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# SUSTAINABLE WASTE MANAGEMENT

## A Case Study of Zero Waste to Landfill at the Doi Tung Development Project, Chiang Rai, Thailand

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# Executive Summary

## Sustainable Waste Management: A Case Study of Zero Waste to Landfill at the Doi Tung Development Project

### Introduction

This report presents the findings and analysis of the integrated waste management model implemented by the Doi Tung Development Project (DTDP), managed by the Mae Fah Luang Foundation under Royal Patronage (MFLF). The project has successfully achieved Zero Waste to Landfill (ZWTL) status since October 2018. Amidst the growing waste management challenges in Thailand and globally, the DTDP serves as a sustainable, community-centered model that offers valuable insights for replication and scaling.

### Key Approaches and Strategies

The project's success is founded on the practical integration of the circular economy concept, driven by the following key strategies:

- **Community-Based Waste Management:** The model empowers the community and fosters a sense of ownership. This begins with source segregation based on a **6+1 category system** (Recyclable, Biodegradable, Dirty, Refuse-Derived Fuel (RDF), Toilet, Hazardous, and Bulky waste) and the establishment of village-level waste management committees.
- **Multi-Stakeholder Collaboration:** The initiative is built on a strong partnership between the MFLF, the Mae Fah Luang Subdistrict Administrative Organization (SAO), the private sector (e.g., Thai Beverage Public Company Limited), and the communities across 24 villages.
- **Material Recovery Facility (MRF):** An MRF was established at the community level to act as a central hub for sorting, processing, adding value to recyclable materials and maximizing recyclability of waste that would otherwise be RDF. This significantly reduces the final volume of waste requiring disposal and generates revenue for the SAO.
- **Enforcement and Incentivization:** Clear community regulations are enforced, such as the mandatory use of transparent bags marked with household details. These are complemented by motivational tools like "Zero-Waste Village" and school competitions to encourage participation.

## Key Findings and Success Factors

A mixed-methods study, including a survey of 337 households and in-depth interviews with 41 stakeholders, revealed high levels of engagement. **92.5% of households reported separating their waste regularly**. Key quantitative outcomes include **100% of waste being diverted from landfills** and repurposed through recycling, composting, or reuse. This has led to an estimated **reduction of 973 tons of greenhouse gas emissions annually**. Economically, the model proves highly efficient; while total annual collection costs increased modestly from $31,220[1] (1,020,000 THB) to $36,730 (1,200,000 THB), service coverage nearly doubled from 11 to 24 villages, significantly lowering the cost per village. This operational efficiency is complemented by the creation of jobs valued at approximately **$31,830** (1,040,000 THB) **per year**.

## The primary success factors identified are:

- **Strong Leadership:** Consistent policy and dedicated support from MFLF and the SAO.
- **Community Ownership:** Active participation and a shared sense of responsibility among villagers.
- **Continuous Education and Awareness:** Ongoing training and communication tailored to the community's context.
- **Accessible Infrastructure:** The establishment of the MRF and an effective waste collection system.

## Challenges

Despite its success, the model faces several challenges:

- Inconsistent understanding and participation in remote or border villages.
- Infrastructure limitations and distances between villages result in high transportation costs.
- Ensuring long-term sustainability and the effective transfer of knowledge to younger generations.

## Policy Recommendations and Future Actions

To scale this successful model to a national level, the following actions are recommended:

- **Promote MRFs Nationally:** The government should support the nationwide establishment of community-led MRFs through financial and technical assistance.

[1] THB = 0.031 USD

- **Apply Economic Instruments:** Implement the **Polluter Pays Principle (PPP)** through mechanisms such as a **Pay-As-You-Throw (PAYT)** system to incentivize waste reduction at the source.
- **Enforce Extended Producer Responsibility (EPR):** Legislate and enforce a framework requiring producers to be responsible for the end-of-life management of their packaging, thereby reducing the burden on municipalities and promoting sustainable product design.

**In conclusion, the Doi Tung Development Project has demonstrated that a decentralized, community-driven waste management system is a highly effective and sustainable solution. This model can serve as a critical blueprint for Thailand's transition towards a circular economy and a zero-waste society.**

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# 01 BACKGROUND

**Waste management** is a worldwide problem that has substantial impact on all nations. Waste collection is generally taken for granted in developed economies, but there are still two billion people living in low- and middle-income countries without these basic services. In the absence of such services, people resort to dumping or burning their waste close to where they live. These practices are harmful to public health, local economies, and the environment. Plastic packaging waste, for example, not only blocks drains and pollutes the ocean but also, when burned, harms the lungs, eyes and skin, and is a major contributor to urban air pollution. The Zero Waste initiative is emerging with the need to shift to a circular economy. Thailand's Roadmap on Plastic Waste Management 2018–2030, sets a goal for recycling 'target plastic waste' at 100% by 2027[2].

**Zero Waste to Landfill (ZWTL)** is a sustainable waste management approach that ensures all waste is either recycled, reused, composted, or converted into energy, with nothing sent to landfills. This method conserves resources, reduces the need for raw material extraction, lowers energy use, and decreases costs through recycling and reuseing materials. It greatly minimizes environmental pollution by reducing greenhouse gas emissions and harmful landfill toxins, aiding in the fight against climate change. Moreover, it enables businesses to meet regulatory standards, enhances their public image, and creates new economic opportunities in recycling and waste management sectors.

The global waste management market was valued at USD 1,293.70 billion in 2022, which is anticipated to grow at a CAGR of 5.4% from 2023 to 2030. To enhance the service, strict government laws like the Resource Conservation and Recovery Act and the Waste Shipment Regulation are anticipated to drive the market[3].

Each day, a typical human produces 4.4 lb. (1.9 kg.) of waste. Recycling can help in reducing greenhouse gas emissions and save a lot of energy. Transitioning towards zero waste is possible by focusing on municipalities and communities to adopt integrated planning for waste management. Community-based waste management programs offer populations in low- and middle-income countries where there is no, or inadequate, municipal waste management services with a low-cost, effective, and engaging waste management system. Such systems encourage: Direct community-member engagement and accountability, tracking of waste collection and reduction, segregation of waste at the household level, on-site utilization of valuable and reusable items, composting of organic waste, collection and transportation of waste to a treatment site by a public collection service.

Community-based waste management programs are collaborations between NGOs, government agencies and impacted communities, to provide the equipment, resources and training necessary to establish an effective waste management program and to run the program independently.

[2] Investigation of plastic waste management in Thailand using material flow analysis, Waste Management & Research 2023, Vol. 41(4) 924– 935, DOI: 10.1177/0734242X221126376 journals.sagepub.com/home/wmr

[3] Market Analysis Report, 2022, https://www.grandviewresearch.com/industry-analysis/global-waste-management-market#

Decentralization of waste management has proven to be successful in cities like Surabaya (Indonesia), Bangalore (India), and Quy Nhon (Vietnam), where community-level approaches, integrating informal waste sectors with formal municipal services have been observed. For example, Surabaya's zero-waste initiative mobilizes households to segregate waste, promoting recycling and composting at the community level[4]. In Vietnam, partnerships between non-governmental organizations (NGOs) and local communities have been key in developing sustainable waste management systems in peri-urban areas, focusing on sanitation infrastructure and decentralized management[5]. Furthermore, informal waste recycling plays a critical role in countries like India, Indonesia, and Vietnam, where informal collectors and recyclers complement municipal efforts, as seen in Hanoi and Delhi[6]. These cases demonstrate that integrating informal practices, fostering public-private partnerships, and decentralizing waste management systems tailored to local needs can become successful practices in developing countries.

Community waste management practices significantly contribute to achieving several Sustainable Development Goals (SDGs), starting with SDG 3 (Good Health and Well-being). Effective waste management reduces health risks by minimizing pollution and the spread of disease. It also supports SDG 6 (Clean Water and Sanitation) by controlling pollution and protecting water resources from waste contamination. SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production) emphasize the role of sustainable waste practices, encouraging recycling, segregation, and responsible consumption (United Nations, 2023). Furthermore, proper waste management aids SDG 13 (Climate Action) by reducing greenhouse gas emissions, while SDG 14 (Life Below Water) and SDG 15 (Life on Land) benefit from the prevention of waste disposal in natural habitats, helping to protect and restore ecosystems.

Over the past three decades, the Doi Tung Development Project (DTDP), under the management of the Mae Fah Luang Foundation under Royal Patronage (MFLF), has been a leading model for holistic and sustainable development in Thailand. By integrating social welfare, environmental protection, and economic viability through the Sustainable Alternative Livelihood Development (SALD) approach, the project has empowered local communities to transition from subsistence living to self-reliance. Today, a variety of business units—including Coffee, Macadamia, Café, Tourism, Handicrafts and Horticulture—operate

[4] João, Aleluia., Paulo, Ferrão. (2016). Characterization of urban waste management practices in developing Asian countries: A new analytical framework based on waste characteristics and urban dimension. Waste Management, 58(58):415-429. doi: 10.1016/J.WASMAN.2016.05.008

[5] Julie, Beauséjour. (2009). Managing delivery of sanitation infrastructures for poor communities. International Journal of Managing Projects in Business, 2(3):355-369. doi: 10.1108/17538370910971027

[6] Rémi, de, Bercegol., Jérémie, Cave., Arch, Nguyen, Thai, Huyen. (2017). Waste Municipal Service and Informal Recycling Sector in Fast-Growing Asian Cities: Co-Existence, Opposition or Integration?. Resources, 6(4):70-. doi: 10.3390/RESOURCES6040070

successfully within the DTDP, contributing to significant improvements in household income and economic resilience. With this economic progress, however, comes the growing challenge of managing increasing volumes and complexity of waste generated by both business operations and community consumption.

In light of this, the DTDP's achievement of zero waste to landfill since October 2018 presents an important case for studying sustainable waste management in practice. The Foundation employs a circular economy framework that emphasizes the 4Rs—reduce, reuse, recycle, and repair—alongside upcycling and minimization of single-use plastics. Incineration is only used when absolutely necessary, aligning the waste strategy with broader environmental goals. This success demonstrates how a resource-based, people-centered approach to development can be extended to environmental sustainability, offering valuable insights for other communities and organizations seeking to implement effective waste management solutions.

**This study aims to examine the strategies, practices, and enabling conditions behind the DTDP's waste management success. In particular, it will explore how institutional policies, capacity-building, access to knowledge, and community engagement contribute to the Foundation's ability to manage waste sustainably. The findings may serve as a practical reference for designing waste management models that are both environmentally sound and socially inclusive.**

# Global Waste Management

Economic growth and unsustainable consumption patterns have led to a continual increase in global waste production each year. Municipal solid waste is expected to rise significantly, from 2.1 billion tons in 2020 to 3.8 billion tons by 2050. This marks a 56% increase within a single generation[7].

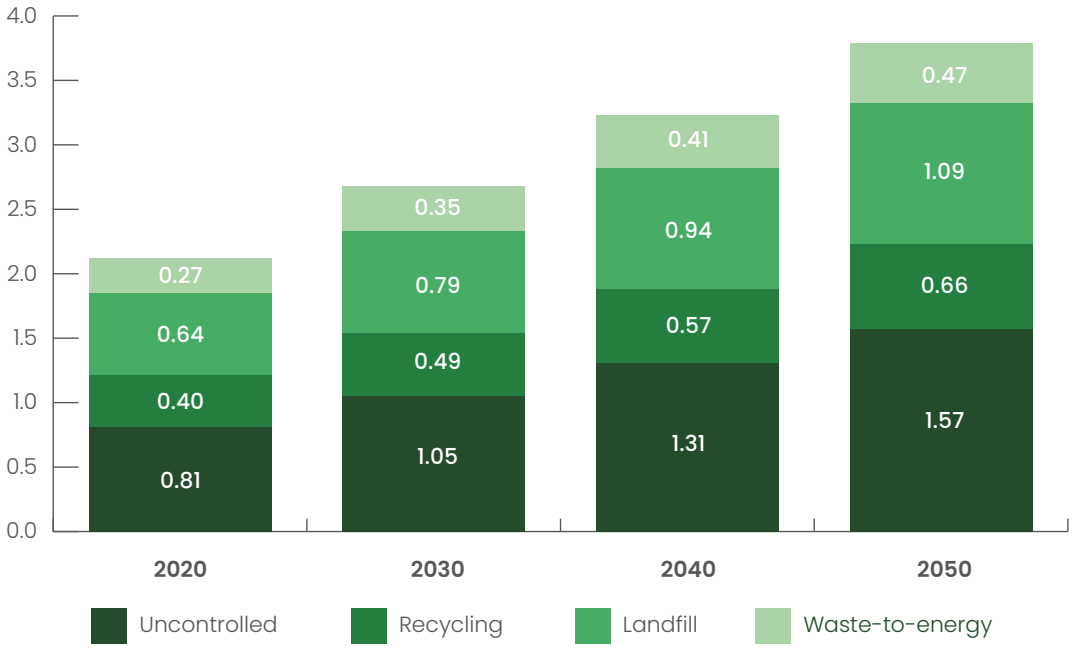



Figure 1: Projected global municipal solid waste destinations in 2030, 2040 and 2050 compared with 2020
Source: UNEP, Global Waste Management Outlook 2024

In 2020, 38% of municipal solid waste, around 810 million tons, was unmanaged, being either dumped in the environment or openly burned. If current waste management practices persist, this number could nearly double to 1.6 billion tons annually by 2050, exacerbating climate change, marine plastic pollution, and health issues. This is a global concern, as waste pollution crosses borders. The fastest-growing economies are projected to see the highest increase in waste, outstripping their management capacity.

[7] UNEP, Beyond an Age of Waste - Global Waste Management Outlook 2024, P.22

Considering both direct and indirect costs, along with recycling benefits, the total global cost of municipal solid waste management in 2020 was estimated to be $361 billion. The 2024 report highlights three global waste management priorities:

1. to stop waste growth and move towards zero-waste practices and circular economy models
2. to provide all communities with affordable services and stop the harmful practices of open dumping and burning
3. to offer goods and services that minimize waste, while the most harmful and polluting materials need to be eliminated

Addressing the global waste crisis requires integrated and adaptive approaches. Adopting a circular economy and zero-waste strategy is vital for a sustainable future, but there is no one-size-fits-all solution. Each country must tailor its approach based on local contexts. Key concepts such as Circular Economy, Waste to Energy (WtE), and Extended Producer Responsibility (EPR) offer practical frameworks to reduce waste, recover resources, and shift responsibility across the product lifecycle, supporting more efficient and sustainable waste management.

## *Circular Economy*

The core idea of a circular economy is to minimize waste by keeping resources in use for as long as possible, through recycling, reuse, and recovery, thereby creating a closed-loop system. One of the central concepts of the circular economy is the "waste hierarchy," which ranks strategies for waste management from most to least preferable priorities based on sustainability. To be sustainable, waste management cannot be solved only with technical end-of-pipe solutions and an integrated approach is necessary. The aim of the

waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. Proper implementation of waste hierarchy can bring several benefits such as preventing greenhouse gases (GHG emissions, reducing pollution, saving energy, conserving resources, creating jobs and stimulating the development of green technologies.


Figure 2: The waste hierarchy
Source: Adapted from Action Plan on Plastic Waste Management Phase II (2023-2027)

According to the waste hierarchy, material recovery and recycling are prioritized over energy recovery through Waste to Energy (WtE). By incinerating waste to generate energy, materials that could have been recycled or reused are destroyed, breaking the material cycle and leading to resource depletion. This is one of the reasons why WtE is considered to hinder the efforts to move towards a fully circular system by reducing the availability of materials for recycling.

## *Waste to Energy (WtE)*

Waste to Energy (WtE) concept works on the concept of converting waste into usable energy, basically through incineration or gasification. It can offer benefits such as managing non-recyclable waste and reducing reliance on landfills but often contradicts with the core principles of circular economy, particularly on its emphasis on material recovery and waste reduction. By destroying materials that could be reused or recycled, WtE can disrupt the circular flow of resources and potentially act as a barrier to achieving a more sustainable, resource-efficient economy. For WtE to align more closely with circular economy principles, it must be seen as a last option in the waste hierarchy, following efforts to reduce, reuse, and recycle waste.

WtE has its own challenges, such as it might create a demand or a steady flow of waste to keep the systems operational and economically viable. This can act as a disincentive to waste reduction strategies, such as product redesign, repair, and reuse, which are central to a circular economy.

## *Extended Producer Responsibility (EPR)*

EPR is an environmental policy where a producer's responsibility extends to the waste stage of a product's lifecycle. This includes managing the collection, pre-treatment (sorting, dismantling, depollution), reuse, recycling, recovery, or disposal of products. EPR systems can require producers to provide financial resources or take over operational aspects from municipalities, either voluntarily or through mandatory regulations. These systems can be implemented individually by producers or collectively to minimize waste and encourage sustainable product design.

Various countries face significant obstacles to achieving the goals of EPR as it includes complexity of implementing effective waste management systems and adds financial burden on producers, which can increase costs for consumers. Limited recycling infrastructure, especially in developing

regions, hinders EPR effectiveness. Regulatory differences across countries complicate compliance for global producers, and inadequate monitoring mechanisms make it difficult to enforce regulations.

