Agroteknika 9 (4): xx-xx (2026)

AGROTEKNIKA

ISSN: 2685-3450 (*Online*) www.agroteknika.id ISSN: 2685-3450 (*Print*)

Waste Management Strategies for Penyengat Island's Coastal Area: An Integrated SWOT-AHP Analysis

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Abstract. *Coastal waste management is an important environmental concern due to its impacts on marine ecosystems, public health, environmental quality, and coastal tourism sustainability. This study aimed to identify and prioritize waste management strategies for the coastal area of Penyengat Island, Tanjungpinang City, Riau Archipelago Province. A mixed-methods approach integrating quantitative and qualitative methods was employed. The quantitative component surveyed 40 community members and tourists selected through accidental sampling using a structured questionnaire with a five-point Likert scale. The qualitative component involved a focus group discussion (FGD) with 9 experts purposively selected based on their experience in waste management, environmental management, and tourism development. Field observations and documentation were also conducted. SWOT analysis identified internal and external strategic factors based on questionnaire findings and expert assessments. Factor weights and ratings were used to construct the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices and determine the SWOT position. Alternative strategies were subsequently prioritized using the Analytical Hierarchy Process (AHP). Expert judgments were aggregated into a collective pairwise comparison matrix, and consistency was assessed using the Consistency Ratio (CR). The results placed Penyengat Island in Quadrant I (Strengths–Opportunities), indicating that existing strengths can be leveraged to maximize available opportunities for improving coastal waste management. AHP identified TPS3R optimization as the highest-priority strategy (weight = 0.262), followed by strengthening local wisdom and community participation (weight = 0.248). The CR value of 0.09 indicated acceptable consistency in expert judgments. The findings support an integrated approach combining improved waste-processing infrastructure with local wisdom and community participation. As a single-site case study, the findings provide context-specific recommendations and should not be directly generalized to other coastal areas or small islands.*

Keywords: *Coastal Waste Management, Small Island, TPS3R, SWOT Analysis, Analytical Hierarchy Process (AHP).*

Diterima: 29 Mei 2026; Disetujui: 5 September 2026; Diterbitkan: ***TERBITAN AKAN DATANG***
https://doi.org/10.55043/agroteknika.v9i4.765
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1. Introduction

Coastal pollution has become one of the most critical environmental challenges worldwide because it threatens marine ecosystems, public health, tourism sustainability, and coastal livelihoods. In developing archipelagic countries such as Indonesia, waste management in small islands remains particularly challenging due to limited infrastructure, transportation constraints, restricted land availability, and inadequate waste collection systems (Indasah, 2020; Rauf *et al*., 2025). The issue of waste in coastal areas is an increasingly urgent environmental concern because it is directly related to the quality of marine ecosystems, public health, the aesthetics of the area, and the sustainability of economic activities in coastal communities. Poorly managed waste has the potential to be carried by water currents, tides, and human activities into the water, thereby increasing the risk of marine pollution. In the context of Indonesia as an archipelagic country, this issue becomes even more complex because many coastal areas and small islands face limitations in infrastructure, transportation access, processing land, and an inefficient waste collection system (Rauf *et al*., 2025).

Nationally, the challenge of waste management is still quite significant. Data from the National Waste Management Information System shows that in 2025, from 274 districts/cities that input data, waste generation reached approximately 29.07 million tons per year, while managed waste was only about 32.98%, and unmanaged waste reached 67.02%. This condition indicates that waste management still requires strengthening, both in terms of waste reduction at the source, handling, sorting, transportation, and final processing (KLHK, 2025). Indonesian waste management policies emphasize integrated, sustainable, and community-based waste management through Law No.18/2008 on Waste Management (Peraturan Perundang-undangan, 2008) and Presidential Regulation No.83/2018 concerning Marine Debris Management, which targets a 70% reduction in marine plastic debris (Peraturan Presiden, 2018).

Penyengat Island in Tanjungpinang City, Riau Islands Province, is one of the coastal areas with significant characteristics, both historically and culturally, in terms of tourism and in the socio-economic aspects of the community. This island is known as a national cultural heritage site with 46 historical relics and is developed as a cultural and religious tourism destination, which is expected to provide economic benefits to the local community (Dinas Lingkungan Hidup Kota Tanjungpinang, 2025; Pemerintah Provinsi Kepulauan Riau, 2025). However, the character of Penyengat Island as a small island and a cultural heritage area presents its own challenges in waste management. Waste management on small islands cannot be fully equated with mainland areas because it depends on sea transport access, the availability of collection facilities, land limitations, and area preservation regulations. The Environmental Agency (DLH) of Tanjungpinang City, Riau Islands, stated that the pile of inorganic waste in several coastal areas of the region is estimated to

reach 3.5 m (Dinas Lingkungan Hidup Kota Tanjungpinang, 2021). From several sources, it is reported that household waste amounts to 0.5 - 1.5 tons/day, which gives an idea of the large amount of waste generated by households of Tanjung Pinang city. Additionally, waste on Penyengat Island is reported to reach around 1–1.2 tons/day (Prasetiya *et al*., 2024). Meanwhile, the management is still done manually, including the transportation of waste using boats to Tanjungpinang. This fact indicates the need to formulate a more effective, adaptive, and area-appropriate waste management strategy (Rauf *et al*., 2025).

