Technical Guidelines for

# PLASTICS AND RESIN PELLETS LEAKAGE PREVENTION FROM RECYCLING FACILITIES

## PATTAYA CITY, THAILAND

RRC.AP
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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# Contents


Acknowledgements i
List of abbreviations ii

**Chapter 1 Introduction 1**

1.1 Background 1
1.2 Objectives 1
1.3 Scope of the Guideline, and Study Area and Existing Initiatives in the Study Area 2
1.3.1 Scope of the Guideline 2
1.3.2 Study Area 2
1.3.3 Existing Initiatives in the Study Area 3
1.4 Target Users of the Guideline 3

**Chapter 2 Gaps 5**

2.1 Existing Policy/Regulations 5
2.2 Institutional Arrangements 5
2.3 Technology 6
2.4 Resources 7

**Chapter 3 Value Chain of Plastics and Resin Pellets in Pattaya City 9**

**Chapter 4 Recycling Processes and Activities in Pattaya: Case Studies 13**

4.1 Recycling Processes and Activities in Pattaya with Case Studies 13
4.2 Analysis of Case Studies 16

**Chapter 5 Interventions for the Reduction in Plastic Leakage 19**

5.1 Reduction at source 19
5.2 Improvement in Infrastructure and Technical Capacity 20
5.3 Incentivizing Plastic Collection 21

**Chapter 6 Internal Site Audit 25**

**Chapter 7 Remediation Options with Available Technology Practices 29**

7.2 Current Practices on Recycling of Plastic Wastes 30
7.2.1 Plastic Waste Recycling Practices in the Formal Sector 30
7.2.2 Plastic Waste Recycling Practices in the Informal Sector 30
7.2.3 Collaborative (Formal and Informal Sector) 31

**Chapter 8 Awareness-Raising Programs on Plastic Leaking to the Environment** **33**

8.1 Awareness-Raising Programs for the Public 33
8.2 Awareness-Raising Program for the Informal Sector 34

**Chapter 9 Checklist for Setting Up Recycling Facilities** **37**

**REFERENCES** **39**

**APPENDICES**

**Appendix A: Current technologies and practices for reducing plastic pollution** **42**

Appendix A.1 The Micro Plastic Pollution Prevention-Collection Technology 42
Appendix A.2 The Macro Plastic Pollution Prevention and Collection Technology 43
Appendix A.3 The Micro-Macro Plastic Pollution Collection Technology 45

**Appendix B: Field Data Collection and Meetings** **46**

Appendix B1: Informal Site Observations in Pattaya Municipality 46
Appendix B1.1 Selected Cases in Pattaya Municipality 46
Appendix B1.2 Site Visits in Pattaya Municipality and Surrounding Areas 48
Appendix B2: List of persons met and contact information 50
Appendix B3: Photos at Pattaya Municipality Field Visit 51
Appendix B3.1 Pattaya City Office and Wong Panich junk shop – 16th June 2022 51
Appendix B3.2 Other sites around Pattaya City – 13th January 2023 52
Appendix B3.3 Other sites around Pattaya City – 9th June 2023 55

## List of Figures

Figure 1. Map of Pattaya City and the Surrounding Area 2
Figure 2. Plastic Recycling Process 13

## List of Tables

Table 1. Process for plastic recycling 13
Table 2. Guidelines for different sectors to reduce plastic leakage in Pattaya Municipality 21
Table 3. Sample checklist for internal site audit 26
Table 4. Different types of a high scoring technologies 29
Table 5. Checklist to set up recycling facilities. 37

# Chapter 1

# Introduction

## 1.1 Background

Thailand's waste management system has been facing several challenges. These include the lack of applicable technology, insufficient knowledge, and an ineffective process of public participation, policy implementation and institutional support. Waste management practice in the formal waste sector involves segregation, collection, transfer, and disposal. Although sanitary landfill is the most used disposal method, only 119 sites out of 1000 sanitary landfills fulfill the recommended standards (Kamuang and Siriratpiriya., 2017). In the provincial capitals of the country, landfills comprise a total of 54% engineered landfill and 9% sanitary landfill, while 20% are open dumps and 17% are controlled dumps. Besides landfills, incineration is another preferred procedure, but it is costly and there are public health concerns due to pollutant emissions. Currently, Thailand is confronted with significant difficulties in managing plastic waste, with a large proportion of it being mixed with municipal solid waste (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.

In Thailand, the two major obstacles to improving the recovery of waste plastics are the lack of systematic sorting and collection systems and the resulting contamination from the mixing of plastics with other solid wastes. Furthermore, the informal sector, which is mainly responsible for the plastic waste management system in Thailand, is unsystematic; for example, it operates without recording accurate material flow analysis, causing the difficulty in tracking plastic waste accurately. In addition, one study on waste management in Bangkok revealed the challenges in performing waste separation because of lack of proper facilities and overall mistrust in government collection operations, which negatively affects the willingness of citizens to participate in recycling activities.

Another challenge is the Thai government's lack of a suitable action plan that can incentivize the private sector to design or use recyclable and compostable plastic products. This resulted mainly from the high cost of research and production technology. Therefore, creating government policies that support a sustainable circular economy such as promoting the use of environmentally friendly and recyclable products is necessary. However, addressing these impediments will require the involvement and cooperation of all stakeholders, including the government, private sector, and citizens, to work towards a more sustainable future for Thailand. To achieve a reduction of plastic leakage, guidelines must also be developed for the informal waste sector as it portrays a major role in the recycling activities of Thailand.

## 1.2 Objectives

The overall objective of the technical guideline is to prevent plastics and resin leakage into the marine environment through the promotion of best technologies and practices at resin-producing factories and informal recycling facilities in Pattaya city. The guideline is expected to achieve the following objectives:

- To facilitate improved environmental management of macro and microplastics by upstream plastic industry handlers of plastic pellets, and downstream informal recyclers of process operations in plastic pellet and resin handling to minimize leakage to marine environment and harm to human and aquatic health.
- To provide reference documents and guidance to key actors of plastic recycling to achieve better operating practice.
- Promote better environmental stewardship of the plastic production and recycling industry and communities (i.e., formal, and informal).

## 1.3 Scope of the Guideline, and Study Area and Existing Initiatives in the Study Area

This section presents the scope of the guidelines, study area and existing initiatives in Pattaya City.

### 1.3.1 Scope of the Guideline

The scope of the guideline is as follows:

1. The guideline focuses on the potential land-based sources of plastic leakage into the marine environment, resulting from mismanaged waste disposal and the logistical mishandling by the informal recycling groups.

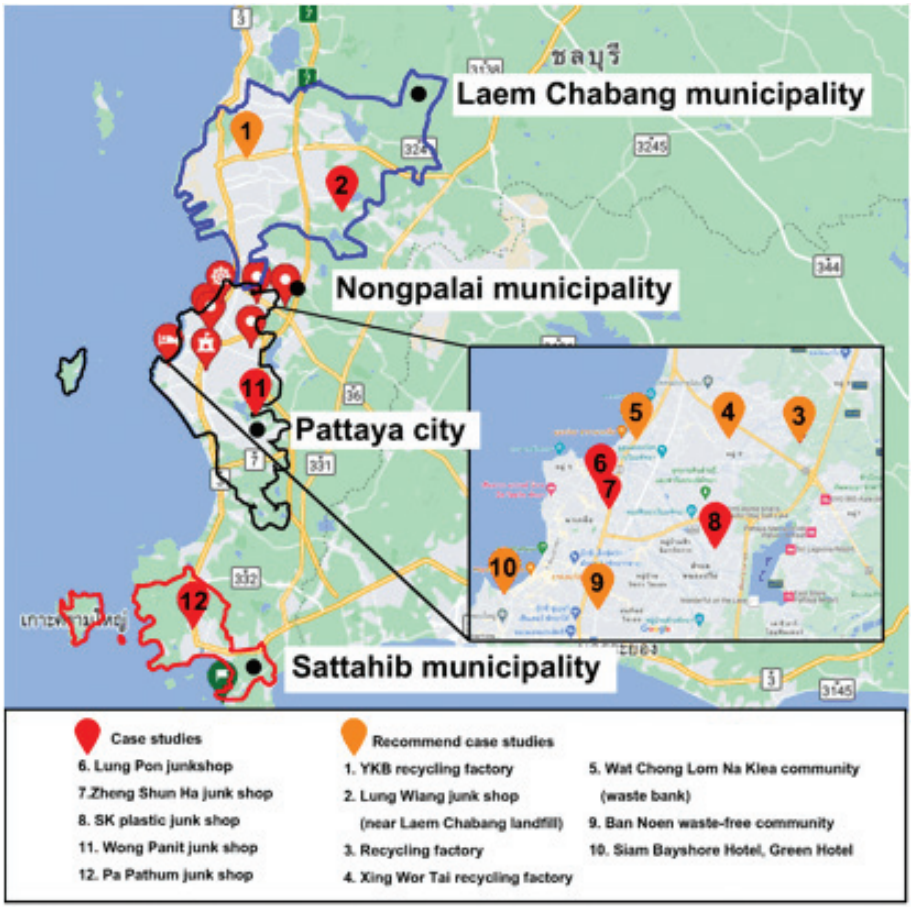
2. The guideline is developed based on the situational analysis report which considered both primary and secondary data. Secondary data were obtained through literature review. Primary data were collected from field visits, stakeholder interviews, and consultation workshops.

3. The study area in this guideline is the city of Pattaya.

### 1.3.2 Study Area

Pattaya City is an urban municipality situated in Bang Lamung District, mostly in Tambon Nong Prue but with areas in Huai Yai Subdistrict, Nong Pla Lai Subdistrict, and the Naklua Subdistrict. It is a popular tourist destination, located 150 kilometers from Bangkok and is easily accessible via the Sukhumvit Highway. The geography of Pattaya City is hilly, with few plains, and major flatlands which are typically commercial districts or sources of water. The city's location as a coastal area in Thailand and rapid urbanization has contributed to the production of significant amounts of plastic waste. in the municipality. This problem has worsened as Pattaya

**Figure 1. Map of Pattaya City and the Surrounding Area**




Source: Study Team based on Google Map

is considered a popular tourist destination and with thriving businesses in various sectors and industries.

Pattaya City was selected as the study area because of its popularity as a tourist destination which generates a large amount of waste from the high volume of tourists and activities. The city has also experienced rapid urbanization and economic growth, leading to increased consumption and waste production. These trends have impacted the waste management infrastructure, while highlighting the importance of sustainable waste management practices. According to a report by the Pattaya City Hall, the city generates around 700 tons of solid waste per day, which is expected to increase to 1,000 tons per day in the near future. Additionally, there are concerns about the possibility of plastic leaking into the water bodies since Pattaya City is located in the coastal area. .

