Situation Assessment Report on

PLASTICS LEAKAGE PREVENTION FROM FORMAL AND INFORMAL RECYCLING FACILITIES

NONTHABURI AND PATTAYA, THAILAND

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Regional Resource Centre for Asia and the Pacific

Regional Knowledge Centre for Marine Plastic Debris

ERIA
Economic Research Institute for ASEAN and East Asia

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This study was conducted for the Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD), Economic Research Institute for ASEAN and East Asia (ERIA)

Published in Pathum Thani in 2024 by Asian Institute of Technology.

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ISBN(e-Book): 978-616-8230-19-0

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Please cite as:
Huno, S. K. M., Nitivattananon, V., Borongan, G., Thu, N.A., Paudel, S., and Tipakornkiat, G. (2024). Situation assessment report on plastic leakage prevention from formal and informal recycling facilities in Nonthaburi and Pattaya City, Thailand. Economic Research Institute for ASEAN and East Asia (ERIA).

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Acknowledgements

The authors wish to thank the Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD) and the Economic Research Institute for ASEAN and East Asia (ERIA) for funding and reviewing the draft reports. The authors gratefully acknowledge the input and contributions of a diverse group of experts from Nonthaburi Municipality (Environmental Health Services Divisions, Sanitation and Environmental Quality, Solid Waste and Sewage Management), Pattaya City (Solid Waste and Waste Management Department; Environmental Quality Promotion Department), as well as several junkshop and recycling business owners who participated in the study and review workshops.

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List of abbreviations

CCAC	Climate and Clean Air Coalition
MSW	Municipal Solid Waste
PPP	Private-Public-Partnership
BMA	Bangkok Metropolitan Administration
PCD	Control Department
DfE	Design for the Environment
HDPE	High-Density Polyethylene
PP	Polypropylene
PS	Polystyrene
PET	Polyethylene Terephthalate
LDPE	Low-Density Polyethylene
AMS	ASEAN Member States
ASEAN	Association of Southeast Asian Nations
INGOs	International Non-Governmental Organization
FDA	Food and Drug Authority
PCR	Post-Consumer Recycled

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EXECUTIVE SUMMARY

Thailand recognizes the environmental challenges posed by improper plastic waste management, particularly the risk of plastic pollution in water bodies. To address this, Thailand has launched the Plastic Waste Management Action Plan Phase II (2023-2027), emphasizing an integrated approach focusing on production, distribution, consumption, and consumer management. However, understanding the practices of the informal recycling sector and addressing logistical issues in processing are crucial for preventing plastic leakage into marine environments.

The main objective of this study is to examine the current state of plastic waste management and sources of leakage, with a focus on the Nonthaburi Municipality and Pattaya City. This study is particularly concerned with land-based sources of plastic leakage into marine environments. It aims to identify potential sources of plastic leakage and challenges in addressing such leakage, with a special focus on the informal sector. To achieve this, primary data from field visits and stakeholder interviews were collected, along with secondary data from literature reviews.

The results show that informal waste workers play a significant role in collecting and sorting recyclable materials, including plastics. They fill gaps in areas with limited access to formal waste collection, thereby contributing to recycling efforts. However, workers in the informal sector face challenges, such as low wages, poor working conditions, health and environmental risks, and limited access to equipment. The results also show that plastic leakage can occur throughout the value chain, encompassing both formal and informal waste sectors. Challenges to addressing this leakage include lower demand, price fluctuations, weak collaboration between industry stakeholders, improper management of landfills, inadequate collection and sorting systems, raw material availability and costs, skilled labor availability, and technological access. Insufficient recycling rates and improper disposal practices can contribute to environmental pollution.

Nonthaburi Municipality generates a significant amount of waste, approximately 15% of which is plastic. The waste management process involves junkshops that purchase waste and sort it based on plastic types. Unfortunately, the shops do not properly clean the plastic materials before being sent for recycling in Pathum Thani Province. This could lead to plastic leakage during transportation, particularly with low-value waste, which ultimately ends up in landfills. However, the municipality is taking proactive measures to address these issues by conducting random monthly inspections of registered shops.

Pattaya City generates waste from various sources, including tourists, businesses, hotels, and industrial facilities. In similarity to Nonthaburi Municipality, the informal sector plays a significant role in the recycling process by sorting plastic waste according to type. However, the cleaning process is often inadequate, and the collected plastic is sent for recycling in Chonburi Province. As in the case of Nonthaburi, the problem of plastic leakage is particularly associated with low-value waste that ends up in landfills.

As observed in both Nonthaburi and Pattaya, the formal sector primarily focuses on waste collection and disposal, whereas the informal sector plays a significant role in plastic recycling. However, restrictions on the location of junkshops in specific areas have an impact on the waste management system. Furthermore, residents and visitors to the city have limited access to recycling facilities, resulting in the transportation of recyclable materials to external locations. Moreover, recycling waste is a voluntary action without enforcement; thus, the community lacks awareness of recycling processes.

To mitigate the problem of plastic leakage, it is imperative to foster collaboration between public and private sectors. Governments should enact comprehensive legislation to improve the recycling market through incentives, tax breaks, and subsidies. Budget allocation for technological innovation in plastic waste management is important. Furthermore, there is a need to strengthen the infrastructure pertaining to waste management and implement policies that facilitate the enforcement of these potential laws. Simultaneously, proactive measures must be implemented to promote public participation through extensive awareness campaigns and community engagement initiatives.

Chapter 1

Introduction

1.1 Background

Globally, plastic use is projected to increase almost three-fold, from 460 million tons (Mt) to 1,231 Mt annually (OECD, 2022). Economic growth fuels rising plastic usage, with increasing production and consumption paralleling the expanding economic activities. A study by the OECD highlights significant shifts in global plastic consumption, with OECD and non-OECD countries contributing 46%. Notably, China, India, and other rapidly growing Asian economies contribute 35%, with China leading the pack (OECD, 2022). A growing concern, however, is plastic pollution in marine ecosystems, which has adverse impacts on life in the oceans, other ecosystems, and ultimately humans. Mismanaged waste, including litter and improper disposal, such as unmanaged landfills and open dumps, is a primary cause of plastic leakage into marine environments. Plastic pellets, including pre-production pellets, flakes, and powders, can also escape during the waste handling, transport, and plastic production and recycling processes.

Seminal studies have identified Southeast Asian cities as significant contributors to plastic waste, both micro and macro, in oceans. The ASEAN Framework of Action on Marine Debris emphasizes regional cooperation to combat marine pollution by pursuing meaningful collaboration between the public and private sectors to enhance capacity and share best practices for preventing and reducing marine pollution. In 2019, plastic consumption in Thailand was estimated at approximately 4 million tons, and plastic packaging at 2 million tons, with domestic consumption averaging 40 kg per year/person (Wichai-Utcha and Chavalparit, 2019). Thailand, a major player in the plastic industry of the region in terms of manufacturing and consumption, has committed to implementing effective cutting-edge solutions and countermeasures for the abatement of marine plastics.

The Thai Government has demonstrated its commitment through Thailand's National Strategy, which aims to address environmental concerns by leveraging the Green Economy and Marine Economy strategies. This aligns with the global Sustainable Development Goals, SDG3 (Good health and well-being), SDG 6 (clean water and sanitation), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (conservation of oceans and marine resources), and SDG 15 (repair of ecosystems and retain biodiversity). The Government of Thailand, along with the private sector, drafted an ambitious plastic pollution reduction strategy entitled the "Roadmap on Plastic Waste Management," which was declared a national priority in 2018 (Marks et al., 2023). Thailand's roadmap has three main goals: to reduce plastic waste at its source, use less single-use plastic during consumption, and manage post-consumer plastic waste. In Thailand, the predominant focus of plastic waste management is waste collection and disposal, rather than recycling, owing to the existing legal framework and municipal solid waste management system. Plastic waste management is primarily carried out by informal and semi-formal waste collection groups, which include the following:

- **Informal waste collectors or waste pickers:** These individuals collect recyclable plastic waste from public bins.
- **Subcontracted waste collectors (Saleng):** These use tricycles or carts to gather recyclables from consumer households, villages, or communities.
- **Subcontracted waste collectors (Rod rae):** Similar to Saleng, they use pickup trucks to collect recyclables from consumers in villages or communities.
- **Waste collectors:** These separate and sell recyclable plastic waste obtained during waste collection from households, organisations, transfer stations, and disposal sites.

- **Small-to medium-sized junk shops:** These establishments purchase packaging waste directly from scavengers or consumers.

- **Large-scale junk shops or waste collectors:** These sell collected plastic waste to recycling factories. In some cases, medium-sized secondhand shops may sell directly to recycling factories, operating under the name of a large-scale waste collector.

Most waste collection groups operate as individual entities or family units. On the other hand, junkshops can vary in size categorized by working hands or employees, as follows:

- Small junk shops with fewer than five employees.

- Medium-sized junk shops with 6-20 employees.

- Large-sized junk shops with more than to 21-50 employees.

1.2 Objectives and Scope of the Report

The main goal of this study is to evaluate plastic and pellet losses and leakage from the logistical handling and pre-processing operations of informal recycling groups in Thailand, focusing on recovered post-consumer plastic waste and factory processing operations. The focus areas of this study are the Nonthaburi Municipality and Pattaya City.

The report explores the sources of plastic loss and leakage into the environment from land-based sources, emphasizing the impact of mismanaged waste disposal practices and logistical mishandling within informal recycling networks. A comprehensive analysis was conducted using both the primary and secondary data sources. Secondary data derived from an extensive literature review provided foundational insights into the study, informing the design and framework of the primary data collection. Primary data were collected through several field visits to stakeholder interviews with keystone recycling facilities and junkshops, aggregators, CSOs, and relevant local and national government officers, offering firsthand perspectives and a contextual understanding of the situation. Multiple stakeholder and expert consultation workshops were held to review and discuss the findings and potential solutions. The study is geographically focused on two distinct urban areas of Thailand, Nonthaburi Municipality and Pattaya City, allowing for the targeted examination of plastic waste management dynamics within these specific urban environments..

1.4 Outline of the Report

Chapter 1 presents the background, context, objectives, and scope of the study. Chapter 2 provides an overview of solid waste management in Thailand, focusing on plastic waste management within the formal and informal recycling sectors, along with pertinent regulations. It examines the sources of plastic losses and leakages across the recycling value chain, encompassing waste collection, logistics handling, and factory processing operations, including resin/pellet production.

Chapters 3 and 4 examine the case studies of Nonthaburi and Pattaya, investigating their current plastic waste management situations and challenges faced by the informal waste sector. These assessments have been drawn from literature reviews and field visit data. Chapter 5 offers conclusions and proposes recommendations for guidelines and best practices to mitigate plastic leakage during pre-processing and handling activities by informal recycling actors as well as resin pellet losses at factories.

1.5 Approach

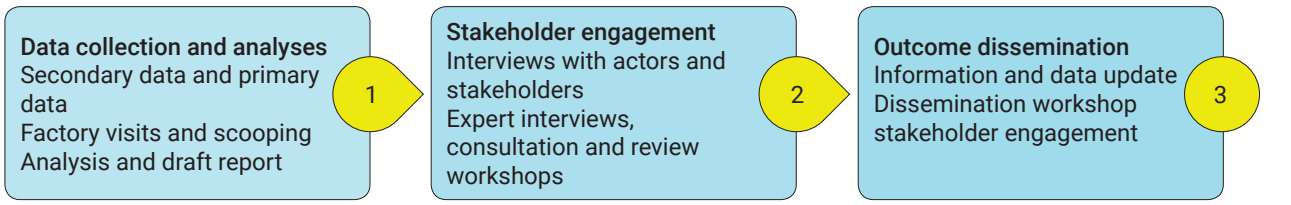
The data and information collection, analysis, and review of findings are primarily combined with both secondary data collection and qualitative assessments, interviews, field visits, and consultation meetings with key stakeholders. The objective, centered on analyzing the current state of plastic waste and potential leakage in these areas, guided the identification of relevant stakeholders. Suggestions from local municipalities led to the identification of stakeholders, such as hotels, junkshops, communities, and factories.

