



EVALUATION OF ENVIRONMENTAL CONTROL EFFORTS AT THE KEJAWANAN NUSANTARA FISHING PORT BASED ON THE K5 PRINCIPLES

EVALUASI UPAYA PENGENDALIAN LINGKUNGAN PELABUHAN PERIKANAN NUSANTARA KEJAWANAN BERDASARKAN PRINSIP K5

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ABSTRACT

The increase in economic activity in the Kejawan Nusantara Fishing Port area has created quite complex environmental problems. To address these problems, the Kejawan Nusantara Fishing Port has implemented the K5 principles (cleanliness, aesthetics, security, order, and occupational safety). However, the extent of their success remains uncertain. This study aims to evaluate the effectiveness of implementing the K5 principles as the basis for environmental control at the Kejawan Nusantara Fishing Port, Cirebon City. This study used a descriptive quantitative and qualitative evaluative approach through field observations, in-depth interviews, focus group discussions, and the distribution of questionnaires to 75 respondents consisting of port managers, security officers, cleaning officers, government agencies, fishermen, business actors, and marine tourism visitors. The evaluation results showed that the implementation of the K5 principles at Kejawan Nusantara Fishing Port was in the good category with an average score of 3.82. The highest score was obtained for the cleanliness aspect (4.05) and the lowest for the orderliness aspect (3.55). The success factors in environmental control were supported by the availability of a wastewater treatment plant (WWTP), the involvement of cleaning personnel, and the implementation of occupational safety standards. The main obstacles were limited human resources, weak coordination between agencies, and low awareness of environmentally friendly behavior among port users. Priority strategies for environmental control were identified in the ecological dimension, such as improving WWTP facilities, solid waste management, and port drainage rehabilitation.

Keywords: effectiveness, environmental control, fishing ports, K5 principles, strategy

ABSTRAK

Peningkatan aktivitas ekonomi di kawasan Pelabuhan Perikanan Nusantara (PPN) Kejawan telah menimbulkan masalah lingkungan yang cukup kompleks. Untuk mengatasinya, PPN Kejawan menerapkan prinsip K5 (kebersihan, keindahan, keamanan, ketertiban, dan keselamatan kerja). Namun demikian, tingkat keberhasilannya belum diketahui pasti. Penelitian ini bertujuan untuk mengevaluasi efektivitas penerapan prinsip K5 sebagai dasar pengendalian lingkungan di PPN Kejawan, Kota Cirebon. Metode penelitian menggunakan pendekatan deskriptif kuantitatif dan kualitatif evaluatif melalui observasi lapangan, wawancara mendalam, *focus group discussion*, dan penyebaran kuesioner kepada 75 responden yang terdiri atas pengelola pelabuhan, petugas keamanan, petugas kebersihan, instansi pemerintah terkait, nelayan, pelaku usaha, dan pengunjung wisata bahari. Hasil evaluasi menunjukkan penerapan prinsip K5 di PPN Kejawan berada pada kategori baik dengan nilai rata-rata 3,82. Nilai tertinggi diperoleh pada aspek kebersihan (4,05) dan nilai terendah diperoleh pada aspek ketertiban (3,55). Faktor keberhasilan pengendalian lingkungan didukung oleh ketersediaan instalasi pengolahan air limbah (IPAL), keterlibatan tenaga kebersihan, dan penerapan standar keselamatan kerja. Kendala utama disebabkan oleh terbatasnya sumber daya manusia, lemahnya koordinasi antarinstansi, dan rendahnya kesadaran pengguna pelabuhan terhadap perilaku ramah lingkungan. Strategi prioritas pengendalian lingkungan didapatkan pada dimensi ekologi, seperti peningkatan fasilitas IPAL, pengelolaan limbah padat, dan rehabilitasi drainase pelabuhan.

Kata kunci: efektivitas, pelabuhan perikanan, pengendalian lingkungan, prinsip K5, strategi

INTRODUCTION

Fishing ports play a strategic role in supporting coastal economic activities, including as centers for landing, processing, and distributing catches. High activity in port areas is an important factor in developing the fisheries supply chain. However, high activity in ports can also put pressure on the environment. Armalia *et al.* (2025) and Mustaruddin *et al.* (2025) state that fishing ports have the potential to become a source of pressure on the coastal environment because they can cause problems such as liquid waste pollution, solid waste, and organic residues from fish processing and marine tourism activities. Uncontrolled environmental pressure has the potential to reduce water quality and disrupt the balance of the marine ecosystem. Therefore, well-planned environmental management and control are required to maintain ecological stability and support the sustainability of economic activities in fishing ports.