As shown in Figure 1, five different junk shops or recycling centers in Pattaya City and the surrounding area were visited (see Appendix B: Figure B1-1). City regulations stipulate that these recycling centers should operate outside the city, except for a few remaining junk shops that are within city limits. Three out of the five sites visited appeared to be small with operations primarily focused on receiving, segregating, and selling waste to factories, without the use of machinery. The remaining two sites, which also engaged in plastic grinding, are situated nearby in the outskirts of the city center.

Examining the plastic waste situation in Pattaya City offers valuable insights into the challenges and opportunities associated with waste management in a rapidly urbanizing and developing area. It also sheds light on the potential influence of tourism and industries on waste generation and its effective management.

### 1.3.3 Existing Initiatives in the Study Area

As Pattaya City aims to transition itself into a Greenovative Tourism City that prioritizes eco-friendliness and sustainable tourism development, effective waste management is considered as significantly important for the city. To achieve this, previous recycling initiatives included the installation of recycling bins at beaches and tourist spots, the distribution of color-coded waste disposal bags, and awareness campaigns in schools. Recent recycling campaigns, "Trash-to-Cash Recycling" and "Cleanliness before Dawn" have also been launched. The "Trash-to-Cash Recycling" project was introduced to enhance people's awareness about waste management in Pattaya; specifically, to promote the 3Rs approach, Reduce, Reuse and Recycle (Pattaya Mail, 2023). For the "Cleanliness before Dawn" initiative, eight community contractors are responsible for waste collection whereby each contractor supervises a team of seven workers who collect and clean the waste daily. Currently, four daily waste collections are spread out in Pattaya using 37 vehicles (ASEAN Now, 2019); the total waste collection reaches approximately 450 tons each day.

## 1.4 Target Users of the Guideline

Target users of the guideline are the following:

- Government officers, including staff members responsible for Environmental Impact Assessment (EIA)
- Local government unit (LGU) of Pattaya City
- Informal stakeholders (e.g., informal waste pickers and recyclers or junk shops)
- Clean production or recycling centers
- Associations of plastic recyclers
- Other actors involved in the plastic industry

# Chapter 2

# Gaps

## 2.1 Existing Policy/Regulations

Thailand's plastic waste management policy has been influenced by international commitments and trade agreements. To effectively address the problem of plastic waste in the country, the government has developed the Action Plan on Plastic Waste Management Phase II (2023-2027), with voluntary participation from all sectors. Thailand has also banned plastic waste imports from several countries, which has encouraged domestic plastic reuse. However, the ban on plastic scrap imports in 2025 does not cover recycled plastic resin needed in the production process.

One of the main challenges in implementing the policies is the lack of good governance caused by limited access to accurate information and knowledge, especially in the informal sector. In Pattaya, for instance, the database of plastic volumes is unavailable due to lack of waste separation techniques. In addition, effective communication among different actors and stakeholders is necessary to achieve successful governance outcomes whereby both the national government and local government units can play a key role as facilitators. In Thailand, the reality is that the private sector consists of a large proportion of small and medium-sized enterprises which are mostly informal. It also lacks organized associations and key representatives which creates a challenge for the government to engage with related parties effectively.

The current regulation with regard to establishing junk shops or recycling centers restricts owners from building them within a residential zone. According to Pattaya Municipality, only one junk shop is registered within the city while others have moved out. In addition, all junk shops are required to comply with the regulations instituted by the Department of Public Works and Town & Country Planning, and Pattaya Environmental Office. A detailed site plan with a proposed space utilization must also be submitted before setting up the business. One major barrier for junk shops from legally registering under the municipality is the strict regulations where one violation could lead to permanent closure without prior warnings.

Nevertheless, several gaps in the policy were observed. At the local government level, comprehensive frameworks with policy and instruments that align with national strategies and plans are lacking. In addition, Thailand's Plastic Waste Policy relies mainly on voluntary compliance rather than strict enforcement. There is also inadequate budget allocation for the informal waste sector, and current policy and regulations do not provide extensive support to those involved in the sector. Lastly, small and medium informal plastic waste recyclers could not access waste-to-energy or RDF factories. To address the gaps, the Thai government should develop a national policy that provides the necessary budget to improve and promote the informal waste sector. It is also important for LGUs to discuss with all actors in both the informal and formal sector to develop effective policies and regulations to manage plastic waste. At the same time, quarterly inspections with all stakeholders must be conducted to ensure that proper waste management protocol is adhered to.

## 2.2 Institutional Arrangements

The responsibility for waste management in Thailand is shared between the national government, local governments, and private sector operators. The national government establishes laws, regulations, and standards at the national level and controls expenditures on solid waste management. On the other hand, local governments are directly responsible for solid waste management which includes waste collection, disposal, and recycling. They are also in charge of developing local regulations, implementing policies, and educating the public on proper waste management practices. The central government also provides support and technical know-how to the local governments.

In Pattaya City, solid waste management including plastic waste management is the responsibility of the local government. The Pattaya Environmental Office and Pattaya Clean City Committee collaborate to formulate policies and regulations related to waste management and enforce them in accordance with the national government's policies. The municipality uses a model of outsourcing waste management; that is, contracted partners in the private sector provide services for waste management systems that include collection, transportation, and disposal of waste. Moreover, the contracted partners invest in the "design system, land, construction disposal system, preparation material, machine technology and employee, etc." (Anantanatorn et al., 2015). Then, plastic waste is sorted, recycled, or sent to a landfill or waste-to-energy plant. Pattaya City Office works closely with different local government offices to develop policies and regulations related to waste management. Apart from this, several agencies and legislations are in place to manage plastic waste and regulate plastic waste trade at the local level.

Despite the progress achieved at the local level in plastic waste management, several gaps have been identified. Firstly, collaboration between local government units (LGUs), the private sector, and the public sector is insufficient. There is also a lack of supportive infrastructure for the informal waste sector in Pattaya. Additionally, cooperation between various private sectors such as tourism associations, hotels, and fisheries, and the local government has been ineffective. Another problem is that the existing legal framework is ineffective in addressing the challenges of plastic waste management. Comprehensive awareness campaigns on recycling within the community are also lacking, and insufficient incentives to encourage the operation of registered junk shops have further hindered the effective implementation of waste management practices in the city.

To address the gaps, several recommendations can be considered. Firstly, it is crucial for the national government and local government units (LGUs) to collaborate effectively in creating a supportive environment for the informal waste sector. One approach for this could be the implementation of policies and programs aimed at empowering informal waste workers and integrating them into the formal waste management system. Additionally, organizing annual meetings between the LGUs and formal and informal waste actors to monitor and evaluate the effective implementation of the strategies and to track their progress over time. Furthermore, priority should be given to collaborative efforts between LGUs, non-governmental organizations (NGOs), and development partners to promote more awareness campaigns on recycling within the community. These campaigns can enhance the understanding of residents about the importance of proper waste segregation and recycling practices, ultimately leading to a more sustainable approach to plastic waste management in Pattaya.

## 2.3 Technology

Technology plays a pivotal role in addressing plastic waste issues, particularly in preventing plastic leakage into the environment. Therefore, effective solutions to plastic pollution necessitate technical expertise across various domains, alongside the promotion of research and development and innovation capacities. However, it was found that technical capacity is inadequate. For example, individuals responsible for plastic recycling processes, especially within the informal waste sector, have limited training in chemical processing, supply chain management, and the environmental implications of different plastic types. Another deficiency is in the budget allocation for innovative waste recycling technologies that could support the overall infrastructure to prevent plastic leakage alongside technological limitations stemming from inadequate. Additionally, there's a lack of initiatives or incentives to advance social and technical innovation for sustainable waste management practices. To address these gaps, systematic technical training programs for plastic recycling must be implemented. An adequate budget should also be allocated to local government units for innovative technology adoption in plastic waste management. Hosting public forums to stimulate technological innovation in the sector is another way to address the gaps. These recommendations are presented for the purpose of enhancing the technical capacity of actors and promoting innovative solutions for sustainable plastic waste management.

## 2.4 Resources

The city of Pattaya is confronted with significant challenges in its plastic waste management infrastructure that could potentially lead to increased plastic leakage into the environment. One of the main factors for this is the inability of the city to provide adequate waste management facilities that meet the growing demands as a major tourist destination. Furthermore, the lack of skilled workers proficient in post-processing recycling techniques exacerbates the issue. Additionally, limited access to financing for eco-friendly solutions and innovations further hampers effective waste management efforts. These challenges, however, can be addressed by improving waste management infrastructure and facilities within Pattaya. This includes the establishment of proper waste treatment plants and recycling facilities. By providing training and workshops to informal workers, their competence in proper waste collection, sorting, and recycling techniques can be improved. Effective collaboration between the national government and local government units (LGUs) is also essential to provide financial options and support for the various needs of the informal waste sector so that they are able to adopt more sustainable waste management practices. Furthermore, LGUs should prioritize creating networks and fostering information transparency to facilitate efficient communication and collaboration among stakeholders involved in plastic waste management efforts. By implementing these recommendations, Pattaya can work towards preventing plastic leakage into the environment and fostering a more sustainable waste management system.

# Chapter 3

# Value Chain of Plastics and Resin Pellets in Pattaya City

The Office of Public Health and Environment in Pattaya City oversees waste collection and transportation, primarily relying on landfill and incineration methods. To address the lack of waste separation infrastructure, the city council has recently approved an incinerator project on Koh Larn. A private company manages the waste transfer operation. This involves collecting plastic waste and transporting it to a transfer station in Soi Sukhumvit-Pattaya, where it undergoes disposal or processing. Informally, waste collectors gather waste from various sources, which is then sorted and processed for sale to other industries. Despite its recycling efforts, Pattaya still generates approximately 350 to 370 tons of waste daily, contributing to plastic leakage in the environment, particularly in water bodies like canals, rivers, and the ocean; thereby, posing significant environmental challenges. With the informal sector lacking formal waste management systems, plastic leakage remains a pressing issue, exacerbated by the city's coastal location and potential sources such as LDPE, HDPE, and Polyester materials.

As mentioned in the report by IUCN-EA-QUANTIS (2020) in 2018, those forms of plastics were the major contributors of plastic leakage in Thailand. LDPE is used to make plastic bags but after discarding them, much of the plastic bags end up in landfills or dump sites due to the absence of LDPE recycling methods in the city. Unlike LDPE, HDPE is collected for recycling but due to its high demand in the packaging sector, there are chances of it being leaked in the marine environment. Likewise, the absence of a proper recycling method for polyester fibers and the limited capacity of sanitary landfills have resulted in certain amounts of polyester ending up in unsanitary landfills or dumps sites, or even remain uncollected. Consequently, some leakage into the marine environment occurs.

Findings from the site visit also reveal that both the formal and informal sectors have contributed to the problem of plastic leakage in the city. The main cause for this is poor communication between the local authorities and those in the informal sector while waste sorting remains an important challenge in the formal sector. . In fact, a study of the site also demonstrates that much of the waste collected in the formal sector is unsorted, so it is disposed of rather than recycled. Therefore, the potential for recycling plastics is underutilized in the case of the formal sector.