1.5.1 Data Collection

Secondary Data Collection: Secondary data were collected based on a literature review and other secondary data sources, such as gray literature. Based on available secondary data, an overview of the current situation of plastic waste management in Thailand was identified.

Qualitative assessments of coping visits: Several scoping visits, discussions, and interviews were conducted, and interviews and consultations were held with recycling facilities/enterprises junkshops, relevant national government authorities, local government officers of Nonthaburi Municipality and Pattaya City, and other stakeholders. The questions covered the current situation of the informal waste sector, its operations, and challenges.

The findings of the study were synthesized and presented at a stakeholder consultation workshop for input and expert review.



Chapter 2

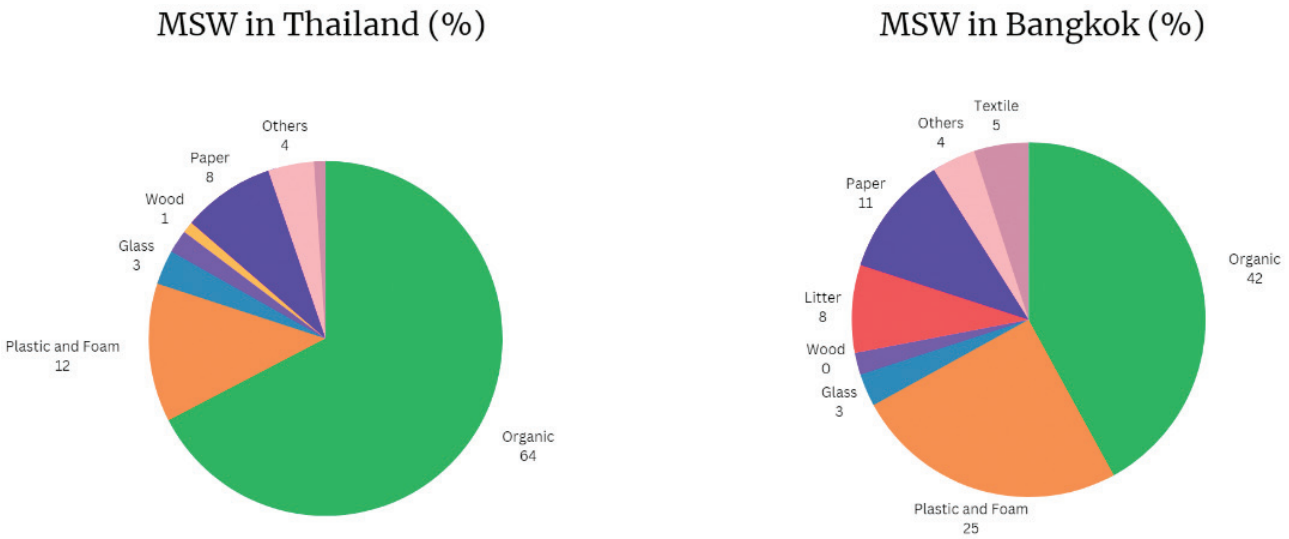
Overview of Municipal Solid Waste (MSW) Management in Thailand

2.1 Waste Management in Thailand

Thailand's waste management system faces multiple challenges, including limited technological applicability, knowledge gaps, insufficient public participation, policy implementation, and institutional support. For example, in 2014, the Bangkok Metropolitan Administration handled nearly 10,000 tons of MSW per day, equivalent to approximately 3.6 million tons annually (CCAC, 2015). Despite this substantial volume, the country's utilization of waste as raw material for recycling and other value recovery options, such as energy, remains inadequate, with only 20% of formally collected waste recycled in 2022 (World Bank, 2023). Consequently, Thailand urgently needs to strengthen its 3Rs policy (reduce, reuse, and recycle) and address these challenges to establish a more sustainable waste management system. Figure 1 provides an overview of Thailand's waste composition (2004 data) and Bangkok's composition (2009 data) (Siriratpiriya, 2013). Consumption patterns in urban centers prioritize convenience, leading to increased consumption of disposable items, such as plastic and foam, owing to the fast-paced lifestyles of the population.

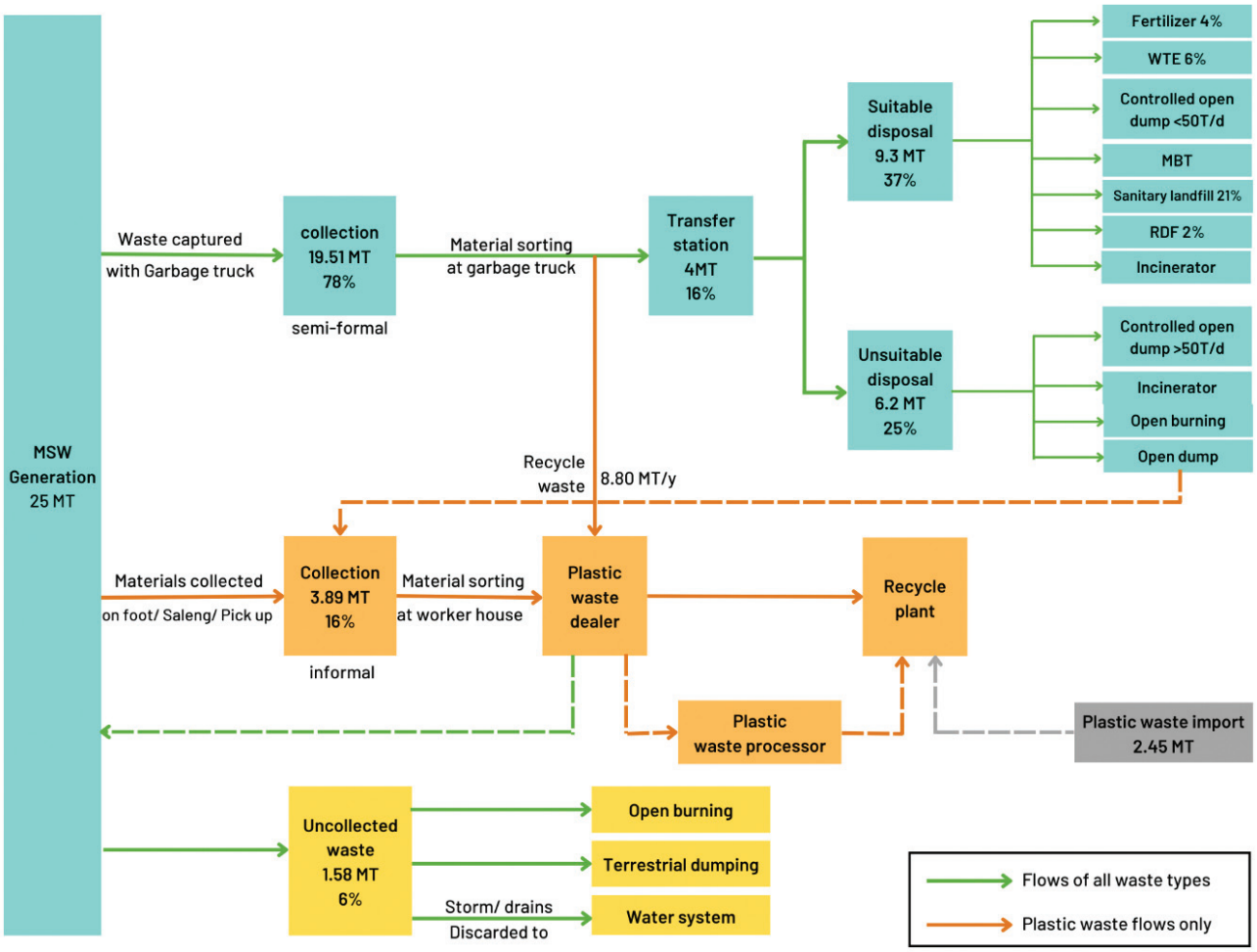
Regarding waste management practices in the formal waste sector, activities such as segregation, collection, transfer, and disposal are encouraged. The Bangkok Metropolitan Administration (BMA) has a private-public partnership (PPP) arrangement for the transfer and disposal of collected MSW management processes. There are also different types of garbage bins based on color, specifically green for food waste, yellow for recyclable waste, orange for hazardous waste, and blue for general waste. There are various types of MSW collection vehicles (trucks, boats, and specific trucks). These comprise 2-ton trucks with compactors, 5-ton trucks with compactors, 8 cubic meter lift trucks, 6-ton rear-opened trucks, and 1.5-tone open-sided trucks (CCAC, 2015). All the formally collected waste is transported to the transfer stations by these vehicles. The informal waste sector, on the other hand, consists of junkshops, second hand/recyclable waste mobile shops, junk collectors, and sorting waste workers.

Figure 1. Comparison of waste generation and composition in Thailand and in Bangkok



Source: Siriratpiriya, 2013

Figure 2. The MSW flow diagram of Thailand



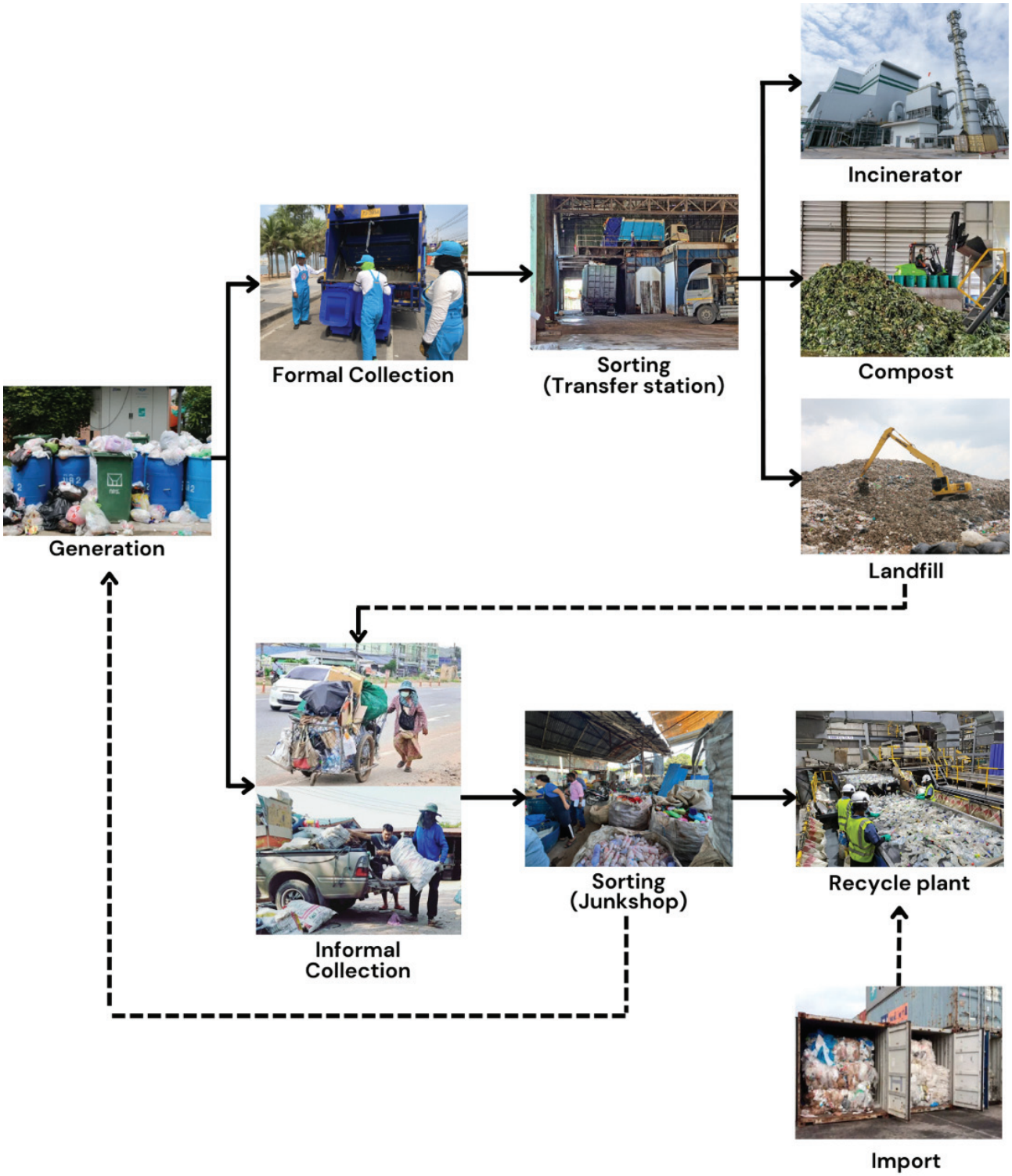
(Adapted from University of Leeds (2020); World Bank (2022) and available information from Pollution Control Department (2023)

The sanitary landfill process is the most common disposal method. However, out of 1000 sanitary landfills, only 119 sites have an appropriate standard. In provincial capitals, 54% were engineered landfills, 20% open dumps, 17% controlled dumps, and 9% sanitary landfills. Incineration follows the landfill method. Unfortunately, this method is costly because of public health concerns caused by pollutant emissions. Figure 2 presents the waste flow diagram for Thailand.