The Kejawanan Nusantara Fishing Port serves as a center for fishing activities and a marine tourism destination. Increased economic activity in the port area has given rise to quite complex environmental problems. The main problems include limited wastewater treatment capacity, low awareness of port users regarding cleanliness, accumulation of waste from river basins, and weak coordination between agencies in environmental management. Kejawanan Nusantara Fishing Port has made efforts to control the environment, but the implementation has not been optimal. An evaluation of environmental control at the port is necessary to ensure that environmental management policies are implemented effectively and sustainably. Therefore, the application of the K5 principles (cleanliness, aesthetics, security, order, and occupational safety) as the basis for environmental management and a reference in strengthening control efforts in the fishing port area is essential.

The K5 principles align with the Ecoport Environmental Management Framework and represent a crucial effort in meeting ecoport criteria. Cleanliness and orderliness support the operational achievement of ecoport goals, while security supports the development of systems to safeguard port activities, and occupational safety supports the development of protection systems for those involved in these activities (Yalçın *et al.* 2023; Pramesthy *et al.* 2024; Mustaruddin *et al.* 2025). Furthermore, aesthetics serves as a key reference point for achieving long-term ecoport objectives,

specifically regarding the visual appeal and comfort of port operations (Darbra *et al.* 2009; Roshid *et al.* 2026).

The implementation of the K5 principles at ports is part of the national policy on the orderly, safe, and environmentally friendly management of fishing ports. The K5 principles include cleanliness, aesthetics, security, order, and occupational safety. Implementing K5 is the basis for maintaining a balance between port operational activities and environmental sustainability. The K5 principles are listed in Government Regulation of the Republic of Indonesia Number 27 of 2021 concerning the Implementation of Marine Affairs and Fisheries, which states the importance of implementing the K5 principles as guidelines in the formation of clean, safe, and sustainable port areas. Each element of K5 plays a complementary role: cleanliness and aesthetics maintain the aesthetic and ecological quality of the environment; security and order ensure the smooth running of port activities; and occupational safety protects workers from potential hazards (Asriani and Purwangka 2018). Consistent implementation of the K5 principles is expected to create a productive, orderly, and environmentally friendly fishing port area.

Implementing K5 principles requires cross-sector collaboration involving various stakeholders, such as port operators, fishers, business entities, coastal communities, and local governments. Relevant studies include Mustaruddin *et al.* (2020), who examined environmental control and technical port infrastructure supported by policy and stakeholder engagement. Halstead *et al.* (2018) discussed environmental management tools and technological support for controlling environmental impacts, particularly those caused by microplastics. Furthermore, Lusic *et al.* (2025) and Sdoukopoulos and Boile (2021) assessed progress in implementing environmental and safety controls while facing various obstacles, including limited supporting facilities, weak institutional coordination, and suboptimal field supervision. Pramesthy *et al.* (2024) addressed occupational safety regarding purse seine vessels conducting loading and unloading operations at ports. Generally, these studies have examined K5 principles only partially, focusing on specific aspects or activities within the port environment, and have often failed to link environmental control measures to the policies in place. Therefore, an in-depth, integrated study on the implementation of K5 principles in fishing ports is needed. The results of such an

evaluation could provide objective information on the success of environmental management policies and assist in formulating necessary improvement measures.

This research has three main objectives. The first is to evaluate the implementation of the K5 principles as the basis for environmental control at the Kejawanan Nusantara Fishing Port. The second is to assess the level of success and main obstacles in the implementation of environmental control based on stakeholder perceptions. The third is to formulate strategies to improve the effectiveness of environmental control through the optimization of the integrated and sustainable application of the K5 principles. The novelty of the research lies in the development of an integrated evaluation framework that combines K5 principles with ecological, social, economic, technological, and institutional dimensions. A comprehensive evaluative study can be a reference for port managers and the government in designing participatory, adaptive, and sustainability-oriented environmental control policies.

METHODS

Material and location

The materials and tools used consisted of questionnaires, stationery, and a camera. The research was conducted from January to April 2025 (the first stage) and from March to May 2026 (the second stage) at the Kejawanan Nusantara Fishing Port. The port is located in Cirebon City, West Java Province, Indonesia.