In summary, effective waste management relies on a balanced approach that integrates circular economy principles, careful use of waste-to-energy, and extended producer responsibility. These frameworks offer practical pathways for reducing waste and conserving resources. Thailand has begun to incorporate these concepts into its national waste management policies, as outlined in the following section.

## Thailand Waste Management Policies

Thailand, like many rapidly developing nations, faces mounting challenges in managing its growing volume of waste. As urbanization, industrialization, and tourism continue to expand, effective waste management has become a critical national priority. In response, the Thai government has implemented a range of policies aimed at promoting sustainability, reducing environmental impact, and fostering a circular economy.

The **Thailand National Strategy 2018–2037** focuses on sustainable development across six key areas including

1. **Security:** Enhancing national resilience and societal stability.
2. **Competitiveness:** Promoting innovation and productivity in the economy.
3. **Human Resource Development:** Developing skills and lifelong learning.
4. **Equality:** Reducing social inequalities and improving quality of life.
5. **Green Growth:** Emphasizing environmental sustainability, including waste management through circular economy practices.

6. **Rebalancing Public Sector:** Improving governance and public sector efficiency.

Waste management has become a critical component under the green growth approach of the National strategy. It emphasizes the need to transition into a circular economy by promoting recycling, waste reduction and sustainable consumption. It also emphasizes improving the waste management infrastructure, phasing out harmful plastic usage, and encouraging public participation in waste reduction.

Thai government promotes the **Bio-Circular-Green (BCG) Economy Model** through various policies and initiatives. The National Economic and Social Development Plan (2023-2027) is a cornerstone, aiming to transform Thailand into a low-carbon society and integrate CE principles into national development. This plan includes measures to reduce waste, promote recycling, and encourage sustainable production and consumption.

The **1992 Cleanliness and Orderliness Act**, commonly referred to as the "Garbage Act" in Thailand, is a law that sets regulations for waste management, public cleanliness, and environmental orderliness. It outlines responsibilities for local governments, individuals, and businesses in waste disposal and includes penalties for illegal dumping, burning waste, and improper waste separation. The Act aims to promote cleaner communities and more effective waste management across the country.

Thailand has developed a comprehensive waste management policy framework involving a strategic roadmap, initiatives from the **Ministry of Natural Resources and Environment (MONRE)**, and legal enforcement under the **Ministry of Interior (MOI)**.

**Thailand Waste Management Roadmap (2016–2021):** The roadmap aimed to enhance waste management and reduce environmental impacts by focusing on four main areas: improving municipal solid waste management, safe disposal of hazardous waste, proper handling of agricultural and industrial waste, and promoting public awareness for waste separation and reduction. It emphasized reducing waste at its source, promoting recycling, and improving hazardous waste disposal facilities. It promotes proper disposal methods, such as centralized facilities for waste-to-energy conversion and composting, aiming to reduce reliance on open burning and unsanitary landfills. The Pollution Control Department (PCD) establishes policies linkages as below (Figure 3).


Figure 3: The Pollution Control Department (PCD) establishes policies
Source: Pollution Control Department, Ministry of Natural Resources and Environment

According to the Pollution Control Department (PCD) in Thailand, the municipal solid waste generated was about 24.98 million tons in 2021. Of this amount, 37 percent was properly disposed of, 32 percent was utilized and 31 percent was improperly disposed of. The amount of waste managed at the source was only 6 percent (Figure 4).

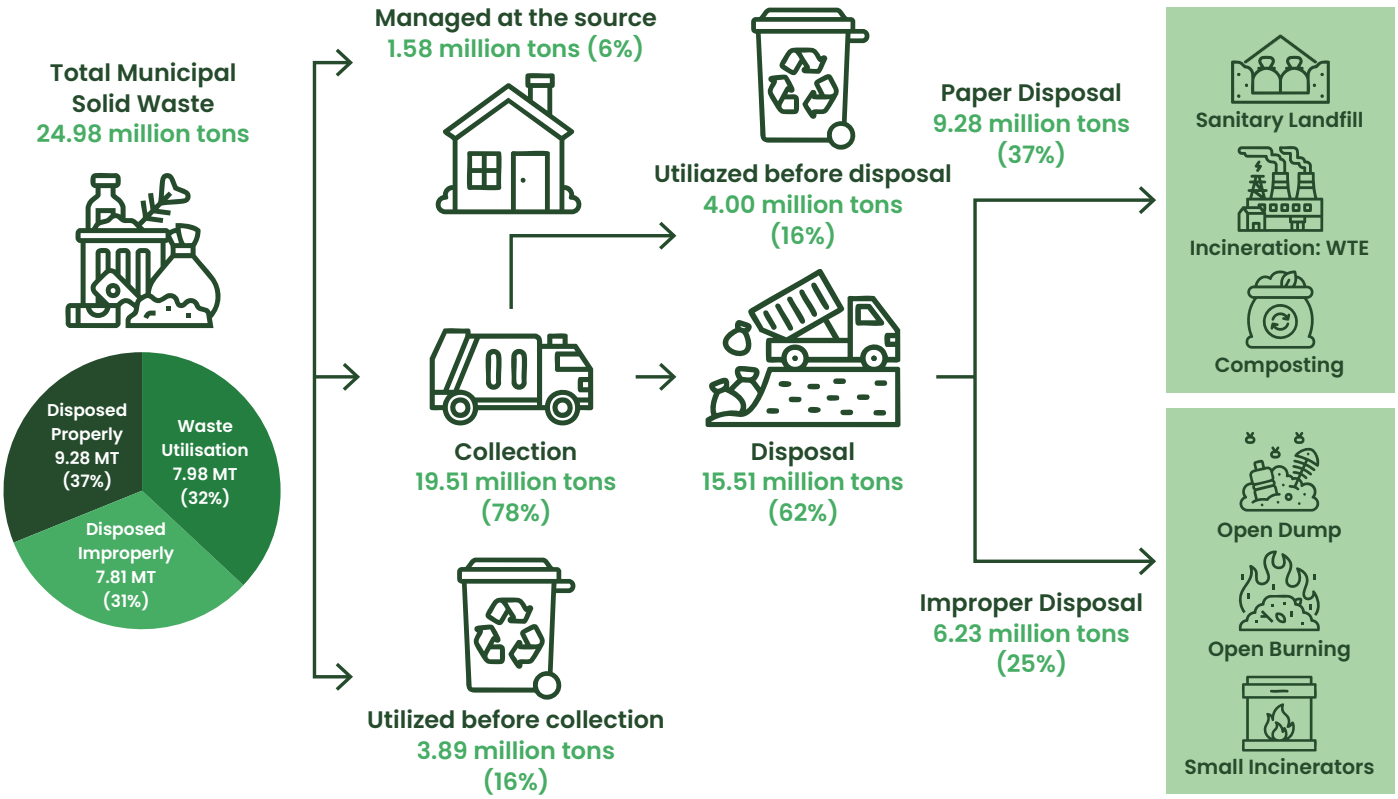



Figure 4: The municipal solid waste
Source: Pollution Control Department, Thailand 2021[9]

**Initiatives by the Ministry of Natural Resources and Environment (MONRE):** MONRE plays a crucial role in addressing waste issues. One of its significant initiatives is the **Plastic Waste Management Campaign**, which targeted a phased ban on single-use plastics, such as plastic bags,

[8] Pollution Control Department (PCD), Thailand, (2022)
[9] Action Plan on Plastic Waste Management Phase II (2023-2027), P.6

straws, and cups, with the goal of eliminating them by 2022. Although this has not be achieved by 2023. MONRE continues to promote circular economy to encourage sustainable production and consumption patterns and involves public awareness programs to educate citizens on waste reduction and separation, targeting 100 percent plastic waste to Circular Economy by 2027.

The following table is a summary of time schedule of plastic waste management policy in Thailand[10]:

Table 1: Time Schedule of Plastic Waste Management Policy in Thailand

| Activity | Detail |
|---|---|
| April 17th, 2018 | Order from the Prime Minister to develop action plans against plastic waste problem. |
| April 17th, 2019 | Approval of "the roadmap on plastic waste management, 2018-2030". |
| September 6th, 2019 | Joining the "No plastic bag distribution project" by 75 businesses. |
| December 23rd, 2019 | The Ministry of Public Health (MOPH) Notification prohibiting cosmetics containing plastic microbeads. |
| March 2020 onwards | Rapid increase of food container waste due to COVID-19 pandemic in Thailand. |
| July 8th, 2020 | Preparation of a new action plan for food delivery companies. |
| By 2022 | Ban of 4 types of single-use plastics, including thin plastic bags with thickness less than 36 microns, Styrofoam food boxes, plastic straws, and plastic cups. |
| By 2027 | Achievement of 100% reuse of plastic waste. |

[10] Ocean Conservancy, Thailand Roadmap on Plastic Waste Mangement, (2017), https://enviliance.com/regions/southeast-asia/th/th-waste/th-plastic-waste

# By 2027, Thailand will achieve 100% reuse of plastic waste.


Figure 5: Thailand's Roadmap on Plastic Waste Management 2018-2030
Source: Pollution Control Department, Thailand 2021

The mechanism of achieving the roadmap goals of Plastic Waste Management in Thailand is as Figure 6 below:


Figure 6: The mechanism of Plastic Waste Management in Thailand to achieve road map goals
Source: Pollution Control Department, Thailand 2021

**Laws and Implementation under the Ministry of Interior (MOI):**
The MOI oversees the enforcement of waste management laws, notably the **Public Health Act (1992)**, which empowers local authorities to manage municipal waste collection, treatment, and disposal. This act assigns local municipalities the responsibility for managing municipal solid waste and infectious/biological wastes, emphasizing proper collection and disposal to prevent practices like open burning that can harm public health. Local authorities are also mandated to encourage waste separation at the source, facilitating more efficient recycling and waste treatment processes.

The **2020 Ministerial Regulation on the Management of Toxic or Hazardous Waste from Communities** in Thailand outlines guidelines for the proper handling, storage, and disposal of hazardous waste generated by communities. It aims to protect public health and the environment by mandating safe collection, transportation, treatment, and disposal practices. The regulation requires local authorities to implement systems for hazardous waste separation, labeling, and safe disposal while imposing penalties for non-compliance to ensure public safety. It is required to instill national discipline to prevent open burning and improper disposal practices.

**Implementation and Collaboration:**
The implementation of these policies involves a multi-faceted approach, requiring cooperation between government agencies, local authorities, and the private sector. Efforts include setting up waste separation centers, establishing waste-to-energy plants, and enforcing strict regulations for hazardous and industrial waste disposal. This holistic approach aims to build a sustainable waste management system in Thailand, focusing on reducing waste generation, promoting recycling, and ensuring safe disposal. Roles and functions of key actors in the policy network[11] are as Figure 7 below

[11] Samitthiwetcharong, S., Kullavanijaya, P., Suwanteep, K. et al. Towards sustainability through the circular economy of plastic packaging waste management in Rayong Province, Thailand. J Mater Cycles Waste Manag 25, 1824–1840 (2023). https://doi.org/10.1007/s10163-023-01657-0

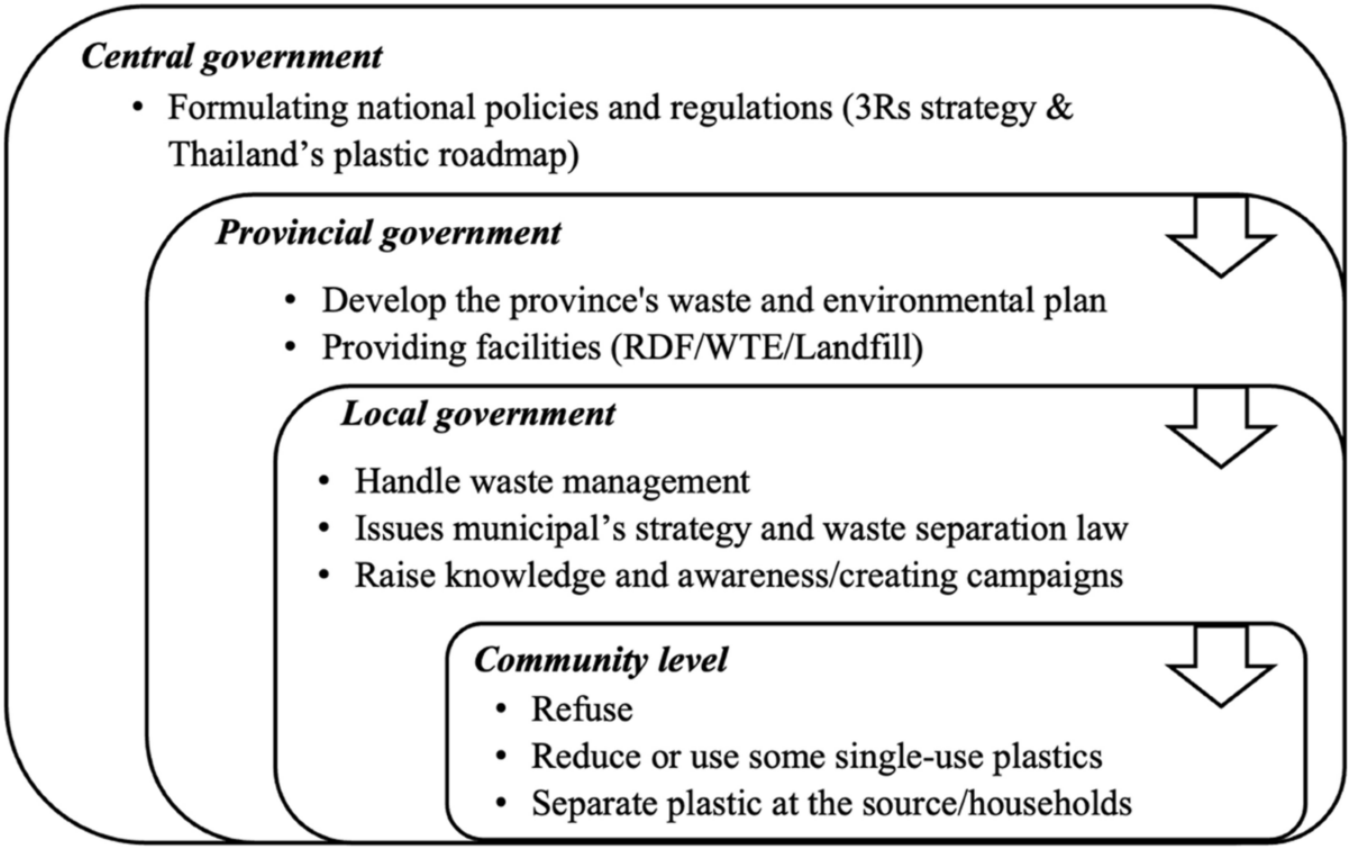



Figure 7: Roles and functions of key actors in the policy network
Source: Towards sustainability through the circular economy of plastic packaging waste management in Rayong Province, Thailand, 2023.

### Current Waste Disposal Infrastructure:

Thailand's waste disposal sites manage solid waste at various locations. As of 2022, there were 2,137 operational solid waste disposal sites. However, only 116 of these sites (5.43%) adhered to proper scientific principles, while the remaining 2,021 sites (94.57%) were improperly managed according to the Department of Local Administration, Ministry of Interior. The types of waste disposal facilities include:

- **Sanitary Landfills:** Engineered sites designed to safely isolate waste from the environment.
- **Incinerators:** Facilities that burn waste, with some equipped for energy recovery.

- **Composting Sites:** Facilities that process organic waste into compost, etc.
- The prevalence of improperly managed sites poses environmental and public health challenges, prompting initiatives to upgrade these facilities and improve waste management practices throughout the country.