As for the informal sector, various companies reported multiple issues with plastic wastes that are attributed to the enormous cost of recycling. For instance, some facilities lack mechanical infrastructure such as plastic cleaning, shredding, or grinding machines that lead to leakage of plastic materials into the water. Because of financial considerations and the high volume of usage, collection and recycling of entire plastic waste is currently not performed and only some forms of plastic wastes are being recycled. Items such as plastic bags and foams, for instance, are used at very high volume which makes them difficult to collect and recycle.

In addition, factories responsible for waste sorting and recycling are unable to conduct proper recycling procedures such as crushing, pelletizing, cutting, modifying, and repairing of old plastic which increases the potential for leakage. In total, it is estimated that as much as 20 percent of the total plastic waste is unsellable and is either disposed of or leaked. Also, junk shops, especially the small and medium-sized ones, concentrated on the waste segregation process where plastics represented merely one third of the waste they handled as observed during the site visits.

Informal waste collectors also lack access to transportation vehicles which makes it difficult to transport collected waste. Collection of smaller plastic waste such as pellets, for instance, requires transportation vehicles. As observed during the site visits, small junk shops utilized open-type trucks

Pattaya City, Thailand

or pickups (see Appendix B3), which generally do not process small plastic wastes like pellets and flakes. However, if they were to handle pellets and flakes, the use of open type trucks or pickups would lead to more plastic leakage. Therefore, the absence of suitable transport vehicles makes it considerably difficult to collect small plastic waste from transfer stations or waste bins of public and residential trash bins and transport them to the junk shops. This condition can result in leakage. Another potential cause could be illegal dumping of the unsold residues of plastic. Hence, understanding and analyzing the waste transport system in the informal sector is fundamental in preventing plastic leakage.

Besides the problems associated with formal and informal waste recycling processes, the larger infrastructure for waste disposal also poses some challenges. In the city, waste from the building industry is disposed of in open landfills. As it lacked its own waste separation system before disposal, the municipality was unable to provide the exact amount of waste collected. Illegal dumping of waste was also evident in the city, particularly in the areas outside the city center. To resolve the issue, the city implemented a waste separation and collection program and introduced a system of fines for illegal dumping.

Based on the data collected, Pattaya City certainly has a high possibility of plastic leakage because of various issues. However, this could not be supported by accurate figures since databases of waste management systems are unavailable. Although there are various waste management facilities such as landfills, incinerators, and composting facilities in the city, they are not operating at their full capacity and there are environmental concerns regarding their operations. At the institutional level, communication regarding plastic leakage between the authorities and the informal sector is poor.

# Chapter 4

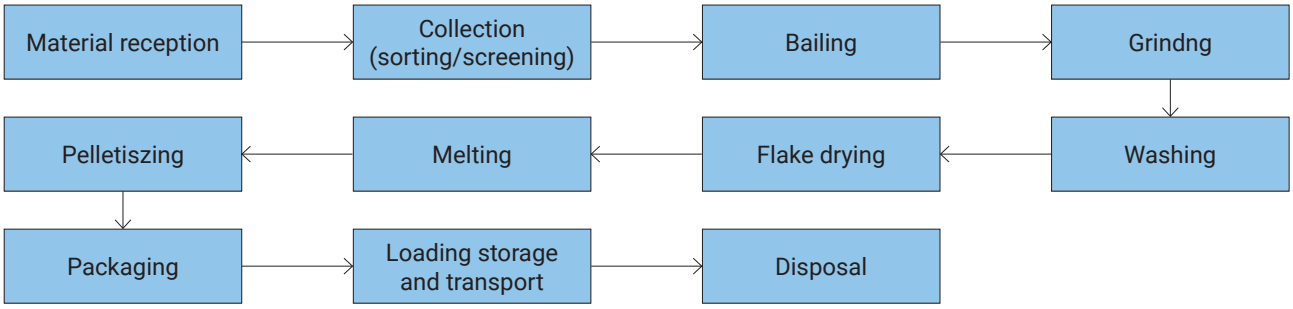
# Recycling Processes and Activities in Pattaya: Case Studies

## 4.1 Recycling Processes and Activities in Pattaya with Case Studies

A suitable full recycling process consists of several steps as illustrated in Figure 2. However, as mentioned in Section 3, recycling centers that operate the whole recycling process were not found during the site visits. Instead, they operated in the material reception, and collection (sorting/screening) while two centers proceeded to baling and grinding.

Table 1 explains how the plastic recycling process is carried out in detail. However, most informal waste collectors in Pattaya have insufficient skills and technical knowledge to operate machinery. Findings from the research reveal that only few recycling

**Figure 2. Plastic Recycling Process**




Source: Adapted from GIZ (2023)

**Table 1. Process for plastic recycling**

| Process | Steps |
|---|---|
| 1. Material reception | Receive the collected waste and separate plastic bottles and other plastics for recycling.<br>If the waste is in bale, open the bale and separate plastics bottles and other plastics. |
| 2. Sorting | Separate the labels using a label remover machine. Remove manually the labels that are difficult to detach.<br>Segregate colored and transparent PET, HDPE bottles and other bottles.<br>Separate other types of plastics |
| 3. Bailing | Compress the plastic into cubes |
| 4. Grinding | Crush plastic bottles and lids to the appropriate size i.e., Flakes allow easy separation between bottle and lid. |
| 5. Flake washing | Clean the flakes by washing them thoroughly. |
| 6. Flake drying | Remove water from the flakes to dry them and ensure moisture in the material output adequately removed |
| 7. Melting | Melt the dried flakes. |
| 8. Pelletizing | Cut them into pellets. |
| 9. Packaging, storage and transport | Pack the finished product for transport to other facilities and manufacturers. |
| 10. Disposal | Dispose generated waste that cannot be further reused or recycled using an appropriate disposal method |

Source: Study Team

factories in the formal sector operate using the whole recycling process (e.g., Indorama Ventures Company Limited).

Pattaya aims to transform itself into "Greenovative Tourism City", as part of the Eastern Economic Corridor (EEC) development plan. Thus, the city has restricted informal junk shops and recycling centers in the outskirts of the city. However, a few registered junk shops remain within the city, but these are mostly small-scale and handle various kinds of waste instead of specializing in plastic waste. Most of these small-scale junkshops concentrate on waste segregation before transporting waste to a larger recycling business area that carries out bailing, grinding, and producing plastic flakes. After looking at the condition of the visited sites in Pattaya City, it was found that the operating processes are inadequate. A total of five sites were visited which are mostly small-medium sized (see Appendices B2 and B3 for more information).

### Site:1 Wongpanich

At Wongpanich, salengs, households, towns, shops, wholesalers, and convenience stores were places from where the small junk shop collected recyclable waste. They collected various types of waste. For plastic waste, the site conducted the plastic sorting process and fixed the prices for different types of plastics like colored plastic, colored and opaque PET water bottles, HDPE white-opaque water bottles, and other forms. However, due to the high cost of plastic recycling, the junk shop could not perform other methods such as crushing and/or pelletizing plastic, cutting scraps, and modifying, repairing, assembling, improving, or changing the form of materials.

### Site:2 Lung Pon

Lung Pon was the second facility that was observed. It is a small-sized junk shop that purchased recyclable and sellable waste from the community and households. After obtaining the waste, the dirty wastes are sorted and sold to Zing Whor Thai and Pattaya Paper Mill Company. Only two to three workers were onsite, which demonstrates the limited capacity in terms of space and human resources at this site. Moreover, the junk shop had no plastic grinder because of constraints in time, finances, and workers. According to the workers, about 3% of plastics such as ABS, PC, PS, or PVC from plastic electrical components could not be sold. They planned to dispose of the unsold items at the Nong Prue landfill since they are not recyclable.

With regard to the collection and transport of waste, the junk shop had four pickup trucks mainly for recyclable plastic waste. Most of the plastics they handled were in their original forms but approximately 3% of the plastics received were non-recyclable, which would end up in the main landfills. This clearly shows that the owner is not concerned about the potential plastic leakage into the public water from the shop. She suggested that the sellers should segregate the waste first before selling it because there is a potential for better earnings from the higher price. Since Pattaya has limited facilities for hazardous waste, she recommended the expansion of landfills to accommodate the hazardous waste.

### Site 3: Pa Pathum

The third site was a medium-sized junk shop called Pa Pathum. In contrast to the other sites visited, it followed some of the procedures prior to plastic recycling. Their waste was from three different places, landfills, markets and other junk shops, and community households. Firstly, the labels were removed using a label remover machine or manually. Then, the plastics were separated based on color and type and then shredded using a shredder machine. Finally, they were sent for recycling. However, the shredded plastic was left unwashed and sold to recycling factories which would continue with the recycling process such as melting and pelletizing.

The owner of Pa Pathum also shared a similar experience that 15-20 percent of the plastic being sent to their shop were unsellable or unrecyclable because of its condition or low quality. Therefore, they were disposed of at the landfill. Selling them to RDF factories is an alternative for the shop, but accessing RDF factories or other waste-to-energy factories has been a challenge for small and medium junk shops such as Pa Pathum as raised during the workshop The owner, however, was not concerned about the plastic leakage despite the fact that some plastic flake leakages were observed in the

surrounding area of the shop which were difficult to sweep or clean.

### Site 4: TungSueHa

TungSueHa is another small-sized junk shop located in the city, beside the hospital. It also sorted and categorized various types of uncleaned waste collected from households. There were two storage areas for plastic waste; one was for PET bottles and another one was for mixed plastic wastes such as HDPE and other types of plastic waste. During the visit, it was observed that salengs and community members brought various wastes in their motorbikes and cars, which were weighed and paid according to the weight and type of waste. The prices of plastic waste are fixed daily depending on the market rate. Most of the plastic waste they handled was PET and HDPE, both white opaque and colored. The labels were removed and sorted separately, but the shop did not perform washing, grinding, and drying due to limited time, money, and resources to hire more workers. They only accepted two types of plastics because of their higher values compared to other types of plastics. The main concern was that the mixed types of plastic bottles were of low quality, and they were sold at low prices because they could not be recycled. According to them, glass bottles were more profitable.

### Site 5: SK Plastic

SK Plastic, the last site we visited, was the largest junk shop in Pattaya. Small and medium-sized junk shops sell their plastic waste back to them. They accepted mixed plastic bottles which were sold for 9 Baht per kilogram and sourced different types of plastic waste from waste pickers, salengs, households, and other junk shops. The waste was sorted manually based on colors and types. They also had a grinding machine which enabled them to grind waste before packing and transporting it to other factories in Pattaya and Samut Prakan including plastic melting factories near Suvarnabhumi airport in Bangkok. Approximately 5-10% residues were generated according to the owner, and out of those residues, around 10% were not acceptable as they were colored plastics mixed with unwanted materials such as metals and other plastic labels.

