The 8th Open Society Conference (OSC) 2026
Faculty of Law, Social and Political Science
Universitas Terbuka
DOI: doi.org/10.33830/osc.v4i1.9282/ ISSN: 3032-2227

Strengthening Digital Governance in Environmental Monitoring: Evaluating Transportation Agency Supervision of Ship Waste Management Compliance in Kubu Raya Regency

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Abstract

Ship waste management supervision is an important component of environmental governance, particularly in areas where rivers serve as major transportation routes. This study examines the strengthening of digital governance in ship waste management supervision in Kubu Raya Regency, West Kalimantan, as an effort to prevent water pollution. The study employed a qualitative approach with a descriptive evaluative design. Data were collected through in-depth interviews, observations, and documentation involving three informants from the Kubu Raya Regency Transportation Agency. Data were analyzed using the Context, Input, Process, and Product (CIPP) evaluation model developed by Stufflebeam. The results show that supervision has been conducted through monitoring, inspections, socialization, guidance, provision of waste facilities, and the issuance of warnings. However, its effectiveness remains suboptimal due to littering behavior, low compliance among passengers and ship operators, limited human resources and facilities, the absence of specific standard operating procedures (SOPs), regulatory limitation, fragmented interagency authority, and limited supervision of vessels operating in open waterways. Supervision is also still dominated by conventional mechanisms and has not been supported by an integrated digital system. The study concludes that strengthening supervision requires integrated digital governance through a database of vessels and waste facilities, e-monitoring, digital reporting, public complaint channels, interagency information integration, compliance indicators, and follow up management systems. Digital governance is expected to establish a more transparent, accountable, responsive, and sustainable supervision system to support the prevention of water pollution in Kubu Raya Regency.

Keywords: *CIPP evaluation, Digital governance, Ship waste management, Supervision, Water Pollution.*

INTRODUCTION

Supervision constitutes a fundamental component in promoting good governance, as it encompasses a range of activities, including monitoring, inspection, control, and the reporting of supervisory outcomes[1]. From the perspective of agency theory, the relationship between the government and society can be conceptualized as a principal agent relationship. Society, as the principal, delegates authority to the government, acting as the agent, to administer public affairs. However, differences in interests, information, and institutional capacity may create gaps between government actions and societal expectations. Therefore, supervision is necessary as a mechanism to ensure that the exercise of governmental authority remains aligned with the objectives, interest, and expectations of society[2]. In the context of environmental management, this supervisory

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DOI: doi.org/10.33830/osc.v4i1.9282/ ISSN: 3032-2227

function becomes increasingly important because the effectiveness of policies is determined not only by the existence of regulatory frameworks but also by the government's capacity to ensure compliance and follow up on various forms of violations.

The urgency of environmental supervision is particularly pronounced in regions that are highly dependent on aquatic resources. Nearly all provinces in Indonesia encompass water areas extending from upstream regions to coastal zones. Environmental degradation in upstream area, combined with the accumulation of waste transported downstream, can place considerable pressure on the quality of aquatic and coastal ecosystems[3]. These challenges become increasingly complex when waterways also serve as transportation routes for community mobility and the distribution of goods. West Kalimantan Province is one of the regions in Indonesia that continues to rely on rivers as important transportation routes[4]. Accordingly, the intensity of water transportation activities needs to be accompanied by effective environmental management and supervision systems capable of preventing vessel generated waste from entering water bodies.

This condition is particularly relevant to the characteristics of Kubu Raya Regency, which has a relatively high level of river transportation activity. According to data from the Central Statistics Agency (BPS), port and pier facilities are distributed across all none sub districts, with a total of 275 piers. This distribution indicates the extensive coverage of the water transportation network, as well as the high level of interaction among vessels, passengers, operators, and communities living in surrounding waterway areas. One of the key facilities within this network is Rasau Jaya Ferry Port, which serves as a berthing facility for vessel, facilitates passenger embarkation and disembarkation, and supports cargo loading and unloading activities[5]. The intensity of the activities has the potential to generate waste from passengers, crew members, and transportation operations, thereby necessitating an effective and sustainable mechanism for monitoring and managing vessel generated waste.

