

FINAL REPORT

# PRE-FEASIBILITY STUDY OF WASTE MANAGEMENT IN KEPULAUAN RIAU

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## **CHAPTER 1 – INTRODUCTION**

### **1.1 – Introduction**

Indonesia and Denmark have signed Strategic Sector Cooperation (SSC) on the Circular Economy and Solid Waste Management. SSC is carried out between the authorities of the two countries. SSC was approved and implemented from June 2018 to December 2022. The overall goal of this collaboration is to grow a green and sustainable economy with sound environmental management and exploration of valuable resources through a circular economy by reducing negative impacts on the environment, livelihoods, economy, and health in Indonesia. SSC's partners consist of the Danish Environmental Protection Agency (DEPA), the Danish Energy Agency (DEA), and the Indonesian Ministry of Environment and Forestry (KLHK). Therefore, SSC is a collaboration between environmental authorities working in a peer-to-peer manner to support a conducive policy and regulatory framework. This cooperation will be carried out by sharing knowledge, improving performance in strategic sectors, and creating better framework conditions for private-sector investment. The SSC is an important tool for the Danish Ministry of Foreign Affairs in economic growth and a high-priority area for the Danish Trade Council.

The Sustainable Island Initiative (SII) is an additional joint initiative and part of the existing strategic sector cooperation (SSC) in the field of Energy and the Environment in Indonesia. SII aims to support islands towards a green and low-carbon pathway through more effective waste management and sustainable bioenergy solutions. SII discusses strategic challenges and constraints in the framework conditions and develops replicable solutions related to waste, circular economy, and waste to energy (WtE). SII is supported by the Indonesian Ministry of Environment and Forestry (KLHK), the Riau Islands Regional Government, the Danish Energy Agency (DEA), the Danish Environmental Protection Agency (DEPA), and the Danish Ministry of Foreign Affairs (MFA).

### **1.2 – Background**

Indonesia faces significant challenges related to the effective handling of the increasing amount of municipal waste in accordance with the National Waste Policy and ensuring that sustainable power generation capacity increases are carried out in line with the goal of transition to more renewable energy generation as stipulated in the National Energy Policy. The National Target of 30% waste reduction and 70% waste management by 2025 is an ambitious target that requires concrete and immediate action at the Provincial and City levels across the country, including many islands, including Bintan and Batam in the Riau Archipelago.

Riau Islands Province has an area of 8,202 km<sup>2</sup> and is inhabited by 2 million people.

As an archipelagic province, the Riau Archipelago consists of 2,408 islands with the 2 largest islands being Batam Island (inhabited by 1.2 million inhabitants) and Bintan Island (inhabited by 350,000 inhabitants). Batam Island is closest to Singapore and is more developed than other islands due to its industrial activity. Bintan Island is known as the home of Tanjungpinang City (the capital) and Bintan Regency which is famous as a favorite tourist destination in the North Bintan area. The two islands produce around 1,000 tons of waste per day. Although the two islands already have sanitary landfills, the landfills are overloaded and prone to pollution. Based on its Regional Policies and Strategies, the Riau Archipelago has a target of managing 100% of waste by 2025, which is in line with the National Solid Waste strategy.

The Riau Archipelago has been selected as part of the SII collaboration and provides a good opportunity for advancements in municipal waste systems (MSW) and waste-to-energy (WtE) investment. The Environment and Hygiene Service (DLHK) and the local government have requested assistance from SII to conduct a study that will assess the current state of the City Waste (MSW) situation and provide suggestions for a future municipal solid waste management system (MSW) and investment in waste into energy. (WtE). This study will describe the current situation and future scenarios for waste generation and management and recommend possible interventions in the Riau Archipelago to improve conditions in an effort to promote investment in waste into energy (WtE). This research will focus on compiling existing waste data, describing and analyzing current waste streams and systems, and making recommendations for initiatives as the basis for a waste-to-energy (WtE) project. The analysis and research recommendations must consider the progress of the circular economy, waste reduction and apply the principles of the waste hierarchy.

### **1.3 – Objectives**

The purpose of this assignment is to prepare research on current and future scenarios for waste management as a basis for future investments in WtE projects in the Riau Islands Province (Batam and Bintan Islands).

The research results should serve as input and catalysts for decision-makers to implement new initiatives on SWM (waste management) and WtE by considering technical, financial, socio-political, legal, and institutional factors.

This research will be the basis for further research, namely a detailed feasibility study if deemed relevant and feasible. This study will be coordinated with another activity, namely the Technology Catalog which is being prepared under the SII project.

There are several objectives in this assignment, which are as follows:



**Figure 1** – Objectives of the Study

The details of the main research objectives are as follows:

1. Analysis of waste characteristics and flows: to understand waste characteristics, which include waste generation, composition, characteristics, estimates, and other relevant data for waste infrastructure investment (in improving waste separation, collection, and treatment) and to understand the waste flow from sources (houses) stairs, markets, offices, industry, etc.) to the end (landfills, recycling facilities, etc.);
2. Analysis of infrastructure and waste management: to understand waste management practices and what infrastructure is available, especially in waste reduction, waste banks, and TPS3R;
3. Analysis of waste policies, strategies, and institutions: to understand policies and strategies to improve waste management and other relevant factors (planning, waste collection coverage, waste infrastructure financing, waste capacity building, etc.) and to understand waste-related institutions responsible for waste management in the province and city, including institutional capacity, staffing capacity, roles and responsibilities, and mandate;
4. Recommendations for improvement: to formulate appropriate recommendations to address waste problems while creating additional value with consideration of the highest implementability (based on the local context of the Riau Islands); and
5. Highlights - the potential of waste to energy: formulating the potential of waste to energy by considering the technology catalog from previous studies, with a more detailed technical and financial feasibility analysis.

## 1.4 – Output

The overall objective of this project is to create a basis for decision-makers in the Ministry of Environment and Forestry (KLHK) and City Governments in Indonesia in deciding which processing technology to use to process household organic waste and investment in waste-to-energy projects. The objective of this project contains recommendations for the ideal input capacity of the recommended processing technology taking into account the principles of the Circular Economy.

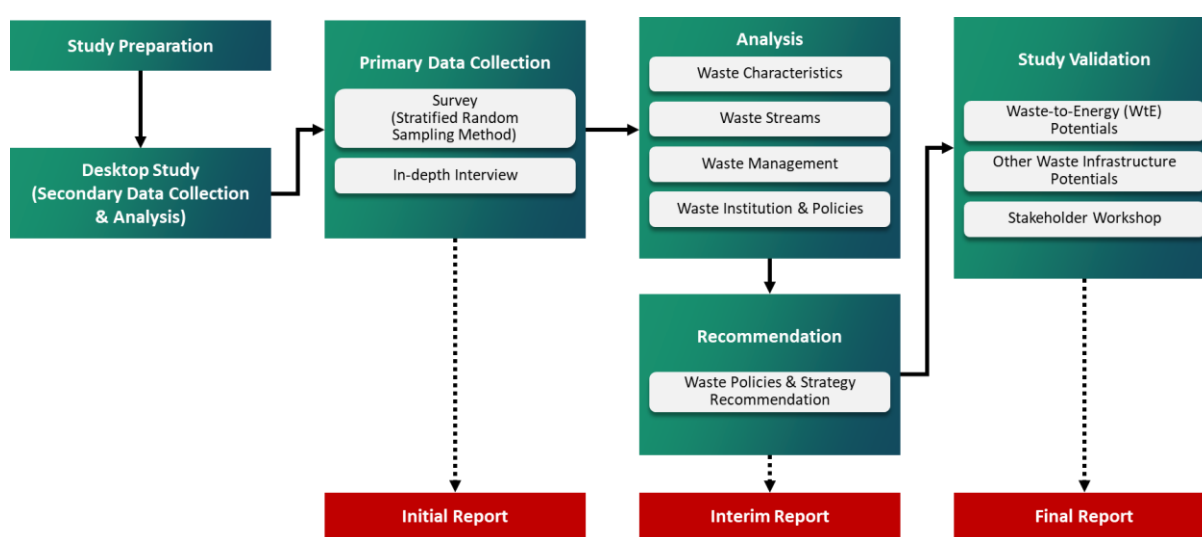
The outputs/results of the research are as follows:

- Pre-feasibility study report;
- Pre-Feasibility Study Interim Report and Executive Summary;
- Workshops conducted with key stakeholders (decision makers at the Provincial and City levels and technical staff from relevant Local Governments/Ministries);
- Final Pre-feasibility Study Report, Executive Summary, and Infographics (in Indonesian and English).

## 1.5 – Methodology

The proposed methodology consists of study preparation, a desktop study from previous studies (including technology catalog), primary data collection by conducting in-depth surveys and interviews, waste analysis (waste characteristics, waste flow, waste management, waste institutional & policy), and recommendations (recommendations). waste policy & strategy, the potential for waste into energy, and potential for other waste infrastructure), and research validation

The proposed methodology is as follows:



**Figure 2 – Methodology of the Study**

As highlight for primary data collection, this study is conducting survey with stratified random sampling method. Stratified random sampling is a method of sampling that involves dividing a population into subgroups or strata and then selecting a random sample from each subgroup. In the context of waste scoping, this method can be used to ensure that the sample is representative of the waste being studied. The first step is to identify the different types of waste that are present in the population, and then a random sample is selected from each stratum based on its proportion to the overall waste population. Using stratified random sampling for waste scoping helps to reduce potential bias in the sample, ensure that all types of waste are represented, and provide a more accurate picture of overall waste characteristics to inform decision-making around waste management strategies.

During the research, monitoring and evaluation meetings will be held with the Danish Embassy in Indonesia, DEPA and the Riau Islands Regional Government at least three times during the assignment.

Aligned to Jakstranas and waste management approach in Indonesia, this study will use two different approaches when discussing about waste policy: waste reduction and waste handling. Waste reduction refers to the methods used to reduce the amount of waste generated in the first place. This can be achieved through a variety of strategies, including reducing consumption, reusing items, recycling materials, and composting organic waste. The goal of waste reduction is to minimize the amount of waste that ends up in landfills and incinerators, and to conserve natural resources by reducing the need for raw materials. Waste handling, on the other hand, refers to the methods used to manage waste once it has been generated. This includes collecting, transporting, treating, and disposing of waste. Waste handling strategies can include landfilling, incineration, and recycling. The goal of waste handling is to manage waste in a safe and efficient manner, while minimizing its impact on the environment and public health. In summary, waste reduction aims to minimize waste generation, while waste handling focuses on managing waste after it has been generated. Both approaches are important components of a comprehensive waste management system.

## **1.6 – Scope of Work**

The proposed scope of work is as follows:

- Geographic: this study is limited to Batam Island and Bintan Island;
- Administrative: this study is limited to Batam City, Tanjungpinang City, and Bintan Regency;
- Timing: the study will use the most recent data from 2017-2022 or extrapolate data from previous years (if the latest data is not available); and
- Data availability: this study will use publicly available data or confidential information provided by stakeholders (with consent).

## 1.7 – Key Data Analysis

The main data analysis is a set of indicators and important points that will be highlighted in this study, which are as follows:

**Table 1 – Key Analysis in the Study**

No	Purpose	Key Analysis
1	Waste Characteristics and Waste Flow	<ul style="list-style-type: none"> <li>• Waste generation (daily)</li> <li>• Waste generation forecast (2020-2026)</li> <li>• Composition of waste by type (food waste, garden waste, paper, plastic, metal, textile, rubber, glass, others)</li> <li>• Composition of waste by source (traditional markets, household flows, home industries, industry, tourism, etc.)</li> <li>• Waste stream by Jakstrada (managed, unmanaged)</li> <li>• Waste flow based on primary research (survey and interview)</li> </ul>
2	Waste Infrastructure and Management	<ul style="list-style-type: none"> <li>• Source separation analysis</li> <li>• Waste primary collection analysis</li> <li>• Waste processing analysis</li> <li>• Waste secondary collection analysis</li> <li>• Current status of landfill</li> <li>• Quantity and effectiveness of regional and municipal infrastructure (waste transport vehicles, TPS, TPST, TPS3R, TPA, waste banks, recycling centers, MRF, etc.)</li> <li>• Current waste infrastructure operational activities</li> <li>• Waste management issues</li> </ul>
3	Analisis Waste Policy, Strategy and Institutions	<ul style="list-style-type: none"> <li>• Local regulation</li> <li>• Waste Management Budget (SWM)</li> <li>• Garbage collection</li> <li>• Ratio of revenue from waste retribution to SWM budget</li> <li>• Institutional mapping</li> <li>• Institutional roles and responsibilities</li> <li>• Involvement of non-governmental organizations</li> <li>• Institutional issues &amp; waste budget</li> </ul>
4	Improvement Recommendation	<ul style="list-style-type: none"> <li>• Analysis &amp; recommendations based on waste hierarchy, 9R or settlement methodology</li> <li>• Analysis &amp; recommendations for the condition of the overall waste management system (source segregation, primary collection, processing, secondary collection and landfill)</li> <li>• Analysis &amp; recommendations based on financing</li> </ul>

No	Purpose	Key Analysis
		aspects (budget review, alternative revenue streams, levy collection schemes, etc.) <ul style="list-style-type: none"> <li>• List and categorization of recommendations</li> <li>• Priority of recommendations (based on value creation and implementation capability)</li> <li>• Schedule of recommendations (short term, medium term, long term)</li> </ul>
5	Highlight – Potential for Waste-to-Energy	<ul style="list-style-type: none"> <li>• Technology selection (based on technology catalog)</li> <li>• Key assumptions for the WtE project</li> <li>• WtE project technical feasibility</li> <li>• Financial feasibility of the WtE proyek project</li> <li>• Off-taker potential analysis</li> <li>• Other relevant recommendations</li> </ul>

## CHAPTER II – PROFILE OF BATAM, TANJUNGPINANG AND BINTAN

### 2.1 – Profile of Batam City

Batam city is part of Kepulauan Riau Province, Geographical of Batam Municipality was strategically on international seas abroad. Batam Municipality lies between: 0o 25' 29" 1o15'00" of North Latitude 103o 34' 35" 104o26'04" of East Longitude. Same as other districts in Province of Kepulauan Riau the area of Batam City is a part of continental. The Large land area in Batam Municipality is about 1.038,84 kilometers square and the ocean area is about 2.791,09 kilometers square.

The islands spread out here a the remaining of erosion or reduction of the mainland pre tersier (before tertiary) which lies from Malaysia/ Singapore island at the north and Moro, Kundur and Karimun islands at the south. Tanjungpinang (the central government in Kepulauan Riau Province) and Bintan at east had strongly tighten emotion and cultural to Batam Municipality. The distance between Batam Municipality to Tanjungpinang Municipality was 44 miles.

The city profile of Batam, which consists mainly of flat land, suggests that waste management in this area could potentially be easier than in hilly areas due to the ease of transportation. However, the presence of small rivers surrounded by jungle could present challenges in waste disposal and management if not handled properly. Furthermore, the large number of islands (373 islands) in the Batam Municipality indicates that waste management strategies will need to take into account the unique logistical challenges that arise from managing waste in an island environment. Overall, these factors suggest that waste management in Batam City will need to be carefully planned and tailored to the specific characteristics of the area to ensure effective and sustainable management of waste.

The tropical climate of Batam, characterized by high temperatures and humidity, can have implications for waste management. High temperatures and humidity can accelerate the decomposition of waste and create conditions that promote the growth of bacteria and other microorganisms. This can increase the risk of odors, pests, and diseases associated with waste. Therefore, waste management strategies in Batam City should take into account the need for proper waste storage and disposal to minimize the potential health and environmental impacts of waste. Additionally, the atmospheric pressure levels in Batam City can impact waste management practices, such as the need to prevent the release of landfill gas, and this must also be considered when designing waste management systems. Overall, the tropical climate of Batam City highlights the need for careful planning and management of waste to ensure effective and sustainable waste management practices.

The Government of Batam City as an executive institution who carry out the wheels of government, development and social, can be to face any problems appear in

accordance with the economic, social, culture and politic development. Government of municipality of Batam formed pursuant by government regulation No. 34 on 1983 legalized on 24 December, it is lead by a mayor which regency / municipality level and to be responsible to Governor of Riau.

The existence of Batam Municipality is an implementation of reconcentration as it stated in Rule of Law No.5 1974. Batam Municipality built in order to increase the services of social and region development as the result of Batam Island turn for industrial, trade and tourism are. Last according to local regulation No. 2, 2005 Batam Administered Municipality was changed to be the autonomy area of Batam city which consist of 12 districts.