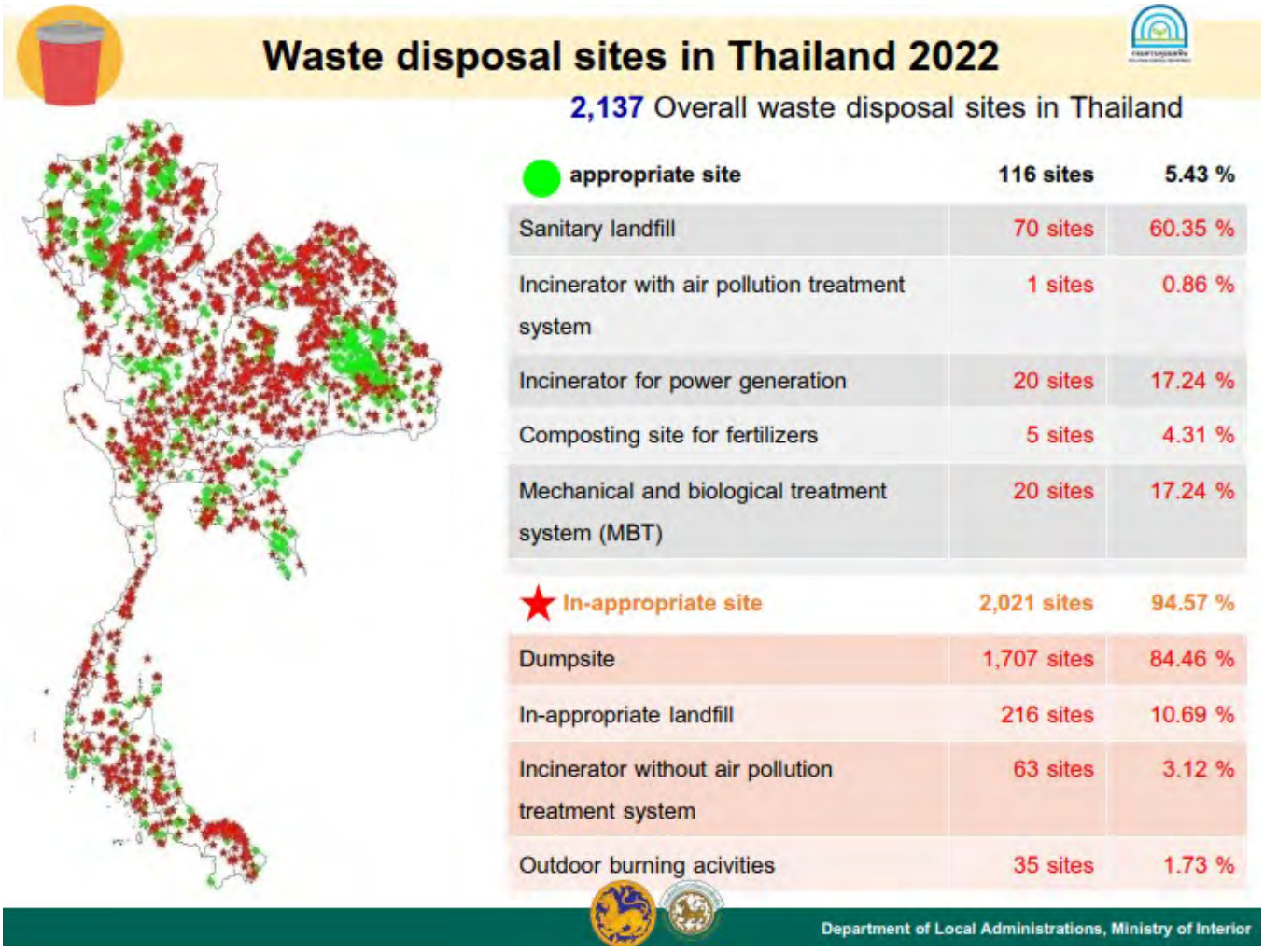



Figure 8: Waste disposal site in Thailand 2022
Source: Department of Local Administration, Ministry of Interior, 2022

## Challenges and Issues to Be Addressed for Better Policy Implementation:

**Waste Management Infrastructure:** need for waste treatment technology, facilities for waste sorting and recycling hinder effective waste segregation, leading to contamination of recyclable materials. Many citizens and businesses lack access to proper waste management systems, slowing the transition to circular practices.

**Awareness and Education:** A limited understanding of circular economy principles among the public and private sectors creates obstacles in unifying efforts and forming cohesive strategies. Targeted education and awareness campaigns are needed to highlight the benefits of circular practices and increase participation.

**Regulatory and Policy Gaps:** Despite government initiatives, gaps in clear laws and regulations, enforcement, and incentives for businesses to adopt circular practices remain. Stronger policy frameworks and compliance mechanisms are essential for success. Better cooperation between local government and private sectors could enhance investment in source separation infrastructure or Material Resource Facility (MRF).

In conclusion, today’s environmental challenges demand a shift in how we produce, consume, and manage resources. Adopting zero-waste principles and transitioning to a circular economy are not mere options but are essential pathways to ensure ecological balance, economic resilience, and social well-being. Traditional linear models of 'take, make, dispose' are inherently unsustainable, leading to resource depletion, environmental degradation, and mounting waste. In contrast, circular systems offer regenerative solutions that prioritize reuse, recycling, and the reintegration of materials into the production cycle. Embracing these models not only addresses the pressing issues of waste and pollution but also unlocks opportunities for innovation, green jobs, and sustainable development.

02

# INTRODUCTION TO THE DOI TUNG DEVELOPMENT PROJECT

# Establishment of the Doi Tung Development Project

The Doi Tung Development Project (DTDP), initiated in 1988 under the management by the Mae Fah Luang Foundation under Royal Patronage (MFLF), is a model of sustainable development that transformed into a thriving, resilient and self-sufficient community. Focusing on the Sustainable Alternative Livelihood Development (SALD) approach, the project promotes a balanced approach to development, combining social welfare, environmental protection, and economic viability. With the people-centered approach and emphasizing a resource-based economy, the initiative fosters sustainable use of local resources, while reducing dependence on external inputs. This holistic model over the years has improved local livelihoods with sustainable income while ensuring environmental conservation and community resilience.

The DTDP consists of 29 villages located in the Nang Non Mountain range, Chiang Rai Province. This area includes both the Mae Fah Luang and Mae Sai districts.

The success of the Mae Fah Luang Foundation in waste management within the Doi Tung Development Project (DTDP) has resulted in the project area maintaining a zero waste to landfill status since October 2018.

The Mae Fah Luang Foundation's waste management strategy follows a Zero-Waste-to-Landfill (ZWTL) approach with incineration used only when necessary. It applies circular economy principles including 4R strategies (reduce, reuse, recycle and repair) and upcycling, aiming for zero waste reducing or eliminating single-use plastics, and promoting the production of environmentally friendly products.

## MFLF: Environment Policy and Current Initiative on Waste Management

The Foundation places great importance on environmental issues, integrating them into its vision and mission alongside other development initiatives. To align with its established vision and mission, the Foundation hereby announces its energy and environmental management guidelines have been summarized as:

The Foundation is dedicated to environmental sustainability by adhering to legal and regulatory requirements. It aims to reduce pollution across air, water, soil, and noise through systematic waste management and implementing a Zero Waste system based on the 4Rs (Reduce, Reuse, Repair, Recycle) and promoting source reduction. Energy and environmental conservation efforts include optimizing resource use, prioritizing eco-friendly products, reducing greenhouse gas emissions, applying the 5S policy, eliminating single-use plastics, developing green products, and shifting towards renewable energy. The Foundation also focuses on training and communicating environmental knowledge and legal updates to employees and is committed to continuous improvement in environmental management through regular reviews and driving a circular economy by reintegrating waste into production processes.

**2007 - 2009**

Established the Doi Tung Development Project's waste sorting facility at the Huay Krai Municipality landfill.

**2012**

DTDP has been conducting a waste management programme under its "Zero Waste" concept, aiming to achieve "Zero Waste to Landfill" within the project area.

**2018**

Achieved zero waste to landfill management within the Doi Tung Development Project.

**2019**

Huay Krai landfill approached capacity. Initiated model waste management in 5 villages.

**2020**

October 1: Closure of the Huay Krai landfill.

**2020**

- Held SAO council and village headman meetings.
- SAO began collecting 7 types of waste using clear bags.
- Established subdistrict and village-level waste management committees.

Since 2012, the DTDP has been implementing a waste management program under the "Zero Waste" concept, striving to achieve ZWTL within the project area. After six years of continuous effort, this goal was successfully reached in 2018 (Figure 9). The success of the waste management process was largely due to the collective efforts of all staff, who followed waste sorting principles from start to finish, ensuring all waste would be utilized. (Figure 10 for achievement timeline).

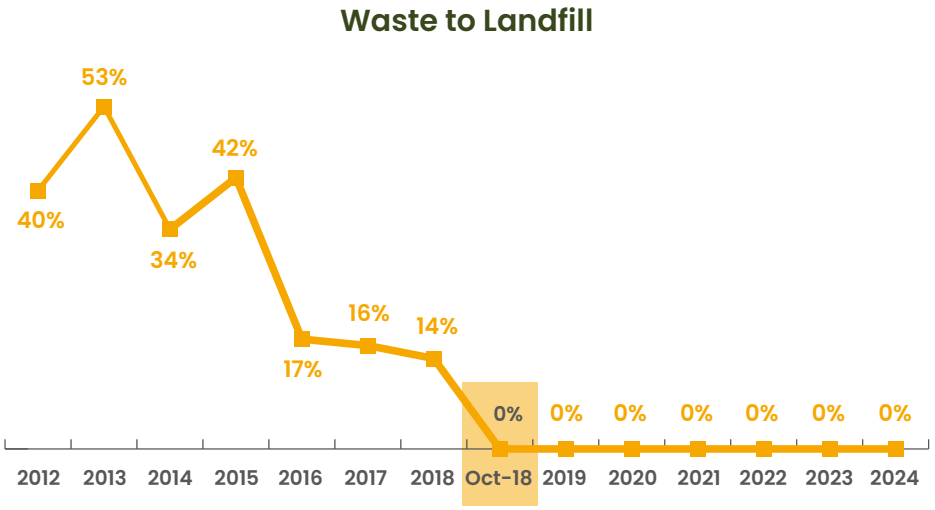



Figure 9: Percent of the DTDP's waste to landfill since 2012 to 2024

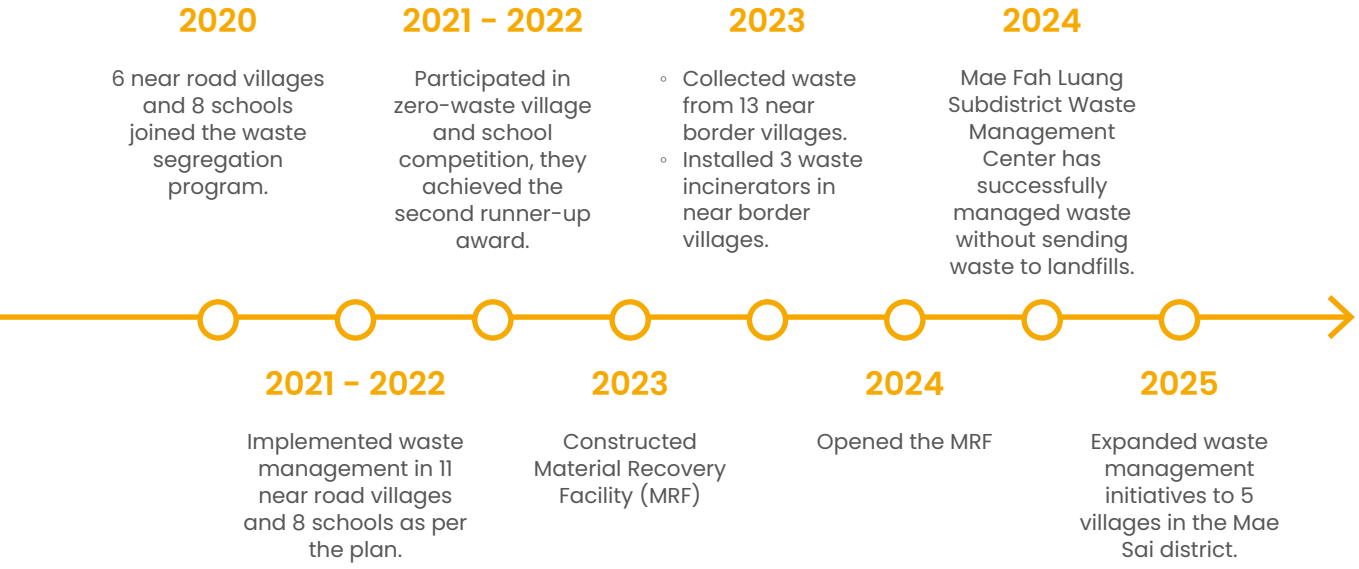
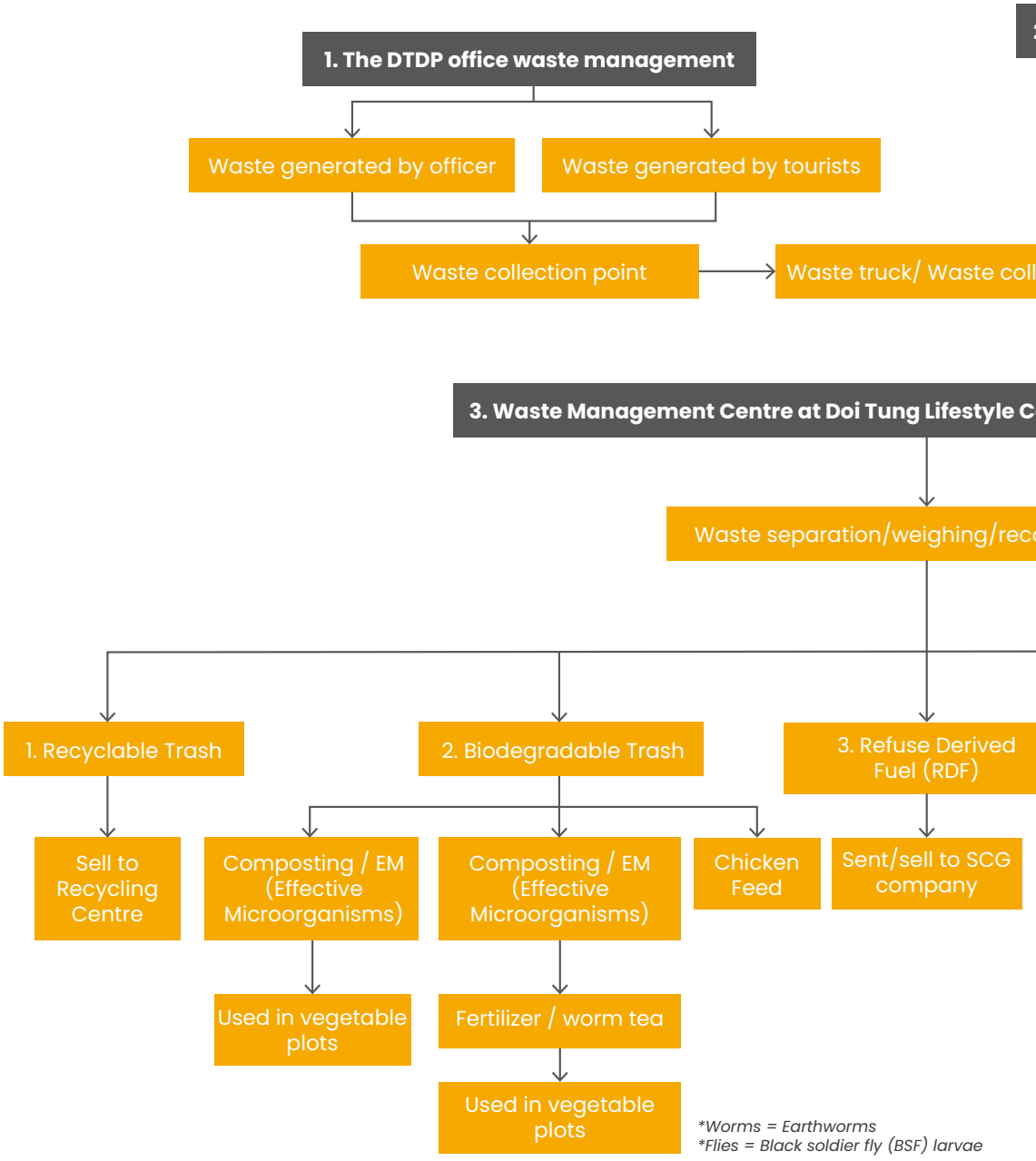



Figure 10: The DTDP's Achievement timeline

The Doi Tung Development Project Waste Management Pathways (Figure 11 below) indicates how all waste is either reused, recycled, composted, or converted into energy, with nothing sent to landfills. This greatly minimizes environmental pollution by reducing greenhouse gas emissions and harmful

## The Doi Tung Development Proje

*Management Operations*



landfill toxins, aiding in the fight against climate change. Moreover, it enables businesses to meet regulatory standards, enhances their public image, and creates new economic opportunities in recycling and waste management sectors.