Normatively, water transportation management and the prevention of vessel generated pollution are supported by an established regulatory framework. Minister of Transportation Regulation No. PM 61 of 2021 stipulates minimum services standards and operational seaworthiness requirements for vessels, including obligations to comply with safety provisions and prevent environmental pollution. At the international level, marine pollution from ships is regulated under the *International Convention for the Prevention of Pollution from Ships* (MARPOL), particularly Annex V, which specifically addresses the prevention of pollution caused by ship generated garbage. These provisions have subsequently been incorporated into the national regulatory framework through Minister of Transportation Regulation No. PM 29 of 2014 concerning the prevention of pollution in the maritime environment. The existence of these regulatory instruments indicates that the prevention of pollution arising from shipping activities has received substantial normative attention. However, the existence of regulations does not automatically

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DOI: doi.org/10.33830/osc.v4i1.9282/ ISSN: 3032-2227

guarantee the effectiveness of their implementation and enforcement in the field.

The gap between normative provisions and actual practices is evident in the conditions observed at Rasau Jaya Port. The intensity of activities and the high mobility of passengers and service users have the potential to generate significant amounts of waste, particularly food and beverage waste consumed during journeys or while users are within the port area. Moreover, according to an ANTARA News report published on March 26, 2026, passengers were still observed disposing of waste directly into the river during the visit of the Regent of Kubu Raya to Rasau Jaya Port. This condition indicates that the issue of vessel generated waste management is not solely related to the availability of regulations, but also to user compliance, the effectiveness of supervision, the availability of waste management facilities, and the government's capacity to detect and follow up on violations in a timely manner.

In its implementation,, the Kubu Raya Regency Transportation agency plays a strategic role in supervising inland waterway transportation activities within its jurisdiction. However, the supervision process continues to face various limitations, including human resources, supporting facilities, supervisory coverage, and inter agency coordination[6]. In addition, the supervision mechanisms, which still rely heavily on conventional monitoring and record keeping practices, may result in information regarding vessel conditions, inspection results, violations, public reports, and follow up actions not being documented in an integrated manner, this condition may hinder the decision-making process and reduce the government's capacity to conduct supervision in a timely, transparent, and sustainable manner.

The development of digital technology provides opportunities to address these limitations through the implementation of digital governance. Digital governance does not merely involve transferring conventional administrative processes to electronic platforms; rather, it encompasses data integration, the utilization of information systems, coordination among actors, information transparency, public participation, and data driven decision making. In the context of vessel waste supervision, digital governance can be implemented through databases of vessels and waste management facilities, e-monitoring, digital recording of inspection results, documentation of violations, public reporting channels, inter agency information integration, and systems for monitoring follow up actions. Through these mechanisms, the supervision process is expected not to stop at inspection activities but to establish a documented, measurable, and actionable supervision cycle.

Although the use of digital technology in government governance and public supervision continues to expand, studies that specifically link digital governance with vessel waste management supervision in inland waterway transportation remain limited. Previous studies have tended to examine waste management, water pollution, shipping regulations, or the digitalization of government services separately. Few studies have analyzed how digital governance instruments can be utilized to strengthen the overall

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supervision process for vessel waste management, ranging from monitoring and inspection to violation recording, public reporting, inter agency coordination, and follow up actions, particularly in the context of river transportation in local areas. This research gap highlights the need for studies that not only identify existing supervision challenges but also evaluate the needs and opportunities for strengthening digital governance as an instrument of environmental supervision.

Based on this research gap, this study focuses on the supervision of vessel waste management conducted by the Kubu Raya Regency Transportation agency, particularly in the context of inland waterway transportation activities at Rasau Jaya Port. This study aims to analyze the existing conditions of vessel waste management supervision and identify the needs for strengthening digital governance to support the supervision of water pollution. Accordingly, this study is expected to provide conceptual and practical contributions to the development of a more integrated, transparent, accountable, responsive, and sustainable supervision system.