In Pattaya Municipality, all the visited junk shops are registered and operate legally as shown in the research conducted in the area. It was also found that all the junk shops maintained a high level of cleanliness and hygiene standards. The workers also wore masks and gloves when handling the waste, which is part of the criteria to ensure health safety. The businesses were generally concerned about creating a clean environment by minimizing the noise and odors, and regularly cleaning the site area. However, the facilities faced various challenges such as reduced prices of plastic waste, an increase in the number of low-grade unrecyclable plastics, and a decline in the amount of plastic waste processed due to a competitive recycling market and shortage of labor. As a result, some plastic factories chose to import plastic waste for recycling purposes as it is more cost effective.

## 4.2 Analysis of Case Studies

As outlined in Table 1, Pattaya City's current recycling process does not follow an acceptable procedure. The previous section highlighted the fact that much of the waste collected in the formal sector is not sorted and is often sent directly to the disposal centers. Similarly, various problems persist in the informal sector. For instance, Wongpanich (Site 1) performed only garbage collection and disposal and did not conduct any other processes involved in recycling. Lung Pon (Site 2) and Pa Pathum (Sites 3), in contrast, sorted the waste before selling them but none of the other recycling processes were followed in these sites. Moreover, TungSueHa's (Site 4) operations involved sorting and grinding but did not engage in recycling processes. Like TungSueHa, SK Plastic handled sorting and grinding but on an enormous scale excluding melting and succeeding processes. In sum, all five sites visited ignored the entire recycling processes although TungSueHa and SK Plastic included some post-processing of plastic materials. Some of the reasons for not expanding their operation could be financial constraints and restrictions in location. For the junk shops to operate with better facilities would require more space in addition to financial resources; this means relocating to the outskirts of the city. Furthermore, the local government has not shown high interest in the informal sector nor has it provided some

support. Hence, policies and regulations on waste management must be improved so as to motivate recycling centers to be involved in the whole recycling processes and eventually minimize the plastic leakage.

Another observation from the site visits was the inability of the informal waste recyclers to recycle all the collected plastics. According to SK Plastics, at least 10% of the recycled plastics received were rejected and transported to the landfills. The other visited junk shops also shared similar feedback. Moreover, accessibility to RDF/Waste-to-energy factories remains a challenge for small and medium-sized junk shops which resulted in their inability to sell the remaining plastics in other places. Some leakages from the residues were also detected in the surrounding areas of the junk shops, either as flakes or in original states. Although the leakages may not be a serious concern in the dry season, they can leak into the marine environment during the rainy season. Leakage can also occur during transportation as most of the junk shops utilized open-type trucks to transport waste while the bags used were loosely tied. Thus, there is a high probability of plastic waste leakage due to improper waste management and mismanaged transportation and logistics processes, harming the marine environment. Providing formal guidelines to and proper training of junk shop owners is necessary to reduce the potential of plastic leakage.

Another essential solution would be regular monitoring and inspections of the sites. Inspections by the municipal authorities are done annually when the business owners apply for yearly re-registration. Sites are checked in accordance with the regulations, and if they fail to meet some criteria, owners are required to address the problems before the next visit. Failure to do this would result in rejection of the registration application and business closure. Although annual inspection for the renewal of license registration enables authorities to inspect and monitor the sites, this is inadequate since the businesses are handling plastic waste and other wastes which might be contaminated. Therefore, regular routine inspections such as those done quarterly must be conducted.

In conclusion, while facilities in all the sites were responsible for waste collecting and selling after segregation, the other recycling processes were excluded except TungSueHa (Site 4) and SK Plastic (Site 5) which also included grinding in their operations. Based on these findings, policies and regulations on waste management must be revised so as to encourage businesses to incorporate the whole recycling processes in their operations. Regular monitoring and inspections to ensure appropriate standards for proper recycling processes must also be included in these policies. Lastly, there is a need to ensure improvements in waste disposal practices, address transportation and logistics related leakages, and promote effective management of waste..

# Chapter 5

# Interventions for the Reduction in Plastic Leakage

Pattaya City was found to have a high possibility of plastic leakage which contributes to growing environmental and health consequences. It is also evident that the city's informal sector lacks the capacity to implement a proper recycling process. Thus, various measures need to be implemented to address the issue which requires the involvement of all sectors, the government, and both the formal and informal sectors .

## 5.1 Reduction at source

As discussed in Section 3 and 4 of this report, one of the key factors that contributed to plastic leakage was the enormous costs involved in sorting waste in the formal and the informal sectors. One important mechanism to reduce this problem is to change consumers' behavior at home. This involves certain activities at home such as cleaning and sorting household waste before disposing of it. However, the public should be educated on the importance of proper waste disposal, separation of waste before it enters the waste stream, and recycling to achieve plastic circularity. Initiatives can also be undertaken at the community level to promote reduction in plastic usage and proper cleaning and sorting. This might involve designing community-based waste management models that involve neighborhood collection stations and incentivizing residents to bring recyclable materials to the stations. A popular example is the Waste Bank Initiative, which is now operational in various locations in Thailand. Under this program, students obtain leadership training to bring and deposit recyclable items from their homes to community waste banks.

Similarly, the Rayong Model that is currently under implementation in Rayong Province also focuses on raising awareness among the locals about different types of waste and waste sorting procedures as requirements for recycling. One advantage of this model is that cleaned and sorted wastes can be sold by households at high prices in the market: thereby generating income for them. The scheme has proven to be an additional source of income for various households in Rayong and a successful venture (Piyasrithong, 2020). At the same time, the local government can promote the use of reusable bags, like paper bags, biodegradable bags and containers to lessen the use of single-use plastics. Some agreements with the retail sector can also be developed by local authorities to encourage them to reduce free plastic distribution.

The informal sector should also be made aware of the impacts of illegal dumping and educate them regarding the proper plastic recycling practices. Local governments should also encourage more door-to-door waste collection services from the informal waste pickers instead of dumpsites and street picking. This could be done by establishing an informal sector cooperative network and collaborating with the formal sector, providing them with salaries or other forms of social securities, or providing them access to highly valued wastes in addition to low value wastes. This process involves providing informal workers access to door-to-door waste or community-based wastes instead of relying mainly on scavenging plastic wastes from dumpsites. Since plastic materials collected near the source of emission tend to be higher than those collected near dumpsites, the initiative can effectively help reduce waste leakage (Velis et.al, 2022).

Pattaya City has, in fact, already started initiating projects aiming for waste reduction and a circular economy. For example, the local government has been promoting the separation of waste (i.e., food waste, recyclable waste, and general waste) in the community through color coding of trash bags. Moreover, the municipality increased the number of trash bins in different colors according to the type of waste in public areas such as beaches and other tourist spots. A recent project, Tod Phapa Garbage Recycle (Trash-to-Cash Recycling), was organized at Pattaya School 7 in June to increase awareness about waste management in the city (Pattaya Mail, 2023). This initiative promotes the value of

recycling reusable materials and how this can benefit individuals who process and sell these materials. The event also provided information on proper waste separation and sorting methods and the 3Rs approach for sustainability. Various government agencies, businesses, and community members expressed their positive support for the program. Therefore, this type of program should continue, and similar activities must be initiated to promote reduction at the source.

Findings from the site visits also revealed that plastic wastes were already sorted beforehand from other types of wastes prior to being sold to the junk shops by the households and community members. This indicates that they are taking the initiative in p waste segregation at the source. Thus, reducing the risk of plastic leakage to the environment.

## 5.2 Improvement in Infrastructure and Technical Capacity

As mentioned in the previous section, designing mechanisms that facilitate cleaning and sorting at homes and in communities is an important step in reducing plastic waste and promoting recycling. However, this would require investment in collection stations and bins by the city government. Furthermore, our analysis shows that Pattaya City has been confronted with challenges related to plastic waste as a consequence of inadequate waste management infrastructure and services. Another issue is the underutilization of the city's existing infrastructure. Therefore, waste management in the city must be improved and strengthened. Local authorities also need to support the existing facilities including landfills, incinerators, and composting so these can operate at full capacity.

To effectively realize the programs, the capacity of the informal sector needs to be strengthened and better coordination between the formal sector, informal sector, and the government must be achieved. This might require establishing formal partnerships between the informal and the formal waste sectors and providing training and capacity building to strengthen the informal sector. For instance, it is evident from a report by ESCAP (n.d.) that partnership between informal and formal sectors is important to address plastic leakage. In the case of Phitsanulok Province, about 95% of waste was prevented from going to landfills as a result of the strong collaboration between the two sectors. Thus, similar efforts can be applied in Pattaya City.

The local government can also design financial interventions like providing the formal and the informal sectors with some financial assistance to purchase equipment and machinery required for various recycling processes. This is aimed at encouraging the sectors to recycle more and lessen the leakage. Moreover, the government can invest in some of the necessary facilities such as suitable material recovery facilities in the informal sector which offer safe and environmentally friendly sorting spaces. Since such facilities can be too expensive for those in the informal sector, the government can provide spaces for them to carry out their activities. This is a crucial intervention because various participants from the survey have reported that due to the volume of plastic wastes, they were not able to sort, clean and process materials properly and had to throw away a lot of high-volume low value plastic in the process. The main reason for this is that storage spaces for the informal sector are mostly family-owned shops or houses that have very small storage capacity. Thus, it is clear that the availability of a storage space is an important mechanism to prevent leakage. Another important method for addressing plastic leakage is the increase in investment in technologies such as waste capture nets.

One main technical challenge, however, in controlling plastic waste in the city is the unavailability of accurate data and information. Currently, there is no reliable mechanism to measure the value chain of plastic flow within the city because various actors including unregistered informal actors are involved in plastic waste management. As a consequence, the authorities have insufficient data on the quantity of waste collected. To address this limitation, there is a need to register and formalize the sector and establish a data registration system that tracks the actual plastic leakage in the city. Since proper assessment of the value of waste

pickers is nonexistent, appropriate mechanisms must be designed to formalize the process of plastic usage and plastic collection. One way to achieve this is by involving the informal sector in a legally established cooperative or collective entity whereby the volume of transactions can be tracked through bookkeeping. The formalization of the value chain can, therefore, assist in tracing and identifying points of leakage. Lastly, through these collective enterprises, the government facilitates the provision of a much-needed large scale infrastructure to the informal sector. It is important to reiterate that the local government should also strengthen laws relating to proper recycling of plastic waste including handling and transport of plastic waste while undertaking timely monitoring of the facilities and enforcing penalties for noncompliance.