Data types and data collection methods

The data collected in this study consisted of primary and secondary data. The primary data included K5 (cleanliness, aesthetics, security, order, and occupational safety) evaluation data, data on factors influencing environmental performance, ecological, economic, social, technological, and institutional data at the port, and strategic options for improving the effectiveness of environmental controls. Secondary data included port profile data, fisheries and supporting business data, and waste management data. Primary data were obtained through field observations, in-depth interviews, focus group discussions, and the distribution of questionnaires to various parties involved in port activities. Data collection was carried out to obtain a comprehensive picture of the environmental control conditions at the Kejawanan Nusantara Fishing Port, Cirebon,

West Java. Data collection was carried out in two stages. The first stage was conducted through in-depth interviews with port managers, security officers, cleaning officers, government agencies (environmental bureau and spatial planning bureau), fishermen, business actors, and marine tourism visitors between January and April 2025. The interviews covered ten government agencies, five port managers, ten business actors, fifteen security officers, fifteen cleaning officers, ten fishermen, and ten marine tourism visitors. The number of respondents was determined by considering the specific functions and the relationship of each institution to K5 issues at the site. A larger number of respondents was selected from security officers and cleaning officers due to their direct responsibility for K5, whereas fewer fishermen and tourism visitors were included as they are users of the port.

In the second stage of the study, focus group discussions were conducted and follow-up questionnaires were distributed. The focus was on gathering input regarding improvement measures to enhance the effectiveness of environmental controls. Questionnaires were also distributed to groups of security officers, cleaning officers, government agencies, port management, fishermen, business actors, and marine tourism visitors (totaling seventy-five respondents). These groups were selected because they are related to environmental management or their activities pose a risk to the port environment. The sample size was considered appropriate because the population of these activity groups at the Kejawanan Nusantara Fishing Port is approximately 692 units. Benavides *et al.* (2022) explain that selecting 10% of the population as respondents can represent the data for that population. The sampling method used was purposive sampling based on the respondents' level of knowledge and involvement in port environmental management activities. According to Eriyanto (2007), the purposive sampling method in in-depth interviews and FGDs is appropriate for selecting respondents based on specific considerations.

Descriptive analysis of the application of the K5 principles

Descriptive analysis is a data analysis method that aims to describe, explain, and evaluate a phenomenon based on the results of observations or questionnaires. Because it is explanatory and descriptive in nature, statistical tests that examine the influence or relationship between variables are not

required (Nasution 2017). Descriptive analysis was used to evaluate the implementation of the K5 principles at the port, which included aspects of cleanliness, aesthetics, security, order, and occupational safety. The assessment was conducted through questionnaires from various respondents, such as fishermen, port officials, fish traders, and coastal communities. The questionnaire results were assessed using a five-point Likert scale to obtain an average score for the effectiveness of the K5 principle implementation. The Likert scale was used to assess the achievement of each proposed K5 principle (cleanliness, aesthetics, security, order, and occupational safety) and did not analyze their influence or comparison with each other, which would require statistical testing. The assessment categories were compiled based on the score ranges as presented in Table 1.

The average score for each aspect is used to assess the level of effectiveness of environmental control implementation in the port area. The assessment results form the basis for further evaluation of the success factors and obstacles to the implementation of the K5 principles.

Analysis of success factors and obstacles in environmental control

The analysis was conducted descriptively and evaluatively to determine the internal and external factors that influence the effectiveness of environmental control. Internal factors include infrastructure conditions, workforce involvement, and port operational management. External factors include government policy, community support, and socioeconomic dynamics around the port area. Evaluative analysis was used to identify the level of success and main obstacles in the implementation of environmental control based on stakeholder perceptions. Ash-Shiddieqy and Hermina (2025) reinforce that evaluative analysis is an approach used to assess and measure the effectiveness of a program and its activities. This

approach combines various data from surveys, interviews, and field observations. The results of the evaluative analysis are used to explain the effectiveness of the implementation of the K5 principles and to identify areas that require improvement in environmental management performance. Implementation is declared effective if the environmental infrastructure is functioning optimally, port operations are smooth, coordination between agencies is conducive, and there is support from the local community (Halstead *et al.* 2018; Ly 2024; Roshid *et al.* 2026). These findings serve as the basis for developing strategies to improve the effectiveness of environmental control.