The environmental agency has installed warning banners and conducted socialization to prevent littering in the sea. In addition to technical difficulties, waste management on Penyengat Island is also closely related to community behavior, tourist participation, the role of local government, and collaboration among actors. The Riau Islands Provincial Government, for example, has made Penyengat Island the starting point of the Clean and Regenerative Tourism Movement in Kepri, with community service activities involving local officials, the military, the police, and the community. The activities target coastal areas, residential areas, routes to the Balai Adat, and cultural sites, indicating that the cleanliness of the area is considered an important part of the sustainable tourism strategy (Dinas Lingkungan Hidup Kota Tanjungpinang, 2025).

Based on research by Macap *et al.* (2025), plastic waste management on Arborek Island is carried out by the Non-Governmental Organization (NGO) Barefoot Conservation, involving the local community, especially children and adolescents aged 7-16 years. The management carried out includes collection, sorting, and transportation. The questionnaire results showed that respondents' responses to waste facilities had a mean score of 3, categorized as quite satisfactory. Meanwhile, respondents' responses to waste infrastructure averaged a score of 4, categorized as poor. The management strategy obtained from the SWOT analysis is the S-O strategy, a progressive strategy that uses strengths to seize opportunities. This strategy is to reduce plastic waste as much as possible starting from the source by implementing the 3R method and increasing the active role of the community and related agencies or other parties (private-sector actors) as management partners (Macap *et al*., 2025).

Setiawan's research highlights the importance of community participation and stakeholder collaboration in coastal waste management. The SWOT analysis identified four strategic approaches: S-O, strengthening cooperation between the Environmental Agency and stakeholders; W-O, optimising existing collaborations; S-T, maximising human resources to improve waste management; and W-T, strengthening the waste management system for more effective implementation. These findings emphasise that integrated institutional collaboration, community participation, and improved waste management capacity are essential for sustainable coastal waste management (Setiawan *et al*., 2025).

Previous studies have demonstrated that SWOT analysis is useful for identifying strategic directions for coastal waste management (Macap *et al*., 2025; Setiawan *et al*., 2025). However, SWOT alone cannot determine the relative priority of each strategic alternative. Consequently, integrating SWOT with AHP offers a more systematic approach for prioritising waste management interventions, particularly in environmentally sensitive small islands.

Given the background outlined above, there is a clear need to formulate a waste management strategy that is effective, adaptive, and tailored to local characteristics. Preliminary observations on Penyengat Island reveal that waste volumes are steadily rising (piles of inorganic waste in several coastal areas of the region reached a height of 3.5 meters), disposal practices are haphazard and improper, and waste management remains inadequate. If left unaddressed, this issue will become a persistent environmental problem for the area as the problem may become increasingly severe without proper intervention and will have a significant impact on the local community. Previous studies have primarily focused on community participation or SWOT-based waste management strategies in coastal areas. However, limited research has integrated strategic prioritization methods, such as the Analytical Hierarchy Process (AHP), with SWOT analysis to formulate evidence-based waste management strategies for small cultural heritage islands characterized by tourism activities, spatial constraints, and limited waste management infrastructure.

Based on these conditions, research on waste management strategies in coastal areas with a case study of Penyengat Island, Riau Islands, becomes important to conduct. This study aims to (1) identify internal and external factors influencing waste management on Penyengat Island; (2) formulate strategic alternatives using SWOT analysis; and (3) prioritise the most feasible waste management strategy using the Analytic Hierarchy Process (AHP). Unlike previous studies that relied solely on SWOT analysis, this study integrates SWOT and the Analytical Hierarchy Process (AHP) to identify and prioritise waste management strategies. This integrated approach enables strategic alternatives to be evaluated not only qualitatively but also quantitatively according to stakeholder priorities. The results of this research are expected to provide practical contributions to local governments and communities in building a more integrated waste management system, while also making an academic contribution to the development of waste management studies in coastal areas and small islands based on sustainability.