## 5.3 Incentivizing Plastic Collection

The interviews revealed that one important cause of the plastic leakage in the city was the significant volume of low value plastic waste. This can be attributed to the high costs of storage, cleaning, and low market prices. Considering the costs of negative externalities created by plastics, such as environmental costs when pricing plastic; thereby, raising the prices of plastic waste and making them more profitable for collection. This could be one approach the city government can pursue in order to create a more gainful income-generating work for the waste pickers. More incentives and facilities can also be provided for those in the informal sector to enable them to address their basic needs and make their jobs more economically profitable. For example, incorporating them in the formal sector, providing them with salaries or a minimum wage or other forms of social security, or providing them access to high-value waste along with low value wastes are some forms of support.

Based on the analyses presented in the previous sections, some recommended guidelines for different stakeholders to reduce plastic leakage in Pattaya are presented in Table 2.

**Table 2. Guidelines for different sectors to reduce plastic leakage in Pattaya Municipality**

| | |
|---|---|
| Local Government | • Strengthen community-based waste management models and encourage waste collection and sorting at the source.<br>• Create awareness among locals regarding the importance of proper waste management.<br>• Develop partnerships between the formal and the informal sectors to enhance waste management capacity.<br>• Develop guidelines for the informal sector regarding operation and proper waste handling.<br>• Conduct regular inspection and monitoring of the recycling facilities and the movement of plastic waste to prevent any plastic leakage.<br>• Ensure compliance of regulations related to waste management and recycling.<br>• Provide financial assistance and incentives to the informal sector to improve recycling.<br>• Invest in waste management infrastructure to support proper waste sorting and disposal.<br>• Develop mechanisms to improve data governance.<br>• Allow accessibility to RDF and other alternatives for the small and medium-sized junk shops to dispose of the non-recyclable plastics |
| | **Management Practices** |
| Informal Sector | • Strengthen existing door-to-door picking of waste instead of dumpsite and street picking.<br>• Incentivize the collection of low-value plastic waste to reduce the gap of leakage.<br>• Enhance human resources capacity through training and skills development programs.<br>• Prepare internal site audit plan, implement and monitor it on a regular basis. |

*Continued next page*

Table 2 continued

| | Human Resource Practices |
|---|---|
| | • Educate employees on the identification and separation of different types of plastics based on their types, color, and recycling capacity.<br>• Maintain a proper storage system for segregated and unsegregated plastic waste to reduce the leakage.<br>• Maintain regular cleaning of the recycling facility.<br>• Properly load plastic waste and use secure and leak proof transportation vehicles to transfer waste.<br>• Adopt a proper disposal method to minimize plastic waste leakage.<br>• Maintain a record of the plastic waste received and sold at the junk shop and the documents related to the operations. |
| Private Sector | • Use biodegradable packaging to minimize unrecyclable plastic usage.<br>• Encourage the reduction of single-use plastic.<br>• Invest and support new initiatives and technologies aimed at reducing plastic leakage.<br>• Partner with the local government and the informal sector to raise awareness on the negative impacts of plastic waste leakage.<br>• Review the internal site audit of the junk shops and recycling facilities and encourage owners to adopt proper waste segregation and recycling methods. |

Source: Study Team

# Chapter 6

# Internal Site Audit

Daily monitoring and recording of data generated from each step must be tracked accurately. These enable the identification of possible leakages and prevention of further leakages through containment and appropriate treatments. Before initiating the site audit, the selected auditors need to be trained properly in collecting accurate and consistent data. The following steps need to be taken to schedule an internal site audit:

1. Form an audit team consisting of individuals from different departments or disciplines within the organization.

2. Develop an audit checklist or questionnaire to guide the data collection process.

3. Conduct interviews or discussions with key personnel involved in the whole chain of operation.

4. Collect data in each step of the recycling process (from waste collection to the disposal of excess and unrecyclable plastics)

5. Compile and organize the collected data in a centralized database for data analysis.

6. Identify specific areas or processes for possible leakages so that remediation options can be identified to reduce plastic leakages.

7. Prepare a comprehensive report summarizing the audit findings including quantitative data, observations, and key insights.

8. Highlight areas of concern, inefficiencies, or opportunities for improvement.

Provide recommendations for further improvements.

A sample checklist that needs to be observed for the internal site audit is displayed in Table 3 for the main purpose of quantifying the level leakage and identifying proper methods for improvements.

## Table 3. Sample checklist for internal site audit

| Process | Question | Finding (Yes/No/NA) | Level of Leakage (%) | Scope of Improvements |
|---|---|---|---|---|
| Material reception | Are the plastics separated properly into recycling? | | | |
| Collections and Segregation | Have the handlers conducted any of the following activities:<br>• Sort by plastic type<br>• Remove labels (if applicable)<br>• Wash the plastics properly to prevent contamination | | | |
| Bailing | Are all the segregated plastics bailed properly into cubes? | | | |
| Grinding | Are the bailed plastics being grinded?<br>Have there been any evidence of microplastics around the grinders? | | | |
| Washing | Are the plastic flakes properly washed?<br>Are there any signs of leakages during the transport from washing to drying process? | | | |
| Flake Drying | Are there any leakages when the flakes are put into dryers?<br>Are there any leakages when the flakes are taken out of the dryers for melting? | | | |
| Melting | Are all the flakes melted without spillovers? | | | |
| Pelletizing | Are there any signs of leakages during the pelletizing process? | | | |
| Packaging, Storage and Transport | Have the handlers conducted the following activities:<br>• Package and seal the pallets properly.<br>• Store in the designated areas<br>• Transfer the properly packaged pallets into the transportation | | | |
| Disposal | Are the unrecycled plastics sorted properly?<br>Are the unrecycled plastics properly packaged and put into transportation?<br>Are the vehicles' storage doors closed properly? | | | |

Source: Adapted from Sustainable Electronics Recycling International (2014)


pepsi
nestlé
CONTENT 1500 ML

# Chapter 7

# Remediation Options with Available Technology Practices

One of the technology practices that the Pattaya City Municipality has adopted is waste-to-energy (WTE) technology. WTE projects have also received positive support from the national government, so they are expanding throughout Thailand. One of the companies, Corsair Group in Thailand employs innovative technology that converts plastic waste into viable products that reduce the growing plastic pollution problem in the country. It also uses innovative "Pyrolysis technologies" to convert plastic waste into advanced bio-oil. As plastic is the byproduct of oil/fuel, plastic waste is transformed back into liquid using this technology (Bangkok Post, 2021; Corsair Group, 2023). The main objective of this development is to reduce the amount of plastic waste ending up in landfills.

Some of the current technologies and practices being used to reduce plastic pollution according to Schmaltz et al. (2020) are robotic technology that captures water pollution, GPS devices that track ghost nets in the oceans for collection, and microplastic collection technology using sand filter method (see Appendix A, Tables A-1, A-2 and A-3). Commonly used in residential households, microplastic collection technology should be adopted in an industry setting to reduce industrial plastic leakage from the processing plants. A study

**Table 4. Different types of a high scoring technologies**

| Technology Name | Sector | Description | Geographical focus |
|---|---|---|---|
| Seabin Smart Tech | Sea - Based | Floating device that passively captures marine litter and is solar compatible to reduce energy consumption | North America; South America; Europe; Asia; Australia |
| Thomsea | | Floating device which collects floating waste from the sea, such as algae, petroleum and solid waste such as plastics and plants | North America; Europe; Asia |
| Plastic Bank | Land- Based | Recycling ecosystem in coastal communities incentivizing the collectors. Operated under a blockchain technology that ensures transparency and traceability | Haiti, Brazil, Indonesia, the Philippines, and Egypt, with wider application potential |
| Project STOP | | Sustainable waste management system that follows four step approach, selecting cities and assessing, designing systems, implementing with support and expanding to new regions | Indonesia in the coastal cities of Muncar in East Java, Lekok and Ngulign in Pasuruan in East Java, and Jembrana in northwest Bali, with wider application potential |
| StormX Netting Trash Trap | Rivers, Streams and Harbors | Capturing system that collects both floatable and non-floatable waste. Efficient for waste filtration at sewers and pipe outfalls | North America; Asia; Africa; Australia |
| Trash Wheel | | Technology that collects floating waste powered by renewable energy requiring manual operation | Baltimore, Maryland, USA, with plans to expand to Newport Beach, California and Panama City, Panama |

Source: Winterstetter et al. (2021)

conducted by Winterstetter et al. (2021) provides an overview of existing technologies that address marine plastic pollution. For the study, independent experts reviewed 75 proposed solutions across the plastic value chain and based on their assessment, the technologies were scored ranging from 1 to 5 as shown in Table 4.

In Thailand, some of the technologies have already been introduced. The SCG-DMCR Litter Trap is a lid opening mechanism to trap marine debris on the surface with a maximum capacity of 700 kgs without allowing it to flow back out with the ebb and flow of tides (SCG, 2019). Another technology, KoomKah, is a mobile application that assists in streamlining the waste procurement process and simplifies the organization of data. Thereby, allowing users to obtain real-time accurate and traceable data from both the buyer and vendor sides. It is also an application introduced to support the waste bank's waste management initiatives (SCG, 2020).

## 7.2 Current Practices on Recycling of Plastic Wastes

Pattaya City is moving towards the waste-to-energy concept, which is one of the expanding practices in waste recycling in Thailand. Recently, the Pattaya City Council has approved one project to be implemented in Koh Larn, an island near Pattaya. Other existing practices for plastic waste recycling inside and outside of Thailand are enumerated below.

### 7.2.1 Plastic Waste Recycling Practices in the Formal Sector

Indorama Ventures has been operating PET recycling projects globally with the establishment of its recycling plants in various countries including Thailand. The company procures plastic waste bottles from the informal sector and transforms all types and colors of PET waste into valuable resources. The bottles are washed and chipped into PET flakes, where some are further melted into recycled fibers and yarns and others into packaging and bottles. Moreover, the company has been involved in awareness raising by educating those in the government, private sector, and schools on the importance of waste separation and plastic recycling (IVPCL, 2023).

In addition, Corsair Group, whose global head office is situated in Bangkok, is developing business solutions to solve global environmental issues such as plastic waste, air pollution, water pollution and climate change. Its main objective is to convert plastic waste back into usable products in the most eco-friendly way. The Group uses pyrolysis technologies in the plastic waste conversion process into advanced bio-oil (Bangkok Post, 2021). Its facility transforms waste plastics such as plastic bags, wrapping materials, and packing products into low Sulphur oil which is similar to crude oil that can be refined into diesel, gasoline and kerosine, or partially used for creating new plastic products. The company's Waste Plastic to Oil/Chemical recycling facility is located in Bangkok and has the capacity to produce approximately 120,000-240,000 liters of fuel per month by the end of 2020. Currently, it is being expanded to generate approximately 600,000 liters per month (Corsair Group, 2023).

### 7.2.2 Plastic Waste Recycling Practices in the Informal Sector

Individuals in the informal waste sector such as the waste pickers and small to medium business owners play an important role in creating economic opportunities which are often overlooked by others. These actors are engaged in activities such as buying and selling recycled materials, waste collection, and operating small recycling centers. Therefore, they require similar technical, financial and management capacities to those in the formal sector. However, oftentimes, they have been excluded from the planning process and in accessing related services due to their illegal status.