Strategic assessment analysis to improve environmental control effectiveness

The concept of strategic analysis refers to a process carried out systematically by organizations to examine the business environment, collect data, analyze it, and transform it into useful information for decision makers in setting goals, priorities, and objectives. Based on this information, organizations can formulate appropriate and relevant strategic plans to achieve their established goals (Al-Shammari 2025). Strategic analysis is carried out by assessing the level of importance and contribution of each aspect of environmental control based on five main dimensions, namely ecological, social, economic, technological, and institutional. These five dimensions are assessed because they are the main pillars of sustainable environmental management, including in port areas (Darbra *et al.* 2009; Mustaruddin *et al.* 2020). If an activity at a port has an environmental impact, it will disrupt one or more of these dimensions. Each dimension is weighted based on stakeholders' perceptions of its urgency and impact on the successful implementation of the K5 principles. The analysis is carried out through four main stages as shown in Table 2.

Table 1. Categories for interpreting the average Likert scale scores used to evaluate the implementation of the K5 principles (cleanliness, aesthetics, security, order, and occupational safety).

Average Range of Values	Category	Effectiveness Interpretation
4.21–5.00	Very good	The implementation of the K5 principles runs very effectively
3.41–4.20	Good	The implementation of the K5 principles runs effectively
2.61–3.40	Fair	The implementation of the K5 principles runs quite well but needs improvement
1.81–2.60	Poor	The implementation of the K5 principles has not run optimally
1.00–1.80	Very poor	The implementation of the K5 principles is not effective

Table 2. Stages of the strategic analysis conducted to improve the effectiveness of environmental control.

Analysis Phase	Main Activity	Method or Approach	Output Achieved
Identification of Influencing Factors	Identify strengths, weaknesses, opportunities, and threats related to the implementation of the K5 principles	Descriptive analysis of survey results and FGD	List of internal and external factors influencing the effectiveness of environmental management
Evaluation of Environmental Management Dimensions	Analyze the average value of five dimensions: ecology, social, economic, technology, and institutional	Scoring, descriptive evaluation based on stakeholder perceptions	Prioritization of values for each environmental management dimension
Determination of Strategic Priorities	Identify dominant aspects that need attention based on score values and impact scores	Evaluation matrix (Evaluative scoring matrix)	Strategic priorities order based on environmental management effectiveness
Formulation of Improvement Strategies	Develop operational strategies based on priority evaluations	Descriptive analysis based on quality evaluation	Recommendations for improving the effectiveness of environmental management based on K5 principles

The results of the strategy analysis produced a priority order for strengthening that focuses on five main aspects, namely strengthening cleanliness and aesthetics management through ecological aspects, improving occupational safety through social and technological aspects, increasing environmental funding efficiency through economic aspects, and strengthening coordination between agencies through institutional aspects. This approach is in line with the views of Mustaruddin *et al.* (2025) and Darmawan *et al.* (2022), who emphasize the importance of applying participatory, collaborative, and adaptive principles in port environmental management. The participatory principle is characterized by indicators such as active involvement, the initiative to voice aspirations, a sense of belonging, and joint decision-making. For the collaborative principle, measurement indicators include shared vision and goals, cross-functional cooperation, resource sharing, and a win-win mindset. Finally, indicators for the adaptive principle are flexibility, a growth mindset, and proactivity regarding opportunities. The overall data analysis provides a scientific basis for the formulation of a strategy to improve the effectiveness of environmental control at the Kejawanan Nusantara Fishing Port in an integrated and sustainable manner.

RESULTS AND DISCUSSION

Overview of Kejawanan Nusantara Fishing Port

The Kejawanan Nusantara Fishing Port is located in Cirebon City, West Java Province.

The port functions as a center for fishing and marine tourism activities. Fishing activities at the port play an important role in supporting the coastal economy through various activities, such as fish landing, seafood processing, and distribution of fishery products to various regions. High fishing activity makes the port an important hub in the national seafood supply chain. Based on data, fishery productivity at Kejawanan Nusantara Fishing Port in 2023 and 2024 was 5,619 tons and 6,189 tons, respectively. The fishery productivity data show that fishery activity increased from 2023 to 2024, and high fishing activity can contribute to a decline in environmental quality at the port.