The administrative boundaries of Batam City are as follows:

North : Singapore Strait and Singapore

East : Bintan Island and Tanjung Pinang

South : Lingga Regency

West : Karimun Regency

**Table 2 – Area of Subdistricts in Batam City**

No.	Subdistrict	Capital of Subdistrict	Total Area (sq.km)	Percentage to Subdistrict's Area (%)
1	Belakang Padang	Sekanak Raya	581,55	15,11
2	Bulang	Pulau Buluh	463,13	12,03
3	Galang	Sembulang	2018,49	52,44
4	Sungai Beduk	Tanjung Playu	120,67	3,14
5	Sagulung	Sungai Langkai	63,86	1,66
6	Nongsa	Kabil	290,36	7,54
7	Batam Kota	Belian	46,81	1,22
8	Sekupang	Sungai Harapan	106,78	2,77
9	Batu Aji	Buliang	61,94	1,61
10	Lubuk Baja	Baloi Indah	36,12	0,94
11	Batu Ampar	Sungai Jodoh	39,99	1,04
12	Bengkong	Sadai	19,27	0,50

Source: Badan Pusat Statistik (2021)

Kepulauan Riau Province's population is largely centered in Batam City. Batam City hosts to about 60% of the Kepulauan Riau Province's population. The significant number of people living in Batam is due to economic activity in Batam City. This is also supported by Batam City's strong Population Growth Rate (LPP) of 2.32 percent in 2020. Batam's total population was 1,196,396 people as of 2020.

**Table 3 – Total Population of each Subdistrict in Batam City**

No	Subdistrict	Population			Population Density per sq.km	Annual Population Growth Rate
		Male	Female	Total		
1	Belakang Padang	12,405	10,034	22,439	39	1.88
2	Bulang	5,616	5,091	10,707	23	1.13
3	Galang	8,998	7,991	16,989	8	1.22
4	Sungai Beduk	48,584	47,609	96,193	797	1.76
5	Sagulung	108,359	101,027	209,386	3,279	3.30
6	Nongsa	42,380	39,071	81,451	281	4.87
7	Batam Kota	99,067	99,550	198,617	4,243	1.98
8	Sekupang	79,153	77,130	156,283	1,464	4.40
9	Batu Aji	70,874	68,638	139,512	2,252	0.88
10	Lubuk Baja	41,919	42,614	84,533	2,340	0.44
11	Batu Ampar	31,215	29,235	60,450	1,512	0.28
12	Bengkong	60,829	59,007	119,836	6,219	2.59

Source: Badan Pusat Statistik (2021)

The population density of Batam City, with an average of 311 people per square kilometer, suggests that the waste generation rate in the area may be relatively high. Therefore, waste management strategies in Batam City should be designed to accommodate the potentially high volume of waste generated. The gender proportion in Batam City, with a slightly higher male population than female population, may didn't have significant implications for waste management.

The high dependence of Batam City's economy on the industrial sector suggests that waste management strategies should take into account the potential impacts of industrial activities on the environment and public health. The fluctuation in the number of medium-large industrial companies in recent years, particularly the decline caused by the Covid-19 pandemic in 2020, may also affect the volume and types of waste generated in the area. This highlights the need for waste management strategies in Batam City to be adaptable and responsive to changes in the local economy. Furthermore, the shift of some industries to small-scale operations may lead to different waste management needs and practices, which should also be taken into account. Overall, the industrial profile of Batam City underscores the importance of developing waste management strategies that are tailored to the unique economic and environmental conditions of the area.

## **2.2 – Profile of Tanjungpinang City**

Tanjungpinang City is the capital city of Kepulauan Riau Province, located on Bintan Island with a geographical location at coordinates 0051' to 0059' of North latitude and 104023' to 104034' of East longitude with a land area of Tanjungpinang City only about 1.42 percent of the entire land area of Riau Islands Province. In general, Tanjungpinang City has a wet tropical climate with air temperatures ranging from 26.50C to 33.90C with an average of 23.20C and an average air humidity of 82 percent, which is between 78 percent and 98 percent. The highest average rainfall was recorded at 516.8 mm per day in November 2020 with 20 days of rain. While the lowest average rainfall occurred in January, which was 47.8 mm per day with an average sunshine of 57.9 percent. The maximum wind speed is 15 knots.

The hilly and rugged terrain of Tanjungpinang City may pose challenges for waste management, particularly in terms of access to waste disposal sites and transport of waste. The acidic and bauxite-rich soil structure may also affect the suitability of certain waste management practices, such as composting, which may require specific soil conditions to be effective. Additionally, the presence of sandstone rock formations may complicate excavation or construction of waste management infrastructure, such as landfills or incineration facilities. Therefore, waste management strategies in Tanjungpinang City need to be designed to accommodate the unique geological conditions of the area, and take into account factors such as accessibility, soil characteristics, and construction requirements.

Tanjungpinang City has several tourist areas, including Penyengat Island, which is only about 2 miles from the Port of Sri Bintan Pura, Trikora Beach, which has white sand and is about 65 kilometers from the city, and Tepi Laut, an artificial beach located on the city center's coastline as a sweetener or face of the city (waterfront city). Tanjungpinang Sea Port in Sri Bintan Pura provides domestic ferries and speedboats to Batam Island and other islands such as Karimun and Kundur Islands, as well as other cities in Riau. In addition, the port offers international access to Malaysia and Singapore.

Administratively, Tanjungpinang City consists of 4 Subdistricts and 18 villages. The total area of Tanjungpinang City is 144.56 km<sup>2</sup>. Tanjungpinang City consists of West Tanjungpinang Subdistrict, Tanjungpinang Kota Subdistrict, East Tanjungpinang Subdistrict, and Bukit Bestari Subdistrict. East Tanjungpinang Subdistrict has the largest area at 58.95 km<sup>2</sup> with a percentage of 40.78 percent. While the smallest area is West Tanjungpinang with an area of 4.55 km<sup>2</sup> or 3.15 percent.

The administrative boundaries of Tanjungpinang City are as follows:

North : Bintan Regency

South : Bintan Regency

West : Batam City

East : Bintan Regency

**Table 4** – Area of Subdistricts in Tanjungpinang City

No.	Subdistrict	Capital of Subdistrict	Total Area (sq.km)	Percentage to Subdistrict's Area (%)
1	Bukit Bestari	Dompok	45.64	31.57
2	Tanjungpinang Timur	Melayu Kota Piring	58.95	40.78
3	Tanjungpinang Kota	Kampung Bugis	35.42	24.50
4	Tanjungpinang Barat	Tanjungpinang Barat	4.55	3.15

Source: Badan Pusat Statistik (2021)

The population is a crucial factor in the development of an area, and not just in terms of quantity, but also quality. A large and high-quality population can significantly improve the overall quality of life and prosperity of an area. In 2020, the population of Tanjungpinang Municipality was 227,663 people, comprising 114,784 males and 112,979 females. However, the population density in each district was not evenly distributed. Tanjungpinang Barat Subdistrict had the highest population density, with 9,275 inhabitants per square kilometer due to its 4.55 km<sup>2</sup> land area and 44,247 people. Meanwhile, Tanjungpinang Kota Subdistrict had the lowest population density, with only 543 people per square kilometer.

**Table 5** – Total Population of each Subdistrict in Tanjungpinang City

No	Subdistrict	Population			Population Density per sq.km	Annual Population Growth Rate
		Male	Female	Total		
1	Bukit Bestari	27,315	27,095	54,410	1,192	0.05
2	Tanjungpinang Timur	55,456	54,324	109,780	1,862	4.33
3	Tanjungpinang Kota	9,828	9,398	19,226	543	1.18
4	Tanjungpinang Barat	22,085	22,162	44,247	9,725	-0.23

Source: Badan Pusat Statistik (2021)

The population density of Tanjungpinang City, with the highest density of 9,275 inhabitants per square kilometer in Tanjungpinang Barat Subdistrict, suggests that

waste generation rate in the area may be relatively high. Therefore, waste management strategies in Tanjungpinang City should be designed to accommodate the potentially high volume of waste generated. The gender proportion in Tanjungpinang City, with a slightly higher male population than female population, may not have significant implications for waste management.

The tourism industry in Tanjungpinang City is closely related to waste management. With the presence of several tourist areas, it is essential to ensure that these areas remain clean and attractive to visitors. Effective waste management practices are necessary to prevent littering and maintain the natural beauty of beaches and islands. Additionally, as the city serves as a major transportation hub, including international access to Malaysia and Singapore, waste management practices must take into account the potential environmental impact of increased transportation and waste generation. Sustainable waste management practices, such as recycling and proper disposal, can help reduce negative environmental impacts while promoting a clean and healthy environment for both residents and tourists.

### **2.3 – Profile of Bintan Regency**

Bintan regency is located between 105°03.94" North Latitude and 104°28'56.23" East Longitude. The area of Bintan regency is a part of continental shelf called "Papan Sunda". The islands spread in this area are formed by erosion landslide in pre tertiary era. The area is stretching from Malaysia Peninsula in the North to Bangka and Belitung in the South. The area of Bintan Regency is recorded at 1,318.21 square km. The biggest sub district is Teluk Sebong recorded at 285.72 square km. Bintan Utara sub district is smallest area, about 43.26 square km.

The unique geography of Bintan Regency, consisting of multiple islands and rivers, presents a complex challenge for waste management. With only 39 islands populated (from 272 islands) and the remaining cultivated for farming, the population distribution and waste generation can be difficult to predict. Additionally, the small and shallow rivers are not suitable for transportation, but only for drainage. However, the large Pulau River in Bintan Island serves as a vital source of fresh water for the population of Tanjungpinang Municipality. The tropical wet climate of Bintan Regency, with high temperatures and humidity, may also contribute to the generation and decomposition of waste. Therefore, waste management strategies in Bintan Regency should consider the unique geographical and climatic factors of the area in order to effectively manage waste disposal and minimize environmental impact.

Bandar Seri Bintan is the capital city of Bintan Regency, which is located in Teluk Bintan subdistrict. Administratively, in 2020, Bintan Regency consists of 10 subdistricts with 36 villages and 15 urban villages. These subdistricts are Bintan Bay, Seri Kuala Lobam, North Bintan, Teluk Sebong, East Bintan, Bintan Pesisir, Mantang,

Gunung Kijang, Toapaya, and Tambelan. In 2020, Bintan Regency had 71 RW and 616 RT. Tambelan subdistrict was recorded as the subdistrict with the highest number of urban villages/villages with 8 urban villages/villages, followed by Teluk Sebong subdistrict and Teluk Bintan subdistrict with 7 and 6 urban villages/villages respectively.

The administrative boundaries of Bintan Regency are as follows:

North : Natuna Regency

South : Lingga Regency

West : Tanjungpinang City and Batam City

East : West Kalimantan Province

**Table 6** – Area of Subdistricts in Bintan Regency

No.	Subdistrict	Capital of Subdistrict	Total Area (sq.km)	Percentage to Subdistrict's Area (%)
1	Teluk Bintan	Tembeling Tanjung	125.44	9.52
2	Bintan Utara	Tanjung Uban Kota	43.26	3.28
3	Teluk Sebong	Sebong Lagol	285.72	21.67
4	Seri Kuala Lobam	Teluk Lobam	123.50	9.37
5	Bintan Timur	Kijang Kota	100.18	7.60
6	Gunung Kijang	Gunung Kijang	192.89	14.63
7	Mantang	Mantang Lama	63.61	4.83
8	Bintan Pesisir	Kelong	116.11	8.81
9	Toapaya	Toapaya	176.48	13.29
10	Tambelan	Tambelan	91.02	6.90

Source: Badan Pusat Statistik (2021)

The population of the Bintan Regency is an important factor to consider in waste management planning. As of 2020, the population of the area was 159,518 people, with an annual growth rate of 1.11 percent compared to the 2010 population census. The population density in 2020 was estimated at 121.01 people per square kilometer, with the most densely populated subdistrict being Bintan Utara with 520.74 people per square kilometer, and the least densely populated subdistrict being Tambelan with 53.74 people per square kilometer. Proper waste management strategies need to be implemented to accommodate the potential waste generation from the growing population, particularly in the sectors with high employment rates, such as agriculture, forestry, and fisheries, processing industry, and wholesale and retail trade.

**Table 7 – Total Population of each Subdistrict in Bintan Regency**

No	Subdistrict	Population			Population Density per sq.km	Annual Population Growth Rate
		Male	Female	Total		
1	Teluk Bintan	6,055	5,312	11,367	91	2.36
2	Bintan Utara	11,395	11,132	22,527	521	0.59
3	Teluk Sebong	9,455	8,779	18,234	64	1.26
4	Seri Kuala Lobam	9,017	8,895	17,912	145.00	0.15
5	Bintan Timur	23,561	22,368	45,929	458	1.59
6	Gunung Kijang	7,777	7,019	14,769	77	2.04
7	Mantang	2,203	1,959	4,162	65	0.64
8	Bintan Pesisir	3,566	3,291	6,857	59	-1.49
9	Toapaya	6,624	6,219	12,843	73	1.84
10	Tambelan	2,537	2,354	4,891	54	-0.16

Source: Badan Pusat Statistik (2021)

The population density of Bintan Regency, which is estimated at 121.01 people/sq.km in 2020, may not have significant implications for waste management in the area. With a relatively low population density, waste generation rates are likely to be lower. However since the population is still growing, it is important for waste management strategies to be designed and implemented to accommodate this potential increase in waste generation. The differences in population density between subdistricts, with Bintan Utara being the most populous and Tambelan being the least populous, should also be taken into consideration when designing waste management strategies.

The labor force is an important factor in waste management, as they are the ones responsible for generating waste in their daily activities. In 2020, the labor force in Bintan Regency was 74,475 people, indicating a 6.25 percent increase from the previous year. The Labor Force Participation Rate (TPAK) in 2020 was 61.28 percent, indicating the percentage of the working-age population who are economically active. This rate was lower than the 2019 TPAK of 61.98 percent, suggesting a potential decrease in economic activity and waste generation in the area.

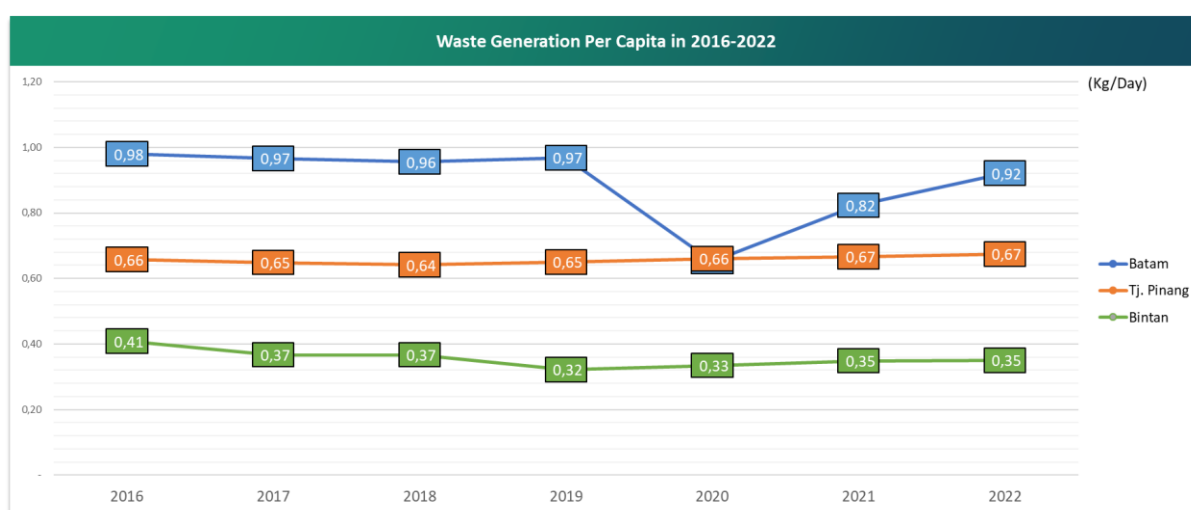
The Open Unemployment Rate of the Bintan Regency in 2020 was 8.86 percent. This figure has increased when compared to 2019, which reached 8.01 percent. In terms of waste management, the high unemployment rate in Bintan Regency may lead to a higher informal waste sector activity. It is important to provide proper training and support for informal waste workers to ensure they can contribute positively to waste

management practices. The high percentage of the population working in the agriculture, forestry, and fisheries sectors could also contribute to organic waste generation, which requires proper management to prevent environmental problems. The low percentage of the working population in the electricity and gas supply sector, water supply, waste management, waste, and recycling also highlights the need for investment and capacity-building in these sectors to improve waste management practices in the region.