Establishing a cooperative in the informal sector and incorporating it into the formal sector will provide informal workers with salaries or wages as well as other forms of social security. In Prune, India, for instance, access to high-value wastes along with low value wastes is currently provided under SWaCH, a waste pickers cooperative, authorized by the Municipal Corporation. The cooperative offers informal workers access to door-to-door waste or community-based waste instead of relying on scavenging plastic wastes from dumpsites. Since plastic materials collected near the source of emission tend to be higher than those collected near dumpsites, this reduces the amount of leakage.

Thus, this initiative has been an important factor in reducing waste leakage (SWaCH, 2023). A similar initiative has been initiated in Iloilo, Philippines where a waste workers association called USWAG Calahunan Livelihood Association Inc (UCLA) was established and officially registered as a formal business enterprise. Through the association, the workers jointly recover waste materials. In addition, they can access alternative opportunities for income generation such as creating handicrafts from recycled packaging, and producing compost (GIZ, 2011).

### 7.2.3 Collaborative (Formal and Informal Sector)

Extended Producers Responsibility (EPR) is another practice which has been implemented at various levels around the world. It offers a unique opportunity for waste pickers and other individuals in the informal waste sector by involving them in designing greener jobs and transforming the sector through systematic training (Talbott et al, 2022). In fact, Thailand has been making progress in implementing EPR. Studies show that the success of an EPR system relies on an effective collection mechanism, and waste pickers can play a crucial role in achieving material recovery targets (see Scheinberg et al., 2016; OECD, 2016). Hence, the private sector should develop an inclusive waste management system that integrates the informal sector in all aspects. Additionally, the government should acknowledge the informal sector's contribution and ensure their integration in the process (Talbott et al, 2022).

Amway (Thailand) is one of the leading companies in Thailand that applies the EPR concept of collecting wastes and recycling them. The company also offers a wide range of products in concentrated forms which enables the reduction of packaging size and materials. Biodegradable packaging is also used to ensure that items decompose naturally into the environment. Moreover, the company initiated a campaign, "I'm not Rubbish", where used packaging materials are collected, recycled and used to create bags. This campaign encouraged Amway members to return used items, earn points, and exchange them for eco-travel programs (Chotichanathawewong & Thongplew, 2009).

To successfully implement EPR in Thailand, all stakeholders must collaborate. Firstly, the government should effectively implement and enforce EPR policies. Companies also need to ensure the proper collection and recycling of their packaging waste and develop an inclusive waste management system that involves the informal sector. Last but not least, the consumers should be responsible for sorting and managing waste.

# Chapter 8

# Awareness-Raising Programs on Plastic Leaking to the Environment

The leaking of plastic and resin pellets to the environment has been a major issue in Pattaya City. Being a popular tourist destination in Thailand, plastic pollution is a growing problem along with leakage of plastic in the water bodies. Raising awareness is an important strategy to reduce plastic waste and create a less-polluted environment. At present, Pattaya City is actively engaged in various awareness programs related to waste management and circular economy.

## 8.1 Awareness-Raising Programs for the Public

One of the important mechanisms to overcome the issue of plastic leakage is to change consumers' behavior at home. Conducting awareness programs at schools educates students on the negative impacts of plastic leakage. The waste bank initiative in Thailand, for example, trains students how to collect and deposit recyclable items from their homes to community waste banks. This initiative is being implemented in various locations in Thailand. Another strategy is to collaborate with various public and private stakeholders to reduce tourism-related waste. Pattaya Municipality has also been a part of this initiative through e.g., 'Travel Thailand in Style, Reduce Plastic Waste'.

Residents should also be educated on separating plastic from other waste and disposing of it properly, making it easier for the informal sector to reduce the leakage from the source. However, awareness raising programs need to be conducted regularly at the community level. Additionally, Pattaya City must expand the current "Saving our Environment" campaign to involve more schools and communities whereby students and youth groups are mobilized to make the public more aware of the negative impacts of insufficient waste management.

Single-use plastics are another important issue in the city. To address it, the "Every Day Say No to Plastic Bags" initiative was implemented in Pattaya as well as in some other cities in Thailand. The initiative involves online campaigns to raise awareness, active lobbying and participation of retail shops to remove plastic bags from their stores. Similar campaigns could also be undertaken to discourage people from using single-use plastics. Moreover, forging collaborative partnerships with businesses, hotels, and restaurants to implement this campaign and encourage the use of eco-friendly packaging products is another strategy to address the problem of plastic waste. With the collaboration of the public and private sectors, refillable water stations can be installed in various tourist hot spots to discourage the purchase of plastic bottles.

Awareness raising can be expanded through active media signs such as posters in major markets and other public areas including beach areas to highlight the issue of plastic leakage and its impact on marine life. Environmental clean-up events such as beach cleanup can be organized to draw attention among the local people and tourists to the importance of reducing waste, particularly plastic waste. Bali has been organizing a similar cleanup campaign under "One Island One Voice" since 2015 which is effective in reducing plastic waste on the island. Apart from this, promoting sustainable travel and tourism targeting the tourism sector can also be achieved through social media campaigns.

Current campaign programs for promoting waste management and circular economy, under the Tod Phapa Garbage Recycle (Trash-to-Cash Recycling), continue to receive positive support from government agencies, businesses, and the community. These campaigns emphasize the 3R principles, waste sorting methods, organic waste separation, and reducing of textile waste in Pattaya. Other activities that relate to raising awareness about recycling in schools were carried out. Pattaya Municipality also provided different colored bins in schools, beaches, and other tourist spots. The "Cleanliness before Dawn" campaign is

also a recent initiative by the city where contracted companies collect and clean the waste on a daily basis, and then, transport it to the waste transfer station.

It should be noted, however, that certain strategies are more effective than others in raising awareness on plastic pollution. Similarly, designing recycling approaches, though challenging, provides a sense of accomplishment, which can lead to moderate to long-term behavior change (SEI, 2021). Despite the fact that Pattaya is actively raising awareness at the community and household level, developing and conducting awareness programs for the informal waste sector is lacking. Therefore, more emphasis should be given to the informal sector to progress.

## 8.2 Awareness-Raising Program for the Informal Sector

To raise awareness regarding plastic pollution in the informal sector, technical training on the plastic recycling process must be organized for those involved in the informal sector in partnership with the local government and the formal sector. Regular information sessions must also be conducted to enhance their knowledge about the city's Waste Management Master Plan as well as the city's existing waste management infrastructure. Another strategy is organizing regular workshops and interactive discussions on issues related to waste management and the impact on the environment and health.

Pattaya City, Thailand

# Chapter 9

# Checklist for Setting Up Recycling Facilities

Currently, there are no proper guidelines for the informal sector to set up recycling facilities or junk shops. Moreover, regulations and guidelines available are broad and nonspecific, particularly on recycling waste or plastic waste recycling facilities. Therefore, a checklist was developed to assist in building recycling facilities in Pattaya and other cities, a sample of which is enumerated in Table 5

**Table 5. Checklist to set up recycling facilities.**

| Description | Process |
|---|---|
| Research and Planning | • Identify the type of recycling facility (e.g., PET, LDPE, etc.)<br>• Research local regulations and permits required to operate a recycling facility in Pattaya.<br>• Determine the scale and capacity of the recycling facility based on the resources and market demand |
| Location and infrastructure | • Find a suitable location, considering factors such as accessibility, zoning regulations and facility size<br>• Location should not be in a residential zone; within 100 meters of neighboring public facilities and government office workplaces, as well as natural resource conversation and environmental preservation areas as specified by the Cabinet<br>• Should be situated at a distance of no less than 300 meters from water bodies<br>• The premises should be enclosed by a fence<br>• Assess the infrastructure requirements that would fulfill major criteria of Pattaya Municipality such as buildings, utilities (water, electricity), and environmental impacts (e.g., pollution)<br>• Obtain necessary permits and approvals |
| Equipment, Machinery and transportation logistics | • Identify the specific recycling equipment and machinery needed based on the type of plastics for recycling<br>• Purchase or lease the necessary equipment, such as shredders, balers, sorting machines, conveyers, and compactors<br>• Implement safety measures to prevent accidents. Provide operational manuals for machinery<br>• Ensure the equipment meets safety and environmental standards based on local regulations and guidelines<br>• Purchase or lease transportation vehicle based on efficiency and cost effectiveness |
| Staffing and Training | • Determine the staffing requirements for the facility<br>• Recruit and hire qualified staff members with relevant experience<br>• Provide comprehensive training on equipment operation, safety protocols, waste management practices, and environmental regulations<br>• Implement safety measures and ensure compliance with labor protection laws and relevant regulations during work activities<br>• Provide adequate personal protective equipment for employees (e.g., gloves, safety shows, nose covers) |

*Continued next page*

*Table 5 continued*

| Description | Process |
|---|---|
| Collection and Segregation Systems | Develop a collection system for different plastic materials from households, landfills or other dedicated collection points<br>Establish an efficient sorting system to separate different types of plastic recyclables<br>Implement quality control measures to ensure the purity of recycled plastics<br>Provide proper collection or disposal of residual waste which cannot be used further, ensuring they are in a suitable condition. Regular cleaning of the workplace.<br>Set rates based on different categories of plastic recyclables |
| Waste Management and Disposal | Set up a waste management system for handling non-recyclable materials generated during the recycling process<br>Partner with other waste management companies or local authorities to dispose of non-recyclable waste properly<br>Implement procedures for hazardous waste management if applicable |
| Compliance and Reporting | Ensure compliance with all applicable environmental regulations, permits and reporting requirements by Pattaya Municipality<br>Implement systems for preventing, controlling, and treating air pollution, unpleasant smells, noise pollution, vibrations, and other hazards that may arise from work activities or business operations<br>Establish monitoring and reporting systems with proper internal site audit<br>Periodically review and update the processes and systems to improve efficiency and sustainability |

Source: AFRA, (Nd)