## ct Waste Management Pathway

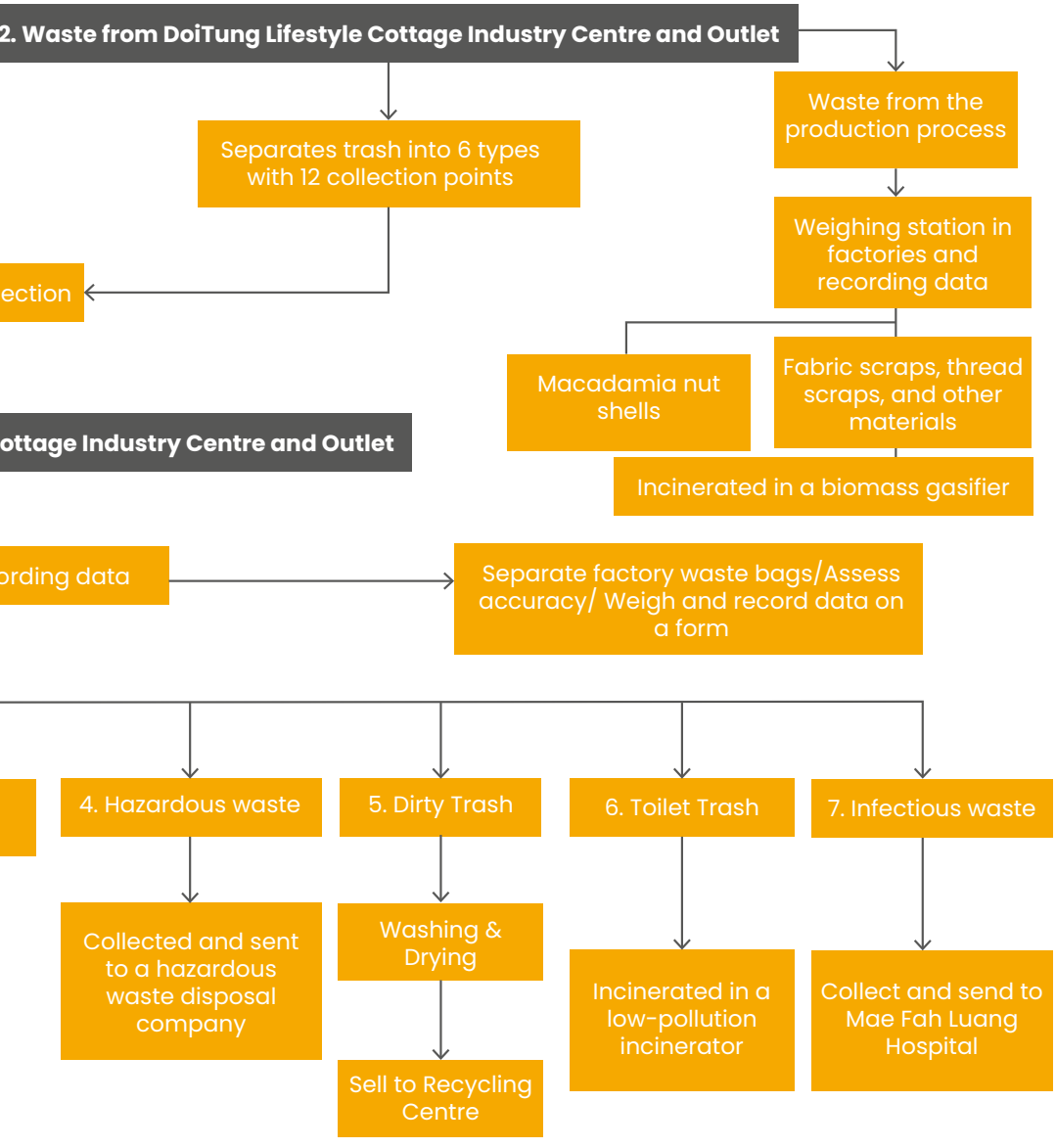



Figure 11: The Doi Tung Development Project Waste Management Pathways

# Local Government Initiatives through the MFLF

## *Waste Management Operations*

Effective waste management relies on robust infrastructure and collaboration with local government bodies, primarily the SubDistrict Administrative Organization (SAO). The DTDP, in collaboration with the SAO, implement waste management operations and operates a Material Recovery Facility (MRF).

Before the establishment of the MRF, the waste management model of the SAO handled waste in the following order: dirty waste, toilet waste, and Refuse-Derived Fuel (RDF). Dirty waste and toilet waste were incinerated at the local facility (local incinerator as Figure 12), while RDF was sent to SCG Lampang for energy recovery at the cement plant.

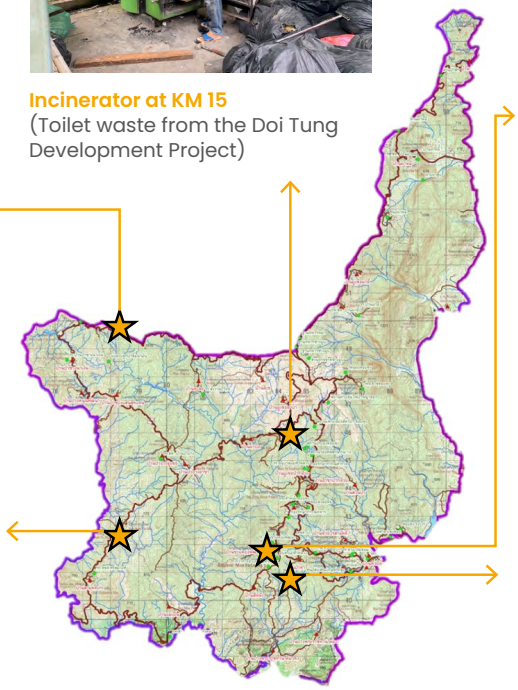
**Overview of the Area for Establishing Waste Incinerators/ Waste Management Centre.**

**Incinerator at Pa Sang Na Ngoen Village**
(Handles waste from Pa Yang Lahu and Akha Village, Pa Sang Saen Sut Dan Village, Pang Nun Phatthana Village, Pa Sang Na Ngoen Village)

**Incinerator at KM 15**
(Toilet waste from the Doi Tung Development Project)

**Incinerator at Pang Pra Ratchatarn Village**
(Handles waste from 11 near road villages and government agencies)

**Incinerator at Huai Pu Mai Village**
(Handles waste from Mae Poen Village / Sa Makkhi Mai Village, Sa Makkhi Kao Village, Huai Pu Mai Village)



Community Waste Management Center Located near the Mae Fah Luang SAO

Figure 12: The Area of Waste Incinerators and Waste Management Centre.

In 2024, with the introduction of the MRF, dirty waste is processed through washing, shaking off contaminants, and separating into recyclable waste and RDF. The management process is as follows: RDF is sent to SCG, recyclable waste is sold, toilet waste is incinerated, and hazardous waste is collected by the Provincial Administrative Office (PAO) and sent for disposal.

Infectious waste from the subdistrict health promotion hospital is sent for disposal at the waste management center at Mae Fah Luang University, the same facility used by the Doi Tung Development Project.

Hazardous waste from the Doi Tung Development Project is sent to the Provincial Administrative Organization, while chemical waste is disposed of through a procurement process with a certified chemical disposal company.

The DTDP in collaboration with the SubDistrict Administrative Organization (SAO) is responsible for running the MRF, that manages sorting RDF, dirty waste and toilet waste. The waste sorting is done into 6+1 categories (additional category for large items, collected every 6 months) following the methods set by the DTDP and the SAO as defined in Figure 13 below.
The different types of waste categorized are defined as:

Table 2: Types of waste, definition and managing process.

| No | Types of waste | Definition | Managing process |
|---|---|---|---|
| 1. | Recyclable Waste | Materials that can be processed and reused to create new products, such as paper, glass, metals and certain plastics. | Households sell to scrap buyers, with some villages pooling resources for a waste management fund. |
| 2 | Biodegradable waste | Organic waste that can naturally decompose and be broken down by microorganisms into simpler substances, such as food-stained packaging, used tissues and certain contaminated plastics or textiles. | Managed by households to use as animal feed or to make compost using green cones. |
| 3 | Dirty waste | Contaminated or soiled waste that cannot be easily recycled, such as food-stained packaging. used tissues, and certain contaminated plastics or textiles. | Collected every Monday in clear plastic bags provided by the SAO. If official bags are unavailable, households may use other clear bags, with their house and village numbers written on them. |
| 4 | Refuse-derived fuel (RDF) | Waste that has been processed to remove non-combustible materials and is used as an alternative energy source. It often includes non-recyclable plastics and textiles. | Collected every Tuesday in clear plastic bags provided by the SAO, is later compressed and send to SCG International Company for recycling process. |
| 5 | Toilet waste | Human excreta and waste collected from sanitary facilities, often treated or incinerated to prevent contamination and disease spread. | Collected by the SAO every Wednesday, to be incinerated by low-emission incinerator, leading to produce light weight concrete/ brick. |
| 6 | Bulky waste | Large furniture or huge components that are not easily disposable. | Collected by the SAO twice a year. SAO dismantled and segregated as recyclable RDF or used as construction material. |
| 7 | Hazardous waste | Waste that poses a risk to health or the environment due to its toxic, corrosive, flammable, or reactive properties. Examples include chemical waste, batteries, and medical waste. | Collected by the SAO on the first Friday of each month. |

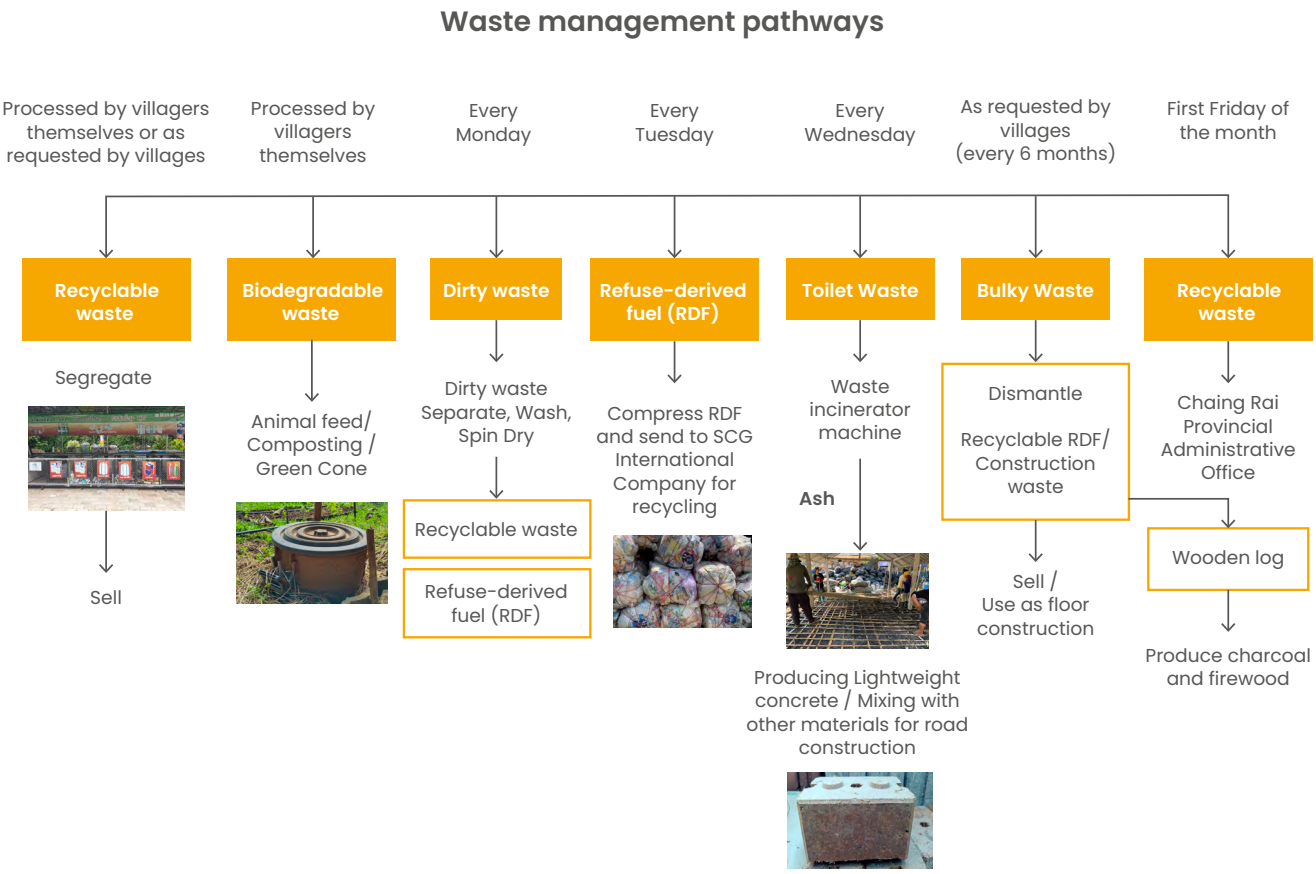



Figure 13: Waste Management Pathway at village level
Source: Adapted and compiled from SAO and the DTDP, 2024

## *Establishment of Material Recovery Facility (MRF) at community level*

MRF plays an integral role for waste management at community level by sorting, processing, and recovering recyclable materials from the waste stream. These facilities are essential for promoting sustainability and supporting the principles of a circular economy, where resources are reused and recycled rather than disposed of in landfills. Some of the key benefits of MRF are:

- **Resource Recovery:** MRF help to divert large volumes of recyclable materials from landfills and incineration. By separating valuable materials like plastics, metals, paper, and glass, these facilities ensure that these resources can be reprocessed and reused in the production of new products. This reduces the demand for virgin materials, conserving natural resources.

- **Reduction in Landfill Use:** MRF significantly decrease the volume of waste sent to landfills, extending the lifespan of existing landfill sites and reducing the environmental and economic burden of constructing new ones. By diverting recyclables, MRF contribute to reducing greenhouse gas emissions, methane in particular, which is released from landfills.
- **Energy Savings:** Recycling materials like aluminum, plastic, and glass through MRF requires much less energy than producing these materials from raw resources. For example, recycling aluminum saves up to 95% of the energy required to make new aluminum from bauxite ore. This energy efficiency reduces the carbon footprint of manufacturing industries.
- **Economic Value Creation:** MRF can generate economic value by creating jobs in sorting, processing, and recycling industries. They also support industries that rely on secondary raw materials, reducing the costs associated with raw material extraction. Additionally, recovered materials have market value, providing income streams for local governments and waste management companies.
- **Reduction in Environmental Impact:** By promoting recycling and reducing the need for extracting and processing raw materials, MRF minimize the environmental impacts associated with resource extraction, such as deforestation, water pollution, and ecosystem destruction. They also help reduce pollution and carbon emissions associated with the disposal of waste in landfills or through incineration.

The MFLF established MRF in SAO incorporating certain infrastructure including waste sorting, washing, drying machine and water treatment system, baler machine and pickup truck to manage logistics.

Waste Management Building

Waste Sorting Machine

Waste Drying Machine

Pickup Truck in Near Boarder Village

Waste Water Treatment System

Waste Washing Machine

Baler Machine

Figure 14: Picture of Establishment of MRF in SAO

The MRF centre has the maximum capacity of 2 tons per day. The investment cost and budget for operation of the Mae Fah Luang Community Waste Management Centre for 24 villages can be seen as below:

Table 3: Construction and equipment costs

| No. | Description | Total (Baht) | Note |
|---|---|---|---|
| 1 | Construction and equipment costs | 2,110,000 | Waste sorting building, Waste storage facility, Waste washing machine, Waste drying machine, Waste baler machine, Incinerator, Waste incinerator building |
| 2 | Pickup truck | 864,000 | |
| **Total construction and equipment costs** | | **2,974,000** | |

Table 4: Budget for operations.

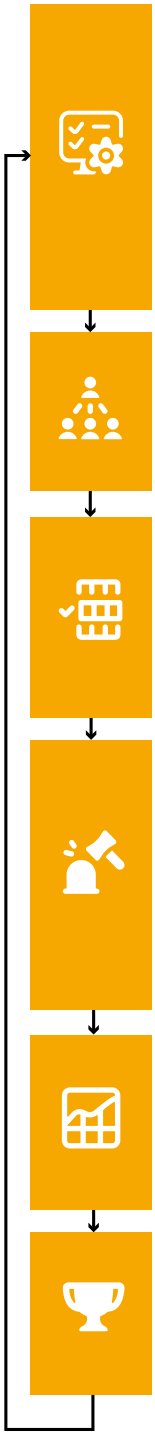
| No. | Description | Ongoing Costs (Baht) | Note |
|---|---|---|---|
| 1 | Salary | 1,089,550 | |
| 2 | Supplies for waste management | 15,790 | Gloves, face masks, aprons, boots, etc. |
| 2 | Fuel costs for waste transportation and maintenance costs for waste collection vehicles. | 82,681.02 | |
| Total Ongoing Costs | | 1,188,021.02 | |

# Local Community Collaboration

A clear illustration of how to structure and foster local community collaboration in waste management can be seen in the following six-step framework:

The six-step framework for implementing a community-based waste management program. The strategy emphasizes a holistic approach that integrates top-level policy and administrative leadership with community participation. It details a structured process beginning with establishing clear policies and role models, followed by practical steps for waste sorting, the enforcement of rules and regulations, and diligent monitoring. To ensure sustainability and encourage widespread adoption, the model strategically incorporates motivational tools such as public competitions and reward systems, fostering a collective responsibility for effective waste management.

## 6 Steps of Waste Management



**1. Establish Policies and Budgets from Administrators:**

- No waste is sent to Landfills (Zero Waste)
- Every household manages food scraps and biodegradable waste within the community.
- Each household has at least six types of waste bins for segregation.
- All households sort and dispose or waste on specific days as scheduled by the SAO, using clear bags.
- Hazardous waste is taken to designated hazardous waste disposal points.
- Waste segregation is practiced at all events, including religious ceremonies and community activities.

**2. Be a Role Model:**

- SAO officials and government agencies practice waste segregation.
- Establish waste management committees at the subdistrict and village Levels.
- Organize study visits for community members to learn best practices waste management and adapt them to the local context.