METHOD

This study employed a qualitative approach with a descriptive evaluative research design to examine the strengthening of digital governance in the supervision of ship waste management in Kubu Raya Regency. A qualitative approach was employed because the study sought to understand supervisory practices. Institutional conditions, actors' experiences, and the need for digital governance based on data obtained from field observations, interviews, and documents. The descriptive evaluative design was used to describe the existing conditions of ship waste management supervision and systematically evaluate the context, resources, implementation processes, and outcomes of supervision. The evaluation was directed not only at identifying existing problems but also at assessing the needs and opportunities for strengthening digital governance within the supervisory system. The research was conducted at the Kubu Raya Regency Transportation Agency, which was selected based on its institutional authority and role in the provision, management, and supervision of inland waterway transportation services within the regency. The research focused particularly on supervisory activities related to ship waste management in the context of water transportation activities at Rasau Jaya Port.

The study used both primary and secondary data. Primary data consisted of information obtained directly from research informants through in-depth interviews and observations of supervisory activities and conditions at the port. The informants were selected purposively based on their knowledge, responsibilities, and involvement in inland waterway transportation management, vessel supervision, and activities within the port area. The informants included officials and staff of the Kubu Raya Regency Transportation Agency who were directly involved in these areas. Secondary data consisted of relevant laws and regulations, institutional documents, supervision and activity reports, official records, and scientific literature related to inland waterway transportation, ship waste management, environmental pollution prevention, public supervision, and digital governance. The use of both primary and secondary data enabled the researchers to compare information obtained from field actors with documentary and regulatory evidence.

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Data were collected through in-depth interviews, observation, and documentation. In depth interviews were conducted to obtain information concerning the implementation of supervision, supervisory constraints, waste management practices, inter agency coordination, reporting mechanisms, and the utilization or potential utilization of digital technology. Observation was conducted to examine the actual conditions of supervision, ship waste management facilities, monitoring activities, and practices within the port area. Documentation was used to examine regulations, institutional records, reports, reports, and other relevant documents supporting the findings obtained from interviews and observations.

Data analysis employed the CIPP evaluation model (Context, Input, Process, Product) developed by Daniel L. Stufflebeam [7]. The CIPP model was originally developed as a comprehensive evaluation framework and is intended to provide information for program improvement and accountability. Stufflebeam explains the four evaluation dimensions as context, input, process, and product, which respectively examine needs and problems, resources and strategies, implementation processes, and outcomes. The model has also been applied beyond education, including in social programs, health services, business, government agencies, and other organizational settings, making it relevant to the evaluation of public sector supervision.

In this study, the four CIPP dimensions were operationalized as follows. The context dimension examined the existing conditions of ship waste management, the potential for water pollution, problems and challenges in supervision, applicable regulatory frameworks, and the need for strengthening digital governance. The input dimension assessed the availability and adequacy of human resources, institutional arrangements, budgetary resources, facilities and infrastructure, regulatory support, and technological resources required for effective supervision. The process dimension analyzed how supervision was implemented, including monitoring mechanisms, inspection activities, recording and reporting of ship waste, documentation of violations, inter agency coordination, the use of digital technology, public reporting mechanisms, and follow up actions. The product dimension assessed the outcomes of existing supervision, including the extent to which supervision supports effectiveness, transparency, accountability, compliance, and the prevention of water pollution, as well as the need for further strengthening of digital governance.

The CIPP model was selected because its four dimensions allow the study to examine supervision comprehensively rather than focusing only on the final outcomes. Context evaluation identifies needs and problems that provide a basis for determining appropriate objectives; input evaluation examines the resources and strategies available to address those needs; process evaluation examines the implementation and identifies problems arising during implementation; and product evaluation examines the results and provides information for subsequent improvement. Accordingly, the CIPP framework in this study was used to connect the existing supervisory conditions with the resources, implementation mechanisms, and outcomes required for strengthening digital governance.