2.2 Plastic Waste Management in Thailand

Thailand is facing a significant challenge in managing plastic waste, with a large proportion mixed with MSW and ending up in landfills. According to the Pollution Control Department (PCD), up to 80% of plastic waste mixed with MSW is contaminated and has low potential for recycling. Furthermore, up to 28% of plastic waste is disposed of in landfills, creating a negative impact on the environment, including soil, water, and air pollution, as well as the need for massive space requirements. This increases the likelihood of plastic leakage into the environment. As presented in Figure 3, the waste management system in Thailand involves two main sectors: formal and informal. The formal sector mostly disposes of waste in landfills, without separation. Meanwhile, individuals are employed to collect waste and voluntarily separate it to earn money. The informal sector, represented by waste pickers, plays a crucial role in separating recyclable materials, particularly plastics. Their efforts have contributed significantly to the recycling of plastic waste in Thailand.

Figure 3. Simplified schematic of a MSWM system and plastic waste flow in Thailand



(Adapted from University of Leeds (2020)

The recycling of post-consumer plastic waste is still significantly low in comparison to the high plastic production rate. As depicted in Figure 4 of the PCD report, the challenges in plastic waste management can be attributed to three main factors.

Design and production: There is a lack of research focusing on finding substitute materials or adopting "Design for the Environment" (DfE) principles. Moreover, the absence of regulations mandating the use of recyclable polymers further complicates waste separation.

Consumption: The widespread use of plastic across diverse consumption avenues, including plastic bags, product packaging, and disposable items, significantly contributes to this issue. The problem is further compounded by the absence of legislation regulating the use of single-use plastics, thus amplifying the challenge at hand. Consequently, the unrestricted proliferation of single-use plastics exacerbates environmental degradation, leading to increased pollution levels and adverse effects on ecosystems and human health. Efforts to address this issue require comprehensive measures, including the implementation of stringent regulations, promotion of sustainable alternatives, and fostering awareness among consumers regarding the detrimental effects of single-use plastics. By adopting proactive strategies and embracing sustainable practices, societies can mitigate the harmful effects of plastic pollution and promote a healthier and more environmentally conscious future.

Post-consumption: Inadequate public engagement and awareness regarding appropriate plastic waste disposal coupled with a lack of stringent regulatory measures present significant barriers to achieving effective waste reduction, sorting, and disposal. Furthermore, the absence of a well-developed collection and transportation infrastructure for recycling exacerbates this problem. This leads to inefficient handling of plastic waste, resulting in its accumulation in landfills, water bodies, and natural habitats, thereby escalating environmental pollution and posing threats to biodiversity and public health. To address these challenges, concerted efforts are needed to enhance public education and outreach programs, enact waste management policies, and robustly enforce them, and invest in the expansion and improvement of the recycling infrastructure. By fostering a culture of responsible waste management and implementing comprehensive solutions, societies can mitigate the adverse impacts of plastic pollution and promote a more sustainable future (Pollution Control Department, Ministry of Natural Resources and Environment, 2021).

Collaboration among stakeholders is essential for effective plastic waste management and combating marine plastic pollution in Thailand. This involves the public and private sectors, informal businesses, and citizens. Government regulations play a crucial role, and compliance from the private sector, including informal businesses, is vital. Private entities should adhere to regulations governing plastic production, consumption, and post-consumption, adopting sustainable practices such as utilizing alternative materials and implementing DfE principles. Appropriate waste segregation and disposal must also be ensured. Engaging the private sector through incentives, awareness-raising, and capacity-building programs promotes sustainable plastic management. Collaboration with the informal sector, which includes waste pickers and recyclers, is crucial. Formalizing and integrating their roles within a waste management system ensures responsible practices. By involving all stakeholders and enforcing regulations, Thailand can develop a comprehensive circular economy for plastic waste management, promote environmentally friendly products, reduce pollution, and preserve its natural resources and marine ecosystems.

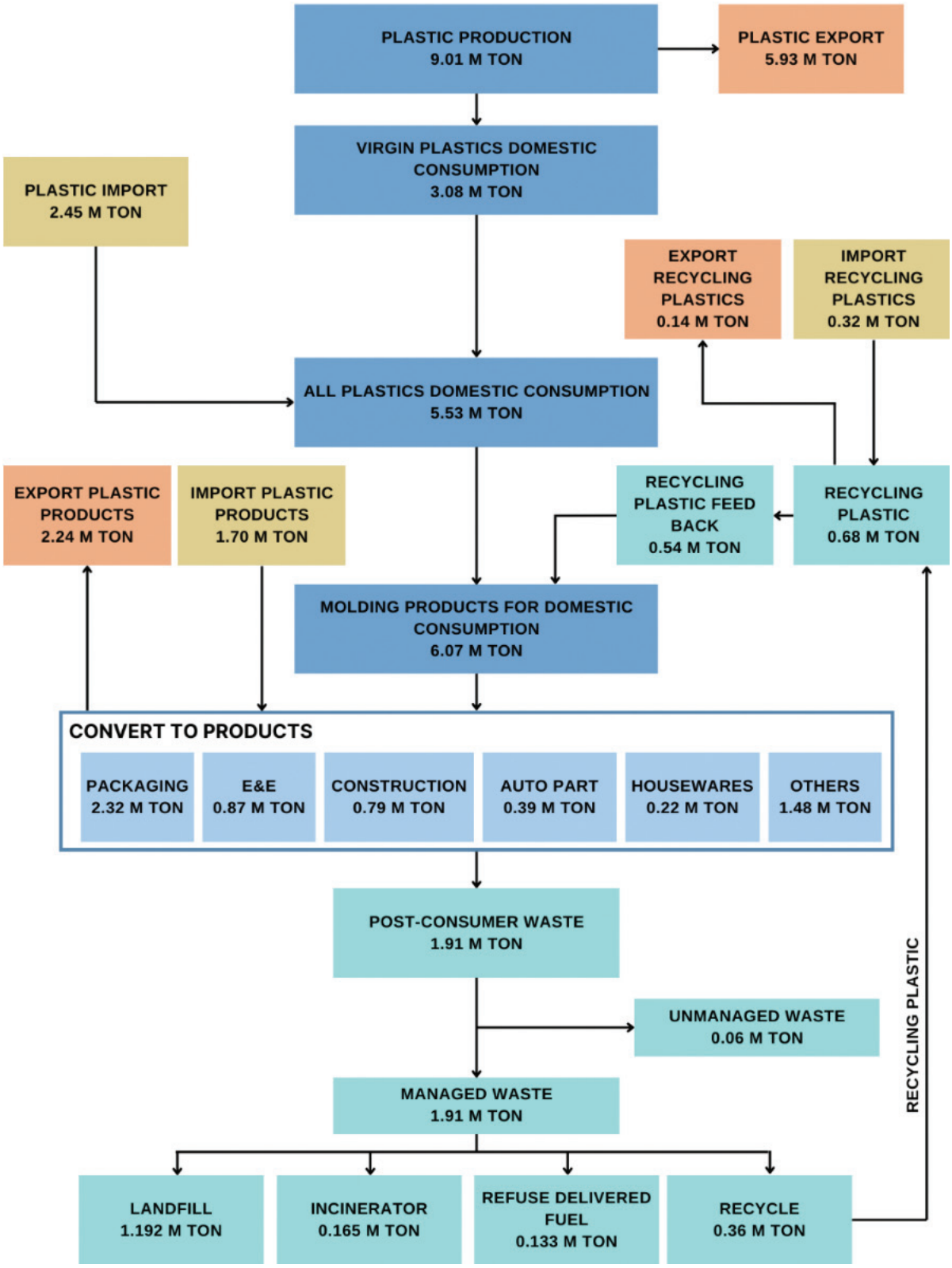
2.2.1 Institutions

The responsibility for waste management in Thailand is shared among the national government, local governments, and private sector operators. The national government establishes laws, regulations, and standards at the national level and controls expenditure on solid waste management, whereas local governments have more direct responsibilities for solid waste management, including waste collection, disposal, and recycling. They are also responsible for setting local regulations, implementing policies, and educating the public about proper waste management practices (Figure 5).

2.2.2 Relevant laws and regulations

Thailand's plastic waste management policy is influenced by international commitments and trade agreements. The country has developed an Action Plan on Plastic Waste Management Phase II (2023–2027) to address plastic waste issues, with voluntary participation from all sectors. Thailand has also banned plastic waste imports from several countries, encouraging domestic plastic reuse. However, the ban on plastic scrap imports by 2025 does not cover the recycled plastic resin needed in the production process. The analysis suggests that

Figure 4. The plastic waste flow in Thailand



(Adapted from Pollution Control Department, Ministry of Natural Resources and Environment (2021))

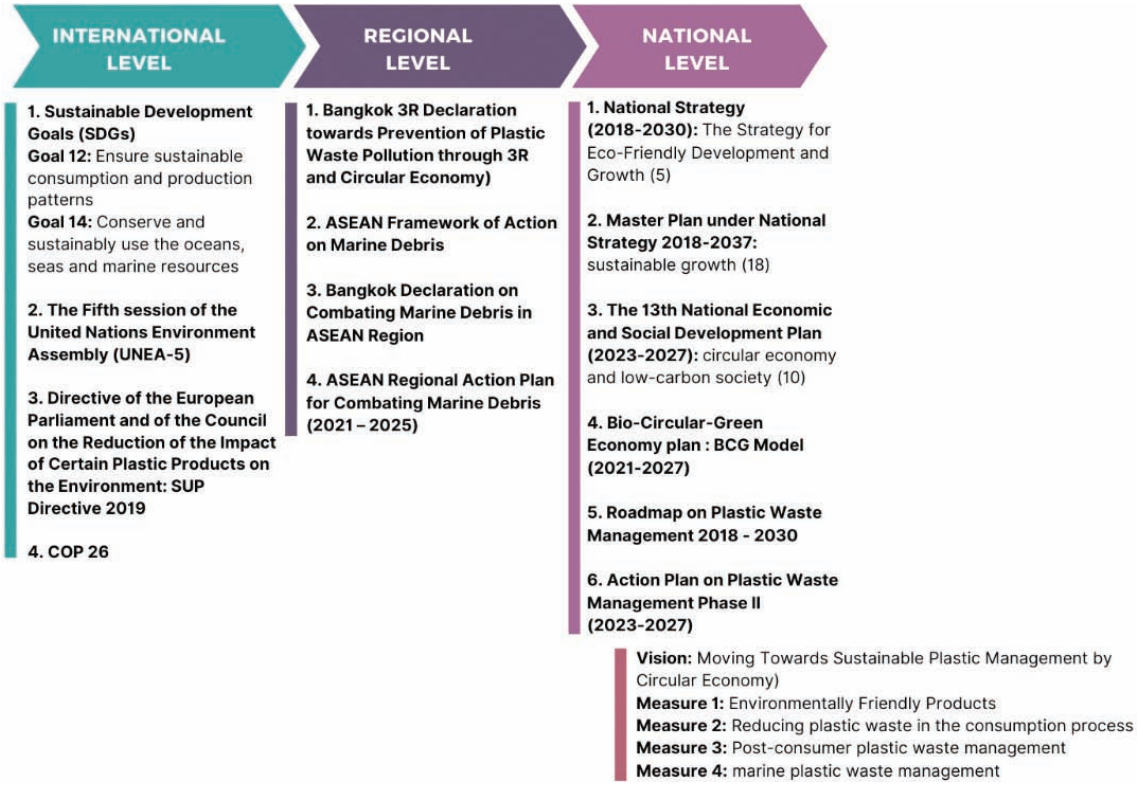
the country should focus on finding measures to solve contamination problems rather than relying on imports, which goes against the country's policy of promoting a sustainable circular economy (Figure 6).