2. Materials and Methods

This study employed a mixed-methods approach (Yasril, 2025). This study was conducted on Penyengat Island, located in Tanjungpinang City, Riau Islands Province, in April 2026. The tools and materials used included questionnaires and a camera for documentation. The research

began with an observation phase utilizing a literature review approach to obtain statistical and existing data regarding waste generation on Penyengat Island. The subsequent observation stage involved the use of questionnaires to gather factual data and information from the field concerning waste management practices, facilities and infrastructure, and the roles of the community, NGOs, and the government in waste management implementation on the island. Accidental sampling (convenience sampling) was employed to select the study population and sample; respondents were selected based on their presence and willingness to participate at the specific research locations at the time of data collection, rather than through a predetermined population list, resulting in a total of 40 respondents. Following data collection, the researcher analyzed the information using SWOT analysis, beginning with the categorization of the collected data for processing into a SWOT matrix (Abdillah & Suhartini, 2023). The data were then analyzed and used to develop strategies from the SWOT matrix so that the analysis results are expected to become recommendations for waste management on Penyengat Island. The SWOT matrix used in this study is presented in Table 1.

Table 1. Standard SWOT Combination Matrix.

IFAS / **EFAS**	**Strength (S)** List of Strengths (Internal)	**Weakness (W)** List of Weakness (Internal)
Opportunity (O) List Of Opportunity (External)	**S-O Strategy** Strategy that uses strength to seize opportunities	**W-O Strategy** Strategy to minimize weaknesses to seize opportunities
Threats (T) List Of Threats (External)	**S-T Strategy** Strategy that uses strength to overcome threats	**W-T Strategy** Strategy to minimize weaknesses while avoiding threats

Source: (Macap *et al*., 2025)

Waste management strategies were subsequently determined and conducted through a focus group discussion (FGD) involving nine purposively selected experts with relevant experience in environmental management, waste management, governance, and risk analysis. The experts comprised 1 provincial government representative, 2 Tanjungpinang City Environmental Agency (DLH) representatives, 1 River Basin Management Centre (BPDAS) representative, 2 environmental experts, 1 risk analysis expert, and 2 environmental observers/NGO representatives. All experts had at least 5 years of relevant professional experience and were selected based on their expertise and direct involvement in related fields.

The FGD was conducted on 4 April 2026 for approximately 90 minutes to identify waste management issues, risks, strategic factors, and potential alternatives. Participants were informed about the study objectives, voluntary participation, confidentiality, and their right to withdraw. Differences in opinion were discussed and retained where relevant. The FGD findings were subsequently structured into an AHP hierarchy consisting of the objective, criteria, and strategic alternatives.

Pairwise comparisons were assessed by the 9 experts using a 1–9 scale. Individual judgements were aggregated using the geometric mean to produce a group comparison matrix. Priority weights were calculated using Expert Choice 11, and consistency was assessed using the Consistency Ratio (CR), with CR ≤ 0.10 considered acceptable. Sensitivity analysis was conducted to assess the stability of strategy priorities. Ethical procedures included informed consent, confidentiality, coded participant identities, and secure data storage. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Fort De Kock under approval number 394/UFDK.KEPK/2026. This procedure ensured that the priority strategies were systematically derived from qualified expert judgements through a transparent FGD and AHP process (Abdillah & Suhartini, 2023; Kurniawan *et al*., 2021; Mulyawan *et al*., 2020).

3. Results and Discussion

3.1 Identification of SWOT and AHP Analysis

The SWOT analysis was conducted based on interviews and questionnaire responses obtained from local communities and tourists to identify the internal and external factors influencing waste management in the coastal area of Penyengat Island. Internal factors were analysed using the Internal Factor Analysis Summary (IFAS), whereas external factors were evaluated through the External Factor Analysis Summary (EFAS). Subsequently, the SWOT matrix and Analytical Hierarchy Process (AHP) were integrated to formulate and prioritise strategic alternatives for sustainable coastal waste management. Then, the Internal Strategic Factor Analysis Summary (IFAS) and External Strategic Factor Analysis Summary (EFAS) matrices were prepared to obtain the total score. Next, internal and external factors are considered to determine the strategic position of the study area and to create the Internal-External (IE) matrix. Additionally, a SWOT matrix is created, resulting in four different strategies: Strength-Opportunities (S-O), Strength-Threats (S-T), Weakness-Opportunities (W-O), and Weakness-Threats (W-T). The AHP method is used to support decision-making with multiple criteria. Determination of the weight of each factor from the SWOT strategy is followed by constructing pairwise comparisons to determine the importance level of each strategic alternative using Expert Choice 11 so that priority strategies can be obtained for selecting the appropriate strategy in managing waste in the coastal area of Penyengat Island. Figure 1 shows the SWOT-AHP hierarchy in this study.

