

# Penta Helix Analysis on Coastal Waste Management Policy in Tanjungpinang City, Riau Islands Province

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**Abstract.** Coastal waste handling is a crucial issue that has a major impact on environmental sustainability and the quality of life of the people in Tanjungpinang City, Riau Islands Province. This study examines the effectiveness of the implementation of coastal waste management policies using the Penta Helix model approach involving the government, the private sector, academia, non-governmental organizations (NGOs), and civil society. Qualitative research methods are used with interview data collection techniques, observations, and document studies. The results of the study show that despite the existence of waste management regulations and programs, the success of policies is still constrained in coordination and cross-sectoral participation. A harmonious collaborative role according to the Penta Helix model is needed to realize effective and sustainable coastal waste management in this region. This research provides strategic recommendations to increase synergy between elements to support the sustainability of marine ecosystems and the quality of the coastal environment.

**Keywords:** Penta Helix, Waste Management Policy, Coastal Waste, Tanjungpinang City, Collaboration, Sustainability

## 1 Introduction

The problem of coastal waste management is one of the significant environmental challenges in many coastal cities in Indonesia, including the city of Tanjungpinang in the Riau Islands Province. This city has geographical characteristics as an archipelago with a wide coastline that is susceptible to waste pollution, especially plastic and other types of household waste (Riwandi, 2024). This problem is very urgent because waste that is not handled properly can threaten the sustainability of marine ecosystems, marine-based economies, and the health of coastal communities.

As a coastal city and provincial capital, Tanjungpinang is faced with the generation of coastal waste that affects the local ecosystem and economy. Recent studies show problems with

the performance of coastal waste management policies that have not fully accommodated coastal issues [6]. Statistics show that marine debris in the Riau Islands region continues to increase every year, mostly from land and human activities on the coast that are not supported by an effective waste management system [5]. Single-use plastic waste, plastic bags, bottles, and abandoned organic waste are major contributors to coastal pollution that cause damage to marine habitats and endanger marine flora and fauna.

The Tanjungpinang City Government has issued various policies and programs aimed at reducing waste and improving overall waste management. One of them is Mayor Regulation Number 14 of 2022 concerning Reducing the Use of Plastic Bags, which is in line with national efforts to overcome the problem of marine debris [7]. These policies include regulating household waste management and improving waste management facilities. However, obstacles in implementation such as budget limitations, low public awareness, and weak coordination between government agencies are still the main obstacles in achieving effective waste management targets.

Facing this complex problem, an approach that involves various actors synergistically is needed so that the resulting solutions are sustainable and touch all aspects of coastal waste management. The Penta Helix model that combines the roles of government, the private sector, academia, non-governmental organizations, and civil society is one of the relevant and potential strategies to address this problem holistically [4]. This approach offers a collaborative framework that focuses not only on regulation, but also on innovation, education, and broader public participation. This paper will analyze Tanjungpinang's coastal waste management policy using the Penta Helix model to map the role of actors and implementation weak points, as well as prepare recommendations for improvement.

This study aims to analyze the implementation of the Penta Helix model in coastal waste management policies in Tanjungpinang City and evaluate the factors that support and hinder its success. With an emphasis on interaction and collaboration between elements of Penta Helix, this research is expected to provide more effective and targeted policy recommendations to improve the quality of the coastal environment and the welfare of local communities.

## **2 Research Methods**

This study uses a qualitative approach with a descriptive design to describe in depth the implementation of coastal waste management policies in Tanjungpinang City. This approach

was chosen because it is able to provide a comprehensive picture of the interactions between actors in the Penta Helix model as well as its supporting and inhibiting factors [3]. The literature review method (national/regional regulations and research related to Tanjungpinang) was combined with a thematic synthesis of Penta Helix actors. Primary sources are in the form of legal products and relevant and up-to-date journal articles [13][14][15][16][17].

In-depth interviews were also conducted with government officials, private sector representatives, academics, NGOs, and community leaders to explore views and experiences related to coastal waste management policies. Then a Document Study was also carried out for analysis of policy documents, activity reports, and statistical data related to waste management in Tanjungpinang City. The collected data was analyzed using qualitative content analysis techniques. The analysis process includes data reduction to focus on key themes related to the role of each Penta Helix actor and the existing constraints, Data grouping by theme to find patterns and relationships between collaboration elements, Interpretation of results to draw conclusions about the effectiveness and challenges of policy implementation. The data triangulation approach is applied to improve the validity of research results by comparing data from various sources.