Figure 5. Role of central and local authorities for plastic waste management in Thailand

AUTHORITY	RESPONSIBILITY
CENTRAL GOVERNMENT • Pollution Control Department (PCD) • Department of Environmental Quality Promotion (DEQP) • Office of Natural Resources and Environmental Policy and Planning (ONEP) • Department of Local Administration (DOLA) • Public Health Department	• Issue and develop laws, regulations, policies, guidelines and mechanisms for managing waste. • Supervise and enforce laws related to the environment for waste control. • Investigate, inspect, evaluate, monitor, alert and report waste situations. • Administer the Environmental Fund and the finance of local government organization • Promote and disseminate information pertaining to waste.
REGIONAL GOVERNMENT Provincial offices of the Ministry of Natural Resources and Environment	Coordinate related work between central and local government
LOCAL GOVERNMENT ·Local/District Municipality ·Sub-district Administrative Organizations (SAOs)	Handle and manage waste in their own area

Source: Akenji et al. (2019

Figure 6. Policies on plastic waste management and relevant at the international, regional, and national levels



Source: Akenji et al. (2019) & Pollution Control Department, Ministry of Natural Resources and Environment (2023)

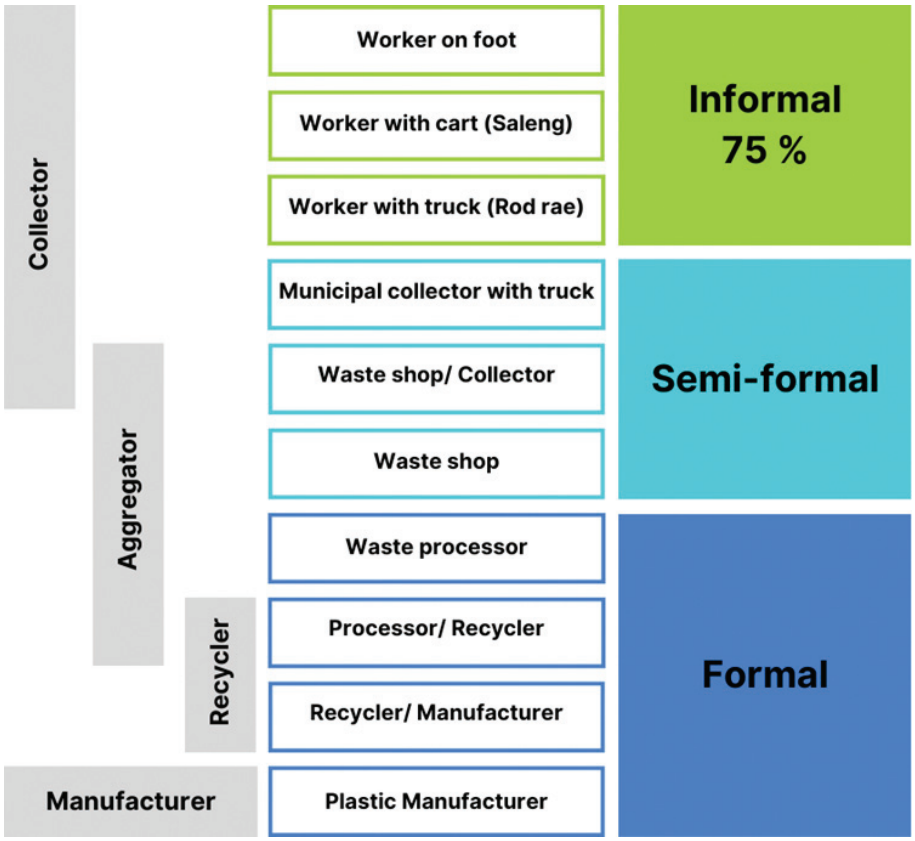
2.2.3 Formal, Semi-formal, and Informal Plastic Actors

The plastic waste management system in Thailand comprises formal, semi-formal, and informal actors, including government agencies, waste management enterprises, small businesses, and waste pickers. These actors have different levels of regulation and responsibility for the collection, transportation, and disposal of plastic waste. While the formal sector is responsible for regulatory oversight and commercial waste management services, the semi-formal and informal sectors play critical roles in collecting and processing plastic waste. However, waste pickers in the informal sector face significant economic and social challenges and are often marginalized, working in hazardous conditions with limited legal protection and low social status. It is essential to integrate these sectors into a coordinated and sustainable waste management system to address the environmental and social challenges posed by plastic waste in Thailand. Based on the study and field surveys, ten actors were identified across the waste flow, some with overlapping roles (Figure 7).

2.3 Plastic Recycling Activities and Market Structuring

According to a market study conducted by the World Bank, Thailand recycled only 17.6% of the key plastic resins in 2018, falling short of the National Plastic Waste Management Roadmap 2018–2030 target of 22% (World Bank, 2022). This means that a significant amount of plastic waste is not properly disposed of and could potentially contribute to environmental pollution. The study further reveals that approximately 87% of the material value of plastics in Thailand, which equates to approximately US$3.6 billion per year, is lost, with 2.88 million tons discarded instead of being recycled into valuable materials. This represents a substantial economic loss for the country. Moreover, despite a high MSW collection and recycling rate of 88.8%, Thailand still has an estimated 428,000 tons/year of mismanaged plastic waste due to the remaining uncollected plastic waste and unsanitary disposal facilities. This indicates that there is still room for improvement in Thailand's plastic waste management systems.

Figure 7. Formal, semi-formal, and informal plastic actors in Thailand



Adapted from Pottinger Glass et al. (2022)

Figure 8. How informal waste workers categorize plastic waste in Thailand

	POLYMER	REMARK
CLEAR PLASTIC	PET(1%), PP(2%), and PS (5%)	Most collectors just collect PET
COLORED PLASTIC BLACK PLASTIC SEMI OPAQUE WHITE PLASTIC	HDPE bottle (2%) bag (46%), and PP bottle (2%) bag (14%)	The cloudy white plastic is priced higher due to its color enabling the material to be more versatile for manufactures
COLD AND HOT PLASTIC	LDPE bottle (1%) bag (24%)	None of the collectors and aggregators collect and buy LDPE at the community level because require the high cost to get rid of the contaminate and receive the low price.
CRUNCHY PLASTIC	PS (5%)and PVC (2%)	Some aggregator buy the material, but virtually none of the collectors collect it because it is not widely available, and the price is very low

Source: Pottinger-Glass et al., 2022

Figure 8 illustrates the sorting technique employed by informal workers, relying solely on physical and visual inspection to categorize plastic waste. The process involves sorting plastics into various polymers, with those exhibiting transparent or pure white appearances fetching higher prices owing to recycling process demands. However, single-use plastic waste, although recyclable, is often not collected and sold widely owing to contamination, its lightweight nature, and transportation challenges. Consequently, antique buyers and recycling plants are discouraged from being involved because of profitability concerns. Recycling plastics and the associated market mechanism in Thailand are complex issues that have attracted significant attention from researchers in recent years. Sorting relies on physical and visual cues to determine waste prices, based on quality and market demand (Figure 9).

The plastic purchasing market in Thailand predominantly targets clear PET and HDPE bottles with specialized recycling plants (Environmental Research Institute, Chulalongkorn University, 2012). However, LDPE plastic bags and films face challenges due to limited recycling plants and difficulties in sorting and collecting lightweight waste from grocery and retail/wholesale stores rather than households. Transportation and labor costs are

Figure 9. The market value of recycling plastic waste

Source: Vanapruk (2011

Figure 10. The recycling plastic waste sellable qualification (Little Big Green (2021)

	CRITERIA			
Recycling factory	The ability of recycling equipment	Market demand		
Junk shops	Mono-material	High recycling rate	The purity of the material	The adequate quantity for cost-effective operations.
Waste picker	Good condition	Sell-able		

major expenses in plastic recycling, with recycled waste prices prone to volatility, impacting recyclers' revenues. The importation of cheaper plastic scrap poses a threat to local recycling businesses, prompting concerns and potential exits from the industry. To address these issues, owners have suggested enforcing a ban on plastic waste imports to bolster domestic market competitiveness (Figure 10). Overall, the recycling plastic market in Thailand is influenced by a variety of factors, including the demand for recyclable materials, price fluctuations, and availability of a collection and sorting system. Although the informal sector plays a significant role in plastic waste management, there is a need for more effective policies and regulations to promote sustainable waste management practices and reduce environmental pollution in Thailand.

2.4 Plastic Leakage From Recycling Processes

Plastic leakage poses a significant challenge in Thailand due to its substantial plastic waste generation and inadequate management practices. The informal waste sector, crucial where formal systems are lacking, faces hurdles in recycling market information gaps and the transportation of collected recyclable plastic waste, particularly smaller plastic items from public and residential bins to junkshops. These gaps increase the leakage risk. While there is low potential for leakage during transport from junkshops to recycling factories, illegal dumping of unsold plastic residues remains a concern. Thus, a thorough analysis of waste transport logistics in the informal sector is vital in

Figure 11. Sankey Diagram of the physical flow of plastic waste down the waste chain from source to sea (The World Bank, 2022)