Data analysis followed three interconnected stages; data condensation, data display, and conclusion drawing and verification. Data obtained from interviews, observations, and documentation were first organized and condensed according to the research objectives and the four CIPP dimensions. The condensed data were then displayed in a

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structured manner to identify patterns, relationships, similarities, and differences among the findings. Conclusions were subsequently drawn and continuously verified by comparing evidence across data sources and research findings. Data validity was ensured through technical triangulation, namely by comparing information obtained through interviews, observations, and documentation. This process was conducted to strengthen the credibility of the findings and ensure that the interpretation of supervisory conditions and digital governance needs was supported by multiple sources of evidence.

RESULTS AND DISCUSSION

Based on interviews with three informants from the Kubu Raya Regency Transportation Agency, namely the Head of the River, Lake, and Crossing Transportation Division (SDP), the Head of the Maritime Traffic and Safety Section of the SDP Division, and the Operational services Officer of the SDP Division, the findings indicate that supervision of ship waste management has been implemented but is not yet fully supported by an integrated supervisory governance framework. The synthesis of the three informants' perspectives using the evolution model CIPP *(Context, Input, Process, Product)* demonstrates that challenges in ship waste management are not solely attributable to public behavior, but also involve institutional readiness, limited resources, fragmented authority, supervisory mechanisms, supporting facilities, regulatory frameworks, and underdeveloped systems for recording and reporting supervisory activities.

Context: Challenges in Ship Waste Management, Limited Supervisory Coverage, and the Need to Strengthen Governance

Within the context dimension, all three informants consistently indicated that waste remains a persistent issue in waterborne transportation activities in Kubu Raya Regency. The Head of the SDP Transportation Division explained that some passengers continue to dispose of waste into the river despite the availability of waste bins. The behavior was described as a deeply rooted habit. Another informant reported that some vessel operators have not yet provided waste bins on board, while members of the public continue to dispose of waste into the water when vessels are operating in the middle of the river. These conditions indicate that ship waste management is not merely a matter of facility availability but also involves the behavior or service users and vessel operators' compliance with waste management requirements.

These findings are consistent with the study by Radjak et al. in (2023) in the Bone River watershed, which found that communities continued to dispose of waste into rivers, partly due to the limited availability of waste disposal facilities[8]. Jukrisno et al. in (2023) also found that socialization and awareness raising among passengers remained inadequate and that compliance with applicable regulations was still low[9]. Although these studies were conducted in different context, their findings reinforce the understanding that waste management in water areas involves the interaction of public behavior, facility availability, regulatory compliance, and supervisory capacity.

In Kubu Raya Regency, these problems are further compounded by the limited scope of supervision. The Transportation agency primarily monitors vessel activities when vessels are at or docked at ports. Meanwhile, vessel activities in open waters cannot be continuously monitored directly, this condition creates a gap between the scope of vessel

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activities that need to be supervised and the supervisory capacity available, thus, the primary issue is not simply the absence of supervision, but rather the limitations in the coverage, continuity, and instruments of supervision, particularly for vessel activities in open waters.

The three informants also revealed a distribution of responsibilities among several institutions involved in ship waste management. The Transportation Agency is responsible for transportation activities and vessel operations, while waste and environmental management involve the Environmental Agency. In addition, supervisory authority may vary according to vessel type and size, meaning that other actors or agencies may also have specific responsibilities. This institutional arrangement demonstrates that ship waste management is a cross sectoral issue, rather than the sole responsibility of one institution, consequently, the effectiveness of supervision depends not only on the Transportation Agency but also on clear role allocation, information exchange, and coordination among relevant institutions.

Based on these findings, the need for digital governance can be understood as a response to the identified supervisory challenges rather than as a replacement for field-based supervision. The limited ability to monitor vessels in open waters creates a need for mechanism that enable information concerning vessels, waste management facilities, inspection results violations, public reports, and supervisory follow up to be recorded and tracked systematically. In this context, digital technology can support supervision through recording, documentation, reporting, information sharing, violation tracking, and follow up monitoring. Therefore, the need for digital governance in the context dimension emerges from the characteristics of the problem and the limitations of the existing supervisory system. Digital technology can serve as an important instrument for improving the effectiveness and efficiency of waste management [10].