## CHAPTER III – WASTE CHARACTERISTICS AND WASTE FLOW ANALYSIS

### 3.1 – Historical Waste Generation in Kepulauan Riau

Historical waste generation is an important data that can reflect the scale of waste management and also give figures for feedstock analysis. This data is obtained by conducting waste scoping (survey) that use samples from different location in the three municipalities (Batam City, Tanjungpinang City and Bintan Regency). The survey result then can be summarized as the waste generation per capita. This data then linked and compared to the previous reports and studies. The result is as follows:



**Figure 3** – Daily Waste Generation Per Capita (2016-2022)

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

**Table 8** – Waste Generation Per Capita Per Municipalities (2016-2022)

No	Kab/Kota Municipalities	Timbulan Sampah Per Kapita (Ton/Hari) Waste Generation Per Capita (Ton/Day)						
		2016	2017	2018	2019	2020	2021	2022
1	Batam	0,98	0,97	0,96	0,97	0,65	0,82	0,92
2	Tanjungpinang	0,66	0,65	0,64	0,65	0,66	0,67	0,67
3	Bintan	0,41	0,37	0,37	0,32	0,33	0,35	0,35

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

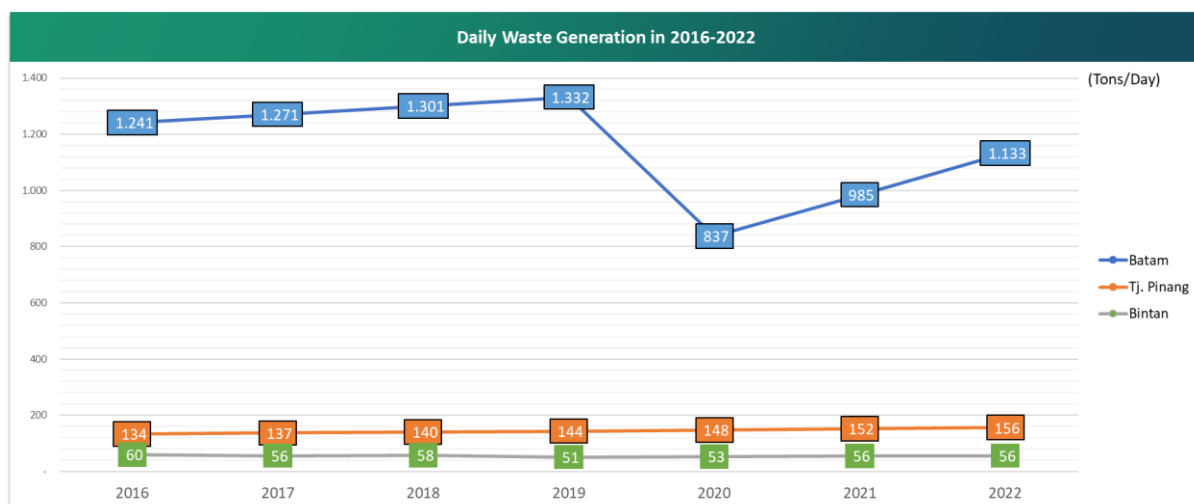
The data shows that Batam generated 0.65-0.98 kg of waste per day between 2016-2022. Tanjungpinang generated 0.64-0.67 kg of waste per day between 2016-2022. Bintan generated 0.32-0.41 kg of waste per day between 2016-2022.

The daily waste generation per capita reflects the livelihood and characteristics of each municipality. Batam is a big industrial city with the highest living cost among all

municipalities in Kepulauan Riau province, therefore it makes sense that it has the highest waste generation per capita. Tanjungpinang is a relatively small city as a province capital, but having plenty of commercial activities, therefore its waste generation per capita is lower than Batam but also higher than other municipalities. Bintan is a big regency with scattered settlements and focuses on tourism and agricultural activities, therefore its waste generation per capita is the lowest.

The data also shows that there is a decline of waste generation during Covid-19 (2020-2021). This condition also happens in other municipalities/area in Indonesia. However, in 2022, the economy is recovering and it also increase more waste generated.

The waste generation per capita then multiplied by number of population in each municipality. The result is as follow:



**Figure 4** – Daily Waste Generation (2016-2022)

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

**Table 9** – Waste Generation Per Municipalities (2016-2022)

No	Kab/Kota Municipalities	Timbulan Sampah (Ton/Hari) Waste Generation (Ton/Day)						
		2016	2017	2018	2019	2020	2021	2022
1	Batam	1.241,4	1.271,0	1.301,4	1.332,4	837,5	985,1	1.132,8
2	Tanjungpinang	133,7	136,9	140,2	143,5	148,0	151,7	155,9
3	Bintan	60,0	56,0	58,0	51,3	53,4	55,7	55,9

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

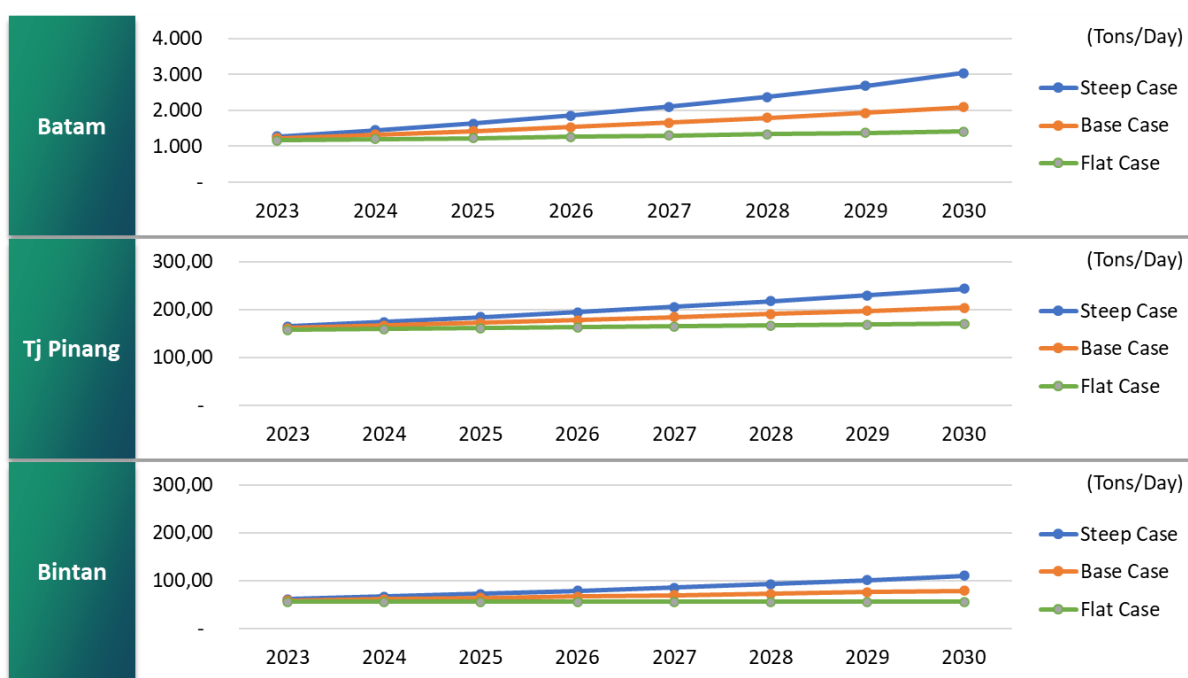
The data shows that before Covid-19, Batam generates 1.241-1.332 tons of waste per day in 2019. This number was declined in 2020 to 837 tons of waste per day due to Covid-19. This makes sense because during Covid-19, industrial activity in Batam is impacted greatly and resulted in many layoffs and labor leaving out Batam to go to

other municipalities with lower living cost. In 2022, Batam is forecasted to generate 1.132 tons of waste per day.

Tanjungpinang and Bintan jointly generate approximately 200 tons of waste per day in 2019 and 2020. During Covid-19 in 2021, the number is not significantly reduced. This is because during Covid-19, although a lot of government and commercial activities were shut down, but labors from Batam was moving to Tanjungpinang and Bintan which have lower living cost. In 2022, Tanjungpinang and Bintan are forecasted to generate approximately 210 tons of waste per day.

### 3.2 – Projected Waste Generation in Kepulauan Riau

Waste generation is largely influenced by Gross Domestic Products (GDP) and also the number of populations. The bigger the pocket of the people and the number of the people itself have same positive influence on the number of waste generation. Therefore, to forecast the waste generation in Kepulauan Riau, this study is using the expected Regional GDP growth and population growth. The result is as follows:



**Figure 5 – Projected Waste Generation (2023-2030)**

Source: Badan Pusat Statistik Batam, Tanjungpinang & Bintan (2022)

There are three waste projection scenarios that are being used in this study: 1) steep case; 2) base case; and 3) flat case. Each case is based on the expected Regional GDP Growth and Population Growth. Regional GDP usually has higher growth than population growth. In Batam, Regional GDP in 2023-2030 is forecasted to be 13,12%, while the population growth is 2,80%. In Tanjungpinang, Regional GDP in 2023-2030 is forecasted to be 5,73%, while the population growth is 1,10%. In Bintan, Regional GDP in 2023-2030 is forecasted to be 8,86%, while the population growth is

stagnating (0,00%). Steep case uses the highest indicator (Regional GDP growth). Flat case uses the lowest indicator (population growth). Base case uses the average between two indicators. All scenarios are based on no intervention.

Batam’s daily waste generation in 2030 is projected to be:

- 3.037 tons per day (steep case)
- 2.256 tons per day (base case)
- 1.451 tons per day (flat case)

Tanjungpinang’s daily waste generation in 2030 is projected to be:

- 243 tons per day (steep case)
- 204 tons per day (base case)
- 170 tons per day (flat case)

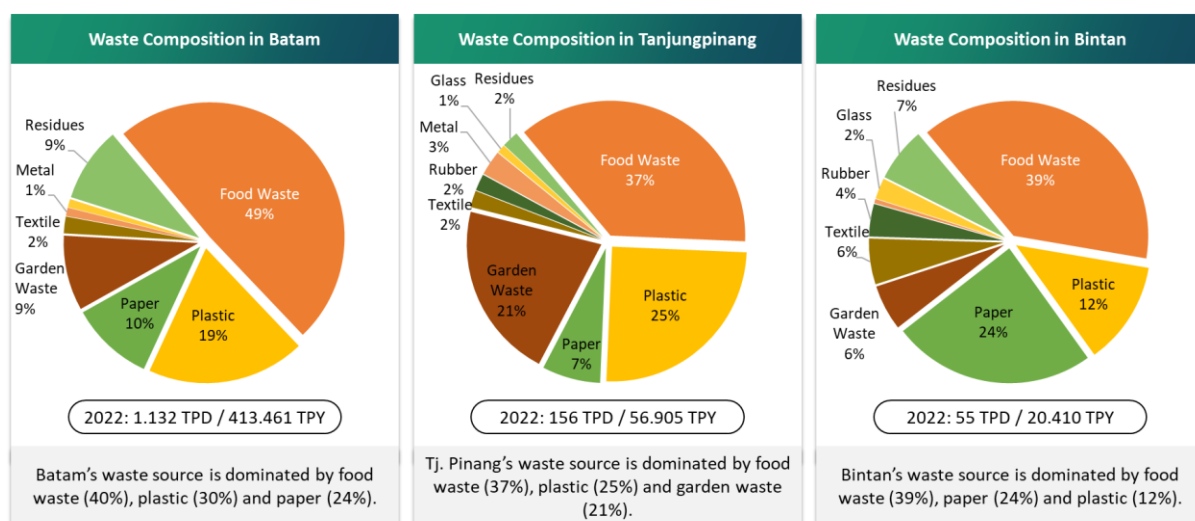
Bintan’s daily waste generation in 2030 is projected to be:

- 110 tons per day (steep case)
- 82 tons per day (base case)
- 56 tons per day (flat case)

These forecasted numbers of waste generation should be altered when the intervention (large waste reduction or waste handling facilities) is identified.

### 3.3 – Waste Composition

Waste composition is an important insight to understand the waste characteristics. This data is also obtained by conducting a waste scoping (survey) that uses samples from different locations in the three municipalities (Batam City, Tanjungpinang City and Bintan Regency). The result is as follows:



**Figure 6 – Waste Composition (2021-2022)**

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

Most waste consists of food waste, plastic and paper (94% in Batam, 69% in Tj. Pinang, 75% in Bintan) – as addition, in Tanjungpinang, the garden waste also contributes a lot (21%).

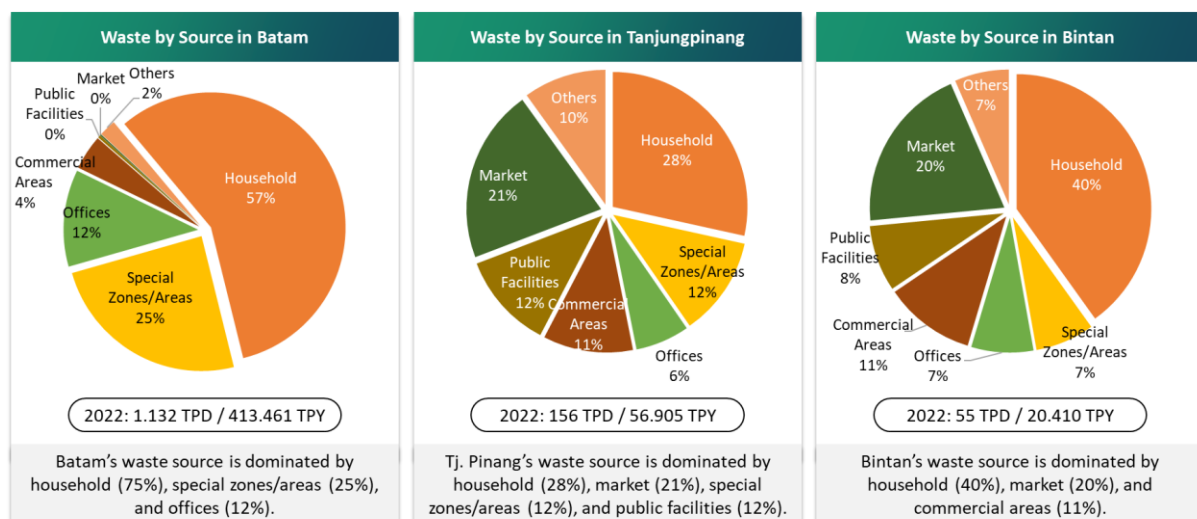
Batam’s waste source is dominated by household (75%), special zones/areas (25%), and offices (12%).

Tanjungpinang’s waste source is dominated by household (28%), market (21%), special zones/areas (12%), and public facilities (12%).

Bintan’s waste source is dominated by household (40%), market (20%), and commercial areas (11%).

### 3.4 – Waste Sources

Waste sources is also an important insight to understand the waste characteristics. This data is obtained by conducting a waste scoping (survey) that uses samples from different location in the three municipalities (Batam City, Tanjungpinang City and Bintan Regency). The result is as follows:



**Figure 7 – Waste Sources (2021-2022)**

Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

Household is the top source of waste in all 3 municipalities (28-57%), but then Batam has more waste from special zones and office, while Tanjungpinang and Batam have more waste from market,

Batam’s waste source is dominated by household (75%), special zones/areas (25%), and offices (12%).

Tanjungpinang’s waste source is dominated by household (28%), market (21%), special zones/areas (12%), and public facilities (12%).

Bintan’s waste source is dominated by household (40%), market (20%), and commercial areas (11%).