The Kejawanan Nusantara Fishing Port area accommodates various small- to large-scale fishing activities with a relatively increasing volume of fish landings each year. Increased activity can have an impact on coastal environmental conditions due to increased liquid waste, sediment, and organic residues from the processing of marine products. Environmental problems that occur include a decline in water quality and an increase in sediment in the harbor basin. Permana *et al.* (2018) state that the high level of fishing activity at Kejawanan Nusantara Fishing Port can produce liquid waste. The liquid waste management system is carried out through a wastewater treatment plant (WWTP) that functions to collect and treat wastewater from harbor activities before it is discharged into the water. The WWTP is an important part of efforts to maintain the quality of the coastal environment in the port area. The increase in the number of tourist visitors and fishing trade activities has an impact on the volume of waste in the port area. The environmental conditions of the port reflect the

interrelated social, economic, and ecological dynamics, making environmental control an important component in the management of fishing port areas (Imron *et al.* 2025; Sitompul *et al.* 2026).

Environmental control at Kejawanan Nusantara Fishing Port has been implemented using the K5 principles, but their implementation needs to be evaluated. Environmental control refers to the application of the K5 principles, namely cleanliness, aesthetics, security, order, and occupational safety. Asriani and Purwangka (2018) emphasize that the K5 principles serve as guidelines for port managers in creating a clean, safe, orderly, and sustainable work environment. Evaluation of the implementation of the K5 principles is the basis for assessing the effectiveness of the overall environmental control system at fishing ports.

Evaluation of the implementation of the K5 principles at Kejawanan Nusantara Fishing Port

The evaluation of the implementation of the K5 principles was carried out to assess the extent to which the K5 system functions as the basis for environmental control at Kejawanan Nusantara Fishing Port. The evaluation was carried out through discussions and interviews with stakeholders, such as fishermen, traders, port authorities, and various other authorities. The assessment was carried out by scoring responses to a set of questionnaire items. The average scores are presented in Table 3.

The cleanliness aspect received the highest score of 4.05, which is classified as good. Waste and sewage management in the port area is carried out through routine activities by cleaning staff and the WWTP system. Cleaning activities are carried out

every day in the dock area, fish auction area, and distribution channels for catches. The implementation of waste management shows an increased awareness of the importance of cleanliness as part of the quality of the port environment. This is supported by Permana *et al.* (2018), who stated that cleaning activities at Kejawanan Nusantara Fishing Port are carried out daily with the support of WWTP. The availability of sanitation facilities reached 70% and waste transportation to the landfill reached 80%; thus, the port's cleanliness conditions were classified as good.

The aesthetics aspect received a score of 3.90, which is categorized as good. The arrangement of public spaces and work facilities has supported the comfort of port users, such as the pier area, green parks, and neatly arranged industrial areas. This condition supports the port's aesthetic function while increasing economic value through marine tourism activities. Handayani *et al.* (2021) report that the Kejawanan area has attractions in the form of sea panoramas, boat tours, and coastal cuisine. Proper maintenance of the area is necessary to preserve it and increase interest in marine tourism.

The occupational safety aspect received a score of 3.85, which is categorized as good. Port workers have undergone safety training and use personal protective equipment while working. However, one of the challenges faced is the lack of outreach to fishermen regarding occupational safety (Imron *et al.* 2025). Pramesthy *et al.* (2024) emphasize that occupational safety plays an important role in preventing and reducing accidents in the workplace. The implementation of occupational safety is very important because it can reduce the risk of workplace accidents and increase awareness of safety.

Table 3. Average scores for the effectiveness of K5 principle implementation at Kejawanan Nusantara Fishing Port.

K5 Aspect	Average Score	Category	Field Description
Cleanliness	4.05	Good	Waste and sewage management are carried out regularly through sanitation facilities and the wastewater treatment plant (WWTP).
Aesthetics	3.90	Good	Public areas are well organized and support user comfort within the port.
Occupational Safety	3.85	Good	Workers use personal protective equipment and participate in safety training programs.
Security	3.75	Good	Security officers actively conduct patrols and regulate loading and unloading activities.
Orderliness	3.55	Good	Traffic flow and loading-unloading activities require improved monitoring.