Input: **Limitations of Resources, Regulations, Facilities, and Supervisory Instruments**

Within the input dimension, the three informants indicated that the Kubu Raya Regency Transportation Agency has several resources to support supervision. A Technical Implementation Unit (UPT) is available to monitor vessel operations through a shift-based work system. In addition, personnel, waste bins, awareness raising materials such as stickers and banners, and supporting facilities within the port area are available. However, these inputs are not yet sufficient to support effective and comprehensive supervision.

These limitations are reflected in the insufficient number of human resources, uneven availability of waste bins on vessels, and occasional delays in waste collection and transportation. The Transportation Agency also does not have personnel specifically assigned to manage ship waste because its personnel primarily focus on transportation services and vessel supervision. This condition affects supervisory effectiveness because officers must perform transportation related supervisory functions while also dealing with ship waste management issues without dedicated human resources. This finding is consistent with Hakim and Abdullah (2024), who found that limitations in human resources contributed to the suboptimal provision of waste transportation services[11].

In addition to human resources and facilities, the regulatory dimension constitutes an important input affecting supervisory capacity. The interviews indicated that no specific

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Standard Operating Procedure (SOP) for ship waste management has yet been established. The regional regulatory framework governing violations and enforcement related specifically to ship waste is also considered inadequate. Consequently, officers' responses to violations remain largely limited to guidance, instructions, socialization, and verbal warnings. This condition demonstrates a direct relationship between regulatory ambiguity and limited enforcement capacity. Without clear SOPs, officers lack standardized procedures for conducting inspections, recording violations, taking appropriate action, and monitoring follow up measures. Similarly, the limited regional regulatory basis constrains the ability to impose sanctions firmly and consistently.

This finding is conceptually supported by Vansolang et al. in (2026), who found that the absence of specific regulations on waste management at the village government level created regulatory ambiguity and contributed to the continued occurrence of indiscriminate waste disposal[12]. However, that study was conducted in a village governance context rather than in ship waste management. Therefore, it is not treated as an identical case but rather as supporting evidence for the broader issue that regulatory ambiguity can reduce certainty in management mechanisms and enforcement of violations.

Input limitations are also evident in the information and documentation instruments used for supervision. The interviews indicated that there is currently no dedicated digital system for integrating vessel data, waste management facilities, inspection results, violation documentation, public reports, and supervisory follow up. This condition is particularly important because the limited supervisory coverage in open waters means that information concerning vessel activities may not be systematically documented and may be difficult to trace. Reliance on manual recording and communication can also create difficulties in monitoring, reporting, violation tracking, and follow up evaluation.

Therefore, the digitalization requirement identified in the input dimension is not merely a need for additional technological infrastructure. Digitalization should be understood as part of strengthening the supervisory instruments. A digital system could support vessel and facility database, recording of inspection results, documentation of evidence of violations, public reporting, inter agency information sharing, and follow up monitoring. In this regard, digital technology functions as a supporting instrument that strengthens field-based supervision rather than replacing direct inspections.

Coordination is also an important component of input readiness because ship waste management involves multiple actors. The Transportation Agency is responsible for transportation and vessel operations, while the Environmental Agency is involved in waste management and environmental matters. The distribution of authority according to vessel characteristics also indicates the involvement of other actors with specific responsibilities. Based on the interview findings, there is currently no dedicated information system that integrates ship waste management data and reporting across these actors. As a result, information concerning supervisory findings, waste related problems, and follow up actions is not yet documented through a single integrated mechanism.