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# APPENDICES

## Appendix A: Current technologies and practices for reducing plastic pollution

### Appendix A.1 The Micro Plastic Pollution Prevention-Collection Technology

| | Name | Year | Description | Used | Location invented |
|---|---|---|---|---|---|
| Prevention -Miscellaneous removal from wastewater | Unnamed Invention by Students at Gering High School | 2017 | Gravity-fed, three-stage attachable filter catches microplastics (*e.g.*, microfibers shed from laundry) before they enter the wastewater | N | United States |
| | GoJelly Project | 2018 | Jellyfish mucus (secreted when they reproduce or become stressed) captures and binds to nano-sized particles, removing microplastics from wastewater | N | Unknown (Funded by European Union) |
| *Prevention -Laundry balls* | Cora Ball | 2019 | Balls placed in the laundry machine capture microfibers shed when washing synthetic fibers | Y | United States |
| | Fibre Free | 2017 | Balls placed in the laundry machine or dryer capture microfibers shed when washing or drying synthetic fiber | N | United States |
| Prevention -Residential wastewater treatment | Lint LUV-R | 2016 | Water filter on laundry machines captures microfibers when water is drained through the machine | Y | Canada |
| | Showerloop | 2012 | Filter removes microplastics while primarily filtering water for reuse | - | Finland |
| Collection -Miscellaneous capture | Unnamed Invention by Anna Du | 2018 | Remotely operated vehicle uses infrared light to detect, photograph, and help remove microplastics from waterways | N | United states |
| | Unnamed Invention by Fionn Ferreira | 2019 | Combination of oil and magnetite powder binds microplastics for extraction with a magnet | N | Ireland |
| Collection -Sand filter | Marine Microplastic Removal Tool | 2013 | Sand is piled on a sheet of fine mesh stretched between two long poles, and the mesh catches plastic and other foreign material while allowing the sand to fall through | Y | United states |

Source: Schmaltz et al. (2020)

## Appendix A.2 The Macro Plastic Pollution Prevention and Collection Technology

| | Name | Year | Description | Used | Location invented |
|---|---|---|---|---|---|
| Prevention -Stormwater and wastewater filters | In-line Litter Separator (ILLS) | 1999 | Trap attached to the drainage system downstream of shopping areas removes litter from passing stormwater | Y | Australia |
| | StormTrap TrashTrap | 2018 | Mesh net system uses water flow to capture and remove trash, floatable, and solids from stormwater and wastewater | Y | United States |
| | PumpGuard | 2016 | Mesh nets remove debris from stormwater and wastewater | Y | United States |
| | Watergoat Trash Trap | 2006 | Floating boom and net attached to embankments, stormwater outfalls, canals, or creeks collects floating debris | Y | United States |
| | Netting TrashTrap | 1999 | Mesh nets capture and remove trash from stormwater and discharge | Y | United States |
| Prevention -Stormwater and wastewater filters | StormX Netting Trash Trap | 1995 | Commercial grade reusable nets provide full capture of gross pollutants as small as 5 mm in stormwater runoff, including organic materials (such as leaves) that could reduce the levels of phosphorous and nitrogen in water | Y | Australia |
| Prevention -Miscellaneous leakage prevention | Stow it, Don't Throw It | 2012 | Tennis ball containers repurposed into fishing line recycling bins for anglers | Y | United States |
| | CLEVER-Volume | 2019 | Sensors allow port authorities to certify the amount of ship waste reported, in comparison to the volume reported to MARPOL inspectors | N | Portugal |
| Collection -Large-scale booms | Ocean Cleanup System | 2013 | C-shaped boom and screens use currents to corral trash | Y | Netherlands |
| | Holy Turtle | 2018 | 1,000-foot-long floating unit is towed by two marine vessels and captures floating waste; large vent hole protects marine life | Y | United States |
| Collection -Drones and robots | FRED (Floating Robot for Eliminating Debris) | 2019 | Solar-powered vessel with conveyor belts collects floating debris | Y | United States |
| | WasteShark | 2016 | Drone modeled after a whale shark skims the water and collects floating debris | Y | Netherlands |
| | Jellyfishbot | 2018 | Remote-controlled robot collects garbage from waterways | Y | France |

| | | | | | |
|---|---|---|---|---|---|
| | Seabin | 2013 | Automated bucket uses a pump to capture floating debris, including plastic | Y | Australia |
| | BluePhin | 2017 | Battery-powered, zero carbon emissions robot uses artificial intelligence to collect floating waste | - | United Arab Emirates |
| Collection -Boats and wheels | SeaVax | 2015 | Solar- and wind-powered ship collects plastic and other debris; sensors detect waste and sonar protects fish and other animals from being collected | Y | United Kingdom |
| | Mighty Tidy | 2003 | Trash skimming boat scoops plastic from the surface, and a conveyor belt moves waste to a bin | Y | United States |
| | Inner Harbor Water Whee | 2014 | Wheel collects trash in the river before it can flow into the harbor | Y | United States |
| | Versi-Cat Trash Skimmer Boat | 2009 | Skimmer collects floating and semi submerged debris in a removable basket for later disposal | Y | United Kingdom |
| | Manta | 2016 | Ship brings waste onboard for manual sorting and mechanical compacting before being carried to land for processing | N | France |
| | The Interceptor | 2019 | Solar-powered catamaran autonomously extracts floating plastics from rivers, using barriers and a conveyor belt | Y | Netherlands |
| | MariClean | 2020 | Catamaran fitted with a conveyor belt collects debris from seas, straits and bays | N | Canada |
| Collection -Detection aids | Malolo I | 2017 | Unmanned aerial robot detects marine debris (especially fishing gear) in the open ocean for later collection or satellite tagging | Y | United States |
| | Unnamed GPS Device on Ghost Nets | 2019 | Vessels place GPS units on ghost nets to mark them for collection | Y | United States |
| | NetTag | 2019 | Low-cost transponders allow fishers to locate and recover lost nets | Y | England |
| | Wikilimo | 2019 | Uses satellite imagery to detect major garbage patches in oceans; uses numerical models and machine learning to identify optimum routes for cleaning up garbage patches | N | United States |
| Collection -Waterway litter traps | Bandalong Litter Trap | 2009 | Floating device uses waterway currents to capture and guide litter into the trap before it flows downstream | Y | Australia |
| | Clear River Litter Trap | 2014 | Floating device uses waterway currents to capture and guide litter into the trap before it flows downstream | Y | Netherlands |

| | | | | | |
|---|---|---|---|---|---|
| | SCG Litter Trap | 2019 | Floating litter trap uses a bypass flap to leverage water flow and pressure to capture and trap floating litter | Y | Thailand |
| Collection -River booms | Clean River Project River Boom | 2005 | Floating beams create a barrier that collects surface debris along rivers | Y | United States |
| | Bandalong Boom | 2015 | Floating boom couplings span waterways to capture waste and prevent it from traveling further downstream | Y | Australia |
| | The Litterboom Project | 2017 | Large pipes anchored across rivers catch surface-level debris | Y | South Africa |
| | AlphaMERS Floating Barrier | 2015 | Floating barricade carries debris to the riverbank for manual or mechanical collection | Y | India |
| | Plastic Fischer Trash Boom | 2019 | Boom made of PVC pipe floaters and galvanized steel catching nets collects surface plastics up to 60 cm deep | Y | Germany |
| Collection -Sand filters | Barber Surf Rake | - | Tractor-towed machine removes waste on beaches | Y | United States |
| | Barber Sand Man | - | Walk-behind sand sifting machine uses a vibrating screen to sift debris from sand and soil on beaches | Y | United States |

Source: Schmaltz et al. (2020)

## Appendix A.3 The Micro-Macro Plastic Pollution Collection Technology

| | Name | Year | Description | Used | Location invented |
|---|---|---|---|---|---|
| Boat | OC-Tech | 2013 | Boat collects oil, microplastics, and other debris using a system of nets and baskets; clean water then flows back into ocean | - | Spain |
| Skimmer | Marina Trash Skimmer | 2016 | Pump in a partially submerged plastic box draws in and catches surface trash | Y | United states |
| Vacuum | Hoola One | 2019 | Vacuums approximately three gallons of sand and debris per minute in to a tank that separates particles by buoyancy, allowing for plastic separation and removal | Y | Canada |
| Air barrier | The Great Bubble Barrier | 2019 | Tubes placed diagonally across the bottom of the waterway create a bubble barrier by pumping air, creating a current that brings debris to the surface and guides it to a catchment system | Y | Netherlands |

Source: Schmaltz et al. (2020

# Appendix B: Field Data Collection and Meetings

## Appendix B1: Informal Site Observations in Pattaya Municipality

### Appendix B1.1 Selected Cases in Pattaya Municipality

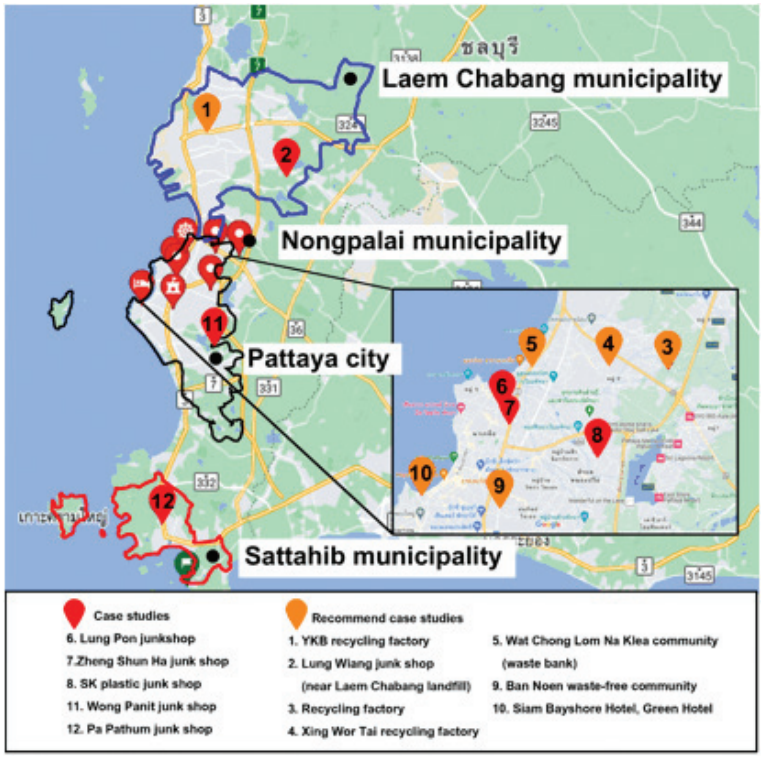
| | Wong Panich | Lung Pon | Pa Pathum | TungSueHa | SK Plastic |
|---|---|---|---|---|---|
| Size | Medium | Small | Medium | Small | Large |
| License | | | | | |
| Operational Resources | Manpower | Manpower, forllift | Manpower, forklift, shredder mill | Manpower, forklift | Manpower, forklift, shredder mill |
| Vehicle | 3-4 | 4 | 2 | 3 | 1 |
| Waste-buy source | waste picker, Saleng, and household | waste picker, Saleng, and household | waste picker, Saleng, household, market, and other junkshop | waste picker, Saleng, and household | waste picker, Saleng, household, Rod ray, and other junkshop |
| Waste-sell source | Pattaya | Pattaya | Samut Prakan, Bangkok, Nakhon Pathom and Ratchaburi | Pattaya | Pattaya and Samut Prakan |
| Employee | 20 | 3 | 10 | 5 | Estimated 10+ |
| Amount of recycling plastic waste (tonn) per day | 0.03 | 0.84-0.9 | 2 | Unknown | Unknown |
| Related laws and regulations | Chonburi Building Control Act, B.E.2560 | Chonburi Building Control Act, B.E.2560 | Chonburi Building Control Act, B.E.2560 | Chonburi Building Control Act, B.E.2560 | Chonburi Building Control Act, B.E.2560 |
| | Pattaya Building Control Act, B.E.2558 | Pattaya Building Control Act, B.E.2558 | Sattahip Building Control Act,B.E.2561 | Pattaya Building Control Act, B.E.2558 | Pattaya Building Control Act, B.E.2558 |
| | Pattaya Municipal Act | Pattaya Municipal Act | Sattahip Municipal Act | Pattaya Municipal Act | Pattaya Municipal Act |
| | the Control of Sale by Auction and Trade of Antiques Act, B.E. 2474 (1931) | the Control of Sale by Auction and Trade of Antiques Act, B.E. 2474 (1931) | the Control of Sale by Auction and Trade of Antiques Act, B.E. 2474 (1931) | the Control of Sale by Auction and Trade of Antiques Act, B.E. 2474 (1931) | the Control of Sale by Auction and Trade of Antiques Act, B.E. 2474 (1931) |