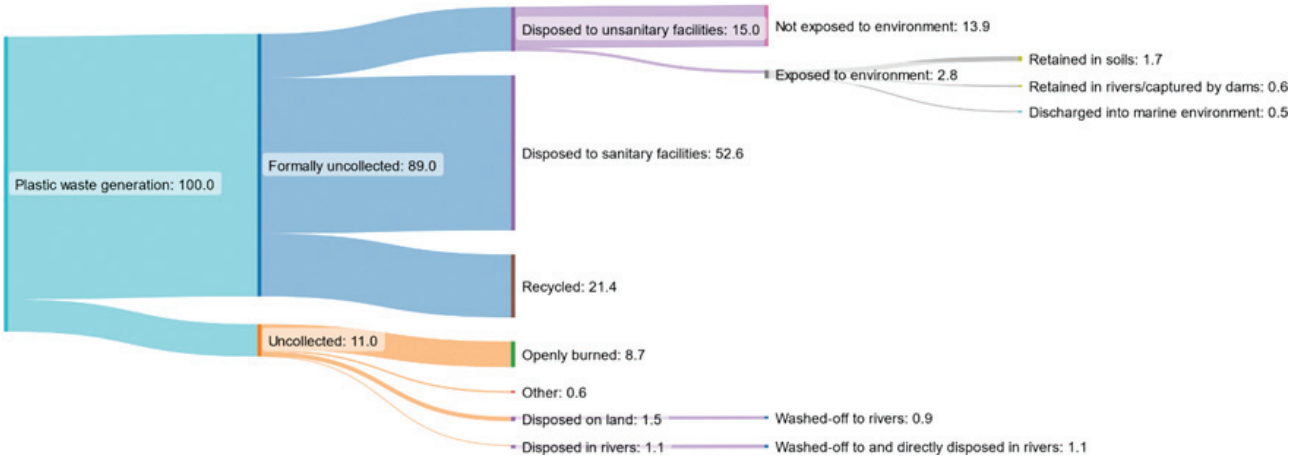
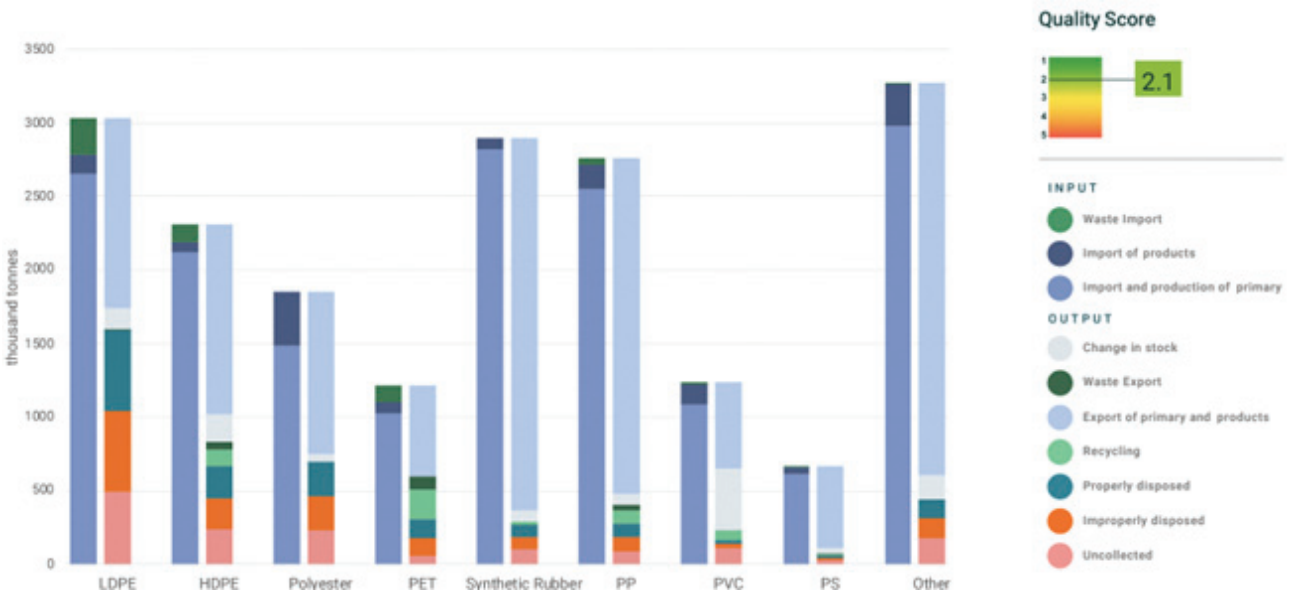


Figure 12. Mass Balance by Polymer of Thailand in 2018



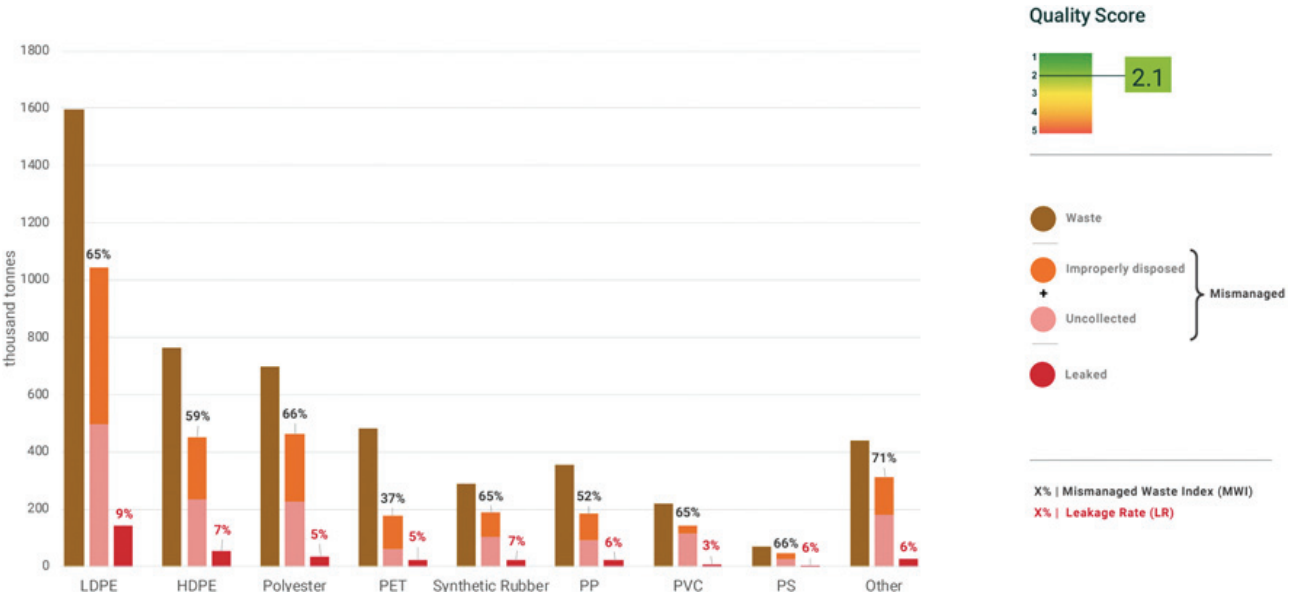
Source: IUCN-EA-QUANTIS, 2020

devising effective guidelines for preventing plastic leakage.

Leakage can also occur during formal waste collection and disposal. According to a World Bank study (Figure 11), only 21.4% of key plastic resins were recycled in Thailand during 2018, which is below the target outlined in the National Plastic Waste Management Roadmap 2018–2030. This indicates that a significant portion of plastic waste is still disposed of in sanitary and unsanitary facilities. Figures 12 and 13 depict the types of polymer waste found in Thailand and the percentages of mismanaged waste and leakages, as reported by IUCN-EA-QUANTIS (2020).

In 2018, LDPE (9% leakage), HDPE (7% leakage), and polyester (5% leakage) emerged as primary sources

Figure 13. Mismanaged Waste and Leakage by Polymer of Thailand in 2018 (IUCN-EA-QUANTIS, 2020)



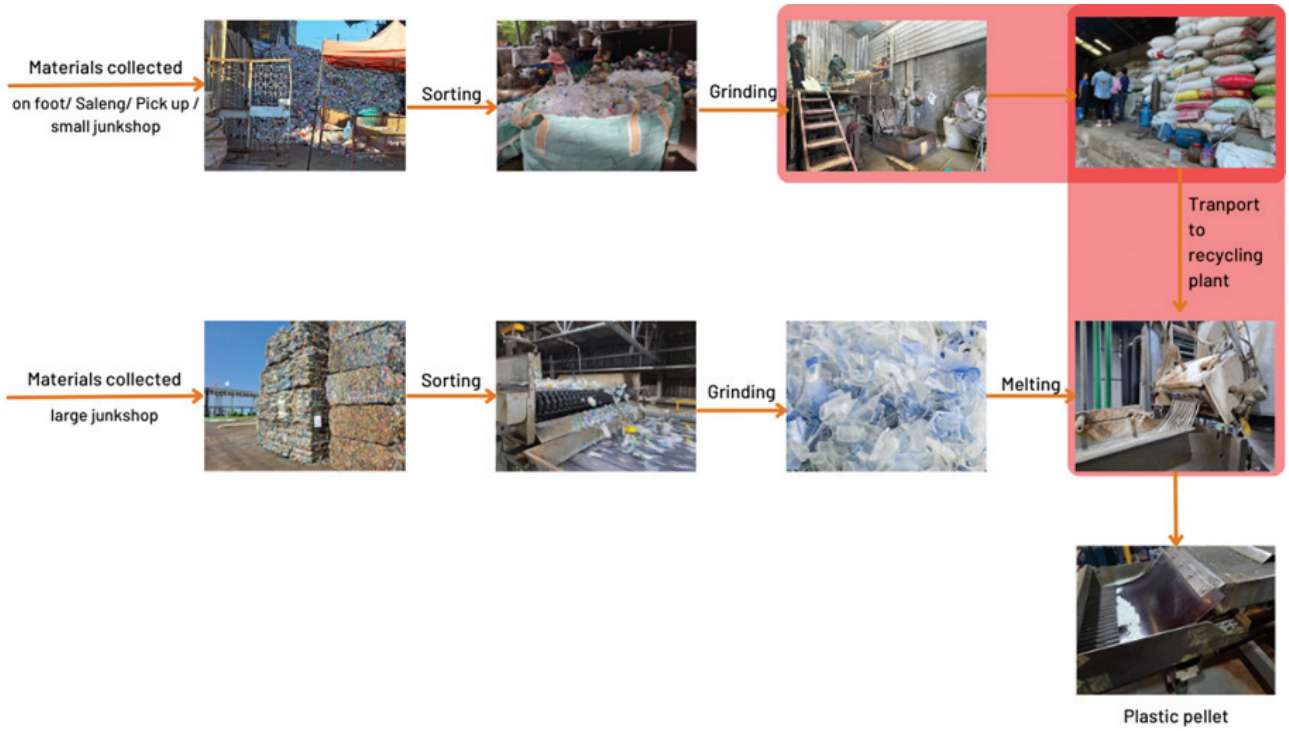
of plastic leakage in Thailand (Figure 12). LDPE, commonly found in plastic bags, faces recycling challenges, with approximately 60% ending up in landfills owing to informal waste pickers' reluctance to transport these lightweight yet bulky items. In contrast, HDPE is typically collected for recycling owing to its high demand in the packaging sector. Approximately 700 kt of polyester waste was generated in 2018, with 66% mismanaged owing to the limited capacity of sanitary landfills. Consequently, 30% ended up in unsanitary landfills, while the rest remained uncollected. Although polyester is extensively used in textiles, the lack of proper recycling of polyester fibers has resulted in 34 kt leaking into the marine environment. Synthetic rubber, although with a lower leakage rate than polyester, still poses a significant issue of 7% due to microplastics from tire abrasion and waste mismanagement, contributing considerably to Thailand's plastic leakage problem..

First, according to a material flow analysis conducted by the World Bank, 10 districts near Bangkok account for more than half of the total exposed mismanaged plastic waste in high-priority catchments close to the marine environment. Therefore, it is essential to implement new technologies in these areas to prevent plastic leakage. Globally, interventions for marine plastic pollution focus on plastic waste collection, while few address plastic leakage prevention at the source. A holistic and comprehensive approach, combining technology, policymaking, and advocacy is required to prevent further plastic pollution and subsequent damage to aquatic ecosystems and human health. In summary, while some technologies are available to prevent plastic leakage in Thailand, they are limited in scope and not comprehensive enough to address the problem. Therefore, it is crucial to adopt a comprehensive approach that combines technology, policymaking, and advocacy to prevent plastic leakage and mitigate the impact of plastic pollution on the environment and human health.

2.5 Post-Consumer Plastic Resin Production

Several factors influence the production and distribution of post-consumer recycled (PCR)

Figure 14. The plastic pellets production process and the hotspot area for the leakage of plastic pellet / scraps



Source: Adapted from PCD (2021)

materials in Thailand, including raw material availability, regulatory conditions, labor skills, and technological access. A key challenge is the cost, with PCR pellets priced 10–30% higher than new plastic pellets. This cost disparity affects the competitiveness and marketing efforts of PCR pellet manufacturers. Additionally, the Food and Drug Authority (FDA) regulations currently prohibit the use of recycled plastic packaging for food and beverage products, with changes to these regulations undergoing a lengthy evaluation process. Inefficient plastic collection in Thailand results in a limited supply of raw materials for PCR production, leading to low-quality PCR and increased reliance on imported plastic waste, thereby impacting the plastic pellet value chain.