3.2 Analysis of Internal and External Factors and SWOT Strategy Matrix

The results of interviews and the distribution of questionnaires were used to compile the factors of strengths, weaknesses, opportunities, and threats in waste management in the coastal area of Penyengat Island. The next step is the preparation of the IFAS matrix as a breakdown of

the internal conditions of the coastal area of Penyengat Island, which is under the Tanjungpinang City Environmental Agency, detailing the strengths and weaknesses that show the weight and rating of each factor, with a strength score of 2.182 and a weakness score of 1.091 in Table 2, resulting in a total internal factor score of 1.091. This is followed by the preparation of the EFAS matrix for mapping the external conditions of waste management in the coastal area of Penyengat Island through opportunity and threats factors. This matrix describes the position of opportunities held by Penyengat Island in waste management and the threats faced in strategy development (Table 2). The EFAS matrix results show an opportunity score of 1.808 and a threats score of 0.962, resulting in a total external factor score of 0.846.

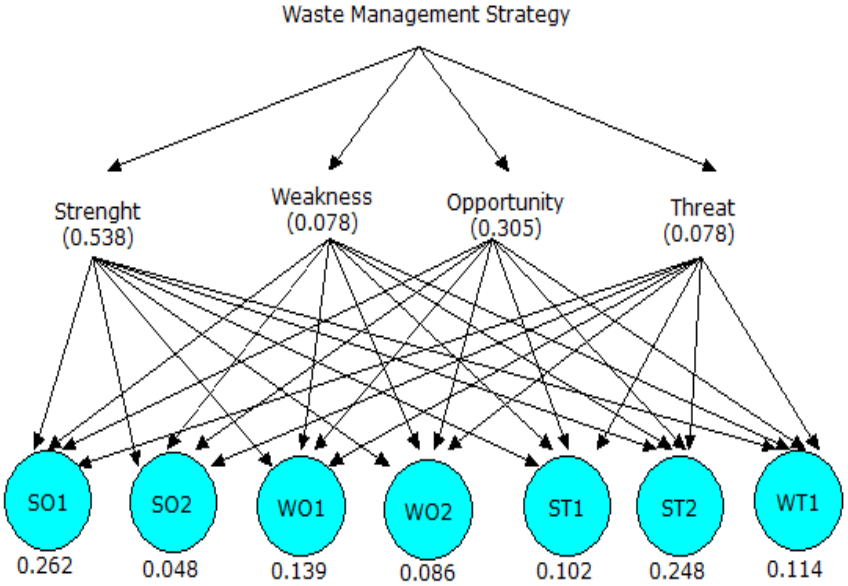

Figure 1. SWOT-AHP Hierarchy.

After the IFAS and EFAS matrices have been prepared, the next step is to create the IE (Internal-External) matrix to determine the position of waste management in the coastal area of Penyengat Island. This matrix serves as the initial step in formulating alternative strategies. The IFAS value is 1.091, while the EFAS score is 0.846 (Table 2). The position of the strategy quadrant is determined through the formulation of the X and Y axes, where the X axis represents IFAS (Strengths – Weaknesses) and the Y axis represents EFAS (Opportunities – Threats).

The integration of the IFAS and EFAS scores positioned Penyengat Island within Quadrant I of the Internal–External (IE) matrix. This strategic position indicates that the study area possesses strong internal capabilities supported by favorable external opportunities, thereby suggesting the adoption of an aggressive growth strategy (strength–opportunity strategy). Such a position reflects the readiness of the region to optimize existing resources while maximizing available opportunities to achieve sustainable waste management.

Table 2. IFAS and EFAS Matrix for Waste Management in the Coastal Area of Penyengat Island.

Number	Indicators	Value (1-5)	Value Normalization (Value/33)	Rating	Scores
A.	**Internal Factors (IF)**				
A1	**Strengths**				
1	Already have TPS 3R	5	0.152	4	0.606
2	There is already a separation of organic and inorganic waste	4	0.121	4	0.485
3	Government commitment regarding waste management	5	0.152	3	0.455
4	There is local wisdom in maintaining coastal tourist areas	4	0.121	3	0.364
5	Strategic location close to the city center	3	0.091	3	0.273
	Total	**21**	**0.636**		**2.182**
A2.	**Weakness**				
1	Lack of waste management facilities	5	0.152	4	0.606
2	Access depends on water transportation facilities	2	0.061	2	0.121
3	Lack of collaboration between agencies	2	0.061	3	0.182
4	Weak implementation of waste regulations	1	0.030	2	0.061
5	Weak supervision regarding waste management	2	0.061	2	0.121
	Total	**12**	**0.364**		**1.091**
	∑	**33**	**1.000**		
	IF Value				***1.091***
B.	**External Factors (EF)**				
B1	**Opportunity**				
1	Increased Public Awareness and Participation	4	0.154	4	0.615
2	The community's desire to create a clean and sustainable coastal tourism area	5	0.192	3	0.577
3	There is a desire from the local government, NGOs and the community to open a waste bank program.	5	0.192	2	0.385
4	There is socialization regarding information on waste management	3	0.115	2	0.231
	Total	**17**	**0.654**		**1.808**
B2	**Threats**				
1	Lack of awareness among tourists and the public in maintaining cleanliness and environmental sustainability from waste pollution	1	0.038	4	0.154
2	Shift in societal values	2	0.077	3	0.231
3	Disruption of community activities outside the area	3	0.115	2	0.231
4	Public Health Problems Related to Waste Pollution	1	0.038	3	0.115
5	The decline in the community's economy	2	0.077	3	0.231
	Total	**9**	**0.346**		**0.962**
	∑	**26**	**1.000**		
	EF Value				***0.846***