**3. Choose Appropriate Waste Sorting Methods:**

- Sellable waste: Managed by villagers or collected at designated points.
- Biodegradable waste: Managed by villagers (e.g., green cone bins, placing under trees, feeding animals, worm farming).
- Other waste types: Dirty waste, energy waste, toilet waste, hazardous waste.
- Bulky waste: Disposed of on specific dates designated by the SAO.

**4. Establish Rules and Regulations:**

- Prohibit waste disposal, food scraps, and waste burning in public spaces:
  - 1st violation: Verbal warning.
  - 2nd violation: Fine of 500 THB, contributed to the village fund.
- SAO will not collect unsorted waste (dirty waste. energy waste, toilet waste, hazardous waste).
- Waste must only be disposed of on scheduled collection days.
- All waste bags must have the household and village number written on them; unmarked bags will not be collected.

**5. Monitor and Report Results:**

- SAO weighs waste from all villages during each collection.
- Committees conduct monthly waste sorting checks (random inspections).
- SAO provides waste data feedback to villagers at monthly community meetings and collects suggestions.

**6. Organize Competitions with Rewards:**

- Hold waste-free village competitions at the sub-district and national level (achieved second runner-up award).
- Hold zero-waste school. competitions at the sub-district and national levels (achieved second runner-up award).

Figure 15: Six-Step Framework of Waste Management

This framework serves as a practical blueprint for local community collaboration. Its core strength lies in its integration of top-down policy with bottom-up community participation, ensuring that residents are not just subjects of the rules but active partners in the waste management process. The inclusion of motivational tools like competitions and rewards further strengthens this collaborative spirit, transforming individual responsibilities into a shared community goal and fostering the collective ownership necessary for long-term success.

Building upon this structured framework, the principles of collective responsibility were put into practice through a Waste Management Initiatives at the Doi Tung Development Project. Developed through intensive community collaboration, these practices translate policy goals into tangible actions. They range from detailed waste segregation at the source and composting to innovative upcycling, all designed to create a replicable model for sustainable waste handling across the community.

Initiatives taken through community collaboration include aligning with good waste management practices, increasing community participation, adding value-added approaches like segregation of waste at the source, composting biodegradable waste and upcycling to better products. All these steps developed by aligning the initiatives to the policy and putting up a model in place, to replicate this at different village levels within the community. The policy orientation focusses on:

- No waste generation
- Segregating waste into 7 types
- Promoting waste management trainings and monthly meeting

- Building learning center and community waste management
- No biodegradable waste is collected
- No burning waste and tree leaves in open-air area
- No general waste throwing in public space, creeks, sideways

These initiatives contributed to the goal of managing waste from the DTDP within 24 villages and 17 other government agencies located in Mae Fah Luang Subdistrict, where SAO collects waste. This collaboration also focusses on the goal of becoming the learning center for approaches and practices towards zero waste to landfill.

In conclusion, embracing zero-waste principles and advancing a circular economy is not just an environmental necessity, it is a strategic move towards achieving the Sustainable Development Goals. This chapter highlighted how localized actions, when thoughtfully implemented, can drive meaningful change. The Doi Tung Development Project (DTDP) stands as a powerful example of this approach, demonstrating how community-led efforts in sustainable waste management, resource efficiency, and land stewardship directly support broader global goals. Specifically, the DTDP contributes to SDG 12 (Responsible Consumption and Production) by minimizing waste and promoting sustainable practices, and to SDG 15 (Life on Land) through ecosystem restoration and biodiversity conservation. As we look to the future, the DTDP reminds us that sustainable change begins at the local level—and that these efforts, rooted in culture and community, can ripple outward to help shape a cleaner and more resilient world.

# 03 ABOUT THE STUDY

## Objective

The research study attempts to understand the issues and challenges of waste management and analyze the waste management practices implemented under the Mae Fah Luang Foundation (MFLF). The study attempts to understand the initiatives towards zero-waste-to-landfill (ZWTL) incorporating various aspects such as the origin of waste, common issues faced by the households, school, factory and community, waste segregation, disposal destinations, successful initiatives, interview with stakeholders and collaboration with the local administration. The study also highlights successful cases of upcycling with eco-friendly products and services that contribute towards circular economy. The study aims to contribute valuable insights into sustainable waste management, supporting policy development and practical implementation for similar initiatives globally.

## Research Methodology

The study integrates primary data from 337 households and 41 stakeholders across local communities, educational institutions, and factories, complemented by secondary data from existing reports and frameworks. The study adopts a mixed-methods approach, combining quantitative surveys, qualitative interviews, and focus group discussions (FGDs).

1. Conduct workshop for focus group meeting (MFLF inviting relevant stakeholders)
    - Available waste related information at the Doi Tung Development Project, MFLF.
    - Identify groups/ communities/ households for conducting survey.
    - Exploring major issues and challenges in managing waste, along with prospects for further research, improvement, and development.
2. Conduct survey of 337 households in the Doi Tung Development Project.

3. Conduct in-depth interviews with the people/ households in the community and experts from related stakeholders.
4. Highlight interesting cases/ practices of waste management in the Doi Tung development project based on the workshop and interviews
5. Analyze the data, hold discussions, and provide recommendations.

# Project Site

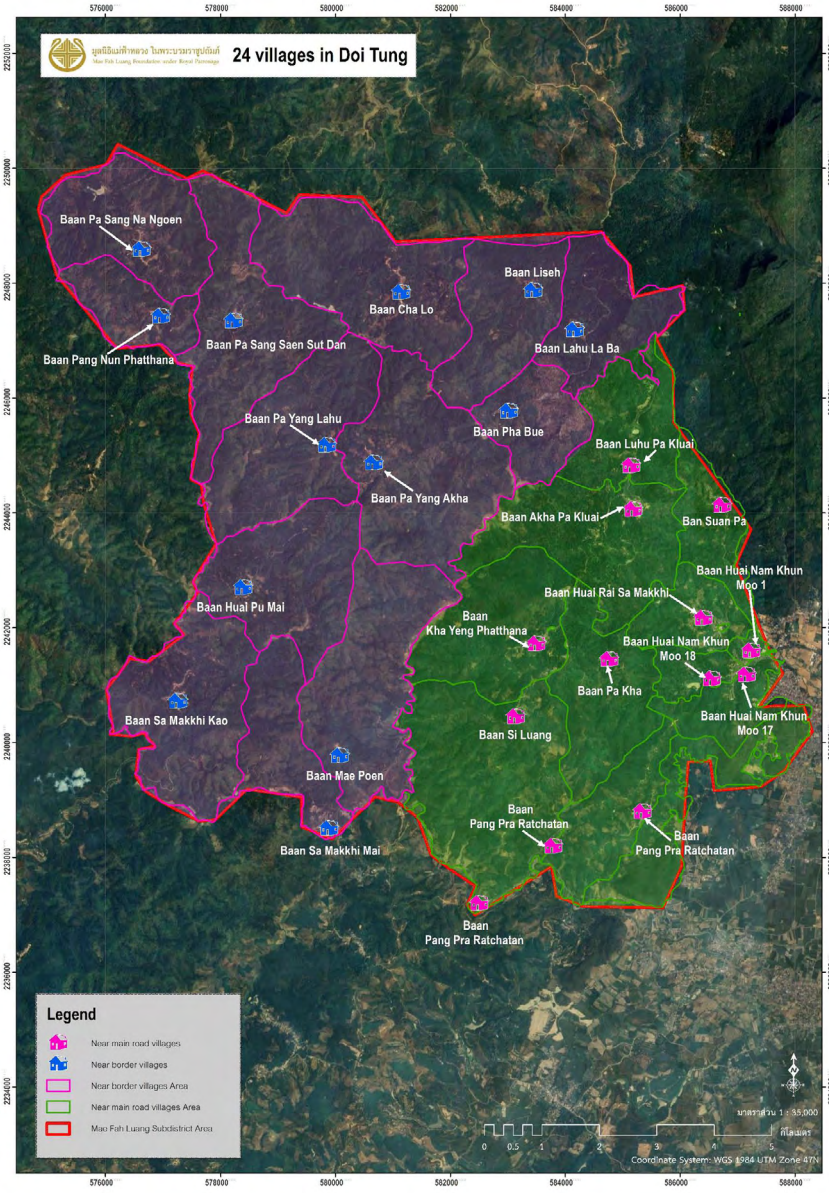



Figure 16: Location of conducting survey at 24 villages in the DTDP, Thailand

# Data Collection Process and Methodology

The Doi Tung Development Project (DTDP) consist of 29 villages located in the Nang Non Mountain range, Chiang Rai Province. This area includes both the Mae Fah Luang and Mae Sai Districts. Since 2012, the DTDP has been implementing a waste management program under the "Zero Waste" concept, aiming to achieve "Zero Waste to Landfill" within the project area. Through sustained efforts over six years, this goal was successfully achieved in 2018. The community involvement for the waste management program began 2019, with 5 volunteering villages. In 2020, waste management program was expanded to include 11 villages near main road, with further expansion to 13 villages near the border in 2023. This report thus focuses on waste management in the 24 villages within the DTDP and the Mae Fah Luang SAO.

## In depth interview and FGDs

FGDs provides insights into how people think and provide a deeper understanding of the phenomena being studied

1. Population and Sampling Procedure
    a. Target Population:
        i. MFLF staff total 13 members
            - Office: Green Office Committee, responsible for waste management, comprising 3 members
            - Representative from the kitchen: 1 member
            - Factory representative (Cottage Industry Centre and Outlet): 9 members
        ii. Representatives from MFLF administration and local government total 10 members
            - School representatives: 5 members from 4 schools (of 8 school) within the DTDP area

- Local government representatives: 2 members from Mae Fah Luang district and 3 members from Mae Fah Luang SAO

iii. Village representatives: total 13 members from 7 villages

- Group 1 (near main road villages): 9 representatives from 5 villages (Huay Nam Khun Moo 1, Huay Nam Khun Moo 17, Huay Nam Khun Moo 18, Akha Pa Kluay Moo 7, Khayaeng Pattana Moo 5)
- Group 2 (near border villages): 4 representatives from 2 villages (Liche Moo 9, Pa Yang Lahu Moo 16)

2. Focus Group Discussion Objectives
   - Understand overall waste management practices
     - Environmental policies and measures of the organization
     - Waste generation
     - Waste segregation
     - Rules and regulations
   - Explore participation and collaboration in waste management include within the community and outside the community
   - Identify successes and challenges in waste management
   - Determine future directions for waste management
3. Operational Steps
   - Coordinate with target groups and schedule activities

- Explain the objectives of the activity
    i. Conduct focus group discussions facilitated by the Knowledge and Learning Centre and Environmental Department, in collaboration with Dr. Shweta Sinha from the Pridi Banomyong International College, Thammasat University. This collaboration resulted in the English publication "Waste Management – the Case of Zero Waste to Landfill" to disseminate the success of the waste management efforts in the Doi Tung Development Project area.
    ii. Consent was obtained for photography and voice recording, ensuring confidentiality of personal data and guaranteeing non-disclosure beyond the stated purposes.

4. Activity Schedule:
    - Day 1 (27 March 2024): VIP meeting room at the DTDP
        - Morning: Group 1 (near main road villages) and Group 2 (near border villages)
        - Afternoon: Group 3 (schools) and Group 4 (local government)
    - Day 2 (28 March 2024): Material Recovery Centre (Cottage Industry Centre and Outlet)
        - Employees at the factories (Cottage Industry Centre and Outlet) and waste sorting officers
    - Day 3 (29 March 2024): Meeting room at the DTDP
        - Green Office Committee, Doi Tung Office staff, and kitchen representatives

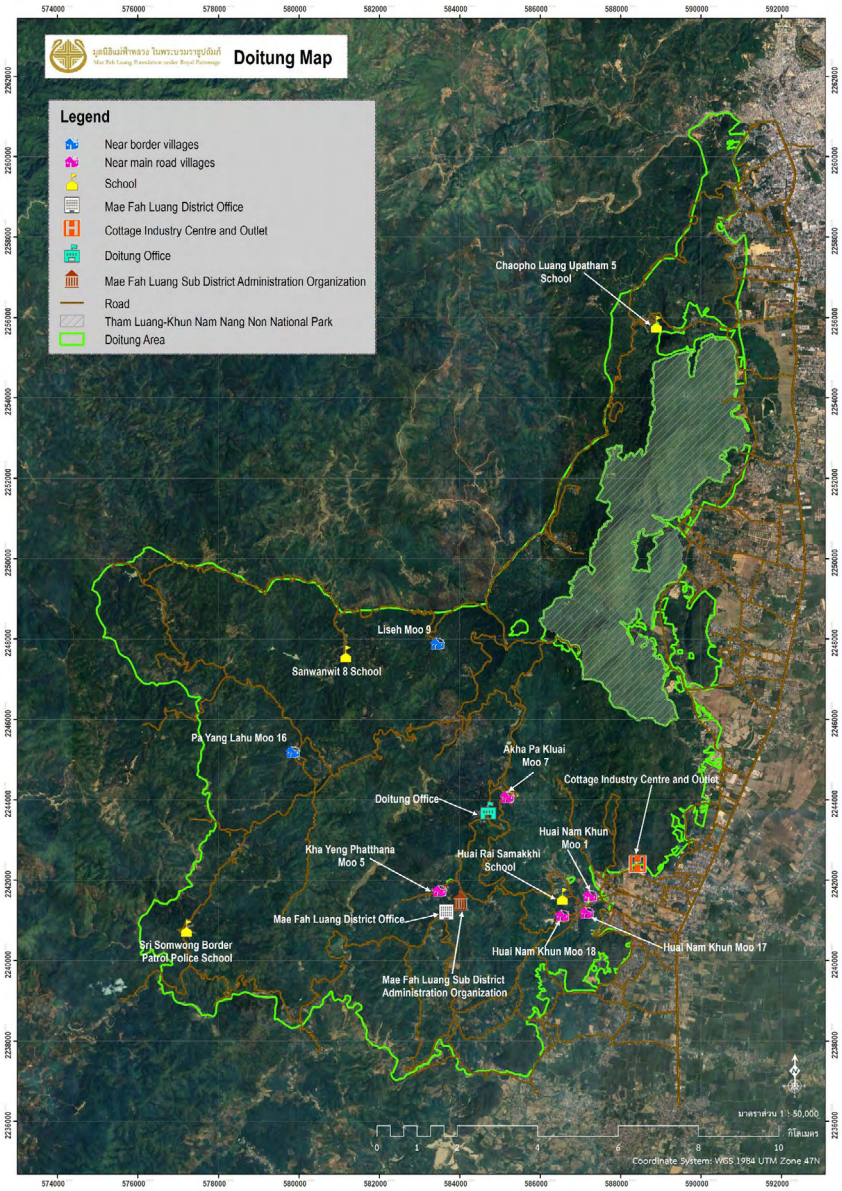



Figure 17: Location of conducting Focussed Group Discussion (FGD) and survey in the DTDP, Thailand

## Survey

The survey was conducted in 24 villages within the DTDP and Mae Fah Luang SAO with a total sample collection of 337 households, with 212 from villages near the main road and 125 from villages near the border as the population per village in villages near the main road are larger than villages near the border. The objective of the survey was to understand and improve waste management practices in the community. The operational steps involved were to plan field visits for distributing the questionnaire offline and sharing online, providing explanation about the objective of the activity. For analysis purpose the data codes were set as demonstrated in Appendix 4 and survey questionnaire as demonstrated in Appendix 5.

1. Population and Sampling Procedure
    - Target Area: Focus on 24 villages within the DTDP and Mae Fah Luang SAO
    - Target Population: At least 300 samples[12]
        - Samples from villages near the main road: 212
        - Samples from villages near the border: 125
        - Total samples: 337
2. Questionnaire Objectives:
    a. Understand and improve waste management practices in the community
3. Operational Steps
    a. Plan field visits for questionnaire distribution
    b. Explain the objectives of the activity
        i. Conduct the survey, facilitated by the Knowledge and Learning Centre and Environmental Department, in collaboration with Dr. Shweta Sinha. The English publication "Waste Management – _the Case of Zero Waste to Landfill" disseminates the project's success.
        ii. Privacy Agreement: Mae Fah Luang Foundation (the Foundation) will collect and use the provided information, including name, address, and photographs, for analysis and data processing. The Foundation ensures the confidentiality of personal data and will not disclose information except as stated.
4. The questionnaire will be conducted both online and offline, depending on the area's context (offline in areas with no signal).

[12] The total number of households in 24 villages in Mae Fah Luang Subdistrict is 1604 households.

## Discussion with policy experts

The methodology for community waste management involves a collaborative approach that starts by defining the objectives, such as waste reduction, recycling, and compliance with environmental regulations. The idea of engaging with a policy expert was to understand and ensure that the implementation at the community level aligns with local and national policies, understanding regulatory gaps, and exploring community incentives like subsidies and grants.

Data collection and monitoring provides information regarding the types and volumes of waste generated, informing tailored strategies like waste segregation, recycling programs, composting, and awareness campaigns.

Policy recommendations are then suggested to support these initiatives based on discussion with the policy expert (questionnaire as demonstrated in Appendix 6) that can help adapt strategies to changing regulations and ensure long-term sustainability of the initiative.