The security aspect received a score of 3.75, which is categorized as good. Port activities are supervised by security officers and a routine patrol system. However, the number of personnel is still limited, so supervision in areas with high activity needs to be expanded. The order aspect received a score of 3.55, which is still categorized as good, but it is the lowest of the five aspects. The regulation of vehicle traffic and loading and unloading activities is not yet fully orderly. Limited parking space and a lack of information boards create the potential for congestion. This indicates the need for improved coordination between port management units in supervising daily activities.

Success factors and obstacles in implementing environmental control

The results of interviews and field observations show that the successful implementation of the K5 principles at the Kejawanan Nusantara Fishing Port is influenced by interrelated internal and external factors. Internal factors include the availability of sanitation facilities, port management support, and human resource involvement. Sanitation facilities and management support are highly influential; without adequate sanitation facilities, K5 principles cannot be optimally implemented, while management support is crucial for policy-making and the allocation of necessary resources, without which budgeting and equipment mobilization would be impossible (Permana *et al.* 2018; Roshid *et al.* 2026). Human resource involvement is also pivotal, as the workforce is responsible for implementing K5 principles, and success depends on their contribution (Alamouh *et al.* 2024).

External factors include inter-agency coordination, port user awareness, and the level of stakeholder participation. Fish handling from landing at the dock to distribution outside the port requires stakeholder involvement and the support of all relevant agencies to ensure smooth operations. Since K5 principles are

integral to all these activities, coordination, user awareness, and stakeholder participation are decisive factors in the level of success achieved (Darbra *et al.* 2009; Ly 2024). These internal and external factors determine the effectiveness of environmental management at the fishing port, which is grounded in the principles of cleanliness, aesthetics, security, order, and occupational safety.

Good environmental control performance requires a management system that is integrated with environmentally friendly infrastructure. The existence of a WWTP at Kejawanan Nusantara Fishing Port is an important component in ensuring that the quality of wastewater continues to meet environmental quality standards. This principle is in line with the Ecoport Environmental Management Framework, which emphasizes the importance of integrating waste treatment systems and green infrastructure to maintain the sustainability of port areas (Yalçın *et al.* 2023; Waheed *et al.* 2025).

Based on Table 4, the highest success for sanitation facilities and wastewater treatment (4.2) indicates that sanitation facilities are available and functioning quite well. The port has a system for collecting and disposing of liquid waste through a wastewater treatment plant that is capable of maintaining the quality of wastewater so that it does not pollute the port waters. The calculation results are supported by Shabib *et al.* (2025), who state that the effectiveness of port environmental management is highly dependent on the existence of waste treatment facilities that meet sustainability standards.

The port management support aspect (score 4.0) also shows strong performance. This support is manifested through the provision of a cleanliness budget, ISO 14001:2026-based environmental policies, and the implementation of the plan-do-check-act (PDCA) cycle to improve the effectiveness of environmental control (ISO 2026). This system ensures that all environmental management activities are controlled and evaluated regularly.

Table 4. Success Factors and Environmental Control Constraints at Kejawanan Nusantara Fishing Port.

Factor	Success (Score)	Constraints (Score)
Sanitation facilities and wastewater treatment	4.2	1.8
Management support	4.0	2.0
Human resource involvement	3.8	2.5
Inter-agency coordination	2.5	3.9
Port user awareness	2.8	4.1
Stakeholder participation	3.7	3.0

Explanation: Score 1–2 = low; 3 = moderate; 4–5 = high.

The human resource involvement factor (score 3.8) shows that workers play an active role in maintaining cleanliness and order in the work area. However, there are still limitations in the number and capacity of technical human resources in solid and liquid waste management. According to Mustaruddin *et al.* (2020), increasing the technical capacity of port human resources is essential for the sustainable implementation of environmental control programs.

In Table 4, the aspects of inter-agency coordination (constraint score of 3.9) and port user awareness (constraint score of 4.1) indicate a high level of obstacles. Weak coordination between government units and managers has resulted in sectoral policies being implemented only partially. This situation illustrates the importance of strengthening institutional governance, as explained by Roshid *et al.* (2026) in Institutional Governance Theory, which states that the effectiveness of environmental management depends on clear roles, coordination systems, and joint evaluation mechanisms. The low awareness of port users, especially fishermen and traders, is a significant obstacle. Lack of knowledge about the importance of environmentally friendly behavior and minimal incentives contribute to the accumulation of waste in loading and unloading areas and the decline in the aesthetics of the area. Ly (2024) emphasizes that environmentally conscious behavior is influenced by personal values, social norms, and government policy support.