Quadrant I represents a favorable strategic condition because organizations operating within this quadrant are capable of utilizing their strengths to capitalize on environmental opportunities (Figure 2). According to Putri *et al.* (2023), organizations positioned in Quadrant I generally demonstrate greater capacity to implement innovative and sustainable environmental management strategies. In the context of Penyengat Island, existing institutional support, community participation, and local cultural values constitute valuable social capital that can facilitate long-term waste management improvements. The research results show that when coastal waste

management is supported by various strengths, such as high community participation, availability of human resources, support from local government, the presence of environmental awareness groups, and the availability of waste management facilities. On the other hand, there are external opportunities that can be utilized, such as the increasing attention of the government toward coastal environmental issues, the existence of community-based waste management programs, support from private institutions and environmental organizations, as well as the development of the ecotourism sector that demands cleanliness in coastal areas. Based on these conditions, the strategy implemented is an aggressive strategy (Strength–Opportunities Strategy), which means utilizing all available strengths to seize opportunities effectively. Thus, the position of Quadrant I in coastal waste management indicates that the area has the potential to develop toward effective and sustainable environmental management. The presence of strong internal factors and supportive external opportunities serves as an important foundation in creating a clean, healthy, and coastal area that supports local economic well-being for the surrounding community. The strategies formulated through a SWOT analysis can be seen in Table 3.



Figure 2. SWOT Analysis Quadrant for Waste Management Strategy Direction in the Coastal Area of Penyengat Island.

Table 3. SWOT Strategy.

	Opportunities	**Threats**
Strength	**1.** Optimization of the TPS3R system (SO1) **2.** Development of tourism areas based on local wisdom and sustainable environment (SO2)	1. Strengthening the government's commitment to reducing the impact of environmental pollution (ST1) 2. Strengthening local wisdom and community participation to increase tourist awareness in maintaining the cleanliness of coastal tourist areas (ST2)
Weakness	1. Improving waste management facilities and infrastructure (WO1) 2. Strengthening collaboration between agencies (WO2)	1. Increased supervision and enforcement of waste management regulations (WT1) 2. Development of an integrated waste management system (WT2)

From Table 3, a SWOT analysis was generated, yielding several strategies to be adopted for waste management in the coastal area of Penyengat Island. Following the strategy development, strategic decision-making is conducted to determine which strategies are prioritised. Based on the SWOT matrix, seven strategic alternatives were formulated. These include (1) optimisation of the TPS3R system, (2) strengthening local wisdom and community participation to increase tourist awareness in maintaining the cleanliness of coastal tourist areas, (3) improvement of waste management facilities and infrastructure, (4) increased supervision and enforcement of waste management regulations, (5) strengthening the government's commitment to reducing the impact of environmental pollution, (6) strengthening collaboration between agencies, and (7) development of tourism areas based on local wisdom and sustainable environment. These strategies collectively address both technical and institutional dimensions of coastal waste management. This strategic decision-making process uses the Analytical Hierarchy Process (AHP), as shown in the following Figure 3.

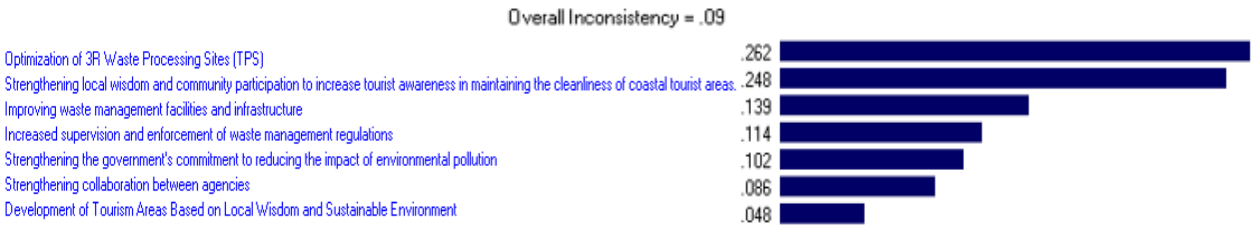

Figure 3. Analysis Results Using AHP.