In summary, this comprehensive methodology ensures a holistic understanding of waste management practices within the DTDP, enabling actionable recommendations tailored to community needs. Through a well-rounded approach that included focus group discussions, surveys, and consultations with policy experts, the research gathered valuable perspectives from both the community and professionals. This well-structured method allowed for a deeper understanding of real challenges and opportunities. The findings lead to practical, community-specific recommendations that support improved waste practices and long-term sustainability. Overall, the study reinforces the importance of locally grounded research in driving meaningful progress toward sustainable development.

# 04

# DATA ANALYSIS RESULTS AND DISCUSSION

This chapter presents and analyses the data collected to evaluate the sustainable waste management model at the DTDP. It begins by presenting the existing operational scenario and quantitative evidence of the Zero Waste to Landfill (ZWTL) achievement. It then delves into the qualitative findings from in-depth interviews and focus group discussions, followed by quantitative survey results to understand stakeholder perspectives and participation. The chapter synthesizes these findings to discuss the model's benefits and drawbacks, its contribution to the UN Sustainable Development Goals (SDGs), and its relationship with existing policies. The aim is to provide a comprehensive analysis of the factors contributing to the success of the DTDP's waste management system.

# Existing Scenario

Overview of the waste management situation at the DTDP since the successful implementation of the ZWTL model in 2018. Waste volume data for 2024 from the DTDP, communities, and schools have been collected and compared with figures 18-19 from previous years. illustrate the significant progress made in waste not sent to landfill.

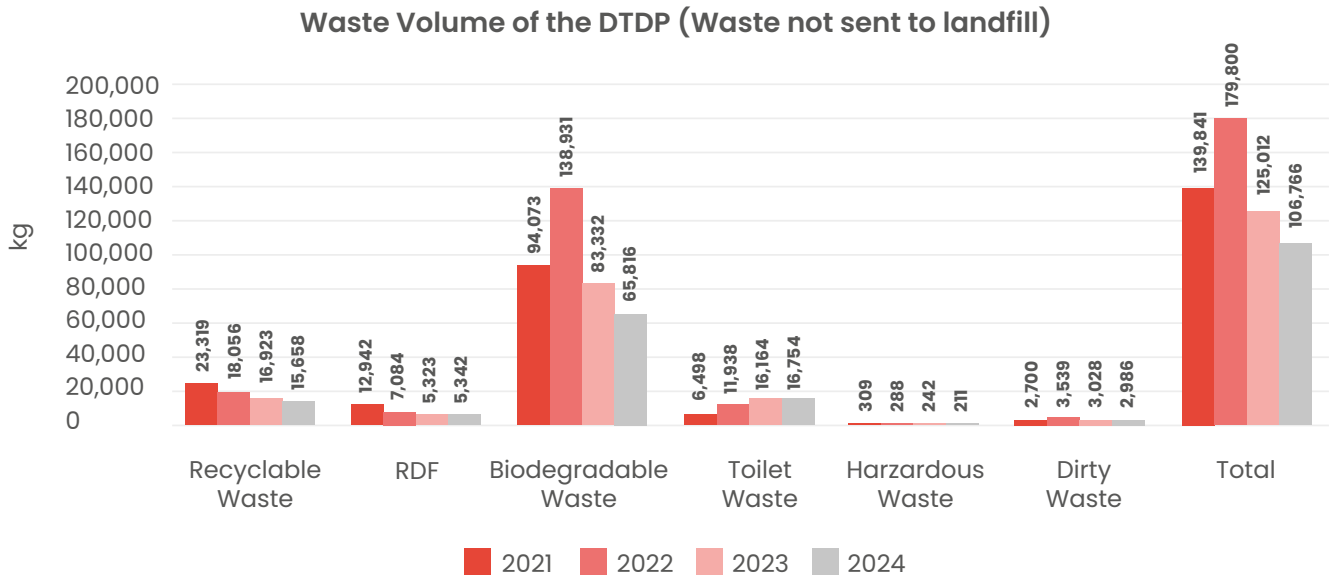



Figure 18: Waste Volume of the DTDP (Waste not sent to landfill)

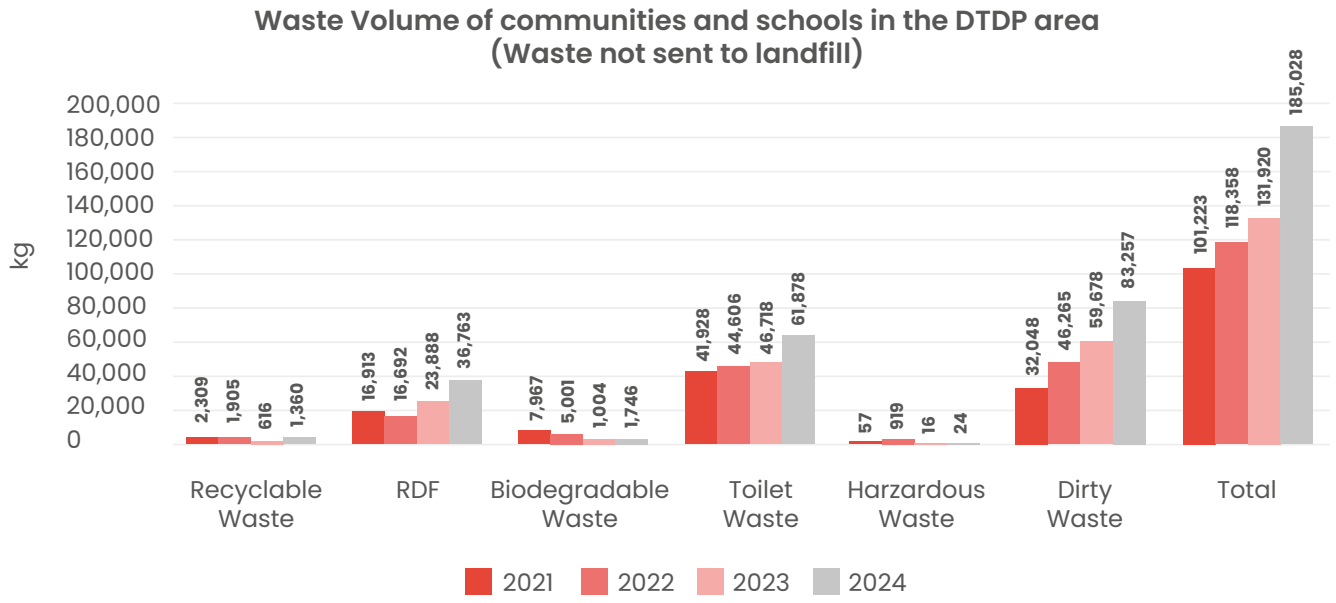



Figure 19: Waste Volume of communities and schools in the DTDP area (Waste not sent to landfill)

For the operation, the waste collection by SAO is scheduled on different days (Figure 20) to reduce the confusion of the stakeholders and support the community needs with appropriate pictures as examples and color-coded visuals that help people remember the schedule, making it clear and easy for residents to follow. The waste collection schedule is a visual communication tool that is appropriate to the community context, along with the educational efforts to support behaviour change.


Figure 20: The SAO's waste collection scheduled
Source: Mae Fah Luang Sub District Office (SAO)

The execution process undertaken by the Foundation to develop and implement the waste management model, including Community Engagement, community training, infrastructure support, and incentive campaigns such as

- **Education and Planning:** collaborative waste management planning, Village visits to explain procedures, study visits and training.

Collaborative waste management planning

Village visits to explain procedures

Trainings to inform villagers about waste segregation

Figure 21: Education and planning activities.

- **Incentivization and Enforcement:** subsidizing equipment, requiring villagers to buy specific bags, examining garbage before collection.

Collaborative waste management planning

Villagers buy plastic garbage

Officers examine garbage before collecting

Figure 22: Incentivization and enforcement activities.

- **Community Activities:** "Plastic Bag Free Day," collected Bulky waste every 6 months., the "Waste-free Village" assessment, and the "Fresh Market to slow down global warming" project

Plastic Bag Free Day

Fresh Market to slow down global warming project

Bulky waste is collected every 6 months

Figure 23: Picture of community activities.

- **Centralized Model:** the DTDP trash management center (or MRF) as the hub and model of these activities

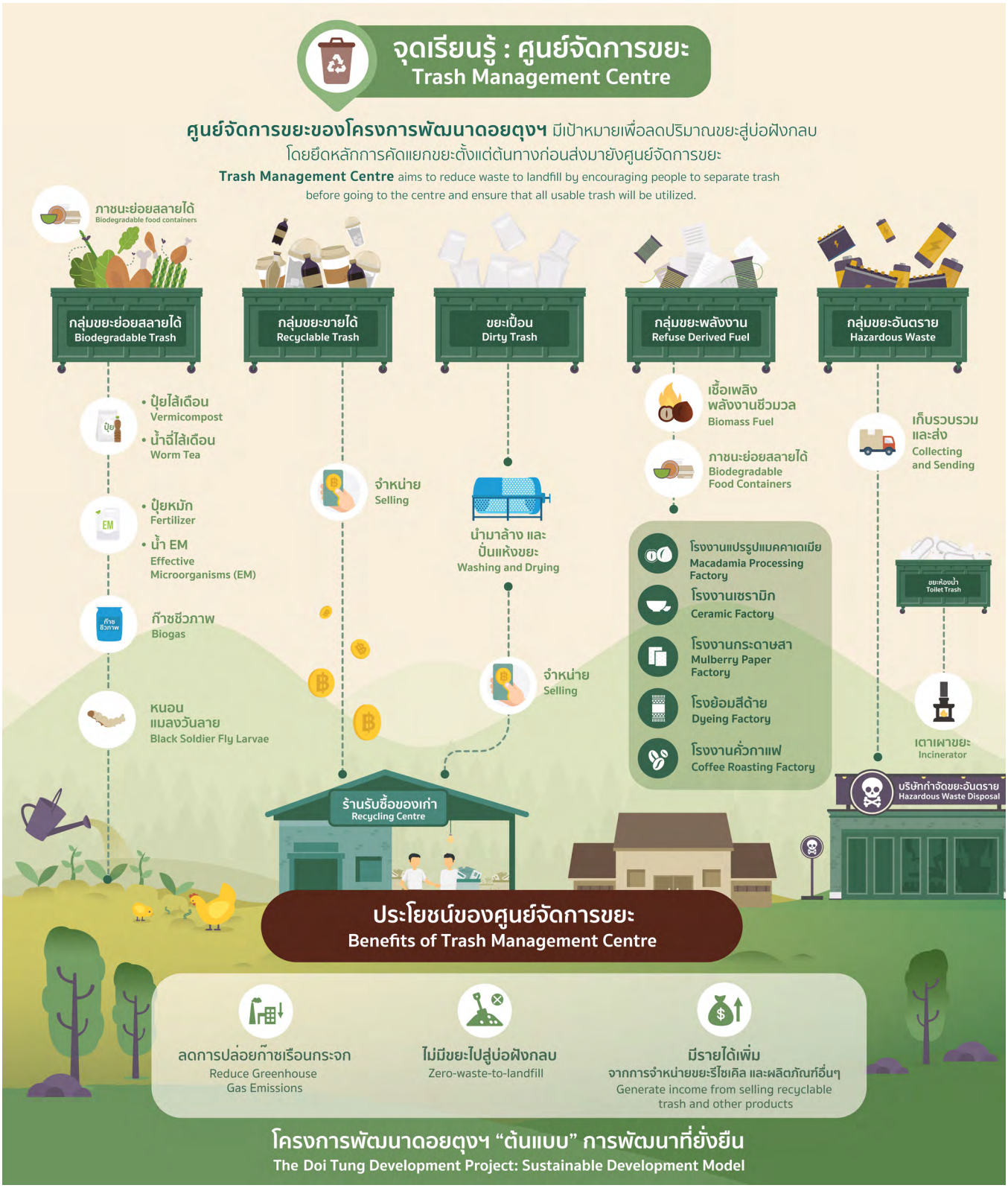



Figure 24: The DTDP trash management center development model, 2024

# In depth Interview and FGDs

This section presents qualitative insights obtained from interviews with key stakeholders and focus group discussions with villagers, school staff, and project officers. These narratives reveal how local perceptions, knowledge, challenges, and behavioural changes contribute to the program's success. The data also highlight how community ownership, leadership support, and inclusive participation play a crucial role in shaping sustainable practices.

After the Huay Krai Subdistrict Municipality landfill reached full capacity (Figure 25), Mae Fah Luang SAO and the DTDP initiated community-based waste management efforts to engage with the community members. The efforts included creating awareness about the importance of waste segregation, implementing regular monthly meetings, and providing training on proper waste segregation practices. Villagers took on the responsibility of monitoring adherence to community waste management rules. Informative leaflets on waste types and collection schedules were distributed to every household. In addition, new regulations were introduced emphasizing the importance of proper waste management. This initiative has led to benefit the community in different ways, improving image supporting tourism to generate income, promoting good health, reducing waste, and creating a cleaner environment.


Figure 25: Landfill at Huai Khrai Subdistrict in 2018

The community is not self-sustaining and still needs support from the SAO.
These findings support the success of this initiative, which includes consistent high-level policies, dedicated budget support, strong leadership commitment, and empowerment of communities to monitor compliance with waste management regulations. Incentive strategies and the potential for friendly competition further promote participation. The entire system is designed as an iterative process, allowing for continuous improvement and adaptation.

### i. Near main road villages

In case of near main road villages, the source of waste was identified as coming from community festivals and activities, purchased goods where plastic bags could not be avoided, households, building construction and tourism waste.

Ongoing efforts were made to strengthen understanding among villagers, with training sessions held to practice proper waste sorting. Informative leaflets containing visuals on waste types and collection schedules were distributed to every household. In addition, new regulations were introduced to community rules, emphasizing the importance of proper waste management. To address language barriers, waste collection schedules were adapted using posters in local dialects and media with corresponding images and colors for each waste collection day. Black bags were prohibited from disposal, and the SAO enforced strict measures by refusing to collect unsorted waste. Households that did not follow waste segregation rules were reported to community leaders, who then ensured that corrective actions were taken under the overall monitoring and supervision of the leaders of the villages.

Waste disposal spots vary by village, with some having centralized locations, such as Moo 17 village where a single disposal spot is monitored by CCTV. Other villages leave segregated waste at the entrances of alleys according to the SAO's collection schedule. Issues arise from outsiders illegally dumping waste in forests or rivers, prompting the community to investigate waste origins using identifiable clues like receipts or packaging. There is also resistance from younger residents who typically work or study outside of the DTDP and return to the village, often questioning the need for waste segregation and disposing of waste improperly.

The community sorts household waste into six main categories, plus an additional type for bulky items (6+1), in accordance with the SAO's waste management policy

The outcome of this waste management initiative has led to benefits at social, economic and environmental level by promoting community image, supporting tourism to generate income for a group of people, promoting good health, reducing waste and cleaner environment respectively. But the overall systems still need support from the SAO.

### ii. Near border villages

In case of near border villages, illiteracy among villagers hindered understanding of waste segregation. Before waste segregation was implemented in 2023, normally people used to manage waste by open burning and sending it to open dump, approximately 2 tons of waste every year. Out of 11 villages at the near border villages, only 4 villages have disposal spots and waste collection system by the SAO. It has helped to bring cleanliness to the villages, improving health by eliminating waste burning practices. Although, there is some difficulty in conducting knowledge transfer especially to senior citizens and there is a need to improve communication with the tourist and external visitors as they lack knowledge of waste segregation practices in the community. Overall, there is a rise in awareness and readiness to learn

### iii. Schools

Since 2019, waste management in schools has expanded and been implemented simultaneously across all eight schools in the Doi Tung Development Project area. Along with model communities, following similar processes such as providing trainings, organizing study visits, developing waste management plans in schools, and holding contests.

The Kha Yeng Pattana school has been considered as the model school for managing waste efficiently (Figure 26). The school performs waste segregation at the classroom level, before it is taken to the school's waste sorting facility, and students are encouraged to sell recyclable to the school's waste bank. The school's cooperative shops enforce regulations against improper waste disposal, while food scraps are repurposed to feed animals like chickens and pigs. These practices are becoming an integral part of learning through various activities. Considering Kha Yeng school as the best practice, similar practices are being shared amongst other schools in the DTDP area.