High-risk areas in a junkshop workplace where plastic pellets or scraps may leak

Interviews with producers of PCR materials reveal that Thailand lacks comprehensive laws, regulations, or policies to promote waste separation and proper disposal practices, negatively impacting the quality of recyclable materials and increasing costs for collectors and recyclers. Most recyclable waste is collected by informal sales groups and junkshops that lack standardized operations and information access. Restrictions on the use of recycled plastic packaging for food and beverages have led to missed business opportunities, requiring manufacturers to import PCR and export products packaged with recycled plastic. Mechanisms such as recycling symbols and product verification systems are needed to validate the claims of recycled material use. In conclusion, addressing the issue of PCR materials in Thailand requires a multifaceted approach, including improved waste management practices, the expansion of recycling facilities, and focusing on sustainability. Collaboration among stakeholders is crucial to finding sustainable solutions to these challenges in the plastic pellet value chain.

Figure 15. High-risk areas where plastic pellets or scraps may leak in a junkshop workplace

Chapter 3

Selected Urban Cases in Thailand

Table 1. Waste management by province; comparison of Bangkok with two provinces covering the selected study areas

Province	Bangkok Metropolis	Chon Buri	Nonthaburi
Population (2020)	10785197	2191356	2184692
Generated (t)	834240	273936	112868
Collected (t)	762541	223032	92643
Collected for recycling (t)	109557	36273	17009
Properly disposed (t)	625585	78058	65922
Improperly disposed (t)	27399	108701	9713
Uncollected (t)	71699	50904	20225
Mismanaged (t)	99097	159605	29938
Leaked (t)	10972	14764	3424
Share of collected	91%	81%	82%
Share of mismanaged	12%	58%	27%
Leakage rate	1%	5%	3%

Source: Adapted from IUCN-EA-QUANTIS (2020

Plastic waste pollution is a significant issue in Thailand, particularly in Nonthaburi and Chonburi Provinces, where our study areas are located. Table 1 illustrates the waste generation and management across different provinces, highlighting the Bangkok Metropolis as the highest plastic waste generator. Nonthaburi and Chonburi are ranked among the top 10 provinces for plastic waste generation..

3.1 Nonthaburi Municipality

3.1.1 Study Area

Nonthaburi, located near Bangkok, is Thailand's largest municipality and seventh-largest city, covering 38.9 square kilometers. Originally a fruit orchard, it has evolved into a bustling urban area with government buildings, businesses, and residences. Natural canals and ditches, once used for transportation, traverse mainly flat land with the Chao Phraya River flowing through. It borders the Pak Kret Municipality, Laksi District, Bang Sue District, Bang Kruai District, and Sai Ma Municipality. With 44 water sources primarily used for drainage, Nonthaburi faces challenges in MSW management due to population growth, migration, urbanization, and economic development. In 2019, 551.38 tons of MSW were generated daily, with plastic waste accounting for 14.1%. While efforts to address the plastic waste issue include waste separation and reusable bag promotion, more comprehensive measures are required for effective management.

3.1.2 Status of Waste Management

In the Nonthaburi Municipality of Thailand, there is a blend of modern waste management systems and ongoing challenges in waste disposal practices. The municipality is praised for its adoption of advanced waste management systems and the promotion of recycling, open dumping, and persistent burning. These modern systems distinguish Nonthaburi from cities relying on traditional approaches, showcasing a commitment to sustainable waste management. However, rapid expansion brings significant challenges, including increased public consumption and waste mismanagement, leading to clogged drains. Inadequate waste management contributes to waste entering waterways, contaminating them,

Figure 16. Study area of Nonthaburi Municipality and surrounding

Figure 17. The waste clogged up the Drain in Nonthaburi municipality

and impacting the quality of the Chao Phraya River (Figure 17).

To address these issues, surveys have been conducted to identify the types of waste commonly found and their contributions to water pollution. In 2017, Tangwanichagapong et al. analyzed the waste composition and generation rates in Bangkok, Nonthaburi, and the surrounding areas. The study found that Nonthaburi had the second-highest rate of waste disposal after Bangkok, with approximately 268,855.4 tons of garbage generated annually. This equates to one kilogram of waste per person per day. Plastic waste accounted for 16.5% of the total waste, whereas food waste comprised 40.30% of the waste generated. One of the significant consequences of inadequate waste management in Nonthaburi is the risk it poses to public health. Owing to the municipality's proximity to the river, waste from neighboring households may flow into nearby ditches and canals, exacerbating the problem. Consequently, contaminated water is unsafe for human consumption and cannot be utilized. Furthermore, this issue affects the traditional way of life in the community of Nonthaburi Municipality, including its local attractions.

Overall, while the Nonthaburi Municipality has made strides in adopting modern waste management systems and promoting recycling, challenges persist. Efforts are needed to improve waste disposal practices, address waste leakages, and mitigate risks to public health and the environment. By implementing comprehensive waste management strategies, Nonthaburi can work toward a cleaner and more sustainable future.

3.1.3 Agencies and Legislations

Nonthaburi is located in the Bangkok Metropolitan Region. The city has its own local government, which is responsible for managing waste management and the plastic waste trade. The following are the relevant agencies and legislation relating to plastic waste management and trade in the Nonthaburi Municipality. A junkshop intending to engage in antiques trading must obtain an antique trading license from Muang Nonthaburi District Office. Simultaneously, under the Public Health Act, the antique dealer must apply for a permit from Nonthaburi Municipality. However, the Town Planning Act poses a challenge since it prohibits the establishment of antique shops in community areas due to the potential nuisance they may cause. Consequently, antique shops are compelled to operate outside the city, particularly in Sai Noi, which inconveniences people who wish to sort recyclable waste and also increases transportation costs for the antique shops.

In addition to the above agencies and regulations (Figure 3.3), Nonthaburi Municipality has been working closely with various organizations and the local community to promote the reduction of plastic waste. These efforts include community education campaigns, waste separation initiatives, and collaboration with local businesses to minimize plastic use.

3.1.4 Waste Flow in Nonthaburi Municipality

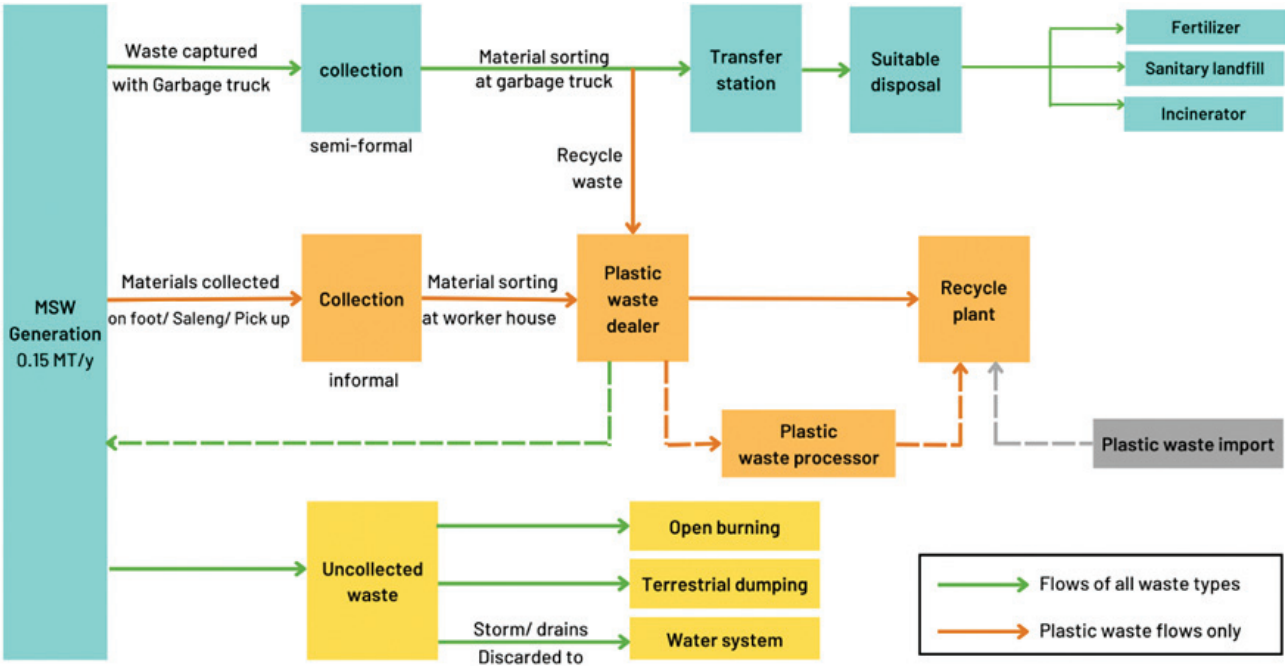
There are partnerships between various offices, houses, and municipalities regarding waste

Figure 18. Main agencies and legislation in Nonthaburi municipality

Nonthaburi Municipality Office	They work in collaboration with the Nonthaburi Environmental Office, which is responsible for enforcing environmental regulations and ensuring compliance with waste management policies.
Nonthaburi Municipal Regulation on Solid Waste Management B.E. 2551 (2008)	guidelines for the proper management of solid waste, including plastic waste, within the municipality.
Nonthaburi Plastic Waste Reduction Campaign	aims to raise awareness about the impacts of plastic waste on the environment and encourage residents to reduce their use of single-use plastic items.

Source: Pottinger-Glass et al., 2022

Figure 19. The MSW and plastic waste flow in Nonthaburi Municipality[1]



management in Nonthaburi Municipality. Public dumpsters in the area receive organic food leftovers and plastic waste from homes and communities. While waste disposal in open public areas is illegal, some garbage continues to be deposited in these areas. The municipality is responsible for collecting garbage and sending green trucks to transport it to landfills after collection in the Sai Noi municipality. However, it seems that semi-informal and informal collectors are also involved in garbage collection and selling the collected material, particularly plastic bottles, to plastic collection shops in Nonthaburi Municipality (Figure 3.4). Moreover, Nonthaburi Province is in the process of developing a waste treatment facility that will be in operation by 2024, converting Nonthaburi's waste into energy.

3.1.5 Informal Waste Recycling and Actors in Nonthaburi Municipality

The inner city of Nonthaburi Municipality has fewer junkshops purchasing used items than the outskirts. These shops rely on manual labor and predate municipal regulations that prohibit their presence within the city. They mainly serve households and nearby businesses, sending the collected waste to factories in Pathum Thani Province for further processing.

The junkshops in the Nonthaburi Municipality categorized as used item shops:

- Small-scale shops: These primarily buy plastic waste from nearby households and distribute it to larger shops or factories within the province.
- Medium-sized shops: They cater to scavengers/ saleng, collecting waste that is subsequently sent to factories in Pathum Thani Province.
- Large-scale junkshops: These serve scavengers/ saleng and smaller junkshops, with the plastic waste also being transported to Pathum Thani Province.
- Special large-scale shops in the Sai Noi area include diverse customers, such as Nonthaburi Municipality's waste collection vehicles, ragpickers, and other smaller junkshops.

To gain deeper insights into the informal sector, the study team visited five junkshops in Nonthaburi and the surrounding areas. These varied in size and handled different types of waste, including plastic.

1 Adapted from University of Leeds (2020) and available information from Pollution Control Department (2023)

Figure 20. Junk shop keeping clean the public road in front of the shop

The focus at all sites was on pre-processing waste, which involved sorting and sending segregated waste to recycling facilities for transformation into pellets. Operating legally, these junkshops maintain some level of cleanliness and hygiene standards and are mindful of minimizing noise and odors to prevent complaints (Figure 20). Regular inspections by the municipality ensure compliance, with a strong emphasis on environmental cleanliness. However, challenges such as reduced plastic prices and labor shortages persist, prompting some factories to import plastic waste for recycling because of the lower costs abroad..

Several factors have been identified as contributing to plastic losses and leakage from informal recycling facilities, including:

- Information symmetry among waste pickers, junkshops, and aggregators on in-demand plastics acceptable for recyclers.
- iPoor handling and disposal of low-value or rejected plastic materials.
- Poor storage conditions for recyclable plastics in some facilities. Wind and flooding facilitate losses and leakages.
- Losses from improper hauling/transportation of plastic materials (Figures 21 and 22).
- Lack of proper housekeeping and solid waste management practices in some recycling facilities.
- Lack of training and know-how on leakage prevention.