To determine the most appropriate strategic priority, the SWOT results were further analysed using the Analytical Hierarchy Process (AHP). The analysis generated an overall inconsistency ratio of 0.09, indicating that respondents' judgements were sufficiently consistent and met the acceptable consistency threshold (<0.10). Therefore, the priority ranking generated by the AHP can be considered reliable for strategic decision-making.

The AHP results identified optimisation of TPS3R as the highest priority strategy, with a priority weight of 0.262. This strategy directly addresses the root causes of waste accumulation through waste reduction, reuse, and recycling at the source. Considering the limited land availability and the high transportation costs associated with island waste management, strengthening the TPS3R system provides an effective and practical solution for reducing waste generation before final disposal. Previous studies have similarly demonstrated that integrated 3R-based waste management significantly improves operational efficiency and environmental sustainability in coastal communities (Darmi & Aryanti, 2022; Emargi *et al*., 2025).

The second-highest priority strategy was strengthening local wisdom and community participation, which received a priority weight of 0.248. This finding highlights that social and cultural dimensions are nearly as important as technical infrastructure in ensuring successful waste

management. Community participation enhances environmental stewardship by encouraging residents to engage actively in waste sorting, collection, monitoring, and environmental conservation activities. These findings are consistent with previous research indicating that sustainable waste management is strongly influenced by community willingness, capacity, and opportunities for participation (Safrina, 2015; Darmi & Aryanti, 2022).

The present findings are further supported by previous studies reporting that successful implementation of TPS3R depends not only on adequate infrastructure but also on active community involvement. Gita *et al*. (2022) emphasized that community participation significantly determines the operational success of TPS3R facilities, whereas demonstrated that community-based 3R programs effectively reduce household waste generation (Hanum *et al*., 2018). Likewise, Alfons and Padmi concluded that community-based waste management is particularly suitable for island regions because of limited landfill availability and expensive waste transportation systems (Alfons & Padmi, 2015). Meanwhile, Kalpikawati and Pinaria stated that the success of waste management in tourist areas is greatly influenced by local culture and public awareness of the importance of environmental cleanliness as a tourist attraction (Kalpikawati & Pinaria, 2023).

The strategic relevance of these findings is particularly evident in Penyengat Island, which functions as an important cultural and religious tourism destination. Tourist activities substantially increase waste generation, especially during weekends and religious festivals. Combined with limited land resources and transportation constraints, these conditions create significant challenges for waste management. Consequently, optimizing the TPS3R system while strengthening community participation provides a practical and sustainable solution. Moreover, the strong Malay cultural traditions and Islamic values embedded within the local community provide substantial social capital that can reinforce environmentally responsible behavior. These cultural values can be translated into community-based environmental programs, including neighborhood waste banks, mosque-based environmental education, regular coastal clean-up campaigns, and customary regulations discouraging littering.

Overall, the findings demonstrate that sustainable waste management in coastal tourism areas cannot rely solely on technical interventions or social approaches independently. Instead, integrating infrastructure development with community empowerment offers the most effective strategy for achieving long-term environmental sustainability. The synergy between optimizing TPS3R facilities and strengthening local participation establishes a comprehensive framework capable of improving environmental quality, supporting sustainable tourism development, and enhancing community welfare on Penyengat Island.

4. Conclusion

Based on research findings, waste management in the coastal area of Penyengat Island still

faces various challenges, particularly limited facilities, poor oversight, and increasing waste volumes due to community activities and tourism. However, Penyengat Island has significant potential for improved waste management, supported by the presence of the Waste Management Facility (TPS3R), government commitment, and the strong local wisdom of the Malay community. The SWOT analysis indicates that the waste management strategy falls into the aggressive (SO) quadrant, indicating that the region possesses strengths and opportunities that can be leveraged to support sustainable environmental management.

Furthermore, the AHP analysis indicates that the top priority strategies for coastal waste management are optimising the TPS3R and strengthening local wisdom and community participation. These two strategies are considered most appropriate for Penyengat Island's characteristics as a cultural tourism area and a small island with limited land and access to waste transportation. Waste management requires not only a technical approach through the provision of facilities and processing systems but also active community involvement to foster a shared awareness of maintaining a clean coastal environment. Therefore, synergy between the government, the community, and various related parties is an important factor in creating effective, sustainable waste management and supporting the development of clean and comfortable tourism on Penyengat Island.