| | | | | | |
|---|---|---|---|---|---|
| | Ministerial Regulations on Control of Business Establishments which are hazardous to health, B.E. 2560 (2017) | Ministerial Regulations on Control of Business Establishments which are hazardous to health, B.E. 2560 (2017) | Ministerial Regulations on Control of Business Establishments which are hazardous to health, B.E. 2560 (2017) | Ministerial Regulations on Control of Business Establishments which are hazardous to health, B.E. 2560 (2017) | Ministerial Regulations on Control of Business Establishments which are hazardous to health, B.E. 2560 (2017) |
| Concerns/ Challenges | | Shorten local labour | Imported waste, lower price | Few amounts of plastic waste | |
| | | Alien work permit procedure | Wage fluctuation | | |
| | | Less profit | Less profit | Only PET and HDPE are highly sought out | |
| Recommendations from case representatives | | Separate waste before sell | Landfill access permission, is better than incineration. | | |
| | No Comment | Increase the hazardous waste disposal area | Improving a fair and transparent bidding process for importing plastic, with prices that are in equilibrium with the market prices of recycled plastics in the country. | No Comment | No Comment |
| | | Expedite of working permit process | Improving access to RDF factories for small-scale business. | | |
| | | | Training and awareness of plastic waste management | | |

Source: Study team based on site visits

## Appendix B1.2 Site Visits in Pattaya Municipality and Surrounding Areas

**Converting discarded plastics and wastes into construction materials.**




### Site 1:Wong Panich

The factory known as Wong Panich is responsible for collecting recyclable waste from salengs, households, towns, shops, wholesalers, and convenience stores. In terms of the material plastic, it offers a plastic sorting process, and the prices of the various varieties of plastic are differentiated from one another.

Plastic comes in a variety of forms, including clear PET water bottles, colored PET water bottles, HDPE white-opaque water bottles, colored plastic, plastic frames, plastic cable tape, plastic CDs, plastic DVDs, and plastic future boards. Due to the increased costs associated with the plastic operation, this branch of the junkshop is no longer capable of crushing old plastic, pelletizing plastic, cutting scraps, and modifying, repairing, assembling, improving, or changing the form of materials.

### Site 2:Lung Pon

The team traveled to visit Lung Pon's shop with environmental officers leading the visit. This junk shop is located in Suan Mali alley. The team spoke with Thunjira Nakpakdee in Lung Pon shop about the junk shop business as an owner. We spoke about the junk shop business, the plastic waste situation, the problem, and suggestions.

Lung Pon shop is a medium size junk shop. Purchase recyclable and sellable waste from people/households. After purchase, unclean waste was categorized and sold to Zing Whor Thai and Pattaya Paper Mill Company. Normally, it was selling about 3 trips in 1 month, it about 280-300 kg of waste with 1 trip. There is no plastic

grinder here because of the time, money, and worker limitation. Some plastic around 3 percent of the overall cannot sell to industries such as ABS, PC, PS, or PVC from plastic electrical components, it will dispose of at the Nong Prue landfill.

The owner was not worried about the plastic leaking into public water from the shop because she sells and purchases the large size. She suggested that people who sell plastic should segregate the waste before selling it because of the higher price. For Pattaya municipality, she would like them to increase the hazardous waste disposal area.

### Site 3:Pa Pathum

The team spoke with Nitchpasorn Sunsanit (Pathum) in Pa Pathum junk shop about the junk shop business as an owner. This junk shop located on Sukhumvit road. We spoke about the junk shop business, the plastic waste situation, the problem and suggestion.

Pa Pathum shop is a large junk shop. The waste was purchased from three different sources namely landfills, markets and other junk shops, and households. Taking out the label of the plastic bottle with the label remover machine is the first procedure. However, the label attached to the bottle surface has to take off by hand. Next, separation into different plastics and colors with the expertise of employees in separate waste. Last, unwashed plastic waste was ground with a shredder machine and sold to recycling industries.

In each purchase, there will be 150-200 kilograms of unsellable, representing 15-20 percent of input plastic waste. This plastic will be disposed of at the landfill. There was a complaint of odor in the rainy season but fixed. The owner was not worried about the leaking waste. One suggestion for the government is waste picker permission to access landfill.

### Site 4:TungSueHa

TungSueHa, considered small size, is located in the city close to the hospital. It also sorted and categorized the unclean waste collected from households. We observed salengs and community members bringing various wastes with their motorbikes and cars. Majority of the plastic waste they handled were PET and HDPE, both white opaque and colored. They removed the labels and sorted them separately. However, it does not do washing, grinding, drying due to limited time, money and resources to hire more workers. According to them, they transport PET to the factory two times per week while for PE, they do two times per month. Out of all the plastic received, 20% is considered loss. The main concern is mixed plastic bottles because of its low prices as they cannot be recycled completely.

### Site 5:SK Plastic

SK Plastic was the largest junk shop we have observed in Pattaya. Small and medium sized junkshops sell back their plastic waste to them. They source the different plastic waste from from waste pickers, salengs, households and other junkshops where they sort them manually based on colors and types. They also have grinding machine. After they have grinded, they pack and transported them to the other factories in Pattaya and Samut Prakan as well as plastic melting factories near Suvarnabhumi airport in Bangkok.

Challenges according to them waere that the decrease price of plastic increasing number of competitors in the city and province. Moreover, they are facing an increase in low grade plastics which do not have value and the factories do not accept this kind of plastic. If the sorted plastic wastes are not accepted by any factories, they will be transported to landfills.

## Appendix B2: List of stakeholders visited and interviewed.

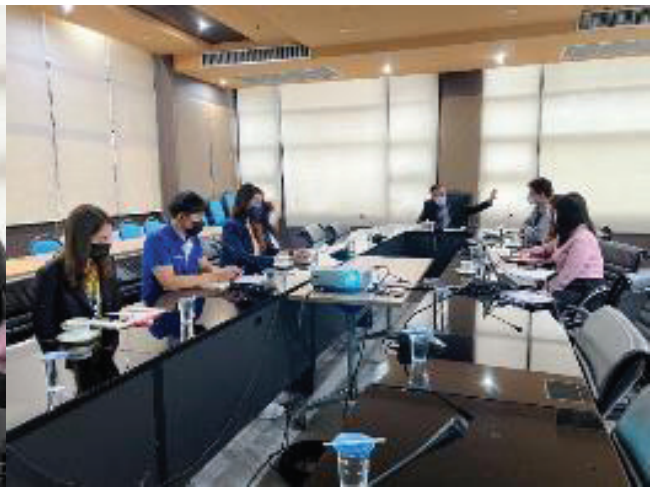
| Organization | Name/position |
|---|---|
| Pattaya City Office, Chonburi<br><br>171 Moo 6, North Pattaya Road,<br>Naklua Sub District<br>Bang Lamung District, Chonburi<br>Province 20150 | Director of Natural Resources and Environment Department |
| | Director of Environmental Quality Promotion Department |
| | Chief of Solid Waste and Waste Management Department |
| | Sanitary Technical Officer, Practitioner Level |
| | Sanitary Technical Assistant Officer |
| Lung Pon junk shop | Ms. Thunjira Nakpakdee |
| Pa Pathum junk shop | Ms. Nitchpasorn Sunsanit |
| Wong Panich | Mr. Korn |
| TungSueHa | Khun Pattaraporn |
| SK Plastic | Khun Sukanya |

Source: Study team

## Appendix B3: Photos at Pattaya Municipality Field Visit

### Appendix B3.1 Pattaya City Office and Wong Panich junk shop – 16th June 2022

Meeting at Pattaya city office



Meeting at Pattaya city office

Garbage Transfer station

Garbage Transfer station

Wong Panich Junkshop

Wong Panich Junkshop

## Appendix B3.2 Other sites around Pattaya City – 13th January 2023

### Pa Pathum Junk Shop

Plastic before sorting

Sorting process

Plastic sorting

Plastic sorting

Plastic sorting

Plastic sorting

Plastic sorting

Samples of the same brand of plastic but different types

Shredder machine

Shredded plastic

Shredded plastic

Interview with Pa Pathum owner

## Lung Pon Junkshop

Lung Pon shop entrance

Lung Pon shop working space

Lung Pon shop working space

Lung Pon shop working space

Bulk bag

PET bottle

Interview with Lung Pon owner

Interview with Lung Pon owner

## Appendix B3.3 Other sites around Pattaya City – 9th June 2023

### Tung Sue Ha Junkshop

Truck used to transport waste


Daily prices for various wastes

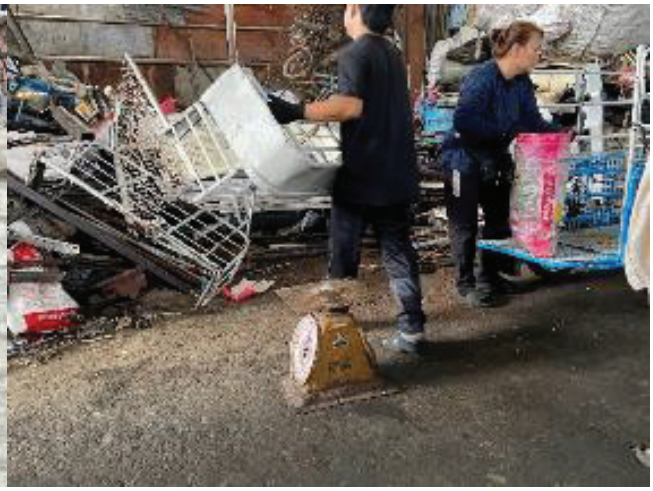
Plastic PET bottles sorted separately

Mixed plastic wastes (low price/low quality)

Worker taking out labels before segregation

Saleng bringing plastic wastes for sale

Placing PET bottles in the designated area



Weighing the received waste for purchase

**SK Plastic**

Various plastic waste before segregation