### **3 Result and Discussion**

#### **The Role of the Government in Handling Coastal Waste**

The role of government is central to the framework of the Penta Helix. The Tanjungpinang City Government functions as a policy maker and regulator through a number of policies such as Regional Regulation Number 14 of 2009 concerning Waste Management Systems, Regional Regulation Number 3 of 2015 concerning Waste Management, and Guardian Regulation Number 14 of 2022 concerning reducing the use of plastic bags. The regulation shows that there are efforts to lower national policies—such as Law Number 18 of 2008 and Government Regulation Number 81 of 2012—to the local level. However, the effectiveness of policy implementation still faces challenges. Enforcement of rules on the use of single-use plastics has not been consistent, while infrastructure and fleet of waste carriers are still limited. The government tends to be stronger on the regulatory and administrative sides, but still weak in terms of policy performance and orchestration of collaboration between stakeholders [6]. The government needs to transform from a "service provider" role to a "collaborative network manager" that facilitates the involvement of other sectors in coastal litter management.

At the national level, Law 18/2008 affirms comprehensive management from upstream and downstream with clarity on the role of the government, the business world, and society; PP 81/2012 operationalizes it in household waste/similar; and Presidential Regulation 83/2018 stipulates an action plan for handling marine debris 2018–2025. The Tanjungpinang City Government plays a central role in coastal waste management through the creation of regulations, supervision, and facilitation of waste management programs. Mayor Regulation Number 14 of 2022 concerning the Reduction of the Use of Plastic Bags is one of the policies that has been implemented. However, based on the results of interviews and observations, the government still faces obstacles such as budget limitations and human resource capacity in implementing regulations comprehensively [7].

In the regions, Tanjungpinang has the Regional Regulation on Waste Management System (No. 14/2009) and the Regional Regulation on Waste Management (No. 3/2015) as local umbrellas; Guardian Regulation 14/2021 establishes the TPA UPTD under the Environment Agency; Guardianship Regulation 14/2022 regulates the reduction of plastic bags; and Regional Regulation No. 4/2024 (RPPLH) emphasizes document harmonization, legal certainty, and stakeholder involvement.

In addition, coordination between relevant government agencies has not been optimal, which leads to inconsistencies in policy enforcement on the ground. This shows the need to strengthen the coordination system and resource empowerment to support government policies to be more effective in managing coastal waste.

### **The Role of the Private Sector in Supporting Waste Management**

The business sector in Tanjungpinang has begun to be involved in waste reduction efforts, especially through the implementation of plastic bag restriction policies. Several modern retailers and culinary business actors have implemented a paid pouch system and the use of environmentally friendly ingredients. However, the level of compliance of small and medium business actors is still low due to the lack of economic incentives and weak supervision.

In the context of Penta Helix, the business sector should ideally not only be subject to regulation, but also an active partner in the Circular Economy and Extended Producer Responsibility (EPR) scheme—that is, producers' responsibility for the recycling of the products they produce. Collaboration between waste management companies, waste banks, and local

MSMEs has the potential to create a new economic value chain from recycled materials, while reducing the burden on the Ganet landfill [4].

The private sector has great potential in supporting waste management through investment, waste management technology innovation, and Corporate Social Responsibility (CSR) programs. However, the results of the study show that the involvement of the private sector in Tanjungpinang City is still limited, especially in terms of active participation in coastal waste management programs [4].

This is due to the lack of incentives and arrangements that encourage the private sector to play a more active role. Therefore, the government needs to design a mechanism that integrates the private sector in coastal waste management as a strategic partner.

### **The Role of Academics in Environmental Research and Education**

Academic actors have an important role in supporting evidence-based policymaking. Universities in Tanjungpinang and its surroundings, such as Raja Ali Haji Maritime University, have conducted empirical studies related to the performance of coastal waste management policies[6]. In addition, research conducted by Wijaya et al. (2024) on the condition of the Ganet Landfill also provides strategic input for local governments to improve the downstream waste management system [8].

However, the involvement of academics is often a temporary project and has not been institutionalized in the regional policy mechanism. Regular collaborative forums between the government, academia, and the private sector are still limited. In fact, the presence of academics can be a link between field practice and sustainable waste management technology innovations, for example in research on the processing of organic waste into compost or energy.