Abbreviations

DLH	Dinas Lingkungan Hidup
BPDAS	Badan Pengelolaan Daerah Aliran Sungai
FGD	Focus Group Discussion
TPS3R	Tempat Pengelolaan Sampah 3R
AHP	Analytical Hierarchy Process

Data Availability Statement

Data will be available upon request

CRediT Authorship Contribution Statement

Abdi Iswahyudi Yasril: article writing, methodology development, data processing, and discussion. **Fanny Yuliana Batubara:** data collection, article writing, and data analysis. **Rahman Arif:** data analysis, reference search, and comparative journals. **Shopian Hadi:** article search, initial draft writing. **Sayyidah Nur Habibah:** research methodology, data collection, article search. **Indang Dewata:** supervision, research methodology. **Abdul Razak:** supervision, data analysis, discussion**. Eni Kamal**: discussion, conclusion drafting, supervision. **Widya Prarikeslan:** reference search, data analysis, discussion. **Nurhasan Syah**: supervision, discussion.

Declaration of Competing Interest

The authors of this manuscript declare no conflicts of interest or competing interests.

Acknowledgement

The authors would like to express their sincere gratitude to the Doctoral Program in Environmental Sciences, Graduate School, Universitas Negeri Padang, for academic support and guidance throughout this research. Appreciation is also extended to the Government of Riau Islands Province and the Environmental Agency (DLH) of Tanjungpinang City for their support, data access, and assistance during the research process on Penyengat Island.

The authors are deeply grateful to the community of Penyengat Island for their participation, cooperation, and valuable information during field observations and interviews. Special thanks are also addressed to the River Basin Management Center (BPDAS), environmental experts, NGOs, and all informants involved in the Focus Group Discussion (FGD) for their insights and contributions in formulating the waste management strategies presented in this study.

References

Abdillah, H. A., & Suhartini. (2023). Analisis SWOT dan AHP untuk Menentukan Strategi Pengembangan Dalam Persaingan Usaha (Studi Kasus: UD. Duta Sumber Ayem Niaga). *Journal of Research and Technology*, *9*(2), 211–220. https://doi.org/10.55732/jrt.v9i2.1073

Alfons, A. B., & Padmi, T. (2015). Analisis Multi Kriteria Terhadap Pemilihan Konsep Pengelolaan Sampah (Studi Kasus: Daerah Perkampungan di Wilayah Danau Sentani). *Jurnal Teknik Lingkungan*, *21*(2), 138–148. https://doi.org/10.5614/jtl.2015.21.2.4

Darmi, T., & Aryanti, M. (2022). Partisipasi Masyarakat Dalam Pengelolaan Sampah Pada KAwasan Wisata Pantai. *Journal of Public Policy and Administration Silampari*, *4*(1), 17–23. https://doi.org/10.31539/joppas.v4i1.5183

Dinas Lingkungan Hidup Kota Tanjungpinang. (2021). *DLH: Tumpukan Sampah Pesisir Tanjungpinang Capai Ketebalan 3,5 Meter.* DLH Kota Tanjungpinang. https://kepriprov.go.id/berita/pemprov-kepri/dlh-tumpukan-sampah-pesisir-tanjungpinang-capai-ketebalan-3-5-meter

Dinas Lingkungan Hidup Kota Tanjungpinang. (2025). *Data Persampahan Tahun-2023-2024*. https://opendata.tanjungpinangkota.go.id/dataset/data-persampahan-tahun-2023-2024.

Emargi, R. E., Rosyani, R., & Guspianto, G. (2025). Strategi Pengelolaan Sampah Rumah Tangga Di Wilayah TPS3R Tunas Jaya (Studi Kasus Kelurahan Patunas Kecamatan Tungkal Ilir Kabupaten Tanjung Jabung Barat). *Inovasi: Jurnal Sosial Humaniora dan Pendidikan, 4*(1), 1039-1048. https://doi.org/10.55606/inovasi.v4i1.4899

Gita, P. S. D., Runa, I. W., & Parwata, I. W. (2022). Analisis Infrastruktur Tempat Pengelolaan Sampah 3R Berdasarkan Aspek Teknis dan Partisipasi Masyarakat di Desa Abiansemal Kabupaten Badung Bali. *Jurnal Indonesia Sosial Dan Teknologi*, *3*(10), 1051–1070. https://doi.org/10.59141/jist.v3i10.512

Hanum, F., Suhendrayatna, S., & Isya, M. (2018). Partisipasi Masyarakat Gampong Nusa Terhadap Pengelolaan Sampah Dengan Program 3R. *Jurnal Arsip Rekayasa Sipil Dan Perencanaan*, *1*(2), 90–101. https://doi.org/10.24815/jarsp.v1i2.10948

Indasah. (2020). *Kesehatan Lingkungan Sanitasi Kesehatan Lingkungan dan K3*. Deepublish. https://opac.perpusnas.go.id/DetailOpac.aspx?id=1017666&pType=Author&pLembarkerja=-1&pLokasi=-1&pPilihan=default&pDataItem=Indasah

Kalpikawati, I. A., & Pinaria, N. W. C. (2023). Partisipasi Masyarakat Lokal Dalam Pengelolaan Sampah Berbasis Sumber Mendukung Desa Wisata Berkelanjutan (Studi Kasus Desa Wisata

