplementary data came from document reviews and digital system analytics. This enhanced triangulation ensured reliability and validity while capturing both operational and environmental dimensions.

Data analysis was conducted using thematic coding, refined into axial categories with particular attention to sustainability themes. A reliability check on 25% of transcripts achieved Cohen's Kappa above 0.75. Themes were organized into clusters related to competence development, sustainability, digital transformation, and stakeholder coordination, with cross-group comparisons highlighting both commonalities and divergences. Narrative synthesis then integrated these findings into a cohesive account that addresses both operational efficiency and environmental sustainability.

3. RESULTS AND DISCUSSION

Quantitative Indicators of Clearance Performance

Four key indicators were measured: Service Performance Indicator (SPI), Process Compliance Indicator (PCI), Environmental Impact Indicator (EII), and Digital Adoption Index (DAI).

Table 1. Enhanced Clearance Performance Indicators.

Indicator	Measurement	Result	Benchmark	Interpretation
SPI (In)	Median time from arrival to clearance in (hours)	6.5	≤5	Above SLA, showing inefficiency
SPI (Out)	Median time from clearance request to departure approval (hours)	7.2	≤5	Prolonged turnaround
PCI	% of documents accepted first-time-right	68%	≥90%	High rate of rework
EII	CO_2 emissions from waiting vessels (kg/clearance)	145	≤100	Environmental impact concern
DAI	% digital process integration	54%	≥90%	Partial adoption, redundancy
SSI	Stakeholder satisfaction (Likert 1-5)	3.2	≥4	Moderate satisfaction

Findings show clearance times consistently exceed the desired five-hour benchmark, largely due to documentation rework and inconsistent coordination. The environmental impact indicator reveals significant CO_2 emissions from vessels waiting for clearance, highlighting the sustainability implications of procedural inefficiencies (Liao & Lee, 2023).

Thematic Results from Interviews and Observations

Qualitative thematic analysis produced six key themes, incorporating sustainability and digital transformation dimensions:

Table 2. Enhanced Thematic Insights from Stakeholder Interviews.

Theme	Description	Illustrative Evidence	Sustainability Link
SOP clarity vs. practice divergence	SOPs exist, but staff adapt them situationally	"Steps are clear on paper, but after-hours shifts create improvisation."	Inconsistency affects environmental compliance
Documentation loops	Frequent errors and mismatched attachments require re-submissions	"Safety certificate dates often mismatch with electronic files."	Delays increase vessel emissions
Coordination breakdowns	Delays occur at handoffs, not at approvals	"Most waiting is for corrections, not actual sign-off."	Poor coordination wastes resources
Partial digitalization	PCS exists but parallel channels persist	"We still send via WhatsApp to be safe."	Digital gaps reduce efficiency

Theme	Description	Illustrative Evidence	Sustainability Link
Environmental awareness gaps	Limited integration of environmental considerations	"Environmental impact isn't measured in clearance time."	Missing sustainability metrics
Service quality impact	Clearance delays affect overall port performance	"If clearance is late, berthing schedules slip, affecting carriers."	Cascading effects on port sustainability

Cross-Group Comparisons

Perspectives differed across groups of respondents, with enhanced focus on sustainability and digital transformation:

Table 3. Enhanced Cross-Group Comparison of Perspectives.

Stakeholder Group	Key Concerns	Sustainability Focus	Digital Readiness
Ship officers	Ambiguity of document priorities; delays impact schedules	Limited awareness of environmental impact	Moderate, prefer traditional methods
Port agents	High rework from incomplete submissions	Growing interest in green processes	High, advocate for digital solutions
Port authority staff	Coordination gaps and resource limitations	Responsible for environmental compliance	Variable, depends on training
PT. Sinar Bintang Samudera staff	Compliance with SOPs but lack of predictability	Company sustainability commitments	High, driven by efficiency needs
Environmental officers	Integration of environmental protocols	Central focus on emissions reduction	High, use digital monitoring tools