This condition demonstrates that cross sectoral coordination requires not only clear allocation of responsibilities but also communication and information sharing mechanisms that support the exercise of those responsibilities. Coordination across organizations is inherently complex because institutions differ in terms of resources, capacities, interests, and priorities[13]. Therefore, strengthening digital governance can

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be directed toward providing mechanisms for information sharing and cross agency monitoring, enabling each actor to access information relevant to its respective authority and to follow up on supervisory findings in a more structured manner.

Overall, the findings in the input dimension demonstrate that limitations in ship waste management supervision are not caused solely by insufficient resources. They also involve inadequate SOPs, regulatory foundations, documentation instruments, information systems, and cross agency coordination mechanisms. Accordingly, strengthening digital governance should be positioned as part of improving supervisory instruments that support recording, reporting, coordination, monitoring, and follow up. Through this approach, digitalization has a direct connection with the supervisory needs identified in the field and can serve as a supporting instrument for improving the effectiveness of ship waste management.

***Process:* Supervision has been Implemented but Remains Conventional and Limited**

Within the process dimension, the three informants provided relatively consistent accounts that supervision has been implemented through monitoring, inspections, socialization, guidance, directives, communication, and warnings. The Technical Implementation Unit (UPT) monitors vessels arriving at and departing from the port. Prior to vessel operations, officers provide guidance to vessel owners, masters, crew members, and passengers regarding cleanliness and the prohibition of indiscriminate waste disposal. When violations or other problems are identified, officers may issue warnings and conduct further inspections.

However, the findings indicate that the implementation of supervision remains limited in terms of coverage and methods. First, there is a supervisory coverage gap in monitoring vessel activities while vessels are operating in open waters. One informant explained that the Transportation Agency does not have a dedicated water patrol fleet; consequently, supervision is conducted primarily from land of when vessels are docked at the port. This condition limits the ability of officers to directly observe waste disposal practices during vessel operations outside the port area. As a result, supervision is more effective at points where vessels can be physically observed than during their movement in open waters.

Second, the supervisory process remains predominantly conventional and has not been fully supported by systematic information management. Field findings are generally obtained through direct observation, inspection, communication, and verbal warnings, while mechanisms for digitally recording inspection results, documenting violations, storing supporting evidence, reporting findings, and tracking follow up actions have not yet been fully established. This limitation affects the continuity and traceability of supervision because information obtained during field activities is not yet managed through an integrated mechanisms that allows supervisory findings to be systematically documented and monitored over time. Reports of violations are also relatively infrequent, making systematic documentation important for identifying recurring problems and supporting evidence based follow up.

Third, coordination among relevant actors has been conducted in relation to ship activities and environmental management; however, the findings do not indicate the existence of a specific integrated digital reporting mechanism for ship waste supervision. Therefore, rather than characterizing coordination as entirely not institutionalized, the finding points more specifically to a coordination and information integration gap. The

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absences of an integrated mechanism for sharing inspection results, violation reports, supporting documentation, and follow up information may limit the continuity of supervision across agencies. This condition is particularly relevant because ship waste management involves responsibilities that may extend beyond a single agency.

The findings demonstrate that the main issue in the process dimension is not the absence of supervision, but the limited coverage, conventional methods, and incomplete integration of supervisory information. The supervisory coverage gap in open waters shows the need for mechanisms that can strengthen the continuity of monitoring beyond direct physical observation at the port. Nevertheless, digitalization should not be understood as a substitute for field inspections. Rather, digital governance can function as a supporting instrument that strengthens the administrative and information dimensions of supervision. Digital mechanism can be used to record vessel inspection results, document the condition of waste management facilities, capture evidence of violations, facilities reporting, track the status of follow up actions, and enable relevant agencies to access and share supervisory information.

In this context, strengthening digital governance is relevant to the supervisory requirement identified in the field. A digital supervision system could provide a structured database of vessels and inspection records, standardized digital reporting forms, documentation of violations, and a follow up tracking mechanism. Such a system would allow information obtained through field inspections to be retained, accessed, compared, and monitored over time. Thus, digitalization does not replace the physical supervision of vessels; instead, it strengthens the recording reporting, tracking, information sharing, and follow up functions that support the effectiveness and continuity of conventional supervision. This approach also provides a stronger basis for inter-agency coordination because supervisory information can be managed systematically rather than remaining fragmented across individual officers or agencies.