Taro, Bali). *Jurnal Ilmiah Pariwisata*, *28*(1), 50. https://jurnalpariwisata.iptrisakti.ac.id/index.php/JIP/article/view/1676. https://doi.org/10.30647/jip.v28i1.1676

KLHK. (2025). *Sistem Informasi Kinerja Pengelolaan Sampah Nasional*. Jakarta: KLHK Indonesia. https://sampahnasional.kemenlh.go.id/

Kurniawan, G. I., Disman, Hurriyati, R., & Dagustani, D. (2021). Penentuan Prioritas Risiko Melalui Analytical Hierarchy Process (AHP) Sebagai Upaya Pengembangan Potensi Kawasan Wisata Pantai Jawa Barat Selatan. *Jurnal Inovasi Penelitian*, *1*(10), 2057–2068. https://www.neliti.com/publications/468700/penentuan-prioritas-risiko-melalui-analytical-hierarchy-process-ahp-sebagai-upay.

Macap, F. A. C., Abu, N., Dwangga, M., & Marasabessy, U. (2025). Strategi Pengelolaan Sampah Plastik di Kampung Wisata Arborek Raja Ampat. *Jurnal Teknologi Lingkungan Lahan Basah*, *13*(2), 29–44. https://doi.org/10.26418/jtllb.v13i2.96656

Mulyawan, R., Mahyudin, R. P., Badaruddin, B., & Ahmadi, A. (2020). Permasalahan Pengelolaan Persampahan di Kota Tarakan. *Sanitasi: Jurnal Kesehatan Lingkungan*, *11*(2), 65–74. https://doi.org/10.29238/sanitasi.v11i2.941

Pemerintah Provinsi Kepulauan Riau. (2025). *Gerakan Wisata Bersih dan Regeneratif Kepri Dimulai dari Pulau Penyengat*. Pemerintah Provinsi Kepulauan Riau. https://www.kepriprov.go.id/berita/gubernur/gerakan-wisata-bersih-dan-regeneratif-kepri-dimulai-dari-pulau-penyengat

Peraturan Perundang-undangan. (2008). *Undang-Undang No 18 Tahun 2008 Tentang Pengelolaan Sampah*. In Ministry Of Law And Human Rights Of The Republic Indonesia. https://peraturan.bpk.go.id/Details/39067/uu-no-18-tahun-2008

Peraturan Presiden. (2018). *Peraturan Presiden Republik Indonesia Nomor 83 Tahun 2018 Tentang Penanganan Sampah Laut*. https://peraturan.go.id/id/perpres-no-83-tahun-2018

Prasetiya, J., Alfiansyah, A., & Perkasa, A. (2024). Evaluasi Kebijakan Terhadap Pencegahan Limbah Sampah Pelantar Kota Tanjungpinang (Studi Penelitian Dinas Lingkungan Hidup Kota Tanjungpinang). *Jurnal Riset Rumpun Ilmu Sosial, Politik Dan Humaniora*, *3*(1), 1–11. https://doi.org/10.55606/jurrish.v3i1.2283

Putri, V. T., Raharjo, S., & Aziz, R. (2023). Strategi Pengelolaan Sampah Menggunakan Analisis SWOT: Studi Kasus TPA Regional Payakumbuh. *Jurnal Serambi Engineering, 8*(3). https://doi.org/10.32672/jse.v8i3.5788

Rauf, M. T. A., Kurnianingsih, F., & Firman, F. (2025). Evaluasi Kebijakan Peraturan Walikota Tanjungpinang Nomor 14 Tahun 2022 Tentang Pengurangan Penggunaan Kantong Plastik. *RISOMA: Jurnal Riset Sosial Humaniora Dan Pendidikan*, *3*(2), 88–95. https://doi.org/10.62383/risoma.v3i2.652

Safrina, S. (2015). Partisipasi Masyarakat Dalam Pengelolaan Wilayah Pesisir Di Aceh. *Jurnal Hukum Lingkungan Indonesia*, *2*(1), 1–20. https://doi.org/10.38011/jhli.v2i1.19.

Setiawan, F. G., Nefilinda., & Putri, R. E. (2025). Strategi Penanganan Sampah di Pesisir Pantai Kecamatan Lengayang, Kabupaten Pesisir Selatan, Provinsi Sumatera Barat. *Indonesian Research Journal on Education*, *5*(2), 655–660. https://doi.org/10.31004/irje.v5i2.2287

Yasril, A. I. (2025). *Metodologi Penelitian Interdisipliner [Interdisciplinary Research Methodology]* (Darwel, Ed.; 1st ed., Vol. 4, Number 1). MMFAST PUBLISHING. https://mmfast.id/product/metodologi-penelitian-interdisipliner/