Low-value plastic waste is highly susceptible to leakage, often overlooked by informal actors owing to its limited economic value, leading to improper disposal and subsequent collection by the municipality for landfill disposal. Inefficiency in handling such waste, both informally and formally, exacerbates its improper disposal and contributes to environmental pollution. Furthermore, the study suggests that economic factors such as reduced plastic waste prices may influence the management and treatment of plastic waste. This can result in an increased chance of leakage during transportation and handling, prompting some plastic factories to resort to importing plastic waste from abroad to cut costs. The study of plastic waste management in Nonthaburi Municipality reveals a mix of modern waste management systems and ongoing challenges in waste disposal practices.

Figure 21. The different type of customers' vehicle to deliver plastic waste to junk shop in Nonthaburi municipality

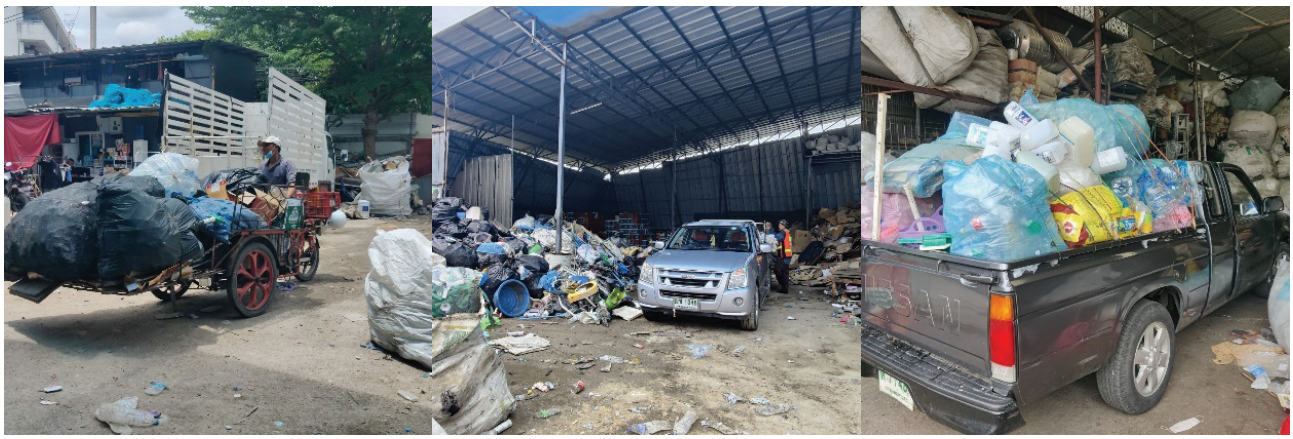


Figure 22. The different types of junkshops' vehicles to deliver plastic waste to recycling factories in Nonthaburi municipality

This research identifies various informal recycling actor groups, such as small-scale, medium-sized, and large-scale used item shops, which play a significant role in the collection and distribution of plastic waste. While these junkshops operate legally and are required to adhere to cleanliness and hygiene standards, they face challenges, such as reduced plastic waste prices, permanent buyers, and labor shortages. The transportation of plastic waste, particularly low-value plastic waste, has been identified as a major cause of plastic leakage into the sea. The inefficiencies and informal practices of actors handling such waste contribute to its improper disposal and subsequent collection by municipalities for landfill disposal. Moreover, economic factors, including reduced plastic waste prices, leading to the importation of plastic waste, may influence plastic waste management and treatment, potentially increasing the likelihood of leakage during transportation and handling.

The Nonthaburi Municipality could implement comprehensive waste management strategies to address the challenges it faces. Efforts should focus on improving waste disposal practices, enhancing informal human resource capacity through training and skill development, addressing waste leakage during transportation, and mitigating risks to public health and the environment. Additionally, promoting sustainable waste management practices and finding economic incentives to encourage technical innovation for proper plastic waste treatment and recycling are essential steps toward a cleaner and more sustainable future for Nonthaburi. Moreover, there is a need for comprehensive guidelines for the informal sector to help improve its operations.

3.2 Pattaya City

3.2.1 Study Area

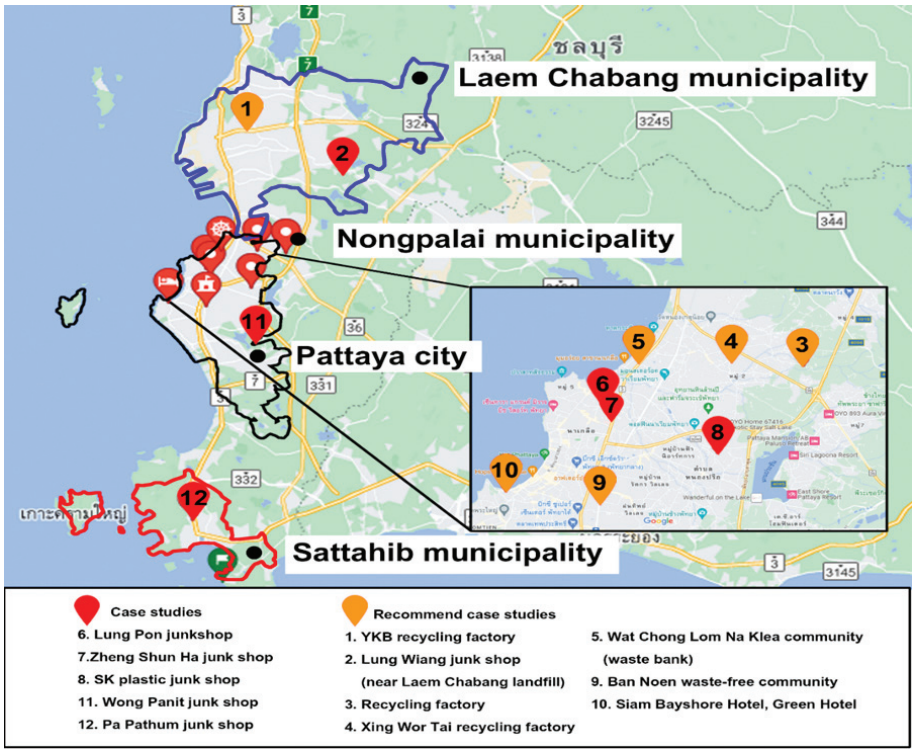
Pattaya City is an urban municipality located in the District of Bang Lamung, mostly in Tambon Nong Prue, but with areas in the Huai Yai, Nong Pla Lai, and Naklua Subdistricts. It is a popular tourist destination located 150 km from Bangkok and easily accessible via the Sukhumvit Highway. The geography of Pattaya City is hilly, with few plains, and the major flatlands are typically commercial districts or sources of water. However, Pattaya City also includes islands such as Koh Lan, Koh Krok, and Koh Sak, situated about 8 km from the coast.

Pattaya is a coastal city in Thailand, and its rapid urbanization has contributed to the plastic situation in the area. As a popular tourist destination and home to many businesses and industries, this region produces a significant amount of plastic waste. Pattaya City is selected as the study area (Figure 23) due to it being a popular tourist destination that generates a large amount of waste from a high volume of tourists and activities. The city has experienced significant urbanization and economic growth, leading to increased consumption and waste production. This growth has put pressure on the waste management infrastructure and highlights the importance of sustainable waste management practices. Additionally, since Pattaya City is along the coast, there is a possibility of plastic leaking into water bodies. Overall, studying the waste situation in Pattaya City can provide insights into the challenges and opportunities related to waste management in a rapidly urbanizing and developing area and the potential impact of tourism and industry on waste generation and management.

3.2.2 Overall Situation of Waste Management

According to Pattaya City Hall, the city currently produces approximately 700 tons of solid waste daily, with projections indicating a future increase of 1,000 tons per day. As a popular tourist destination, Pattaya faces significant solid-waste management challenges stemming from its substantial waste output and insufficient infrastructure and services. To address these issues, the city has introduced a Waste Management Master Plan. This comprehensive strategy seeks to enhance waste collection and treatment efficacy, increase public awareness of waste management, and diminish waste generation. It encompasses initiatives

Figure 23. Study area of Pattaya City and surrounding



to encourage recycling and composting while implementing measures to curtail the consumption of single-use plastics.

In Pattaya, waste management involves collecting waste from various communities using small trucks and transporting it to a transfer station. From there, all waste is sent without separation to a refuse-derived fuel (RDF) facility in Saraburi. However, the city grapples with illegal waste dumping, particularly in the outlying areas. To combat this, Pattaya has instituted fines for such actions and is enhancing the enforcement of regulations. It is important to recognize that waste management is a global issue, with rising waste generation rates posing complex and costly challenges worldwide. Developing nations struggle with unsustainable waste practices, leading to significant health, safety, and environmental risks. Efforts to address these challenges include setting recycling targets, reducing landfill waste, promoting waste separation, and fostering public awareness. Although Pattaya has implemented various initiatives and policies to improve waste management, there is still much work to be done to enhance the efficiency and sustainability of waste management in the city. Collaboration between the government, local communities, and residents is crucial to address these challenges and achieve a cleaner and more sustainable environment for Pattaya.

3.2.3 Agencies and Legislations

Pattaya City Municipality oversees solid waste management at the local level, including plastic waste. They operate a waste management system covering collection, transportation, and disposal, with sorted, recycled plastic waste sent to landfills or waste-to-energy plants. The municipality also promotes plastic waste reduction through awareness campaigns and sustainable practice initiatives (see Figure 24). For junkshops in Pattaya intending to trade in antiques, an antique trading license is required from the Muang Chonburi District Office, along with a permit from Pattaya City under the Public Health Act. However, challenges arise from the Town Planning Act, which restricts the establishment of antique shops in community areas owing to potential nuisance. Consequently, these shops often operate outside the city, particularly in Satthahip, causing inconvenience for recyclable waste sorting and increasing transportation costs. Pattaya City has agencies and legislation in place to manage plastic waste and regulate plastic waste trade at the local level. These measures are intended to promote sustainable waste management practices and reduce the negative environmental impact of plastic waste.