The monitoring process conducted by officers remains subject to several limitations. First, supervision cannot cover all vessel activities while vessels are operating in open waters. One informant noted that the Transportation Agency does not have a dedicated water patrol fleet consequently, supervision is conducted primarily from land or when vessels are docked at the port. Second, the supervisory process remains predominantly conventional. Field findings are not yet fully supported by digital mechanisms for recording, reporting, documentation, and monitoring follow up actions. Reports of violations are also relatively infrequent. Third, although coordination with relevant agencies has been established, it has not yet been institutionalized within an integrated supervisory system specifically designed for ship waste management. Indonesia still faces relatively low levels of digitalization and information technology infrastructure development, largely due to uneven infrastructure provision and development across regions [14].

Product: Supervision has Generated Improvements, but Its Effectiveness Remains Suboptimal

In the product dimension, the three informants indicated that supervision has generated several positive outcomes. Socialization and guidance activities have been conducted, waste bins have been provided, and there are indications that the volume of waste has begun to decrease following supervisory interventions. In addition, effort have

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been made to improve service facilities within the port area. However, these outcomes have not yet demonstrated optimal effectiveness. Some members of the community continue to dispose of waste into the river, some vessels have not provided waste bins, and compliance with supervisory directives remains inconsistent. One informant even assessed that supervision may not yet be fully effective due to limitations in waste management facilities and waste collection services. Increased public awareness is fostered through a combination of socialization, the provision of adequate waste disposal facilities, and participatory approaches [15]. A program can achieve optimal effectiveness when public awareness and participation increase, supporting infrastructure and facilities are adequate, and strong financial and institutional support is available [16].

From an accountability perspective, the outcomes of supervision have not yet been fully documented. The limited availability of violation reports means that data on compliance levels and the frequency of violations cannot yet be optimally utilized as a basis for evaluation and performance improvement. Suboptimal supervision can be reflected in the weakness of performance evaluation mechanisms [17]. Meanwhile, from a responsiveness perspective, officers have issued warnings in response to violations, however, follow up mechanisms remain limited due to jurisdictional constraints and the absence of a sufficiently robust legal framework. Stakeholders also face concerns arising from unclear regulatory guidelines and the costs associated with implementing such regulations [18].

He current outcomes of supervision are primarily reflected in guidance and capacity building activities, public socialization, the provision of facilities, monitoring, and reductions in waste generation. However, these efforts have not yet resulted in a measurable, well documented, transparent, and integrated supervision system. A study conducted by Nuranindita and Choiriyah in 2026 found that supervision remained weak due to the absence of a continuous monitoring system, limited transparency, and the lack of an adequate database [19]. Effective supervision does not depend solely on the existence of applicable regulations but also requires adequate human resource capacity, sufficient facilities and infrastructure, and effective coordination among relevant institutions [20]. Based on interviews with the three informants in this study, these findings can be further illustrated through the following CIPP synthesis matrix:

Table 1. Synthesis Matrix of the Three Informants Based on the CIPP Model

CIPP Dimension	Findings from the Three Informants	Identified Gaps	Needs for Strengthening Digital Governance
Context	Waste continues to be disposed of into the river, while public awareness and compliance remain suboptimal. Furthermore, overlapping and fragmented institutional authorities pose	Cross sectoral challenges persist, while the locations where violations occur are not always accessible to effective monitoring.	Integration of inter-agency information and ship activity monitoring systems.