### 3.5 – Relevance Between Waste Composition and Waste Sources

The relevance between waste composition and waste sources, based on average data from all 3 cities (Batam, Tanjungpinang, Bintan) is as follow:

**Table 10** – Relevance Between Waste Composition and Waste Sources

No	Waste Composition	Household Waste			Accommodation/ Hotel	Restaurant	Health Facilities	Office	Store	Market	School	Total
		High Income	Middle Income	Low Income								
1	Organic	54,56%	55,24%	35,51%	36,80%	78,80%	0,00%	27,00%	38,30%	78,60%	22,80%	40,33%
2	Plastic	18,23%	17,60%	19,86%	28,60%	10,40%	50,10%	33,20%	27,20%	10,80%	48,40%	29,83%
3	Paper	14,74%	7,95%	4,96%	26,20%	10,60%	36,60%	31,80%	26,70%	9,90%	21,20%	23,29%
4	Glass	1,28%	0,60%	1,64%	1,90%	0,00%	0,00%	0,00%	0,40%	0,00%	0,00%	0,32%
5	Wood	1,13%	3,62%	1,93%	0,00%	0,00%	0,00%	0,00%	0,10%	0,00%	0,00%	0,01%
6	Rubber/Leather	0,01%	0,09%	0,23%	0,00%	0,00%	0,00%	0,00%	0,90%	0,00%	0,00%	0,13%
7	Metal	0,80%	2,53%	0,49%	0,20%	0,00%	0,00%	4,50%	0,90%	0,00%	0,00%	0,79%
8	Clothes/Textile	1,51%	1,29%	2,60%	0,00%	0,00%	0,00%	0,00%	1,60%	0,00%	1,00%	0,37%
9	Leaf	1,52%	1,53%	19,89%	0,90%	0,00%	0,00%	0,00%	0,00%	0,00%	0,50%	0,20%
10	Tetrapack	0,15%	1,33%	0,18%	0,40%	0,00%	3,30%	0,00%	0,20%	0,10%	1,60%	0,80%
11	Styrofoam	0,00%	0,14%	0,44%	0,30%	0,10%	5,00%	0,00%	0,30%	0,00%	2,40%	1,16%
12	Pampers	0,00%	6,68%	11,92%	0,70%	0,00%	5,00%	0,00%	0,00%	0,00%	0,90%	0,95%
13	Hazardous and toxic materials waste	0,00%	0,02%	0,28%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0%
14	Others	6,06%	1,38%	0,16%	4,00%	0,00%	0,00%	3,50%	3,50%	0,70%	1,10%	1,84%

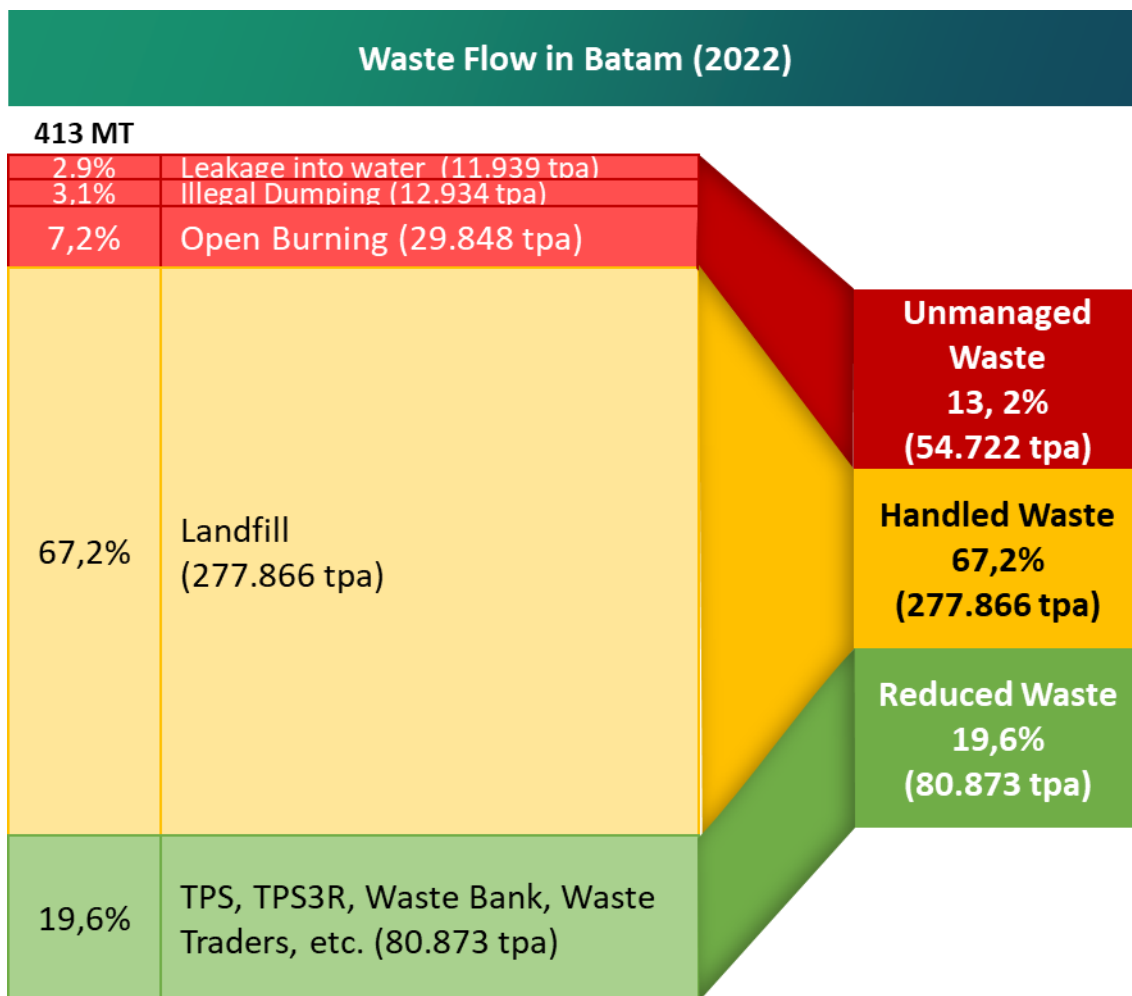
Source: DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

According to the data presented above, household waste is the largest source of waste, and organic waste dominates it with a percentage range of 35-55%. The dominance of organic waste is also observed in waste generated by restaurants (78.8%), markets (78.6%), stores (38.3%), and hotels (36.8%). The second largest type of waste is plastic, which is commonly found in health facilities (50.1%), schools (48.4%), and offices (33.2%). The third largest type of waste is paper, which is typically generated by health facilities (36.6%), offices (31.8%), stores (26.7%), and hotels (26.2%).

### 3.6 – Waste Flow

Waste flow analysis is intended to get the overall picture of current waste management performance. It identified how much waste that reduced, handled, or unmanaged. The data for reduced waste is collected by using the data of waste that can be processed through community-based organizations or non-government actions, such as TPS, TPS3R, waste bank and waste traders. The data for handled waste is collected by using the data of waste that collected by government and goes into landfill. The data for unmanaged waste is the gap between total number of waste generation and combined number of handled and reduced waste. Unmanaged

waste can be detailed again into the number of wastes that leaked into water bodies (river, ocean, etc.), illegal dumping and open burning. The detailed data for unmanaged waste is based on a survey and comparison with previous study.

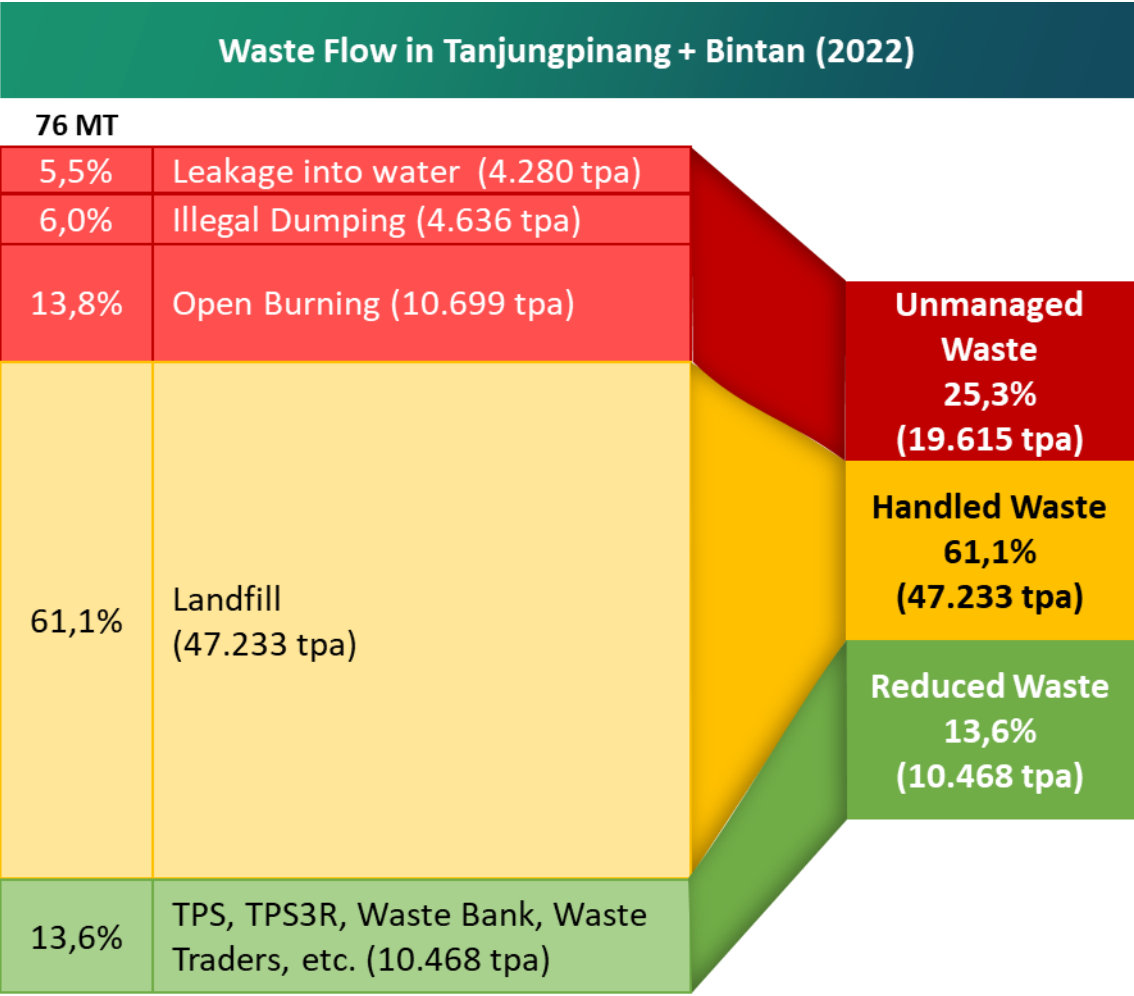


**Figure 8** – Waste Flow in Batam (2022)

Source: SystemIQ, DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

Waste flow in Batam shows that Batam is forecasted to still have 13,24% waste unmanaged in 2022. It consists of potentially 2,89% leakage into water bodies, 3,13% illegal dumping and 7,22% of open burning. Total unmanaged waste is forecasted to be 54.722 tons of waste per year.

Batam is forecasted to have 67,21% handled waste, which equals to 277.866 tons of waste per year. It is also forecasted to have 19,56% of reduced waste, which equals to 80.873 tons of waste per year.



**Figure 9 – Waste Flow in Tanjungpinang + Bintan (2022)**

Source: SystemIQ, DLHK Kepulauan Riau, DLH Batam, Internal Survey & Waste Scoping

Combined waste flow in Tanjungpinang and Bintan shows that it is forecasted to still have 25,33% waste unmanaged in 2022. It consists of potentially 5,53% leakage into water bodies, 5,99% illegal dumping and 13,82% of open burning. Total unmanaged waste is forecasted to be 19.615 tons of waste per year.

Tanjungpinang and Bintan is forecasted to have 61,15% handled waste, which equals to 47.233 tons of waste per year. It is also forecasted to have 13,52% of reduced waste, which equals to 10.468 tons of waste per year.

**3.7 – Waste-related Diseases**

Poor waste management can have serious consequences for public health, with the World Health Organization stating that it contributes to the spread of infectious diseases such as cholera, typhoid, and dengue fever. Improper waste disposal can result in the accumulation of waste in public areas, creating breeding grounds for disease-carrying vectors such as rodents, flies, and mosquitoes. In areas with poor sanitation and limited access to healthcare, this can increase the risk of disease

transmission to humans. The situation can be even more dire for communities living near landfills or waste dumping sites, where exposure to toxic substances and pathogens can lead to health issues.

Diseases that highly relevant with poor waste management are as follow:

1. Malaria: Poor waste management can lead to the accumulation of standing water, which creates a breeding ground for mosquitoes that transmit malaria.
2. Dengue fever: Similar to malaria, dengue fever is transmitted by mosquitoes that breed in standing water created by poor waste management practices.
3. Leptospirosis: This bacterial infection can be contracted through contact with contaminated water or soil, which can occur in areas with poor waste management.
4. Gastroenteritis: Improper disposal of waste can contaminate water sources and food, leading to the spread of gastroenteritis and other food-borne illnesses.
5. Shigellosis: This bacterial infection can be spread through fecal-oral transmission, which can occur in areas with poor sanitation and waste management.
6. Salmonella: Like shigellosis, salmonella can also be spread through fecal-oral transmission, making it a concern in areas with poor waste management.
7. Hepatitis A: This viral infection can be spread through contaminated food and water sources, which can occur in areas with poor waste management.
8. Trachoma: Poor waste management practices can lead to the spread of this bacterial infection, which affects the eyes and can lead to blindness if left untreated.
9. Tetanus: Improper disposal of waste can lead to injuries that increase the risk of tetanus infection.
10. Food poisoning: Poor waste management can lead to contamination of food sources, which can cause food poisoning.
11. Skin infections: Poor sanitation and waste management can increase the risk of skin infections.
12. Worm infestation: Poor sanitation and hygiene can increase the risk of worm infestation.
13. Respiratory infections: Poor waste management can contribute to air pollution, which can increase the risk of respiratory infections.
14. Nervous system disorders: Exposure to hazardous waste through poor waste management practices can increase the risk of nervous system disorders.
15. Heart disease: Although not directly caused by poor waste management, exposure to air pollution from waste burning can increase the risk of heart disease.
16. Cancer: Long-term exposure to hazardous waste from poor waste

management practices can increase the risk of cancer.

The health agency in Batam, Tanjungpinang and Bintan didn't have specific date for each disease, but have information regarding the trends, which are as follows:

**Table 11** – Trends of Waste-related Disease in Batam, Tanjungpinang and Bintan

No.	Subdistrict	Batam	Tanjungpinang	Bintan
1	Malaria	High (Seasonal)	Moderate (Seasonal)	Moderate (Seasonal)
2	Dengue (DBD)	High (Seasonal)	Moderate (Seasonal)	Moderate (Seasonal)
3	Leptospirosis	Moderate	Moderate	Low
4	Gastroenteritis	Moderate	Low	Low
5	Shigellosis	Low	Low	Low
6	Salmonella	Moderate	Low	Low
7	Hepatitis A	Low	Low	Moderate
8	Trachoma	Low	Low	Low
9	Tetanus	Low	Low	Moderate
10	Food Poisoning	Low	Low	Moderate
11	Skin Infections	Low	Low	Low
12	Worm Infestation (Filariasis)	Low	Low	Low
13	Respiratory Infections	Low	Low	Low
14	Nervous System Disorders	Low	Low	Low
15	Heart Disease	Moderate	Moderate	Moderate
16	Cancer	Moderate	Moderate to High	Moderate to High

Source: Puskesmas (Medical Facility) in Each Cities (2023)

Based on the information provided, it appears that there are currently no highly occurring diseases related to waste management in Batam, Tanjungpinang, and Bintan. This is likely due to the fact that waste facilities such as landfills are located far away from residential areas, which helps to minimize the risk of exposure to waste-borne pathogens.

## CHAPTER IV – WASTE INFRASTRUCTURE ANALYSIS

### 4.1 – Existing Waste Infrastructure

Aligned to Jakstranas and waste management approach in Indonesia, this study is using two different approaches when discussing about waste policy: waste reduction and waste handling. Those 2 approaches also served as different category of waste infrastructure. In between, another important category of waste infrastructure is the waste transportation. Therefore, waste infrastructure in Kepulauan Riau can be breakdown into 3 categories: 1) waste reduction facilities; 2) waste transportation facilities; and 3) waste handling facilities.

Waste reduction refers to the methods used to reduce the amount of waste generated in the first place. This can be achieved through a variety of strategies, including reducing consumption, reusing items, recycling materials, and composting organic waste. The goal of waste reduction is to minimize the amount of waste that ends up in landfills and incinerators, and to conserve natural resources by reducing the need for raw materials. Waste reduction facilities consist of primary waste bank, secondary waste bank, small composting unit (at neighborhood level), medium composting unit/composting house, large composting house/organic treatment center, community MRF/TPS3R, community recycling center/TPST, recycling center, and informal sector which includes waste traders.

Waste Reduction Facilities			
	BTM	TJP	BTN
<b>Primary Waste Bank</b> <i>Bank Sampah Induk</i>	1	-	1
<b>Secondary Waste Bank</b> <i>Bank Sampah Unit</i>	221	35	16
<b>Composting Small</b> <i>Komposting Skala RT-RW</i>	-	11	-
<b>Composting Medium</b> <i>Rumah Kompos</i>	1	12	1
<b>Composting Large</b> <i>Pusat Olah Organik</i>	-	1	-
<b>Community MRF</b> <i>TPS 3R</i>	1	3	3
<b>Community Recycling Center</b> <i>TPST</i>	-	1	-
<b>Recycling Center</b> <i>Pusat Daur Ulang</i>	-	-	-
<b>Informal Sector</b> <i>Lapak/Pengepul</i>	14	35	25
<b>Total: 75.760 tpa (18,6% of total waste)</b>			

**Figure 10** – Existing Waste Reduction Facility (2021)

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

From all waste reduction facilities in the three municipalities, approximately 18,6% of total waste can be reduced, which equals to 75.760 tons of waste per year.