Academics make an important contribution through research and public education related to the impact of coastal debris and effective management methods. Collaboration between academics with the government and the community can increase environmental awareness and waste management innovations based on local wisdom [1].

However, there are still obstacles in bridging the results of academic research into policies and practices in the field. The dissemination of information and the involvement of academics in the Penta Helix collaboration forum must be strengthened in order to be able to make a real contribution.

### **The Role of Non-Governmental Organizations (NGOs)**

Communities and non-governmental organizations (NGOs) play a direct role in waste management at the grassroots level. Activities such as coastal clean-up, environmental education in schools, and waste bank management are tangible manifestations of community participation. However, these activities are often sporadic, depending on the momentum or funding support of a particular project.

Research by Hermawana and Astuti (2021) shows that the sustainability of community movements is greatly influenced by institutional support from the government and the private sector. Without regulatory and logistical support, community initiatives tend to lose resilience. Therefore, strengthening the institutional capacity of the community and providing collaborative program grants are key so that community participation can take place in a sustainable manner[4].

NGOs act as a bridge between the community and the government in waste management programs. NGOs in Tanjungpinang are actively conducting community-based waste management education and training campaigns. They also play a role in supervising policy implementation and encouraging community participation [4].

Limited funding support and access to policy makers remain obstacles for NGOs. Therefore, increased synergy and partnerships between NGOs and other actors are urgently needed.

### **The Role of Media, Civil Society and Public Participation**

Continuous education programs with innovative and participatory methods need to be developed to build awareness and change in waste management behavior in coastal communities. The role of the media—both mass media and social media—has a strategic function as a channel of public communication and social surveillance (social watchdog). The media can help build collective awareness about the impact of waste on coastal ecosystems and educate the public about household waste management.

Unfortunately, media involvement in Tanjungpinang is still ad-hoc and has not been integrated into the local government's policy communication strategy. In fact, the media has the potential to be a "connecting actor" that bridges communication between the government, business actors, academics, and the community [4]. Optimizing media functions in Penta Helix

can be done by forming public communication networks and shared digital campaigns, such as #TanjungpinangBersih or #ZeroWasteCoast movements.

Furthermore, the role of civil society is vital in the success of coastal waste management. Active participation in waste management through environmental cleanliness programs and plastic waste reduction has a significant positive impact [5]. However, the level of community participation is still relatively low due to a lack of understanding and ongoing motivation. Continuous education and community empowerment programs must continue to be developed so that the community becomes an effective agent of change.

### **Synergy Between Penta Helix Elements in Policy Implementation**

Collaboration between the five elements of the Penta Helix model—government, private sector, academics, NGOs, and the community—has not been optimal in Tanjungpinang City. The occurrence of silos between sectors has caused the great potential of this collaboration to not be maximized. Clarity of roles, intensive communication, and strong formal coordination mechanisms will strengthen the synergy and efficiency of the implementation of coastal litter management policies. The Penta Helix model can be an effective solution if all elements are actively and harmoniously involved[4].

Overall, the five elements of Penta Helix in Tanjungpinang City are present, but they are still partially working and have not been integrated into one sustainable collaboration platform. The government dominates, academics and communities provide technical and moral support, the business sector plays a limited role in regulatory compliance, and the media has not been institutionalized in public policy. In order for coastal waste management policies to be effective, a cross-actor coordination forum is needed that is recognized by regional law, functioning as a space for communication, monitoring, and joint data-based policy evaluation.

### **Supporting Factors and Obstacles to Implementation**

The implementation of coastal waste management policies in Tanjungpinang City is influenced by a combination of internal and external factors. The analysis shows that the success and failure of the policy depends not only on the substance of the regulation, but also on the institutional capacity, social support, technology, and coordination between Penta Helix actors.

The main supporting factors are the government's commitment and the support of academics and NGOs who are actively implementing education and advocacy programs. The

biggest obstacles include limited resources, weak coordination, and a lack of participation of the private sector and society as a whole.

One of the main supporting factors is the political and institutional commitment of the Tanjungpinang City Government to environmental issues. The issuance of several regulations such as Regional Regulation Number 3 of 2015 concerning Waste Management, Guardianship Number 14 of 2021 concerning UPTD TPA, and Guardian Number 14 of 2022 concerning the reduction of the use of plastic bags, shows the government's consistency in responding to national policies. In addition, routine budget support through the Environment Agency (DLH) strengthens waste transportation and management operations. Although the nominal is still limited, the sustainability of this fiscal support indicates a relatively stable policy orientation.