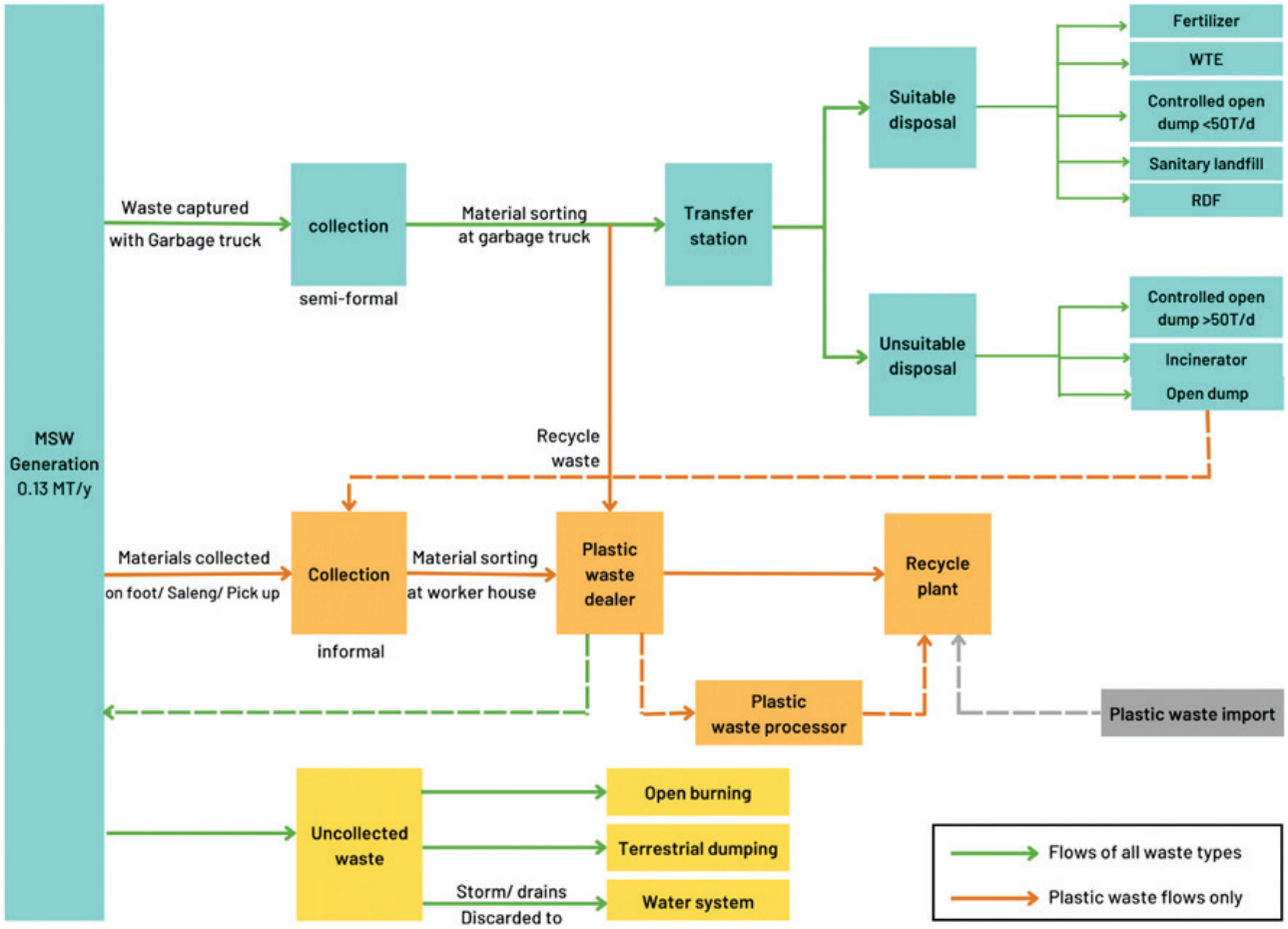
3.2.4 Waste Flow in Pattaya City

The Office of the Environment estimates that Pattaya City generates approximately 300–500 tons of garbage daily, with waste collection and transportation overseen by the Office of Public Health and Environment. The city's waste management plan has shifted toward waste-to-energy, with the Eastern Green World Company Limited handling rubbish collection and disposal transfer services (see Figure 25), and TPI Polene Public Company Limited in Saraburi partnering for renewable waste power generation. However, owing to the lack of waste separation, precise data on waste composition are unavailable. Discussions with the director revealed potential plastic garbage particles in the south Pattaya Canal and Na Kluea, with plastic waste from Bang Lamung posing a risk of leakage into the Bang Lamung Canal. Before the COVID-19

Figure 24. The main agencies and legislations in Pattaya city

Pattaya City Office	They work in collaboration with the Pattaya Environmental Office and Pattaya Clean City Committee, which is responsible for enforcing environmental regulations and ensuring compliance with waste management policies.
Provincial Solid Waste Management Act (B.E. 2554) and the Provincial Plastic Waste Management Act (B.E. 2560).	guidelines for the proper management of solid waste, including plastic waste, within the municipality.

Figure 25. The MSW and plastic waste Flow in Pattaya City[2]



pandemic, daily waste collection averaged 350 tons, but increased to 500 tons during the pandemic, prompting the installation of waste capture nets to prevent leakage. Figure 3.10 illustrates the plastic waste management structure in Pattaya City, with mixed waste transported to a transfer station for composting, landfill, and waste-to-energy plants. Waste-to-energy (RDF) is the preferred method, with most plastic waste transferred to the TPI factory. Informal sectors, including waste collectors and junkshops, play a role in collecting and separating valuable garbage. Additionally, the Pattaya local government has initiated community awareness programs such as beach cleanups and trash-to-cash recycling. These efforts highlight Pattaya City's focus on effective waste management, particularly waste-to-energy solutions, and addressing plastic waste leakage into the waterways.

2 adapted from University of Leeds (2020) and available information from Pollution Control Department (2023)

3.2.5 Informal Waste Recycling and Actors in Pattaya City

In downtown Pattaya, there are few junkshops due to restrictions imposed by the Town Planning Act, similar to the Nonthaburi Municipality. These shops are usually located outside the main city, such as in Sattahip or Laem Chabang. They send their waste to recycling factories in Chonburi Province, with Xing Wo Tai being a significant facility specializing in recycling PET in the Pattaya area. It has an annual capacity of approximately 200,000 tons. However, some waste is also transported to neighboring provinces for processing. To deepen this knowledge, the study team visited five junkshops in Pattaya and the surrounding area. All these registered junkshops handle various types of waste, but not plastic. Most of these small junkshops focus mainly on the sorting of waste before transporting it to the next recycling business which transforms this plastic waste into pellets for recycling and reuse.

All junkshops operate within the bounds of law and must maintain high standards of cleanliness and hygiene, similar to the Nonthaburi Municipality. They are particularly careful about minimizing noise and odors to avoid complaints from nearby communities due to the risk of losing their license. These shops face challenges such as decreasing prices for plastic waste and a shortage of workers. This has led some plastic factories to import plastic waste from abroad for recycling since it is more cost-effective, especially in the free zone.

Shop owners understand the financial implications of waste leakage and strive to prevent leaks. The use of trucks and pickups can increase the possibility of plastic leakage during logistics and transportation (see Figures 26 and 27). In addition, research indicates that shops that grind waste into smaller pieces have a higher risk of leakage. This is primarily because some work areas are situated on soil, making thorough cleaning difficult. Additionally, some of the grinders used in these shops are old and worn out with no cover, increasing the likelihood of plastic pellet leakage (Figure 28). Residual plastic waste in the soil may leak into the environment, including water bodies, although this may be less likely during the dry season. However, during the rainy season, there is a higher chance of leakage into the marine environment because some plastic residuals are outside the sheltered areas. Overall, it is crucial for these junkshops to operate responsibly by following strict guidelines to minimize their environmental impact and avoid negative consequences for the communities around them.

3.2.6 Conclusions in the Context of Pattaya City

In conclusion, Pattaya City faces significant challenges in solid waste management, particularly when dealing with the large volume of waste generated as a popular tourist destination. The city has implemented a Waste Management Master Plan to improve waste collection, treatment efficiency,

Figure 26. The different type of customers' vehicle to deliver plastic waste to junk shop in Pattaya city

Figure 27. The different type of junkshops' vehicle to deliver plastic waste to recycling factories in Pattaya city

Figure 28. The possibility of leakage from machine

and public awareness. However, illegal dumping remains an issue, and stricter regulations are being enforced to address this problem. The lack of a waste separation system in Pattaya City poses a challenge, but efforts are being made to shift toward waste-to-energy solutions. Plastic waste management is regulated by the local municipality, which encourages the recycling and reduction of single-use plastics by separating and turning waste into a merit activity. However, the Town Planning Act restricts the establishment of junkshops in certain areas, leading to operational challenges and increased transportation costs.

In terms of informal waste recycling, junkshops in downtown Pattaya are limited by building restrictions, but many shops operate legally and adhere to cleanliness and hygiene standards. These shops face challenges, such as declining plastic waste prices and labor shortages. In addition, to date, the local government has not yet been aware of the high interest in the informal sector. Research suggests that shops involved in grinding waste into small pieces have a higher risk of plastic pellet leakage, particularly in areas where cleaning is difficult. Therefore, there is a need for support in policies and regulations to incentivize junkshops to adopt the necessary technology to minimize plastic leakage. Based on the case studies of informal actors, there is a need for more systematic technical training and formal guidelines. This would also provide safety and a high-standard work environment. In addition, regular monitoring and inspection from the Pattaya Municipality would strengthen the sector considerably.

The existing situation in plastic waste management and possible sources of plastic leakage:

The plastic leakage sources in Pattaya City are associated with the operation of junkshops, particularly those involved in grinding waste into small pieces. Work areas situated on the soil and the use of deteriorated grinders contribute to a higher risk of plastic pellet leakage.

Status of informal recycling actor groups, logistical handling of plastic waste, and factory processing operations of pellet production:

The status of informal recycling actor groups, logistical handling of plastic waste, and factory processing operations of pellet production in Pattaya City highlight both the challenges and opportunities in the plastic waste management sector. The involvement of junkshops and waste collectors as informal recycling groups is vital for collecting and handling plastic waste. However, the location of these shops outside the main city area and the need to transport waste to recycling facilities in neighboring provinces pose logistical challenges and increase transportation costs. Concerns regarding plastic pellet leakage have been identified, particularly in shops where waste is ground into smaller pieces. The difficulty in thorough cleaning, especially in work areas situated on soil, and the deterioration of some grinders increase the risk of plastic pellet leakage. However, efforts to prevent waste leakage, such as the installation of waste capture nets, have been implemented in certain areas to mitigate the environmental impacts.

Chapter 4

Conclusions and way forward

4.1 Conclusions

Various challenges in plastic waste management are evident across municipalities, including improper landfill management and open disposal. Despite efforts to collect plastic waste and transfer it to RDF facilities, there is a lack of focus on recycling and reduction initiatives owing to insufficient budget allocation. Recycling and reuse efforts remain voluntary and lack enforcement mechanisms. Weak collaboration between the formal and informal sectors impedes progress in plastic waste management and recycling rates. Additionally, strict regulations and the prohibition of junkshops in urban areas discourage community participation in recycling. The limited technical capacity and training for recycling processes highlight the need for enhanced infrastructure and training. The lack of formal recognition and support from both the government and private sector hampers informal actors in the plastic value chain, including access to financing, technology, and training.

Coordination gaps can lead to inefficiency and suboptimal practices. The lack of infrastructure and equipment contributes to the increased leakage of plastic pellets. The limited capacity to address environmental and health risks poses additional challenges. Transportation is a major hotspot for plastic pellet leakage owing to lax monitoring and enforcement. Addressing these barriers requires collaboration and support from all stakeholders. Solutions involve market-based approaches such as door-to-door waste collection and extended producer responsibility programs. Technical solutions, such as robotic technology and microplastic collection methods, are recommended, although financial constraints may hinder their adoption. Policy recommendations include the establishment of a comprehensive legal framework and the introduction of financial incentives. Regional cooperation, capacity building, and public-private partnerships are crucial. Examination of informal recycling actors reveals logistical challenges and potential sources of plastic leakage, emphasizing the need for comprehensive waste management strategies. Integrating informal recycling actor groups and implementing effective policies and regulations are essential steps to prevent plastic pellet leakage and promote sustainable waste management.

4.2 Ways forward

To enhance plastic waste management and reduce leakage in Nonthaburi and Pattaya, the following actions are recommended:

1. **Strengthen waste management systems:** Improve infrastructure and services for waste collection, including implementing segregated waste collection at source. Integrating smart technology for efficient door-to-door waste collection.

2. **Implement strict regulations:** Enforce regulations on the handling and transportation of plastic pellets to prevent leakage. Monitoring and controlling the movement of plastic waste, ensuring compliance with proper packaging and storage practices.

3. **Foster collaboration:** Establish partnerships with stakeholders, including waste collectors, recycling industries, and community organizations, to develop and improve policies and regulations. Collaborative efforts can enhance the collection, recycling, and recovery of plastic waste.

4. **Improve the recycling market:** Provide government incentives, tax breaks, or subsidies to support existing and new recycling centers. Allocate budgets and incentives for technological innovation to enhance plastic material quality and recycling processes.

5. **Enhance logistics and transportation:** Mandate the use of covered vehicles and proper bags for transporting plastic waste to prevent leakage during transportation.

6. **Training:** Provide resources and capacity-building training to informal actors to improve plastic recycling standards and prevent leakage.
7. **Network and information sharing:** Establish a network of stakeholders and ensure the transparency of information for public access to facilitate effective collaboration and communication.

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