Data shows that Batam has more focus on waste bank, as it has 1 primary waste bank and 221 secondary waste bank. Tanjungpinang also has a focus on waste bank, but it also has other facilities such as composting plants and community recycling center. Bintan have way smaller number of waste reduction facilities, but it also has an active waste trader link in the informal sector.

Waste transportation refers to the process of moving waste from its point of generation to its destination, which may include a landfill, recycling facility, or waste-to-energy facility. Waste transportation is an essential component of waste management because it allows for the safe and efficient movement of waste materials to their final destination. Waste transportation facilities consist of waste carts, three-wheeler, pick-up truck, arm roll truck, dump truck, compactor, and temporary waste station. The existing waste transportation facilities in Batam City, Tanjungpinang City and Bintan Regency are as follows:

Waste Transportation Facilities			
	BTM	TJP	BTN
<b>Waste Carts</b> <i>Gerobak Sampah</i>	-	-	-
<b>Three-Wheeler</b> <i>Motor Roda Tiga</i>	21	17	5
<b>Pick-up Truck</b> <i>Mobil Pick-up</i>	89	10	3
<b>Arm Roll Truck</b> <i>Truk Sampah Kecil</i>	38	4	1
<b>Dump Truck</b> <i>Truk Sampah Besar</i>	68	5	2
<b>Compactor</b> <i>Truk Sampah Kompaktor</i>	10	-	-
<b>Temporary Waste Station</b> <i>TPS Sementara</i>	165	16	6
<b>Total: 269.967 tpa (66,2% of total waste)</b>			

**Figure 11** – Existing Waste Transportation Facility (2021)

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Data shows that Batam has a larger quantity of waste transportation facilities. Mobile units mostly consist of large vehicles such as pick-up trucks, arm roll trucks, dump truck and compactor. It reflects Batam’s priority in keeping the city clean by enhancing its waste collection service. On the other hand, Tanjungpinang and Bintan is still lack of waste transportation facilities. Considering the scattered settlement

situations and also narrow street condition, Tanjungpinang and Bintan is mainly using three-wheeler as its waste collecting vehicle.

Waste handling, on the other hand, refers to the methods used to manage waste once it has been generated. This includes collecting, transporting, treating, and disposing of waste. Waste handling strategies can include landfilling, incineration, and recycling. The goal of waste handling is to manage waste in a safe and efficient manner, while minimizing its impact on the environment and public health. In summary, waste reduction aims to minimize waste generation, while waste handling focuses on managing waste after it has been generated. Both approaches are important components of a comprehensive waste management system. Waste handling facilities consist of landfill, biodigester/biogas, gasification waste-to-energy, pyrolysis, incinerator, RDF, methane capture and recycled paving blocks. The existing waste handling facilities in Batam City, Tanjungpinang City and Bintan Regency are as follows:

Waste Handling Facilities			
	BTM	TJP	BTN
<b>Landfill</b> <i>Tempat Pembuangan Akhir</i>	1	1	1
<b>Biodigester/Biogas</b> <i>Pem. Listrik Tenaga Biomassa</i>	-	-	-
<b>Gasification Waste-to-Energy</b> <i>Pem. Listrik Tenaga Sampah</i>	-	-	-
<b>Pyrolysis</b> <i>Pirolisis Solar</i>	-	1	-
<b>Incinerator</b> <i>Insinerator</i>	1	1	-
<b>RDF</b> <i>Bahan Bakar Jemputan Padat</i>	-	-	-
<b>Methane Capture</b> <i>Pemanfaatan Gas Metana</i>	1	1	-
<b>Recycled Paving Blocks</b> <i>Paving Blok Daur Ulang</i>	-	1	-
<b>Total: 269.967 tpa (66,2% of total waste)</b>			

**Figure 12** – Existing Waste Handling Facility (2021)

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

All three municipalities have their own landfill. However, other alternatives for waste handling are still limited. There are some small pilot projects in Batam and Tanjungpinang, but at small scale level. Batam has an incinerator for medical and hazardous waste and small methane capture pilot projects. Tanjungpinang has more pilot projects such as in pyrolysis, methane capture and recycled paving blocks, but the scale is also very limited and needs more fund/investment to scale up the number of waste processed.

## 4.2 – Waste Reduction Facility

The number of waste reduction facilities and total waste processed per day or per year is as follows:

**Table 12 – Waste Reduction Facilities (2022)**

Municipalities	Number of Facilities			Total Waste Processed (Ton/Year)			Waste Processed (Kg/Facilities/Day)		
	Batam	Tanjung pinang	Bintan	Batam	Tanjung pinang	Bintan	Batam	Tanjung pinang	Bintan
Primary Waste Bank / <i>Bank Sampah Induk</i>	1	0	1	1.095	-	628	3.041,7	-	1.743,9
Secondary Waste Bank / <i>Bank Sampah Unit</i>	221	35	16	437	745	75	5,5	59,2	13,0
Composting Small / <i>Komposting Skala RT-RW</i>	0	11	0	-	41	-	-	10,3	
Composting Medium / <i>Rumah Kompos</i>	1	12	1	37	1.749	-	101,4	404,8	-
Composting Large / <i>Pusat Olah Organik</i>	0	1	0	-	197	-	-	546,6	
Community MRF / <i>TPS 3R</i>	1	3	3	378	837	57	1.050,0	774,6	52,4
Community Recycling Center (Alternative Model) / <i>TPST</i>		1	0	-	9	-	-	25,4	-
Recycling Center / <i>Pusat Daur Ulang</i>	0	0	0	-	-	-	-	-	-
Others (Informal Sector / <i>Lapak Pengepul, etc.</i> )	14	35	25	64.924	2.757	1.795	12.881,8	218,8	199,5

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Existing waste reduction facilities have relatively low productivity. Although the facilities' quantity is plentiful, the productivity is low and it resulted in low overall performance. Waste bank can only process 5,5-59,2 kg of waste per day. Community recycling center is also can only process 25,4 kg of waste per day. Composting at medium/large scale can process 101,4-546,6 kg of waste per day. The highest productivity that can absorb more than 1 ton of waste per day per facility are community MRF/TPS 3R in Batam (1.050 kg/facilities/day), primary waste bank in Bintan (1.743,9 kg/facilities/day), primary waste bank in Batam (3.041,7 kg/facilities/day), and other informal sectors in Batam (12.881,8 kg/facilities/day).

Amongst all waste reduction facilities, waste bank is the most common and have positive growth trend in recent years. Waste bank is a community-based waste management system that aims to reduce waste and promote recycling. Waste banks operate at the local level and are typically run by community organizations, schools, or local government agencies. The concept of waste banks in Indonesia began in the 1990s as a grassroots initiative to address the country's growing waste management problems. Today, waste banks are a common sight in many cities and towns across the country, and are seen as an important tool for promoting sustainable development and center of education for circular economy.

The way waste banks work is relatively simple: individuals or households bring their sorted waste (usually plastics, paper, and other recyclable materials) to a local waste

bank, where it is weighed and processed. The waste bank then pays the individual or household a small amount of money for their contribution. The sorted waste is then sold to recycling companies, who process it into new products.

Most waste bank in all three cities face difficulties in the final stage of the supply chain, which is the sale or marketing of the processed waste. This may involve selling the waste directly to recyclers or manufacturers. Currently there are only a few of plastic recycling activities in Batam, and none in both Tanjungpinang and Bintan. Therefore, most recyclables waste from Batam or Bintan island then brought to cities in other island such as in Pekanbaru (Riau Province), Medan (North Sumatera Province), Jakarta (DKI Jakarta Province) and Surabaya (East Java Province). The number of big waste traders which can also be the distributor/transporter to these cities is also very limited. This situation makes it difficult for waste bank in all three cities to sustain, because economic value of their collected waste is decreased due to high logistic cost to send it to overseas plastic recyclers.

However, recently there is a manufacturing company in Batam (PT WIK) which starts to offtake PET bottle from tens of waste banks in Batam, and also seeking more supply from waste banks in Tanjungpinang and Bintan. It is important to ensure that this practice can be followed by other companies, so waste bank can get higher value.

There are several ways to stimulate recycled plastic use in manufacturing activities, especially in Batam:

- Government policies and regulations: Governments can introduce policies and regulations that promote the use of recycled plastic and discourage the use of virgin plastic.
- Certification schemes: Certification schemes can help to promote the use of recycled plastic by providing a way for companies to demonstrate their commitment to sustainability and transparency.
- Provide dialogue/platform for collaboration and partnerships: Collaboration between manufacturers, recyclers, and other stakeholders can help to promote the use of recycled plastic.
- Education and awareness-raising: Education and awareness-raising campaigns can help to promote the benefits of recycled plastic and raise awareness about the environmental impacts of virgin plastic.

Throughout the supply chain, waste banks in Indonesia typically work closely with local communities and other stakeholders to promote waste reduction and recycling. They may also provide training and education programs to help people learn more about waste management and the benefits of recycling. Overall, the waste bank supply chain in Indonesia plays an important role in reducing waste, promoting sustainable development, and creating new economic opportunities.

### 4.3 – Waste Transportation Facility

Waste transportation facilities in three municipalities is still varied. Batam is the only municipality in Kepulauan Riau Province who have decent numbers of waste transportation facility. The existing waste transportation facility are as follows:



**Figure 13** – Waste Transportation Facilities (2022)

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

There are 6 types of waste transportation facilities that commonly used in Batam, Tanjungpinang and Bintan:

- Three-wheeler: Three-wheelers are small vehicles that can carry a limited amount of waste. They are commonly used for waste collection in narrow streets or areas where larger vehicles cannot access. Currently Batam have 21 units, Tanjungpinang have 17 units, and Bintan have 5 units.
- Pick-up: A pick-up truck is a light-duty truck that is commonly used for waste collection in residential areas. They can carry a moderate amount of waste and are suitable for collecting household waste. Currently Batam have 89 units, Tanjungpinang have 10 units, and Bintan have 3 units.
- Arm roll: An arm roll truck is a heavy-duty vehicle that is commonly used for

waste collection at construction sites, industrial areas, or commercial areas. The truck has a hydraulic arm with a roll-off container that can lift and transport large amounts of waste. Currently Batam have 38 units, Tanjungpinang have 4 units, and Bintan have 1 units.

- **Dump truck:** A dump truck is a heavy-duty truck that is commonly used for transporting large amounts of waste, particularly construction and demolition waste. The truck has a hydraulic mechanism that allows the truck bed to be tilted and the waste to be unloaded at the destination. Currently Batam have 68 units, Tanjungpinang have 5 units, and Bintan have 2 units.
- **Compactor:** A compactor is a specialized waste transportation vehicle that is equipped with a hydraulic press that compresses the waste, reducing its volume. Compactors are commonly used for collecting and transporting large amounts of waste, particularly in commercial areas. Currently Batam have 10 units, while both Tanjungpinang and Bintan didn't have any.
- **Temporary waste station:** A temporary waste station is a container that is placed across the city and serve as waste collection point. Currently Batam have 165 units, Tanjungpinang have 16 units, and Bintan have 6 units.

#### 4.4 – Waste Handling Facility

Waste handling facilities in three municipalities are still heavily dependent on the landfill. Each municipality has its own landfill with the following details:

**Table 13** – Landfill Condition (2021)

Municipalities	Batam	Tanjungpinang	Bintan
<b>Landfill Name</b>	<b>Punggur Landfill</b>	<b>Ganet Landfill</b>	<b>Sei Enam Landfill</b>
<b>Location</b>	Jl. Hasanuddin, Nongsa, Batam City	Jl. Angsana, Pinang Kencana, Tanjungpinang Timur	Jl. Sei Enam Darat, Bintan Timur
<b>Coordinate</b>	1.0527765376699145, 104.12425550451752	0.9341744749409423, 104.52476023900238	0.8439312421492742, 104.58495606783903
<b>Operator</b>	DLH Batam	DLH Tanjungpinang	DLH Bintan
<b>Year of Construction</b>	1997	1992	2012
<b>Area (Ha)</b>	46,86	14,20	5
<b>Active Area (Ha)</b>	6,00	12,00	1,20
<b>Landfill System</b>	Controlled Landfill	Controlled Landfill	Controlled Landfill
<b>Active Waste Coverage Frequency</b>	Once a week	Twice a week	Twice a week

Waste Sources	Batam City	Tanjungpinang City	Bintan Regency
Waste Input (tpd, 2021 average)	649,0	88,2	41,1
Overload Projection	2026	2030	2042
Weighing Bridge	Available	Available	Not Available
Recording System	Automatic	Semi-Automatic	Manual
Wastewater Treatment	Available	Not Available	Available
Monitoring Well	3	2	2
Methane Capture	Not Available	Available	Not Available
Scavenger Community	Yes	Yes	No

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Due to lack of other large scale waste handling facilities, landfill in Batam is projected to be overloaded in 2026, followed by Tanjungpinang in 2030 and Bintan in 2042.

Each municipalities have a different approach/phase with waste handling. Batam has more focus in increasing collection rate at larger scale which eventually adds more potential for WtE but didn't have pilot projects for waste handling facilities. Tanjungpinang has more focus in developing various technology in its pilot projects, but at smaller scale. Bintan is still struggling with lack of infrastructure and very scattered settlements, so there are also no waste handling pilot projects yet.

In Tanjungpinang, there are 4 waste handling pilot projects that can be highlighted:

- Landfill Composting: Since 2018, Tanjungpinang has been conducting pilot project in landfill composting by establishing a composting house inside the landfill compound. This facility absorbs approximately 200 kg of organic waste per day. The fertilizer is then used for landscaping purposes in the municipalities.
- Methane Capture: Since 2014, Tanjungpinang has been conducting pilot project in methane capture which also equips flowmeter to monitor methane gas generation. Electricity output of this project is used to power landfill facilities (office, pyrolysis, plastic bricks, etc.) and for cooking purposes in 13 houses. It uses an average of 15.908 m<sup>3</sup> of methane gas annually.
- Recycling Paving Blocks: Since 2021, Tanjungpinang also conduct a pilot project in converting plastic waste from landfill into paving blocks by thermal process and pressing machine. It also uses methane gas that was captured from landfill. Currently it produces 100-200 paving blocks per week. The bricks are sold to property developers.
- Pyrolysis: Since 2018, Tanjungpinang has been conducting pilot project in

pyrolysis by converting app. 5kg/day of clear plastic waste into 2 kg of petrol and 1 kg of diesel fuel. The process will take 3 hours and use captured methane as the power source of this pyrolysis. The capacity will be increased to 200 kg per day.

## CHAPTER V – WASTE POLICY, STRATEGY, AND INSTITUTIONS ANALYSIS

### 5.1 – Waste Management Policy Framework

As regulated at national level, the waste management policy framework in Kepulauan Riau is also using waste reduction and waste handling framework. The legal basis for this framework is based on Law No. 18 Year 2008 on Waste Management and PP No. 81 Year 2012. The details are as follows:

	Waste Reduction	Waste Handling
<b>Legal Basis</b>	Law 18/2008, Chapter 1 (4), Chapter 19, Chapter 20 PP 81/2012, Articles 10 and 11	Law 18/2008, Chapter 1 (4), Chapter 19, Chapter 22 PP 81/2012, Chapter 17, 18, 19, 21, 24
<b>Technical Implementation</b>	Avoid potential waste generation Reduce potential waste generation Reduce waste that should be handled	Increase segregated, collected and picked waste Increase waste handling Reduce waste at last process (landfill)
<b>Activity Component</b>	Limitation of waste generation Waste recycling Waste reuse	Waste Sorting Waste Collection Waste Pick Up Waste Processing Waste Landfilling
<b>Indicator</b>	Waste generation per-capita Number of waste recycled at source Number of waste reused at source Number of waste leakage to environment	Number of waste handled Number of waste send to landfill Number of waste leakage to environment
<b>Main Actor</b>	Public and Producers	Regency or City Government
<b>Approach</b>	Behavior change Tools and machine	Tools and machine Advanced technology Business and professional
<b>Scale</b>	Small to medium scale	Medium to large scale

**Figure 14** – Waste Management Policy Framework – Reduction and Handling

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Waste reduction's focus is to avoid potential waste generation, reducing potential waste generation and reducing waste that should be handled. The approach of waste reduction is mainly to change behavior, so people are willing to reduce, reuse or recycle their waste. To fulfill this purpose, naturally waste reduction is small to medium scale but have bigger quantity and scattered.