The stakeholder participation aspect (score of 3.7) shows that collaboration between relevant parties is already quite good, although it has not yet reached an optimal level. The involvement of government agencies, port managers, and coastal communities in routine cleaning activities strengthens environmental control efforts in port areas. This finding is in line with Alamoush *et al.* (2024), who state that multi-stakeholder collaboration can increase transparency and shared responsibility in sustainable environmental management.

Strategies for improving the effectiveness of environmental control

The strategy to improve the effectiveness of environmental control was formulated based on the results of an evaluative analysis of the application of the K5 principle and an assessment of the five dimensions of environmental control priorities. The five dimensions analyzed include ecological, social, economic, technological, and institutional

aspects. Each dimension was weighted based on stakeholder perceptions of its level of urgency and impact on the effectiveness of the environmental control system at Kejawanan Nusantara Fishing Port. This approach aims to identify the most strategic policy focus in strengthening the sustainable environmental control system of fishing ports.

The analysis results in Table 5 show that the ecological dimension received a priority score of 4.20 and became the top priority in improving the effectiveness of environmental control at Kejawanan Nusantara Fishing Port. This priority value is derived through an evaluative scoring matrix process, wherein dimensions characterized by dominant intensity and dominant impact are assigned a high priority value. Strengthening the ecological aspect was carried out through capacity building, improving the efficiency of the wastewater treatment system, optimizing solid waste management, and rehabilitating the drainage system to prevent flooding and pollution. The solutions provided can support efforts to reduce the pollutant load in the port area. Mustaruddin *et al.* (2020) emphasize that the existence of a WWTP is a key element in maintaining the quality of the port environment in accordance with national quality standards and supporting the principles of an environmentally friendly port.

The social dimension ranks second in priority (score of 3.95). This indicates a strategy that prioritizes increasing awareness and environmentally friendly behavior among port users. Community capacity building is carried out through hygiene training, socialization, and the formation of environmentally conscious communities in port areas. These efforts aim to foster a culture of clean and sustainable work. Alamoush *et al.* (2024) state that the active participation of coastal communities and port stakeholders is key to the success of environmental programs because it strengthens community-based monitoring functions.

The economic dimension scored 3.80 (Table 5), becoming a high priority with a strategy of strengthening environmental management financing. WWTP operational activities, the provision of separate waste bins, and the maintenance of sanitation facilities require sustainable financial support. Environmental levies based on fishing business activities and CSR partnerships from port companies can be alternative sources of funding. Waheed *et al.* (2025) emphasize that collaborative funding models are a strategic solution to ensure the sustainability of eco-ports.

Table 5. Priority strategies for improving the effectiveness of environmental control at Kejawanana Nusantara Fishing Port.

Environmental Control Dimension	Priority Score	Category	Improvement Strategy Direction
Ecology	4.20	High Priority	Improvement of WWTP facilities, optimization of solid waste management, and rehabilitation of port drainage systems.
Social	3.95	High Priority	Enhancement of environmental awareness through training and education for port users.
Economic	3.80	High Priority	Strengthening environmental funding based on the participation of fisheries business actors.
Technology	3.65	Medium Priority	Modernization of environmental quality monitoring systems and digitization of waste management reports.
Institutional	3.55	Medium Priority	Strengthening coordination among agencies and implementing a periodic environmental performance evaluation system.

The technological and institutional dimensions are of moderate priority, with scores of 3.65 and 3.55, respectively. Technological improvements are carried out through the modernization of wastewater quality monitoring systems and the digitization of environmental management reports to make the evaluation process more efficient and transparent. Institutional strengthening is carried out by clarifying the roles of various agencies, improving cross-sector coordination,

and implementing a periodic environmental performance evaluation system. This is in line with Institutional Governance Theory, which emphasizes the importance of integration between actors and evaluation mechanisms in ensuring the effectiveness of environmental management (Ozseker *et al.* 2025; Roshid *et al.* 2026). Figure 1 summarizes all these efforts in the form of a conceptual framework for improving the effectiveness of environmental control in fishing ports.