Discussion

These results directly address the four research questions while providing enhanced insights into sustainability and digital transformation aspects. First, clearance in/out procedures at Jepara Port follow formal SOPs but diverge in practice due to inconsistent enforcement, limited environmental integration, and partial digital adoption. Second, inefficiencies stem from recurrent documentation errors, coordination lapses, and insufficient sustainability consideration. Third, clearance activities have measurable impacts on both service quality and environmental performance, as delays ripple into berthing schedules, increase emissions, and affect overall port sustainability. Fourth, digitalization remains incomplete, creating parallel systems that reduce efficiency and environmental benefits.

The study confirms prior findings that administrative inefficiencies, especially paperwork errors and fragmented communication, are central obstacles to port service quality and sustainability achievement (Qi et al., 2022; Mwendapole & Jin, 2021; Zhou et al., 2024). It extends the literature by applying these observations to tugboat operations in a regional port context, demonstrating their strategic importance for both operational efficiency and environmental performance.

The environmental impact findings align with recent research on green port policies and sustainable maritime operations (Liao & Lee, 2023; Du et al., 2023). The 145 kg CO_2 per clearance cycle represents a significant environmental cost that could be reduced through procedural improvements and digital integration. This supports the argument for viewing clearance procedures as environmental management tools rather than purely administrative requirements.

The partial digitalization results echo findings from port automation studies (Kim et al., 2022), demonstrating that technology adoption without comprehensive governance creates inefficiencies. The 54% digital adoption rate indicates substantial room for improvement, particularly in integrating environmental monitoring and stakeholder coordination systems.

Port resilience considerations, as highlighted by Kim et al. (2021), are evident in the coordination breakdown theme, where procedural inconsistencies create vulnerabilities in port operations. The study suggests that strengthening clearance procedures contributes to overall port resilience and sustainability.

The research also highlights methodological strengths, including enhanced triangulation with sustainability metrics, multi-stakeholder engagement incorporating environmental perspectives, and applied relevance for maritime vocational education. Limitations include the single-port scope and reliance on qualitative self-reporting for some environmental indicators, suggesting future research could employ IoT sensors for real-time emissions monitoring or compare multiple Indonesian ports using standardized sustainability frameworks.

4. CONCLUSION

This study critically evaluated tugboat clearance procedures at Jepara Port, focusing on TB. Bintang Harbour 4009, with enhanced attention to sustainability and digital transformation dimensions. Results revealed inefficiencies caused by documentation errors, inconsistent coordination, partial digitalization, and limited environmental integration, with clearance times exceeding desired benchmarks and generating significant environmental impacts.

The research demonstrates that clearance procedures are strategic levers for achieving multiple objectives: operational efficiency, service quality, environmental sustainability, and port resilience. The 145 kg CO_2 emissions per clearance cycle highlight the environmental cost of procedural inefficiencies, while the 68% first-time-right documentation rate indicates substantial room for improvement in both efficiency and sustainability outcomes.

Key findings include: (1) SOPs exist but require better integration of environmental considerations and digital tools; (2) coordination gaps create both operational delays and environmental impacts; (3) partial digitalization reduces potential efficiency and sustainability gains; (4) stakeholder awareness of environmental implications remains limited; (5) targeted improvements in documentation integrity and digital governance can significantly enhance both service quality and environmental performance.

The study contributes to four domains: port and shipping management through identification of efficiency and sustainability improvements; maritime vocational education through empirical evidence of modern clearance challenges; sustainability governance through linking operational procedures with environmental outcomes; and digital transformation understanding through analysis of technology adoption barriers and opportunities.

Future research should focus on developing integrated digital platforms that combine operational efficiency with real-time environmental monitoring, comparative studies across multiple Indonesian ports to identify best practices, and longitudinal assessments of sustainability improvements following procedural reforms. The urgency of reforming clearance procedures is underscored by the dual imperatives of operational efficiency and environmental responsibility in modern maritime operations.

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