Waste handling's focus is to process waste that can't or hasn't been reduced. It is meant to segregate, collect, and bring waste to landfill or waste handling facilities. The approach of waste handling is mainly to optimize tools and machines with advanced technology and business/professional schemes. Therefore, naturally waste handling has medium to large scale because it needs to achieve certain economies of scale.

## 5.2 – Waste Management Policy and Strategy at Regional Level (Jakstrada)

Waste management policy and strategy at regional level is reflected on *Kebijakan dan Strategi Daerah dalam Pengelolaan Sampah (Jakstrada)* or Regional Policy and Strategy in Waste Management. Jakstrada should align with *Kebijakan dan Strategi Nasional dalam Pengelolaan Sampah (Jakstrada)* or National Policy and Strategy in Waste Management. Jakstrada and Jakstranas also will be used as references for municipalities in determining their waste management policy and strategy.

Jakstrada of Kepulauan Riau from 2018-2025 is as follows:

**Table 14** – Jakstrada Kepulauan Riau (2018-2025)

Kepulauan Riau's Jakstrada (Waste Management Strategy)								
Indicators	2018	2019	2020	2021	2022	2023	2024	2025
Waste Reduction	18%	20%	22%	24%	26%	27%	28%	30%
Waste Handling	73%	80%	75%	74%	73%	72%	71%	70%

Source: DLHK Kepulauan Riau

**Table 15** – Current State of Jakstrada in Kepulauan Riau (2021)

Current State (2021)	
Indicators	Current State (2021)
Waste Reduction	14,67%
Waste Handling	35,05%

Source: DLHK Kepulauan Riau

Based on performance in 2021, Kepulauan Riau still needs to double the waste management performance to achieve 2025 target (30% waste reduction, 70% waste handling). Currently in 2021, Kepulauan Riau's waste reduction is still at 14,67% and waste handling is still at 35,05%.

Batam, Tanjungpinang and Bintan are three municipalities that are better developed compared to other municipalities. Although there are some problem with waste infrastructure and scattered settlements, the waste reduction and waste handling at these 3 municipalities are still better than other municipalities. For other municipalities, waste remains as a big problem but it is hard to prioritize because there are many other issues (education, health, infrastructure, transportation, etc.)

Jakstrada and Jakstranas also will be used as references for municipalities in determining their waste management policy and strategy. In all municipalities inside Kepulauan Riau Province, the waste management policies that refer to Jakstrada are as follows:

**Table 16 – Jakstrada Regulatory / Legal Basis**

No	Municipalities	Regulation Number	Year	Date	Jakstrada Regulatory Level
1	Batam	10	2019	18 Maret	Peraturan Walikota Batam
2	Tanjungpinang	43	2018	15 Oktober	Peraturan Wali Kota Tanjungpinang
3	Bintan	33	2018	25 Juni	Peraturan Bupati Bintan
4	Karimun	40	2018	10 Oktober	Peraturan Bupati Karimun
5	Lingga	85	2018	24-Sep	Peraturan Bupati Lingga
6	Natuna	25	2019	06 Mei	Peraturan Bupati Natuna
7	Anambas	33	2019	31 Mei	Peraturan Bupati Kepulauan Anambas

Source: DLHK Kepulauan Riau

### 5.3 – Waste Management Budget Allocation

Waste management budget in Batam, Tanjungpinang and Bintan are as follows:

**Table 17 – Waste Management Budget Allocation**

Activities	Batam (2022)		Tanjungpinang (2022)		Bintan (2022)	
	Value (IDR)	%	Value (IDR)	%	Value (IDR)	%
Waste Reduction	1.454.934.363	1,9%	-	0,0%	20.000.000	0,1%
Waste Handling (Collection, Landfill, etc.)	70.077.192.292	89,1%	399.852.905	20,8%	637.999.741	4,5%
Provision of Waste Infrastructure	7.085.650.000	9,0%	1.518.560.100	79,2%	13.558.436.714	95,4%
<b>Total Waste Management Budget</b>	<b>78.617.776.655</b>	<b>100,0%</b>	<b>1.918.413.005</b>	<b>100,0%</b>	<b>14.216.436.455</b>	<b>100,0%</b>
<b>Waste Management Budget</b>	<b>78.617.776.655</b>	<b>1,8%</b>	<b>1.918.413.005</b>	<b>0,2%</b>	<b>14.216.436.455</b>	<b>2,1%</b>
Total Environment Agency Budget	101.180.595.952	2,3%	9.947.108.100	1,1%	24.066.021.559	3,5%
Total Budget	4.451.038.342.615	100,0%	920.382.954.688	100,0%	685.053.625.526	100,0%

Source: RKPD Batam, RKPD Tanjungpinang, RKPD Bintan

Data above shows that Batam has the highest budget among 3 municipalities, with budget priority for waste handling. It reassures Batam's priority in waste collection. Batam has a total waste management budget of around IDR 78,6 billion, which 89,1% of it is for waste handling (collection, landfill, etc.), 9,0% of it is for provision of waste infrastructure, and 1,9% of it is for waste reduction.

Tanjungpinang has the lowest budget among the 3 municipalities, with a very limited budget on waste reduction and waste handling. However, most of Provincial programs in waste management are also conducted here as the capital city. Tanjungpinang has a total waste management budget of around IDR 1,9 billion, of which 79.2% of it is for provision of waste infrastructure and 20,8% of it is for waste handling.

Bintan have the highest budget proportion among 3 municipalities, because it plans to establish several new waste infrastructures, particularly for Sei Enam Landfill and TPST. Bintan has a total waste management budget of around IDR 14,2 billion, which 95,4% of it is for provision of waste infrastructure, 4,5% of it is for waste handling and 0,1% of it is for waste reduction.

#### 5.4 – Waste Retribution

Waste retribution's legal basis in Batam is based on Perda 11 Year 2011 on Retribution for Waste/Cleanliness Services. Batam's waste retribution target in 2022 is IDR 50 billion. Batam's detailed waste retribution tariff is as follows:

**Table 18** – Detailed Waste Retribution Tariff in Batam

No	Category	Sub-Category	Monthly Retribution Fee
1	Settlement	Very Simple House (36 m <sup>2</sup> )	7.000
		Simple House (36-45 m <sup>2</sup> )	9.000
		Middle House (54-120 m (> 120 m <sup>2</sup> ))	15.000
		Luxury House	50.000
		Others	5.000
2	Apartment	Small ( ≤ 100 unit)	1.500.000
		Medium (101 to 200 unit)	3.000.000
		Large ( ≥ 201 unit)	4.500.000
3	Home Office	One level	42.500
		Two level	60.000
		Three level	85.000
		Four level	110.500

No	Category	Sub-Category	Monthly Retribution Fee
		>4 level	165.000
4	Boarding school	Small	175.000
		Medium	350.000
		Large	700.000
5	Dormitory	<500 people	875.000
		500 – 5,000 people	7.875.000
		5,000 – 15,000 people	35.000.000
		15,000 – 30,000 people	78.750.000
		30,000 – 50,000 people	140.000.000
		>50,000 people	175.000.000
6	Office	≤ 15 people	25.000
		16-30 people	37.000
		31-50 people	65.000
		50-100 people	120.000
		101-200 people	250.000
		201-300 people	400.000
		310-400 people	560.000
		401-500 people	720.000
		501-1,000 people	1.200.000
		>1,000 people	1.600.000
7	Restaurant	≤60 m <sup>2</sup>	100.000
		61-500 m <sup>2</sup>	497.000
		561-1,060 m <sup>2</sup>	1.297.000
		1,061-2,060 m <sup>2</sup>	2.497.000
		2,061-3,060 m <sup>2</sup>	4.097.000
		3,061-4,060 m <sup>2</sup>	5.697.000
		4,061 – 5,560 m <sup>2</sup>	7.697.000
		5,561-7,060 m <sup>2</sup>	10.097.000
		>7,061 m <sup>2</sup>	13.649.000
8	Hospital		15,000-3,200,000

No	Category	Sub-Category	Monthly Retribution Fee
9	Mall/Plaza		3,500/modul
10	Hotel/ Cottage		60,000 – 3,200,000
11	Bar/Pub		425,000 – 2,500,000
12	Waste Disposal at Telaga Punggur	Waste from industrial production process of non-hazardous and toxic materials waste	25.000
		Industrial waste with special treatment	75.000
		Waste of building debris	25.000
		Waste of expired food	75.000
		Trash extermination from collateral confiscation	40.000
		Cattle extermination waste	80.000
13	Processing results that comes out from final disposal site/ landfill		25.000

Source: DLH Batam

Batam has the clearest waste retribution that based on the number of people, total area and waste characteristics. It also has the best enforcement which resulted in high waste retribution (IDR 50 billion). This retribution is equal to 2/3 of the total waste management budget in Batam.

Waste retribution's legal basis in Tanjungpinang is based on Perda 4 Year 2018 on Waste Services Retribution. Tanjungpinang's waste retribution target in 2022 is less than IDR 1 billion. Tanjungpinang's detailed waste retribution tariff is as follows:

**Table 19** – Detailed Waste Retribution Tariff in Tanjungpinang

No	Category	Monthly Retribution Fee (IDR)
1	House in alley	10.000
2	House in main road	20.000
3	Commercial in Permanent Building	120.000
4	Commercial in Non Permanent (Street Kiosk, etc.)	30.000

Source: DLH Tanjungpinang

Waste retribution's legal basis in Bintan is based on Perda 28 Year 2018 on Technical Implementation for Collecting Retribution of Waste/Cleanliness Services. Bintan's waste retribution target in 2022 is less than IDR 1 billion. Bintan's detailed waste retribution tariff is as follows:

**Table 20 – Detailed Waste Retribution Tariff in Bintan**

No	Category	Monthly Retribution Fee (IDR)
1	Non-Real Estate House	2.000-7.000
2	Real Estate House	7.000-17.000
3	Hospital (/m3 waste)	10.000
4	Restaurant/Hotel (/m3 waste)	15.000
5	Commercial in Non Permanent (Street Kiosk, etc.)	30.000

Source: DLH Bintan

On the other side, Tanjungpinang and Bintan is still struggling in determining the waste retribution guideline and enforcing the policy, which resulted in low waste retribution (currently less than IDR 1 billion).

### 5.5 – Waste Management Institutional Analysis

Waste management in Kepulauan Riau and its municipalities are run by multistakeholders. These stakeholders have different roles, such as regulator, planner, operator, coordinator, or supporter. The detailed waste management institution mapping is as follows:

**Table 21 – Waste Management Institution Mapping**

No	Agency	Technical Work Unit	Function	Related Tasks
<b>Main Institutions</b>				
1	Environmental and Forestry Agency (Dinas Lingkungan Hidup dan Kehutanan/ DLHK)	Waste Management and Pollution Control Department	Regulator Planning Empowerment	Formulate policies and waste management programs, develop plans for the provision of regional waste management infrastructures and facilities Provide guidance on zero waste and waste bank programs Develop regional waste management cooperation
		Regional Waste Management Implementing Unit (UPTD Sampah Regional)	Operator	Manage Telaga Punggur Regional Landfill Operations
2	Regional Development Planning, Research and Development Body (Badan Perencanaan dan Pembangunan Daerah/Bappeda)	Regional Planning and Infrastructure Development Department	Coordination Planning	Coordinate and facilitate the alignment of regional waste management performance improvement programs with other development sector programs
3	Village Community Empowerment Agency	Village Infrastructure	Empowerment	Assist in the conditioning of the provision of waste management facility and

No	Agency	Technical Work Unit	Function	Related Tasks
	(Dinas Pemberdayaan Masyarakat dan Desa/ DPMD)	Facility and Community Economic Business Department Empowerment		infrastructure, as well as activities in rural areas Assist in the formation and construction of a waste bank program
4	Public Works and Spatial Planning Agency (Dinas Pekerjaan Umum dan Penataan Ruang/DPUPR)	Cipta Karya Agency	Planning	Large-Scale Infrastructure Provision
5	Cleanliness, Parks and Cemetery Agency (Dinas Kebersihan Pertamanan dan Pemakaman)	Cleanliness, Parks and Cemetery Agency	Regulator Empowerment	Formulating technical policies in the field of cleanliness, organizing public services in the field of cleanliness, fostering the implementation of tasks in the field of cleanliness, reducing waste and or handling waste, coordinating with Regional Work Units in waste management.
<b>Supporting Institutions</b>				
6	Energy and Mineral Resources Agency (Dinas Energi dan Sumber Daya Mineral/DESDM)	Energy and Mineral Resources Agency	Regulator (WtE)	Develop waste to energy conversion guidelines
7	Agriculture and Plantation Agency (Dinas Pertanian dan Perkebunan / DPP)	Agricultural Facility and Infrastructure Department	Empowerment	Assist in the establishment and strengthening of the Main Waste Bank ( <i>Bank Sampah Induk</i> ), as well as the strengthening of the Provincial Regional Waste Bank Assist in the implementation of the incentive system
8	Animal Husbandry and Health Agency (Dinas Peternakan dan Kesehatan Hewan)	Veterinary Health and Community Department	Empowerment	Assist in the establishment and strengthening of the Main Waste Bank, as well as the strengthening of the Provincial Regional Waste Bank Assist in the implementation of the incentive system
9	Tourism Agency (Dinas Pariwisata)	Tourism Institution Department	Empowerment	Support the implementation of an area-based waste reduction incentive system through 3R activities
10	Trade Agency (Dinas Perdagangan)	Domestic Trade Department	Empowerment	Assist in the implementation of the incentive system
11	Communication and Information Agency (Dinas Komunikasi dan Informasi/ Diskominfo)	Public Information and Public Department	Empowerment	Establish a network of waste banks and 3R Waste Collection Point (TPS3R) operational data

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Additionally, this study also assesses the availability of waste management operators in each municipality and availability of waste management policy to increase waste collection.

The detailed availability of waste management operators in each municipality are as follows:

**Table 22 – Availability of Waste Management Operator Institutions**

No	Operator Information	Batam City	Tanjungpinang City	Bintan Regency
A	<b>Nomenclature</b>	Bidang Pengelolaan Persampahan	UPTD TPA Ganet	UPT Kebersihan dan Pertamanan
B	<b>Main Organization</b>	Environmental Agency	Environmental Agency	Public Work Agency (will be transferred to Environment Agency)
C	<b>Year Formed</b>	2013	2021	2006
D	<b>Legal Basis</b>	Regional Regulation of Batam City Number 11 year 2013	Tanjungpinang City Mayor Regulation Number 14 year 2021	Bintan Regent Regulation Number 21 year 2006
E	<b>Scope of Work</b>	compiling waste management plans and programs, compiling operational technical guidelines for waste management, organizing waste management public services, fostering, monitoring, evaluating and reporting the implementation of waste management.	Manage the implementation of TPA operational activities.	handling of parks and waste in sub-district cities, structuring the construction of waste service networks, TPS and TPA, structuring and supervising the process of transporting waste from TPS and TPA.

*Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan*

Waste operators in Batam and Tanjungpinang is handled by Environment Agency, while in Bintan it is still handled by Public Work Agency and will be transferred to Bintan’s Environment Agency.

The detailed availability of waste management policy to increase waste collection are as follows:

**Table 23** – Availability of Waste Management Policy to Increase Waste Collection

Potential	Batam City	Tanjungpinang City	Bintan Regency
<b>Local Regulation or Mayor/Regent Regulation about Waste Management</b>			
Level of regulation convenience to encourage compliance with waste sorting and collection	<b>High</b> Containers are organized by 3 color categories	<b>High</b> The containers are arranged according to 5 color categories and collection refusal applies if the waste is not sorted	<b>Low</b> Policy is not exist/enforced yet
Statement of responsibility for managing source-level collection and transport activities to TPS	<b>Clear</b> Environmental Waste Management Institutions (For household waste) or area managers	<b>Clear</b> RT/RW; The village/kelurahan is responsible for the delivery of services	<b>Unclear</b> Policy is not exist/enforced yet
<b>Other Supporting Regulations</b>			
Regulations that support waste sorting and collection	<b>Clear</b> Mayor's Regulation No. 60 of 2014 on the implementation guidelines for waste management that encourages waste containerisation, waste segregation, waste transportation, TPS 3R, establishment of waste banks and compost houses	<b>Clear</b> Tanjungpinang City Regional Regulation No. 3 of 2015 on waste management that encourages waste segregation, waste reduction, waste transportation and recycling.	<b>Unclear</b> Policy is not exist/enforced yet

Source: DLHK Kepulauan Riau, DLH Batam, DLH Tanjungpinang, DLH Bintan

Waste collection in Batam and Tanjungpinang is convenient and have regulation that clearly state the responsible actor, but Bintan still needs to develop the policy and determine the responsibilities.