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	challenges to effective governance, and supervision remains limited when vessels are operating in open waters.		
Input	The availability of UPTs, personnel, waste bins, public awareness media, and port facilities.	Limited human resources, uneven distribution of facilities, the absence of specific SOPs, a limited regulatory framework, and the lack of a dedicated digital system for ship waste management.	Ship and facility databases, digital SOPs, information systems, and reporting channels.
Process	Supervision is conducted through monitoring, inspections, public awareness activities, capacity building, and the issuance of warnings.	Supervision remains largely conventional, with limited capacity to monitor activities throughout the waterways, while documentation and reporting mechanisms remain suboptimal.	E-monitoring, digital reporting, digital documentation, and follow up tracking mechanisms.
Product	Capacity building initiatives, improvements in facilities, and indications of reduced waste generation.	Compliance remains suboptimal, violations have not been systematically documented, and overall effectiveness remains limited.	A Supervisory dashboard, compliance indicators, violation data, and a follow up management system.

Source: Author's analysis of interview data

CONCLUSION

Based on the research findings and discussion using the CIPP (Context, Input, Process, Product) evaluation model, it can be concluded that ship waste management supervision conducted by the Transportation Agency of Kubu Raya Regency has been implemented through monitoring, inspections, public awareness activities, capacity building, provision of facilities, and the issuance of warnings. However, the implementation of supervision has not yet been fully effective due to persistent challenges related to public and ship operators' behavior and compliance, limited human resources and facilities, the absence of specific SOPs for ship waste management, limited local

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regulatory frameworks, fragmented inter agency authority, and limited capacity to monitor ship activities while operating in open waterways.

From the context perspective, the complexity of the issues indicates that ship waste management requires cross sectoral coordination and supervisory mechanisms capable of reaching multiple actors and locations. From the input perspective, basic resources and facilities are available: however, they are not yet adequately supported by institutional instruments, regulatory frameworks, databases, and dedicated information systems for ship waste management. From the process perspective, supervision has been implemented, but it remains predominantly conventional, resulting in suboptimal systematic recording, documentation, reporting, and follow up monitoring. Meanwhile, from the product perspective, supervision has contributed to capacity building initiatives, facility improvements, and indications of reduced waste; nevertheless, it has not yet achieved optimal and measurable levels of compliance and supervisory effectiveness.

The research findings indicate that the primary need is not merely to increase the intensity of supervision, but rather to strengthen the governance of ship waste management supervision through the integration of institutional arrangements, regulatory frameworks, resources, supervisory processes, and digital technologies. The strengthening of ships and waste management facilities, e-monitoring of ship activities and conditions, digital recording and documentation of inspection results, public reporting channels, inter agency information integration, compliance indicators, and follow up mechanisms for identified violations. Such a system should be supported by clear SOPs, well defined inter agency roles and responsibilities, enhanced human resource capacity, adequate waste management facilities, and a strengthened regulatory framework. Digitalization in ship waste management supervision should not be viewed merely as the adoption of technology, but rather as an instrument for establishing a more integrated, well documented, transparent, responsive, accountable, and sustainable supervisory systems, thereby supporting the prevention of water pollution in Kubu Raya Regency.

DECLARATION OF GENERATIVE AI

During the preparation of this manuscript, the author utilized Large Language Models (LLMs) to assist in synthesizing extensive interview transcripts and used ChatGPT to support data processing and translation into English. Following the use of these tools and services, the author carefully reviewed and edited the generated content as necessary and assumes full responsibility for the entire content of the publication.

ACKNOWLEDGEMENTS

The researchers would like to express their sincere appreciation and deepest gratitude of the Rector of Universitas Tanjungpura, the Institute for Research and Community Service (LPPKM), and the Dean of the Faculty of Social dan Political Sciences, Universitas Tanjungpura, for their support of the research team throughout the implementation of this study. Appreciation is also extended to the Transportation Agency of Kubu Raya Regency and the Research Team of the Faculty of Social and Political Sciences, Universitas Tanjungpura, comprising a collaboration between lectures and students, for their cooperation and contribution throughout the entire research process, from its initial stage to completion. The researchers acknowledge that the valuable

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DOI: doi.org/10.33830/osc.v4i1.9282/ ISSN: 3032-2227

assistance, support, and cooperation provided by various parties played an essential role in enabling this research to be completed within the scheduled timeframe.

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