**Waste management pathways for Kha Yeng Village School**

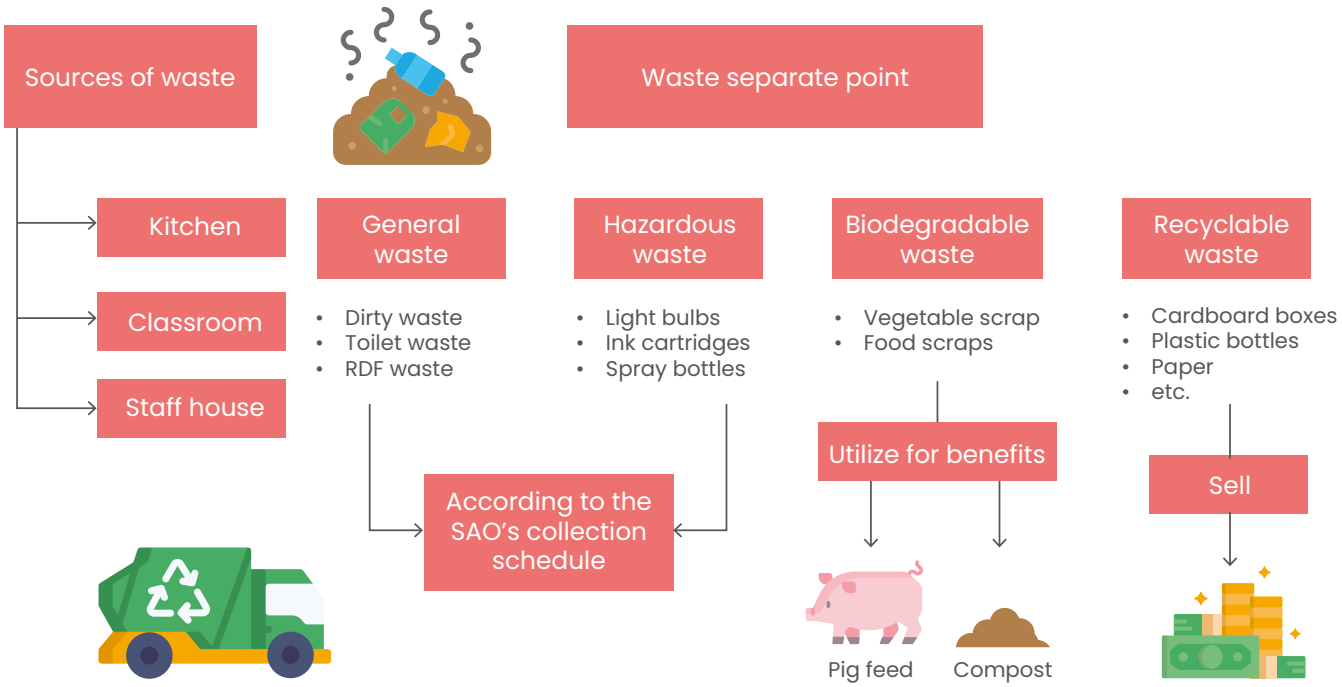



Figure 26: Waste management pathway implemented in Kha Yeng school in the DTDP
Source: Adapted from Kha Yeng Pattana School, the DTDP, 2024

(a) (b) (c)

Figure 27: School waste management initiatives in the DTDP

The waste bank supports competitions for the classroom that generates the least waste and promotes creativity through contests for inventions made from waste. Students are also taught how to reuse waste and add value to it, for example making bags from milk containers (Figure 27(a)). The "Pleasant Classroom" project, conducted over 2-3 years with secondary students, emphasizes cleanliness and waste sorting, with progress monitored through a checklist and weekly awards (Figure 27(b)). Another initiative, the "Compost Save the Earth" project, encourages students to turn food scraps and leaf litter into compost for the school's vegetable gardens (Figure 27(c)).

In 2021, the school won the 3rd place award for medium-sized schools in the Zero Waste School Competition, organized by the Department of Climate Change and Environment (DCCE). The school is keen to integrate waste management into the curriculum for better learning and gaining commercial benefits by selling waste. The school aspires to become a

learning center for waste management by 2026, using the 4Rs process for the community. Currently, the DTDP is also training the communities and school to reduce the dirty waste by improving the segregation and cleaning process with emphasis to increase in recyclable waste.

### iv. District office and Mae Fah Luang Subdistrict Administrative Organization (SAO)

Before starting waste management, the waste management model of the SAO handled waste in the following order: dirty waste, toilet waste, and Refuse-Derived Fuel (RDF). Dirty waste and toilet waste were incinerated at the local facility (local incinerator), while RDF was sent to SCG Lampang for energy recovery at the cement plant.

In 2024, with the introduction of the MRF, dirty waste is processed through washing, shaking off contaminants, and separating into recyclable waste and RDF. The management process is as follows: RDF is sent to SCG, recyclable waste is sold, toilet waste is incinerated, and hazardous waste is collected by the PAO and sent for disposal.

Waste collection by SAO is scheduled on different days, to reduce confusion among stakeholders and accommodate community needs with appropriate pictures as examples and color-coded visuals helping people remember the schedule.

Additionally, tools and innovations like waste-derived products, equipment for extending incinerator lifespan, waste sorting, washing and drying machine, and baler machine are used to improve the overall waste management process. The SAO and community leaders have established rules and regulations for waste management, with discussions held to reach mutual agreements involving the Mae Fah Luang Subdistrict Council. These agreements are then implemented

across the community. One key rule is the requirement to use transparent bags labeled with the SAO emblem, indicating the waste originates from the area and preventing outsiders from disposing of their waste. Each bag must also include the house number, village number.

If waste is not sorted correctly or disposed of on the wrong collection day, the SAO will not collect it, and the community committee will identify the responsible household. Some villages have stricter community regulations, where transparent bags are inspected, and unusually heavy bags are opened for further examination. Random inspections are also conducted, and improperly sorted waste is returned to the owner. Although no serious penalties are currently enforced, non-compliant households are warned and advised. If waste is improperly disposed of, it will not be collected until the next round. These community-driven measures encourage compliance.

Earlier, The SAO incurred an annual landfill fee of approximately $8,200 USD for managing waste at the Huay Krai Subdistrict Municipality landfill. However, in 2024, the SAO has a total budget of approximately $24,600 USD allocated for overall waste management, which excludes the budget for the Material Recovery Facility (MRF) project, funded by Thai Beverage Public Company Limited (ThaiBev). Prior to the establishment of the MRF, the cost of waste management per ton was approximately $47.87 USD. With the implementation of the MRF, the cost per ton has shifted to approximately $131.65 USD. Furthermore, the clear organizational policy focused on achieving Zero Waste to Landfill (ZWTL) is strongly supported by the active participation of all employees in reducing waste disposal.

These efforts have contributed to reducing waste quantity from 35,000 kg/ month in 2019 to an average of 10,000-20,000 kg/ month in 2023. The SAO also received a certificate from

the Department of Environmental Quality Promotion, Ministry of Natural Resources and Environment, in its capacity as an agency supporting Huai Nam Khun Village, Village No. 17.

### v. Green Office Committee, Doi Tung Office and kitchen representatives

In the case of the DTDP office, ten types of waste are sorted with a designated food waste disposal spot. Each department sorts its waste at specific locations, and plastic ropes are used to color-code the waste to assist housekeepers in proper sorting. For instance, blue for dirty waste, and yellow for recyclable waste. Additionally, a wastewater treatment system is in place starting from the kitchen, where food scraps and grease are filtered out first. The division manages waste based on 4Rs.

### vi. Employees at the factories (The Cottage Industry Centre and Outlet)

Between 2015 and 2016, employees sorted waste into 6-7 recyclable categories. In 2018-2019, the DTDP organized visits to the Huay Krai landfill for employees and implemented annual waste sorting practice sessions, along with factory-specific training for both new and current staff. Waste was categorized into six types: RDF, dirty waste, recyclable waste, toilet waste, biodegradable waste, and hazardous chemical waste. Each factory had one designated waste sorting area where employees segregated waste at the source before sending it to the Material Recovery Facility (MRF), monitored by supervisors. One waste disposal spot per factory was deemed sufficient for easy management and monitoring. Large fabric scraps were repurposed into new items like clothes and bags, while small scraps became RDFs for biomass burners. Hazardous waste, such as engine oil, was absorbed using sand and sawdust, then stored in a hazardous waste room before being transferred to an authorized hazardous waste management company for proper disposal

The summary of the FGDs conducted at all 6 levels is indicates as below:

| Group | Source of waste | Starting point | Waste types | Disposal | Tools/ tech/ innovation |
|---|---|---|---|---|---|
| I | Community, household, market, tourists | Started in 2019, after Huay Krai subdistrict municipality landfill stopped accepting waste from SAO. | (6+1)<br>- Dirty<br>- Biodegradable<br>- Toilet<br>- Recyclable<br>- RFD*<br>- Hazardous<br>- Bulky | - Disposal spot at Moo 17 village and other locations.<br>- SAO collects from the spot. | - Product upcycled.<br>- Create plastic products.<br>- Segregation assigned as penalty for youth disruptive behavior. |
| Ii | Community, household, market, tourists | Started in 2023, earlier villagers burnt waste once a year. | (6+1)<br>- Dirty<br>- Biodegradable<br>- Toilet<br>- Recyclable<br>- RFD*<br>- Hazardous<br>- Bulky | - 1 spot in Liche village.<br>-3 spots in Pa Yang Lahu village.<br>- SAO collects from community waste disposal spots. | - No clear regulations yet/ no enforcement.<br>- As at the early stage of waste management, community talk about mutual agreements. |
| iii | Classroom, canteen, cooperative shops in school, school activities, donations to school | Started in 2019 but intensified in 2020. | (6+1)<br>- Dirty<br>- Biodegradable<br>- Toilet<br>- Recyclable<br>- RFD*<br>- Hazardous<br>- Bulky | - Sort waste from the classroom before taking it to the school's waste sorting facility | - Waste bank competition, checklist based on indicators, reusing waste adding value.<br><br>- The Compost Save the Earth / Pui Mak Pitak Lok Project started 2022.<br><br>- Paper shredding, fabric cutting, wood grinding easing recycling activities by students. |

| Regulation implemented by | Participation/ Collaboration | Success factors | Challenges | Next steps |
|---|---|---|---|---|
| -Replacing plastics by baskets.<br>-Sorting waste will reduce waste.<br>-Signs indicate 2000 Baht fine for littering and 500 baht for disposal in public areas.<br>-Segregation committee was established and later discontinued. | - Partners with the DTDP, SAO and Kha yaeng Pattana School to manage waste and build capacity. | -Integrated community cooperation leadership and follow up.<br>-Rewarded, supported and motivated by the DTDP and SAO providing a sense of ownership. | No | -Continuous training and capacity building, seek innovative approaches adding value to waste (upcycling). |
| - No clear regulations yet/ no enforcement.<br><br>- As at the early stage of waste management, community talk about mutual agreements. | - Started training and community engagement with activities.<br><br>- The DTDP provides knowledge.<br><br>- SAO schedules waste pick up from disposal spots. | -Cleanliness in villages.<br>-Awareness and readiness to learn.<br>- Improvement in health by eliminating waste burning practices. | - Illiteracy<br>- Lack of understanding of waste segregation, difference between infectious and hazardous waste and who will dispose it?<br>- Tourists refuse to sort their waste and lack knowledge of waste segregation.<br>- Budget allocation to waste management.<br>- Difficulty in knowledge transfer to senior citizens. | - Guidelines policies expected from the DTDP and take lead for community cooperation. |
| -Policy to reduce paper and plastic usage, follow 4R<br>Use double sided paper and submit work online.<br><br>-Prohibit school cooperatives to sell snacks. Other items in plastic.<br><br>-Monthly meeting and follow up to monitor waste sorting and management. | - SAO and municipality provide budget for municipal waste management activities.<br><br>- The DTDP provides training. | - Increased knowledge of waste sorting<br><br>- Increased awareness on waste generation and its resale value.<br><br>- Received appreciation and awards at competitions. | - No budget allocated to waste management (training, tools and technologies).<br><br>- Lack of collaboration from parents and community.<br><br>- Outside the DTDP only 3 types of waste are sorted unlike (6+1) in the DTDP, this leads to confusion.<br><br>- Need to be retrained to sort waste. | - Collaboration needed by other organization, community and parents.<br><br>- Seek innovative approaches adding value to waste (upcycling).<br><br>- To develop a guideline for school waste management.<br><br>- To develop a space to showcase student's innovative work from waste. |

| Group | Source of waste | Starting point | Waste types | Disposal | Tools/ tech/ innovation |
|---|---|---|---|---|---|
| iv | People in and outside the area dispose black garbage bag by the village roadside, special activity or ceremony generate large waste | Preparation started in 2019 to launch in 2020. | (6+1)<br>- Dirty<br>- Biodegradable<br>-Toilet<br>- Recyclable<br>-RFD*<br>-Hazardous<br>-Bulky | - Compressed and sent to PAO. *<br>- Infectious waste sent to local hospital.<br>- Toilet waste burnt in Incinerator.<br>- RDF compressed and sold to SCG company.<br>- Biodegradable and sellable waste sorted and managed by villagers<br>-Hazardous waste sent to PAO twice a year | - Create plastic products from waste.<br>- Hydraulic waste compactor. |
| v | Toilet waste, coffee mugs and food containers, electronic and other waste from tourists | Each department segregates at the designated spots | 10 types of waste | Disposal at designated points. | - Color coded plastic rope for housekeepers to sort waste.<br><br>- Water treatment system to filter out food scraps and grease. |
| vi | Within and outside the factory | Started in 2015-2016 | 6 types<br>- RFD*<br>-Dirty<br>-Recyclable<br>-Toilet<br>-Biodegradable<br>-Hazardous | - One waste disposable spot for each factory. | - Large fabric scrap is reused to make new cloths and bags.<br><br>- Small fabrics become RDF for biomass burner. |



*Refuse-derived fuel (RFD)

*Provincial Administrative Office (PAO)

| Regulation implemented by | Participation/ Collaboration | Success factors | Challenges | Next steps |
|---|---|---|---|---|
| - Every bag must specify house number and village number else not collected.<br><br>- Incorrectly sorted waste is not collected and returned to the source.<br><br>- Random inspections are conducted.<br><br>- No serious penalty yet. | - The DTDP<br>- Waste management networks.<br>- District office and SAO issue direct orders to village head.<br>- Chaing Rai provincial office sponsors green cones.<br>-PAO<br>-Thai Bev Plc sponsors waste management. - Initiatives under the supervision of the DTDP. | - SAO manages a budget of 300,000 baht per year that was earlier paid to Huay Krai Municipality as a fee for landfill.<br><br>- Villagers generate income from waste and are more disciplined.<br>- Efficient collaboration between government agencies, the DTDP and Thai Bev Plc.<br><br>- Sharing waste management data to the community results in awareness of status and outcome of the implementation. | - More budget required to purchase, repair and maintain equipment.<br><br>- Annual expenses are 3 times the waste collection fee.<br><br>- Restrict frequent movement of official, allocate permanent official responsible for waste management. | - Increase interaction with the stakeholders to improve the process.<br><br>- Focus on the 10% villagers that are still unable to sort waste correctly. |
| - Manage waste based on 4R.<br><br>- Projects to reduce waste.<br><br>- Employees to reduce plastic use and replace it with fabric bags.<br><br>- Reuse food containers.<br><br>- Warning to employees that violate regulations. | - Employees attend 5S activities and waste management.<br>- Training provided by the environmental team. | - Won the green office award by Department of environmental quality promotion, Ministry of Natural Resources and Environment. | - Still some employees find it challenging to sort waste appropriately. | - Arrange regular training for employees. |
| - Supervisor and employees monitor and inspect waste sorting.<br><br>- Manage waste based on 3R/4R.<br><br>- Follow environmental department's standard such as green office, 5S and detailed inspection criteria covering all formats and areas.<br><br>- No penalty/ punishment yet. | - Having new and current employees trained monthly on how to sort waste correctly at the Environment Management Center.<br><br>- Transferring knowledge about waste sorting in their household. | - Clear policy regarding waste management.<br><br>- All employees 'participation in zero-waste to landfill. | - Some employees are unaware of the type of waste.<br><br>- Some factories do not tie the waste bags before transporting them to the environment management center. | - Add value to fabric scraps by making shirts or bags. |

# Survey

Quantitative data gathered through structured surveys are analysed in this section. The survey explores awareness, attitudes, and behaviours related to waste segregation, plastic use, and participation in the DTDP's waste initiatives. This section aims to identify trends across different demographic groups and assess the overall effectiveness of educational campaigns and community incentives.

## Waste segregation

The survey conducted indicates that the 92.5 percent households separate waste regularly, with 312 households confirming waste separation, only 11 indicating not separating and only 14 indicating separating waste sometimes.