Despite the improvement of the transportation and waste management system, the Ganet Landfill still faces the problem of limited land, processing capacity, and sorting facilities. The study by Wijaya et al. (2024) noted that most of the waste is still mixed between organic and inorganic. The absence of a material recovery facility (MRF) causes most of the recycling potential to be wasted[8].

The Environment Agency faces obstacles in the number and competence of operational personnel. Field workers often work without modern waste management training, while incentives and work facilities are limited. The waste budget is also not proportional to the amount of waste generated that increases every year, especially in the tourist season [7].

Penta Helix-based policies demand cross-sector coordination. However, the implementation in Tanjungpinang still shows fragmentation between actors. Governments, the private sector, academia, communities, and the media often work in isolation, without permanent communication forums. Hermawan and Astuti (2021) stated that without a formal coordination mechanism, collaboration is only temporary and difficult to measure its effectiveness[4].

### **Policy Impact on the Condition of Coastal Waste**

Waste management policies in Tanjungpinang City have had a number of impacts on the condition of the coastal environment, both in the form of quantitative changes in waste generation, improved governance, and increased public awareness. However, the effectiveness of the policy still varies between regions, especially because of the geographical characteristics



of Tanjungpinang which is dominated by coastal areas with fisheries, ports, and tourism activities.

Ecologically, waste management policies have helped reduce the frequency of garbage accumulation at river mouths and certain tourist areas such as Tanjung Siambang Beach. However, the results of the study by Nazaki et al. (2025) found that Tanjungpinang's waste management policy still does not explicitly integrate the issue of marine debris leakage[6]. The flow of solid waste from land to sea remains high, especially after the rainy season, due to the absence of drainage and waste filtration systems in waterways. This indicates that waste management policies are still focused on land and have not fully implemented watershed-based management principles .

Existing policies have succeeded in reducing the amount of coastal waste that is still limited, especially single-use plastic waste. However, the maximum impact has not been achieved due to coordination and implementation problems in the field. The Penta Helix-based collaborative program is expected to increase the effectiveness of coastal waste management in a sustainable manner.

The impact of waste management policies on the coastal conditions of Tanjungpinang shows that success at the regulatory level has not been fully converted into significant environmental outcomes. The government has initiated strategic policies, but its implementation still faces a gap between policy design and policy outcomes. Therefore, it is necessary to strengthen land-sea policy integration, develop GIS-based coastal litter spatial monitoring, and implement a cross-actor collaboration forum (Penta Helix) to ensure policies run effectively and adaptively to dynamic coastal conditions[6][8][4].

#### **4 Conclusion**

The city of Tanjungpinang has a relatively comprehensive policy framework for waste management and the handling of leaks to the coast. However, Penta Helix's analysis shows the need for more systemic collaborative orchestration, consistency in plastic reduction policy enforcement, and downstream capacity building at the Ganet landfill. Strengthening collaborative governance, cross-actor performance indicators, and circular economy schemes are the key to increasing the effectiveness of coastal policies in the future. This study found that the implementation of coastal waste management policies in Tanjungpinang City still faces a number of obstacles, especially in terms of coordination between stakeholders and private sector and community participation that is not optimal. Penta Helix's approach with the collaboration

of the government, the private sector, academia, NGOs, and civil society has great potential to increase the effectiveness of waste management policies. However, the success of implementation is highly dependent on active synergy and sustainability of cooperation between actors.

Suggestions for Governments and Stakeholders should strengthen the coordination framework between government agencies and Penta Helix actors with clear formal mechanisms and routine coordination, increase incentives and opportunities for the involvement of the private sector as strategic partners in waste management, facilitate the use of academic research results for data-based policies and innovations, support the role of NGOs in education and advocacy and increase community empowerment through Active participation program, carrying out continuous education for the community so that understanding and motivation to maintain coastal cleanliness increases. Academically, for further research, it is recommended to explore more specific collaboration models and continuous evaluations, the success of the Penta Helix approach in coastal waste management in various regions, and the development of community-based management technologies and monitoring systems are also strategic directions that need to be studied in depth.

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