## CHAPTER VI – IMPROVEMENT RECOMMENDATIONS

### 6.1 – Key Issues Identification and Root Cause Analysis

Based on waste characteristics and waste flow analysis, waste infrastructure analysis and waste policy, strategy & institutions analysis, this study has mapped out several key issues in waste management in Batam, Tanjungpinang and Bintan. These key issues are as follows:



**Figure 15** – Key Issues in Waste Management in Batam, Tanjungpinang and Bintan

Source: Internal Analysis

The identified key Issues consist of low waste segregation, inefficient waste reduction facilities, low waste collection rate, landfill problems (will overload and prone to pollution), lack of (large scale) waste handling facilities, limited financial capacity and other important issues. Detailed root cause in each issue are as follows:

Low waste segregation, caused by:

- Low awareness for waste prevention and/or segregation
- Limited segregated waste recycling/upcycling
- No segregated waste collection system

Inefficient waste reduction facilities, caused by:

- Waste bank business model is not attractive
- Waste bank service & quality is varied
- Waste bank have bad profitability
- Waste bank service coverage is too narrow
- Lack of recycling companies
- Lack of offtaker

Low waste collection rate, caused by:

- Low awareness to avoid leakage/illegal dumping/open burning
- Limited waste transportation vehicle
- Inefficient system of waste transportation

Landfill problems (will overload and prone to pollution), caused by:

- Limited landfill active area capacity
- Lack of wastewater treatment plant
- Lack of methane gas capture

Lack of (large scale) waste handling facilities, caused by:

- Feedstock is limited (in tanjungpinang and bintan)
- Lack of offtaker
- Low/inavailability of tipping fee
- Lack of private initiatives

Limited financial capacity, caused by:

- Low waste retribution
- Waste budget is least prioritised
- Lack of creative funding

Other issues, caused by:

- Inaccurate waste data
- Lack of hazardous/specific waste treatment

Each issues and root cause will be assessed in the next section to formulate the potential solutions.

## **6.2 – Strategic Recommendations Identifications**

Potential solutions to each issues and root cause is provided in the following table. This table also categorized the potential solutions into strategic recommendations. There are 5 (five) strategic recommendations, which are: 1) Reform and empower the waste bank; 2) Establish WtE in Batam island; 3) Establish regional landfill with Large Scale Material Recovery Facility in Bintan Island; 4) Strengthen Waste Financing; and 5) Implement Effective Waste Prevention Strategy.

**Table 24 – Identification of Potential Solutions Toward Each Issues/Root Cause**

Issues	Root Cause	Potential Solution	Solution Categorization				
			Reform & Empower Waste Bank	Establish WtE Batam Island	Establish Regional Landfill + MRF in Bintan Island	Strengthen Waste Financing	Implement Effective Waste Prevention Strategy
Low Waste Segregation	Low Awareness for Waste Prevention/ Segregation	Increase Awareness Through CBO (Waste Bank, etc.)	Yes				Yes
	Limited Segregated Waste Recycling/Upcycling	Increase Waste Bank/Recyclers Capacity	Yes				Yes
	No Segregated Waste Collection System	Implement Waste Segregation in Collection Vehicles		Yes	Yes		Yes
Inefficient Waste Reduction Facilities	Waste Bank Business Model Is Not Attractive	Experiment with Different Business Model	Yes				
	Waste Bank Service & Quality is Varied	Standardization of Waste Bank	Yes				
	Waste Bank Have Bad Profitability	Provide Incentive/Subsidy for Waste Bank	Yes			Yes	Yes
	Waste Bank Service Coverage is Too Narrow	Equip Waste Bank with Three Wheeler	Yes			Yes	
	Lack of Recycling Companies	Provide Incentive for Waste Recyclers	Yes			Yes	
	Lack of Offtaker	Connect WB with Offtaker (Agriculture Agency, Farmer Associations, etc.)	Yes	Yes	Yes		
Low Waste Collection Rate	Low Awareness to Avoid Leakage/Illegal Dumping/Open Burning	Increase Awareness Through CBO (Waste Bank, etc.)	Yes				Yes
	Limited Waste Transportation Vehicle	Add More Waste Transportation Vehicle				Yes	
		Open Partnership with Private Waste Collector		Yes	Yes		
	Inefficient System of Waste Transportation	Improve Waste Collection Scheduling		Yes	Yes		Yes
Landfill Problems (Will Overload in 2026-	Limited Landfill Active Area Capacity	Conduct Landfill Mining		Yes		Yes	
	Lack of Wastewater Treatment Plant	Renovate/Upsize Existing Wastewater Treatment Plant			Yes	Yes	

Issues	Root Cause	Potential Solution	Solution Categorization				
			Reform & Empower Waste Bank	Establish WTE Batam Island	Establish Regional Landfill + MRF in Bintan Island	Strengthen Waste Financing	Implement Effective Waste Prevention Strategy
2042 and Prone to Pollution)	Lack of Methane Gas Capture	Add More Methane Gas Capture				Yes	
Lack of (Large Scale) Waste Handling Facilities	Feedstock is Limited (in Tanjungpinang and Bintan)	Find Alternative for Low-Medium Scale Waste Handling			Yes		
	Lack of Offtaker	Explore Partnership with PLN		Yes			
		Explore Partnership with Others (Smelters)		Yes	Yes		
	Low/Inavailability of Tipping Fee	Advocating Tipping Fee Necessities to Politicians		Yes	Yes		
		Establish BLUD (Regional Service Body)		Yes	Yes		
Lack of Private Initiatives	Invite Private Players (Locally, Nationally, Globally)		Yes	Yes			
Limited Financial Capacity	Low Waste Retribution	Increase Waste Retribution Tariffs				Yes	Yes
	Waste Budget is Least Prioritised	Advocating Waste into Basic Service				Yes	
	Lack of Creative Funding	Add More Initiative to Facilitate CSR as Impact Investment (e.g. in Waste Bank)	Yes				
		Add More Initiative to Seek International Funding				Yes	
Others	Inaccurate Waste Data	Implement Multi-Point Waste Data Verification/Validation		Yes	Yes		
	Lack of Hazardous/Specific Waste Treatment	Establish Hazardous/Specific Waste Treatment				Yes	

Source: Internal Analysis

The five strategic recommendations now have 8-11 key activities. These activities then sorted based on two factors: 1) value creation, which reflects the impact if these activities be implemented; and 2) implementability, which reflects the possibility to implement these action plans. The result of these prioritizations and its strategic timeline is provided in the section below.

## 6.3 – Strategic Recommendation and Implementation Timeline

### 6.3.1 – Reform and Empower Waste Bank

Waste bank remains as the ideal channel to do education on waste awareness and also to increase waste reduction. However, waste bank still has problem in terms of productivity. Although there are plentiful number of waste banks, the overall productivity such as number of reduced wastes is still limited. The prioritization for strategic recommendation 1: Reform and empower waste bank is as follows:

**Table 25** – Detailed Initiatives for Strategic Recommendation 1

No	Initiatives	Description
1	Experiment with Different Business Model	Waste banks can experiment with different business models to find the most effective way to operate. This can involve by reallocating the incentive budget to waste bank promotion to invite and educate more of the society about the benefits of waste bank, instead of using it for higher price of waste that paid by waste bank (but the amount is still insignificant for customers).
2	Standardization of Waste Bank	The waste bank system can be standardized to ensure consistency and quality. This can involve developing standard operating procedures, training waste bank staff, and ensuring that waste is sorted and processed correctly.
3	Increase Waste Bank/Recyclers Capacity	Waste banks and recyclers can be expanded or upgraded to increase their capacity. This can involve providing additional equipment or resources, building new waste bank facilities, or partnering with other waste management organizations.
4	Connect WB with Offtaker (Agriculture Agency, Farmer Associations, etc.)	Waste banks can be connected with off-takers such as agriculture agencies or farmer associations to ensure that waste is processed and sold effectively. This can involve developing partnerships or agreements with off-takers.
5	Add More Initiative to Facilitate CSR as Impact Investment (e.g. in Waste Bank)	Waste banks can add more initiatives to encourage corporate social responsibility (CSR) as impact investment. This can involve providing resources or training to companies that invest in waste banks, or partnering with CSR organizations.
6	Provide Incentive/ Subsidy for Waste Bank and Recyclers	Governments or other organizations can provide incentives or subsidies for waste banks and recyclers. This can involve offering financial support or other resources to encourage participation in the waste bank system.

7	Equip Waste Bank with Three Wheeler	Waste banks can be equipped with three-wheelers to help collect and transport waste. This can involve providing funding or resources to purchase and maintain the vehicles.
8	Equip Waste Bank with Digital System	To equip waste banks with a digital system, a needs assessment should first be conducted to determine the appropriate system for each waste bank. Potential vendors or developers should then be identified and evaluated based on cost, quality, and suitability. Once a vendor or developer is selected, the digital system should be procured and installed, ensuring that it is user-friendly and accessible to waste bank staff and customers. Waste bank staff should also be trained on how to use the system to record and track waste transactions, manage customer accounts, and generate reports. Finally, the effectiveness of the digital system should be monitored and evaluated regularly to make adjustments and ensure optimal performance.
9	Increase Awareness Through CBO (Waste Bank, etc.)	Waste banks can increase awareness of their services and the importance of waste management through community-based organizations (CBOs). This can involve partnering with CBOs to provide education and outreach programs, or hosting community events to raise awareness.

Source: Internal Analysis

The proposed timeline to execute these initiatives are as follows:

Activities	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Reform &amp; Empower Waste Bank</b>												
Experiment with Different Business Model	■	■										
Standardization of Waste Bank	■	■										
Increase Waste Bank/Recyclers Capacity			■	■								
Connect WB with Offtaker (Agriculture Agency, Farmer Associations, etc.)			■	■	■	■	■	■	■	■	■	■
Add More Initiative to Facilitate CSR as Impact Investment (e.g. in Waste Bank)			■	■	■	■	■	■	■	■	■	■
Provide Incentive/Subsidy for Waste Bank					■	■	■	■	■	■	■	■
Provide Incentive for Waste Recyclers					■	■	■	■	■	■	■	■
Equip Waste Bank with Three Wheeler					■	■	■	■	■	■	■	■
Equip Waste Bank with Digital System					■	■	■	■	■	■	■	■
Increase Awareness Through CBO (Waste Bank, etc.)					■	■	■	■	■	■	■	■

**Table 26** – Implementation Timeline for Strategic Recommendation 1

Waste banks need to be reformed and empowered through several steps. First, there is a need to reevaluate and reassess the current business model of waste banks.

Currently, waste banks offer a small amount of money as an incentive for customers to store waste in them, with the aim of stimulating and shifting people's behavior towards proper waste management. However, this incentive is not attractive enough, and the current model may actually repel many citizens from using waste banks because monetary incentives are not their main motivation. Therefore, waste banks should explore different business models, especially by reallocating the incentive budget to the promotion budget to attract and educate more segments of society.

Secondly, waste banks need to be standardized to enhance service quality and sustainability. The government can also assist waste banks by connecting them with potential off-takers. Some waste banks have good initiatives in converting organic waste into black soldier fly maggots, but they face difficulties in selling the products. It could have a significant impact if the government, through the agriculture agency, could off-take these maggots or channel them to adjacent farmers.

Waste banks also have the potential for cooperation with private parties (state-owned enterprises, regional-owned enterprises, private companies, associations, etc.) by utilizing Corporate Social Responsibility (CSR) funds. The government should assist waste banks in accessing these funds by providing a platform for them to connect with private parties. In the future, the government should also consider providing incentives for waste banks to conduct waste awareness education programs. Moreover, the supply chain around waste banks is also crucial, and the government should consider providing incentives for recyclers as well. Finally, improvements and empowerment in waste banks can be achieved by equipping them with more equipment such as three-wheelers, digital systems, and marketing materials to educate society about waste awareness.

### 6.3.2 – Establish Waste-to-Energy in Batam Island

Among all municipalities in Kepulauan Riau Province, Batam City have the highest potential to establish Waste-to-Energy (WtE) facility. Currently there are no large scale waste handling facility in Batam, so all waste is sent to landfill. This is unfortunate considering that Batam already implement good waste collecting services which ensure the secure feedstock for a WtE facility. The prioritization for strategic recommendation 2: Establish waste-to-energy in Batam island is as follows:

**Table 27** – Detailed Initiatives for Strategic Recommendation 2

No	Initiatives	Description
1	Conduct Feasibility Study based on Technology Catalogue	Based on technology catalogue which previously have been done under SII, it is advised to continue the progress by conducting feasibility study on recommended technology. There are 3 potentials

		that can be explored in Batam: 1) Waste-to-Electricity in Punggur Landfill by selling electricity to PLN; 2) Refuse-derived Fuel by selling RDF (mostly organic waste) to PLN's powerplants (Tanjung Kasam, Tanjung Sauh, Galang Batang, etc.); 3) Refuse-derived Fuel by selling RDF (mixed waste) to bauxite smelters in Bintan (PT Bintan Alumina Indonesia).
2	Invite Private Players (Locally, Nationally, Globally)	Batam City Government can invite private players to invest in the system. This can involve developing partnerships, hosting events or roadshows, or providing incentives to attract private investment.
3	Establish BLUD (Regional Service Body)	A regional service body, known as BLUD, can be established to oversee waste management in a particular region. This can involve setting up a separate legal entity, hiring staff, and establishing procedures for managing waste.
4	Explore Partnership with PLN	Batam City Government can explore partnerships with the national electricity company, PLN, to generate energy from waste. This can involve developing agreements or partnerships with PLN, installing waste-to-energy facilities, or providing training and support to PLN staff.
5	Explore Partnership with Others (Smelters)	Batam City Government can explore partnerships with other organizations, such as smelters, to recycle waste. This can involve developing partnerships or agreements with smelters, providing training or resources, or collaborating on waste management initiatives.
6	Advocating Tipping Fee Necessities to Politicians	Batam City Government (executive agencies) can advocate for tipping fees to be implemented by politicians. This can involve lobbying, developing policy proposals, or working with other waste management organizations to promote the benefits of tipping fees.
7	Conduct Landfill Mining	Landfill mining can be conducted to extract valuable resources from waste. This can involve developing plans for mining, hiring staff and equipment, and conducting environmental assessments.
8	Implement Multi-Point Waste Data Verification/Validation	Waste data can be verified and validated at multiple points in the waste management process to ensure accuracy and consistency. This can involve

		developing procedures for data verification and validation, training staff, and implementing quality control measures.
9	Open Partnership with Private Waste Collector	Batam City Government can open partnerships with private waste collectors to increase efficiency and effectiveness. This can involve developing partnerships or agreements with waste collectors, sharing resources or equipment, or collaborating on waste management initiatives.
10	Implement Waste Segregation in Collection Vehicles	Waste segregation can be implemented in collection vehicles to ensure that waste is properly sorted before it reaches the waste bank. This can involve providing training and resources to waste collection staff, developing new collection procedures, or purchasing new equipment.
11	Improve Waste Collection Scheduling	Waste collection schedules can be improved to ensure that waste is collected and processed in a timely manner. This can involve developing new collection schedules, providing resources or training to collection staff, or upgrading collection equipment.

Source: Internal Analysis

The proposed timeline to execute these initiatives are as follows:

**Table 28** – Implementation Timeline for Strategic Recommendation 2

Activities	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Establish WtE Batam Island</b>												
Conduct Feasibility Study based on Technology Catalogue	■	■										
Invite Private Players (Locally, Nationally, Globally)	■	■										
Establish BLUD (Regional Service Body)	■	■	■	■								
Explore Partnership with PLN	■	■	■	■								
Explore Partnership with Others (Smelters)	■	■	■	■								
Advocating Tipping Fee Necessities to Politicians	■	■	■	■								
Conduct Landfill Mining					■	■	■	■	■	■	■	■
Implement Multi-Point Waste Data Verification/Validation					■	■	■	■	■	■	■	■
Open Partnership with Private Waste Collector					■	■	■	■	■	■	■	■
Implement Waste Segregation in Collection Vehicles					■	■	■	■	■	■	■	■
Improve Waste Collection Scheduling					■	■	■	■	■	■	■	■

Source: Internal Analysis

The steps to establish a Waste-to-Energy (WtE) facility in Batam can be initiated by reassessing the recommended technology, such as those listed in the technology catalogue of SII. Then the process can be continued by inviting private players at the local, national, and global level. The study found out that there are already a plentiful

number of proposals and partners that have approached Batam municipalities and expressed their interest in establishing a Waste-to-Energy facility. These proposals/ideas need to be analyzed, filtered, and followed up.