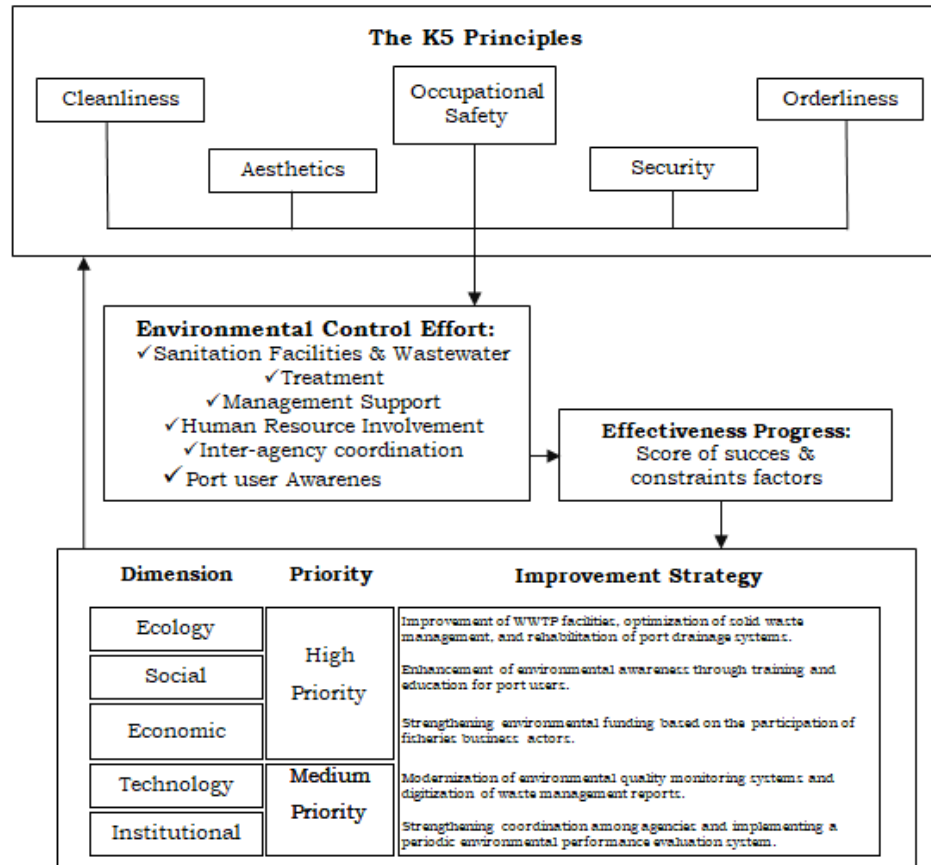


Figure 1. Conceptual framework for improving the effectiveness of environmental control at Kejawanana Nusantara Fishing Port.

Implications of the sustainable environmental control strategy

Strategies to improve the effectiveness of environmental control at Kejawanan Nusantara Fishing Port have direct implications for the sustainability of fisheries activities and coastal zone management. Implementing strategies to optimize solid waste management and rehabilitate port drainage will strengthen environmental quality, increase operational efficiency, and maintain the carrying capacity of aquatic ecosystems. Furthermore, strategies to increase the capacity of the WWTP and environmental monitoring systems will reduce the potential for pollution. These implications will be sustained if the strategy recommendations are consistently implemented. According to Alamoush *et al.* (2024) and Shabib *et al.* (2025), adherence to standards and consistent implementation will yield tangible results for port management, including addressing the environmental issues they face.

Environmental quality and port operational efficiency can be maintained through participatory approaches. Stakeholder participation in cleanup activities and environmental training will strengthen a responsible work culture. Inter-agency coordination and the use of data-driven monitoring technology will support efficient and sustainable port management (Darbra *et al.* 2009; Sdoukopoulos and Boile 2021).

CONCLUSION

The evaluation results showed that the implementation of the K5 principles was in the good category with an average score of 3.82. The cleanliness aspect received the highest score of 4.05, while the orderliness aspect received the lowest score of 3.55. This condition indicates that the environmental control system has been running effectively and has made a significant contribution to improving the cleanliness and comfort of the port area. However, improvements are still needed in the supervision of loading and unloading activities, internal port traffic management, and the arrangement of public facilities. Improving the effectiveness of port environmental control can be achieved by implementing priority strategies: (a) increasing wastewater treatment plant (WWTP) capacity according to the quantity of liquid waste generated by the port, (b) optimizing the management of both biodegradable and non-biodegradable solid waste, and (c) rehabilitating port drainage through the development of a

guided control system and interconnection across all port areas.

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