The second step is to establish a Badan Layanan Umum Daerah (BLUD) or Regional Service Body. Without this body, Batam municipalities will find it difficult to have an instrument in collecting revenue from WtE, thus reducing the commercial attractiveness of WtE. The WtE facility in Batam also needs to explore partnerships with offtakers, such as PLN. Currently, there are many large industries in Batam, and some of them are using coal, gas, or electricity as a power source. These industries can be potential offtakers for WtE's output.

One essential factor in WtE is to secure the tipping fee. A tipping fee is an amount that is paid by the government to WtE operators as an incentive for handling waste. The value of a tipping fee should be decided by municipalities with approval from the legislature (politicians). It can be a difficult consideration to allocate an ideal amount of tipping fees if the politicians do not have full knowledge of the WtE business model and the necessities of having a WtE facility. Therefore, the series of advocacy in this area needs to be amplified.

WtE can also consider using landfill mining as a substitute or complementary to fresh waste. Unlike fresh waste, which has a high moisture level, landfill mining usually has a lower moisture level and is more flammable and suitable for WtE, but it depends on the chosen technology. With an existing WtE, Batam municipalities should have the possibility to improve the overall waste management by implementing multi-point waste data verification/validation, open partnerships with private waste collectors, implementing waste segregation in collection vehicles, as well as improving waste collection scheduling.

### **6.3.3 – Establish regional landfill with Large Scale MRF in Bintan Island**

Currently in Bintan island there are two municipalities and two landfill: Ganet Landfill, operated by Tanjungpinang City and Sei Enam Landfill, operated by Bintan Regency. Each landfill is not overloaded yet and still have the possibility to keep running until 2030-2042. However, both municipalities have limited financial and knowledge capacity in running these landfills. There are also some facilities that are broken and cannot be used, such as Wastewater Treatment Plant (WWTP). Most areas in Bintan Regency are also closer to Ganet Landfill in Tanjungpinang rather than to Sei Enam Landfill in East Bintan. Therefore, to improve the landfill condition and effectiveness, one possible solution is to transform Ganet Landfill into a regional landfill in Bintan island which can process waste from Tanjungpinang City and Bintan Regency.

Prioritization for strategic recommendation 3: Establish regional landfill in Bintan island is as follows:

**Table 29** – Detailed Initiatives for Strategic Recommendation 3

No	Initiatives	Description
1	Conduct Study Tour to Large Scale MRF Facility and Alternative Waste Handling Facilities	Tanjungpinang City and Bintan Regency can conduct study tours to large scale Material Recovery Facilities (MRFs) and alternative waste handling facilities. By visiting such facilities, they can observe and learn about effective waste handling processes, best practices and technologies used, and gain insights on how to improve their own waste management practices.
2	Conduct Feasibility Study based on Study Tours	After conducting study tours, Tanjungpinang City and Bintan Regency should conduct a feasibility study based on the observations and knowledge gained from these tours. This study will help them to determine the viability and potential outcomes of implementing similar waste management practices in their own regions.
3	Invite Private Players (Locally, Nationally, Globally)	Tanjungpinang City and Bintan Regency should invite private players locally, nationally, and globally to participate in waste management initiatives. Private players can provide valuable expertise, resources, and financial support to improve waste management practices in the region.
4	Establish BLUD (Regional Service Body)	Tanjungpinang City and Bintan Regency should establish a Regional Service Body or Badan Layanan Umum Daerah (BLUD) to collect revenue from waste-to-energy (WtE) and other waste management activities. This will help to improve the commercial attractiveness of WtE and provide a reliable source of revenue for ongoing waste management efforts.
5	Explore Partnership with Others (Smelters)	Tanjungpinang City and Bintan Regency should explore partnerships with smelters and other industries that can use the waste generated in the region. This can help to increase the value of waste and reduce the overall waste disposal costs.
6	Advocating Tipping Fee Necessities to Politicians	Tanjungpinang City and Bintan Regency should advocate the necessity of tipping fees to politicians. Tipping fees are paid by the government to WtE operators as an incentive for handling waste. This will require a series of advocations and education for politicians to understand the importance of tipping

		fees in the WtE business model.
7	Renovate/Upsize Existing Wastewater Treatment Plant	Tanjungpinang City and Bintan Regency can renovate or upsize existing wastewater treatment plants to handle the growing volume of waste generated in the region. This will ensure that the wastewater treatment process is effective and efficient, reducing the environmental impact of untreated wastewater.
8	Open Partnership with Private Waste Collector	Tanjungpinang City and Bintan Regency should open partnerships with private waste collectors to improve waste collection and disposal practices. Private waste collectors can provide specialized equipment, expertise, and resources to improve waste management practices in the region.
9	Improve Waste Collection Scheduling	Tanjungpinang City and Bintan Regency should improve waste collection scheduling to ensure that waste is collected regularly and efficiently. This will reduce the amount of waste that accumulates in public spaces, reduce the spread of diseases, and improve the overall appearance of the region.
10	Implement Waste Segregation in Collection Vehicles	Tanjungpinang City and Bintan Regency should implement waste segregation in collection vehicles. This will help to ensure that waste is sorted properly, reducing the amount of contamination and improving the overall quality of recyclable materials.
11	Implement Multi-Point Waste Data Verification/Validation	Tanjungpinang City and Bintan Regency should implement multi-point waste data verification/validation to ensure that waste data is accurate and reliable. This will help to improve waste management practices, reduce the environmental impact of waste, and increase the efficiency of waste management operations.

*Source: Internal Analysis*

The proposed timeline to execute these initiatives are as follows:

**Table 30 – Implementation Timeline for Strategic Recommendation 3**

Activities	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Establish Regional Landfill in Bintan Island</b>												
Conduct Study Tour to Large Scale MRF Facility and Alternative Waste Handling Facilities												
Conduct Feasibility Study based on Study Tours												
Invite Private Players (Locally, Nationally, Globally)												
Establish BLUD (Regional Service Body)												
Explore Partnership with Others (Smelters)												
Advocating Tipping Fee Necessities to Politicians												
Renovate/Upsize Existing Wastewater Treatment Plant												
Open Partnership with Private Waste Collector												
Improve Waste Collection Scheduling												
Implement Waste Segregation in Collection Vehicles												
Implement Multi-Point Waste Data Verification/Validation												

Source: Internal Analysis

The first step to establish a regional landfill in Bintan is to to conduct study tour to large scale MRF Facility and other alternative waste handling facilities, which mostly located in Java and Bali islands. The study tour then continued by conducting feasibility study to assess which technology that suitable for Bintan Island. After than, the government should invite private players at local, national, and global levels. The provincial government must own and operate the landfill, but third parties can support facilities around it, such as composting houses, maggot bioconversion houses, scalable pyrolysis machines, scalable methane capture, RDF, and others.

The second step is to establish Badan Layanan Umum Daerah (BLUD) or Regional Service Body. Without this body, Kepulauan Riau province officials will find it challenging to collect revenue from facilities around the landfill, thus reducing the commercial attractiveness of these facilities. The smelters in Bintan's mining industry, which use coal as a power source, can become potential off-takers for waste handling facilities' output, such as WtE or RDF. One essential factor in regional landfill facilities is to secure the tipping fee. The tipping fee is an amount paid by the government to regional landfill facilities operators as an incentive for handling waste. The municipalities should decide the tipping fee's value with approval from the legislatures (politicians). It may be challenging to allocate an ideal amount of tipping fees if the politicians lack full knowledge of the waste handling necessity and its business model. Therefore, advocacy in this area must be amplified.

Since the feedstock is relatively small (less than 200 tons of waste per day), the regional landfill needs to find alternatives for low-medium scale waste handling facilities. The regional landfill should also improve basic facilities such as the wastewater treatment plant (WWTP). With a regional landfill, Tanjungpinang City and Bintan Regency have the possibility to improve overall waste management by enhancing waste collection scheduling, implementing waste segregation in collection vehicles, and implementing multi-point waste data verification/validation.

### 6.3.4 – Strengthen Waste Financing

One of the crucial problems in waste management is the lack of waste financing. Some municipalities have difficulties in allocating sufficient budget to provide good waste management service. A series of advocacy needs to be amplified, so politicians and decision makers can prioritize the budget for waste management. To enhance this, the government also should play other financial instruments such as waste retribution tariffs and creative funding. The prioritization for strategic recommendation 4: Strengthen waste financing is as follows:

**Table 31** – Detailed Initiatives for Strategic Recommendation 4

No	Initiatives	Description
1	Advocating Waste Financing Necessity to Local Parliaments	This initiative involves advocating the importance of waste financing to local parliaments to increase their understanding and support for waste management programs. Steps to achieve this include presenting data on the impact of inadequate waste management on public health and the environment, identifying and engaging with key stakeholders in the parliament, and drafting policy proposals to address gaps in waste financing.
2	Increase Waste Retribution Tariffs	Increasing waste retribution tariffs can provide a significant source of revenue for waste management programs. The steps for this initiative include conducting a study to determine the current retribution tariffs and identifying potential areas for increase, holding stakeholder consultations to obtain feedback and support, and presenting the proposed tariff increases to the relevant government bodies for approval.
3	Advocating Waste into Basic Service	This initiative aims to include waste management as a basic service provided by local governments, which would require the allocation of sufficient funding for waste management programs. Steps include advocating for this concept to local governments and providing evidence-based data on the need for waste management as a basic service, developing policy proposals and presenting them to relevant government bodies, and engaging with key stakeholders to gain their support.
4	Explore Plastic Credit to	Plastic credit schemes incentivize the reduction of

	Boost Waste Financing	plastic waste by creating a market for plastic waste credits that can be traded and sold to companies seeking to offset their plastic use. Steps to implement this initiative include conducting a feasibility study to determine the viability of a plastic credit scheme, establishing a mechanism for issuing and trading plastic credits, and promoting the scheme to potential buyers and sellers.
5	Add More Initiative to Seek International Funding	International funding can provide a significant source of financing for waste management programs. Steps for this initiative include conducting a thorough analysis of available international funding opportunities, developing project proposals that align with the funding priorities, and submitting proposals to the relevant funding agencies or organizations. Additionally, engaging with potential international partners and building relationships can increase the likelihood of securing international funding.
6	Strategic Use of Waste Financing	Use the obtained waste financing for strategic usage, such as (also explained in previous recommendations): <ul style="list-style-type: none"> <li>• Add More Waste Transportation Vehicle</li> <li>• Renovate/Upsize Existing Wastewater Treatment Plant</li> <li>• Add More Methane Gas Capture</li> <li>• Equip Waste Bank with Three Wheeler</li> <li>• Provide Incentive/Subsidy for Waste Bank</li> <li>• Provide Incentive for Waste Recyclers</li> <li>• Establish Hazardous/Specific Waste Treatment</li> </ul>

*Source: Internal Analysis*

The proposed timeline to execute these initiatives are as follows:

**Table 32 – Implementation Timeline for Strategic Recommendation 4**

Activities	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Strengthen Waste Financing</b>												
Advocating Waste Financing Necessity to Local Parliaments												
Increase Waste Retribution Tariffs												
Advocating Waste into Basic Service												
Explore Plastic Credit to Boost Waste Financing												
Add More Initiative to Seek International Funding												
Strategic Use of Waste Financing: <ul style="list-style-type: none"> <li>• Add More Waste Transportation Vehicle</li> <li>• Renovate/Upsize Existing Wastewater Treatment Plant</li> <li>• Add More Methane Gas Capture</li> <li>• Equip Waste Bank with Three Wheeler</li> <li>• Provide Incentive/Subsidy for Waste Bank</li> <li>• Provide Incentive for Waste Recyclers</li> <li>• Establish Hazardous/Specific Waste Treatment</li> </ul>												

Source: Internal Analysis

Steps to strengthen waste financing can begin by advocating for the necessity of waste financing to local parliaments. Local parliaments play an essential role in waste financing as they set the regional budget, including the waste management budget. The second step is to reevaluate and reassess waste retribution tariffs. While Batam has effective waste retribution tariffs, Tanjungpinang and Bintan need to improve their tariffs and enforcement. Without sufficient tariffs, it will be challenging to establish good waste management facilities.

The third step is to advocate for waste to be considered a basic service to increase its visibility and budget allocation. This requires a series of advocacy efforts targeting politicians and decision-makers. If increasing waste retribution tariffs and budget allocation proves challenging, governments can explore creative funding options such as plastic credit and establish partnership initiatives with potential international partners.

Once sufficient funds have been secured, the government can provide various waste management facilities such as more waste transportation vehicles, renovate or upsize WWTPs, enlarge methane gas capture, recycle plastic into paving blocks, enlarge pyrolysis capacity, provide subsidies for waste banks/recyclers, and establish hazardous/specific waste treatment facilities.

### 6.3.5 – Implement Effective Waste Prevention Strategy

Last but not least, it is also important to implement an effective waste prevention strategy in the cities. This recommendation highlight the important of increasing education to boost waste awareness. The prioritization for strategic recommendation 4: Strengthen waste financing is as follows:

**Table 33 – Detailed Initiatives for Strategic Recommendation 5**

No	Initiatives	Description
1	Reintroduce Waste Reduction Target	The government can set a waste reduction target and implement it through regulations. The target can be set by taking into account the current waste generation rate, population, and other relevant factors.
2	Implement Extended Producers Responsibility (EPR)	The government can establish regulations that require manufacturers and producers to take responsibility for the end-of-life disposal of their products. This can be done by implementing EPR schemes, which would encourage producers to design products that are easier to recycle or dispose of.
3	Promote Sustainable Consumption	The government can promote sustainable consumption patterns by encouraging citizens to reduce their consumption of goods and services that generate waste. This can be done by conducting awareness campaigns that educate citizens on the benefits of reducing their consumption.
4	Ban or Restrict Single-Use Plastics	The government can implement regulations that ban or restrict the use of single-use plastics, which are a major contributor to the waste problem. This can be done by conducting awareness campaigns and enforcing the regulations through penalties and fines.
5	Strengthen Waste Education in Schools & Universities	The government can strengthen waste education in schools and universities by including waste reduction and management as part of the curriculum. This can be done by providing training for teachers and students on waste management practices, and by integrating waste reduction and management into other subjects.
6	Encourage Waste Research and Development	The government can encourage waste research and development by providing funding and incentives for research institutions and private organizations to develop innovative solutions for waste reduction and management. This can be done by providing grants, awards, and tax incentives for organizations that contribute to waste reduction and

		management.
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Source: Internal Analysis

The proposed timeline to execute these initiatives are as follows:

**Table 34 – Implementation Timeline for Strategic Recommendation 5**

Activities	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Implement Effective Waste Prevention Strategy</b>												
Reintroduce Waste Reduction Target												
Implement Extended Producers Responsibility (EPR)												
Promote Sustainable Consumption												
Ban or Restrict Single-Use Plastics												
Strengthen Waste Education in Schools & Universities												
Encourage Waste Research and Development												

Source: Internal Analysis

To implement the initiatives to increase the effectiveness of waste prevention in Tanjungpinang City and Bintan Regency, a 3-year plan can be developed. In the first year, the focus should be on reintroducing waste reduction targets, implementing extended producer responsibility, and promoting sustainable consumption. Quarterly targets can be set for each initiative, such as conducting research to identify feasible waste reduction targets, engaging with producers to develop EPR programs, and launching a sustainable consumption campaign. The first year should also include a thorough waste audit to identify key areas where waste prevention efforts can be targeted.

In the second year, the focus should shift to banning or restricting single-use plastics, strengthening waste education in schools and universities, and encouraging waste research and development. Quarterly targets can include conducting feasibility studies on single-use plastic bans, developing and implementing waste education programs for schools and universities, and partnering with research institutions to advance waste management technology. Additionally, the second year should focus on expanding waste infrastructure to support waste prevention efforts, such as establishing waste recycling centers and developing composting facilities.

In the third year, the focus should be on evaluating the effectiveness of waste prevention initiatives and implementing further improvements. Quarterly targets can include conducting waste audits to measure progress towards waste reduction targets, analyzing the impact of single-use plastic bans and other initiatives, and refining waste education programs based on feedback and evaluation. The third year should also focus on identifying and engaging with key stakeholders, such as local

businesses and community groups, to build support for waste prevention efforts and encourage their adoption. Additionally, the third year should focus on ensuring the long-term sustainability of waste prevention initiatives by securing funding and institutional support, as well as developing partnerships with other organizations working towards the same goal.