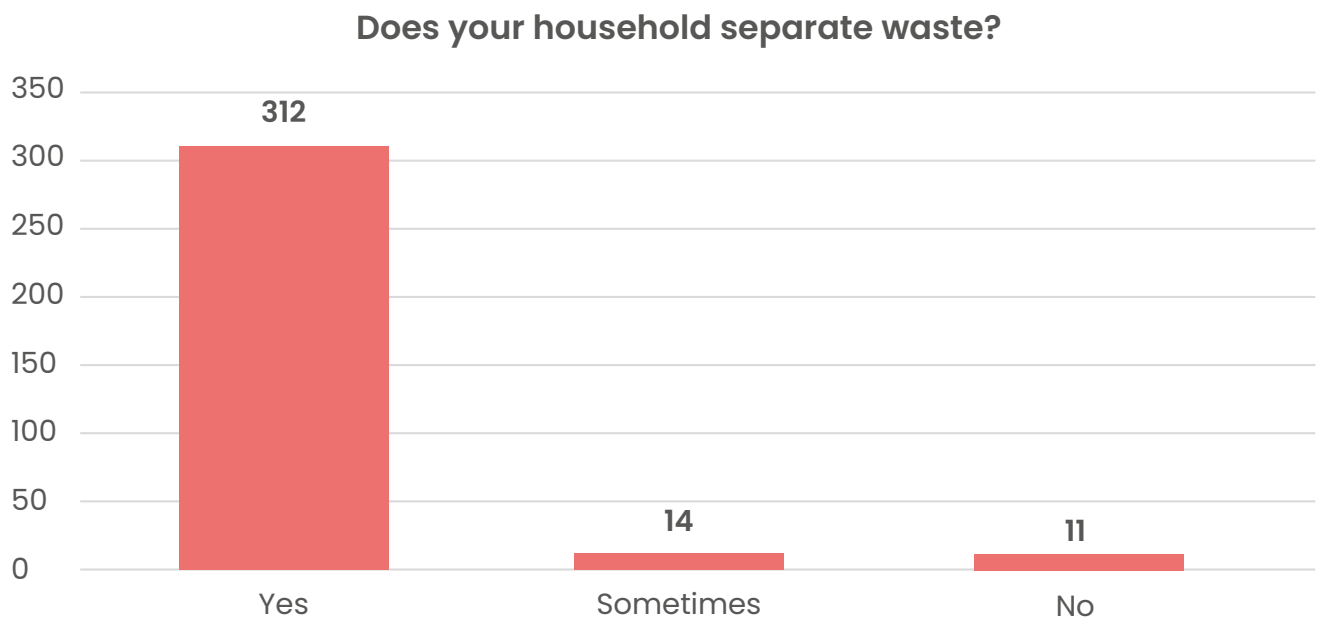
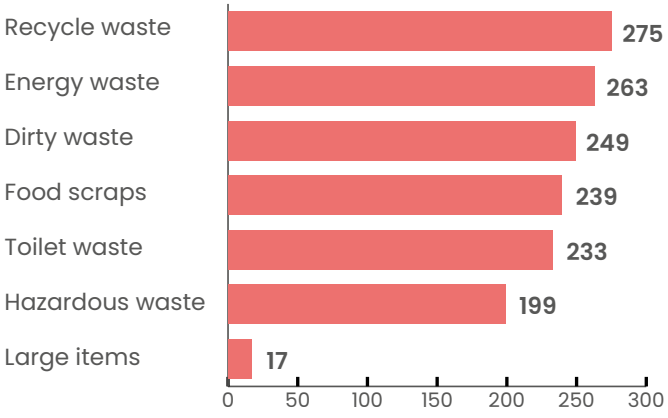



Figure 28: Number of households separate waste.

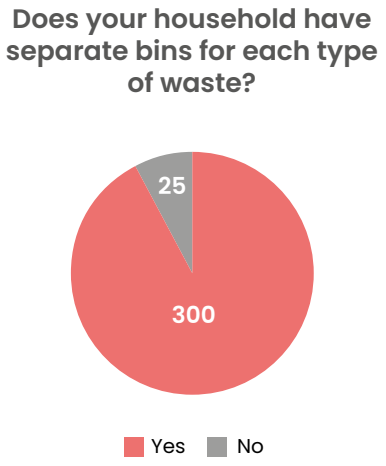
About 81.6 percent households separate recyclable waste, 78 percent separate energy waste, 73.8 percent separate dirty waste, 70.9 percent separate food scraps, 66.1 percent

separate toilet waste and 59 percent separate hazardous waste in the community. About 89 percent respondents confirmed the households having separate bins for each type of waste.

Almost everyone, around 99.1 percent respondents confirm managing organic waste. About 49.8 percent respondents confirm reusing waste especially, plastic bottles followed by plastic bags and sacks.




(a)

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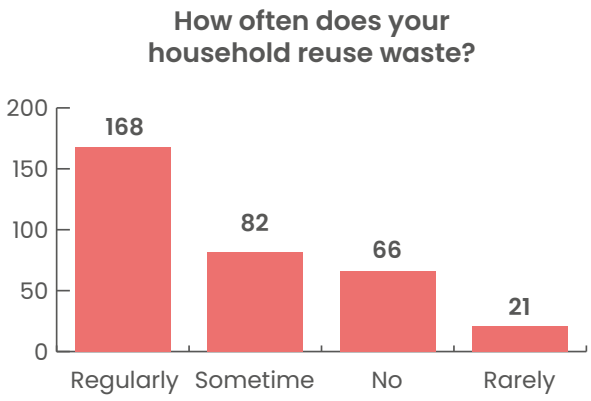


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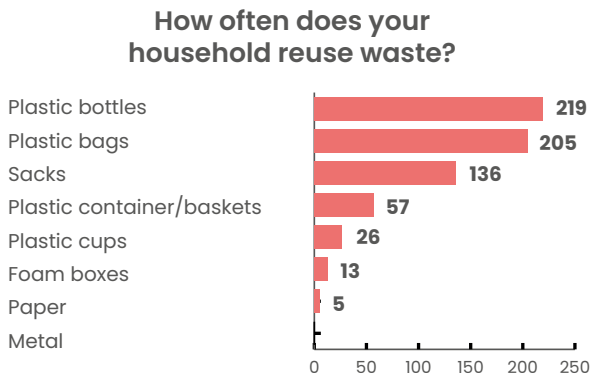


(d)

Figure 29: (a) Number of types of waste separated, (b) Number of households with bins for separating waste by types, (c) Frequency of household waste reuse and (d) Types of waste reused

## Hazardous Waste

About 81.3 percent of respondents confirm disposing hazardous waste at the community disposal site but some respondents face challenges in disposing hazardous waste indicating the process is inconvenient, insufficient or that they are unaware of the community hazardous waste disposal points. Hazardous waste is typically managed at subdistrict level, and thus knowledge sharing can be improved to make the process more efficient.

## Collection Service

When asked about the satisfaction level of the waste collection service in the community, 93.1 percent respondents are either satisfied or very satisfied. Only 6 percent indicated some problems regarding waste collection service and 15.4 percent provided suggestions to improve the collection service.

Some of the suggestions include:

- Senior citizen do not understanding the segregation process correctly.
- Establish a waste bank to exchange goods/ or setting up a waste donation centre.
- SAO bags are sometimes out of stock, are expensive and need to purchase in advance, other bags should be allowed to avoid holding onto waste for a long time.
- Hazardous waste is collected infrequently, the containers get full, and disposal points are far outdoors, request to add more collection points.
- More frequent collection of all types of waste needed.
- Waste collection is too detailed, sometimes leads to confusion regarding collection schedule.

## Waste reduction

About 81.6 percent respondents claim that they try to reduce waste in their households and 81 percent participate in community cleaning activities or projects associated to waste management education or capacity building.

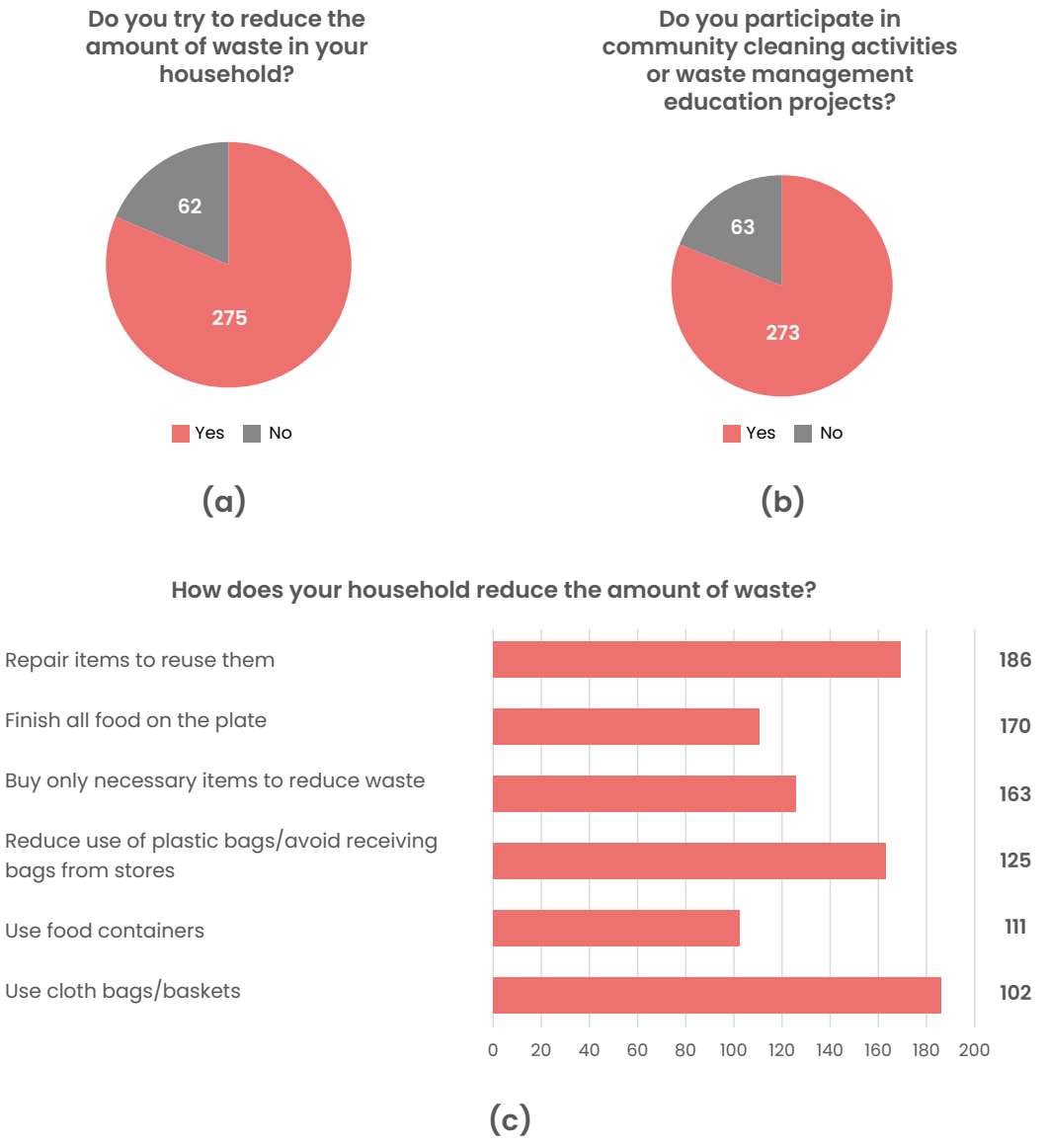


Figure 30: (a) Number of reduce waste in households, (b) Number of participate in community cleaning activities and (c) The way of households to reduce amount of waste.

Many refer to reducing use of plastic bags, using cloth bags, reduce excessive purchasing and buying only necessary items, avoid food waste and disposable containers, and try to repair and fix items for reuse.

## The survey observed several challenges

- Understanding of waste management among villagers: dirty waste = wet waste, biodegradable waste (food scraps, vegetables, fruits).
- The frequency of waste disposal with the Subdistrict Administrative Organization (SAO) depends on the number of family members. If there are few people, they dispose of waste once a month or every 2-3 months.
- Organic waste management: most villagers manage it by feeding it to animals such as pigs, chickens, dog and fish, or by discarding it in the garden, using it as fertilizer, burying it, or placing it in green cone.
- Some households with less waste use it as fuel for cooking stoves.
- Villagers in remote areas (near border village) do not understand waste separation, the reasons for using clear bags provided by the SAO, or what happens to the waste after collection, assuming it is just burned.
- Almost every village has 1-2 households that do not care about waste management, finding it cumbersome and not feeling burdened by their waste volume.
- In remote areas like Pa Sang Na Ngoen, Pa Yang Akha, Pa Ya Lahu, and Pa Sang Saen Sut Dan, villagers put energy waste and dirty waste in the same bag for the SAO to collect, believing it will be burned at the SAO incinerator. Now, training is provided, and the community is encouraged to separate waste.

- There are issues with the high cost and long ordering time for SAO waste bags, making it inconvenient for many households.

## Benefits and Drawbacks of the Model

The DTDP waste management model highlights many success factors across various stakeholders. Firstly, the cooperation between all stakeholders has helped to build a sustainable waste management ecosystem. Strong leadership by the DTDP and SAO provide the sense of ownership and recognition to the communities. Consistent training and building capacity by community leaders has made Moo 17 a model community, providing learning opportunities for neighboring communities and external organizations. This success is due to the villages' ability to adapt, improve, and create a cleaner, healthier living space by eliminating waste burning practices. Clear communication, such as sharing waste data with villagers has been very crucial to share the progress. The continuous focus on raising awareness, along with a shared vision and unified action, has helped integrate the waste management work. Villagers have become familiar with the process with knowledge of waste sorting, awareness on waste generation and its resale value through hands-on participation. This initiative is now contributing to generate income from waste and create more discipline in the community. SAO managed a budget of 300,000 baht ($9,180) per year that was earlier paid to Huay Krai Municipality as a fee for landfill. Later, SAO increased the budget to 1,200,000 baht ($36,730) per year to manage waste in the district. Initiatives of collaboration between government agencies, the DTDP and Thai Bev PCL are contributing to upcycling products. Clear policy at the organization level is supported by all employees' participation in zero waste to landfill.

Waste management outcomes under the Doi Tung Development Project (DTDP) in 2024 shares various benefits. One of the most important contributions is that 100 percent

waste volume generated yearly is diverted (recycled, composted or reused) and does not go to the landfill contributing to a 100 percent diversion rate, as one of the important KPIs to waste management.

- Waste volume of 197 tons in 2024 did not go to landfills.
- 40% of total waste was repurposed under the principles of the circular economy.
- Reduced emissions by 973 tons per year, equivalent to preserving 1,024 Rai of forest area.
- Generated jobs valued at approximately $31,830 per year.

## *Waste Management KPIs*

Key Performance Indicators (KPIs) for community waste management practices should measure the effectiveness, efficiency, and impact of waste management initiatives. The table below organizes the KPIs by category, explaining the measurement criteria, making it a comprehensive guide for implementing and tracking community waste management practices in the future: By systematically measuring these KPIs using data collection, surveys, and regular monitoring, communities can effectively track and improve their waste management practices.

| No. | Waste Management KPIs | Description | MFLF Status (Yes/No/Planned) | 2024 |
|---|---|---|---|---|
| 1 | Waste Reduction and Diversion | Monitor diversion rate by tracking volume of waste recycled, composted or reused compared to total waste generated, YoY reduction in waste generation, recycling rate, composting rate, etc. | Yes | ZWTL, 100% diversion rate. |

| No. | Waste Management KPIs | Description | MFLF Status (Yes/No/Planned) | 2024 |
|---|---|---|---|---|
| 2 | Participation and Engagement | Assess community participation rate by conducting surveys and tracking participation, track event attendance in trainings/ workshops, track feedback response rate. | Yes | Organize training to provide knowledge on waste management to community leaders of 5 villages in Mae Sai District. |
| 3 | Operational Efficiency | Evaluate cost per ton of waste managed (total cost/total waste managed in tons), monitor percentage of correctly sorted/ segregated waste at source. | Yes | Cost per ton of managed waste: 6,100 THB/ton<br><br>Even though higher cost but increase collection from 11 to 24 villages.<br><br>Waste sorting efficiency evaluation at the source, with a scoring system for accuracy. |
| 4 | Environmental Impact | Monitor reduction emission due to waste diversion practices, track number of illegal dumping cases reported, monitor amount of waste sent to landfill. | Yes | Reduction in greenhouse gas emissions: 973 tons of $CO_2$ equivalent in 2024<br><br>Monitoring illegal waste dumping cases and landfill waste reduction. |
| 5 | Economic Impact | Track income generated from selling recyclables, track waste disposal cost and compare to pre-diversion practices, track number of jobs or value of jobs generated by waste management program. | Yes | Revenue from recycled waste sales: 49,334.30 THB<br><br>Employee wages for waste management: 426,504 THB<br><br>Creation of jobs valued at approximately 1,040,000 THB per year |

| No. | Waste Management KPIs | Description | MFLF Status (Yes/No/Planned) | 2024 |
|---|---|---|---|---|
| 6 | Health and Cleanliness | Conducting periodic inspection to assess cleanliness, log and monitor complains to analyse and understand trends. | Yes | Regular cleanliness inspections and complaint analysis. (5S Activities: Sort, Set in Order, Shine, Standardize and Sustain) |
| 7 | Awareness and Education | Conduct campaigns and surveys to assess awareness, focus on knowledge improvement and building capacity, track the training programs and information materials shared with the community. | Yes | Training sessions for employees: 11 Training, 139 participants.<br><br>Study visits: 39 Groups; 1 074 participants. |
| 8 | Innovation in Waste Management | Number and type of technologies introduced. | Yes | - Upcycled plastic bottle caps into magnets.<br>- Eco-friendly bricks; Lightweight concrete blocks made from hemp stalks and plastic waste, paving blocks made from plastic waste and glass scraps, interlocking bricks made from glass scraps and hemp stalks, and bricks made from ceramic sludge.<br>- Hot-pressed sheets, such as compressed plastic sheets, compressed corn husk sheets, compressed hemp stalk sheets, compressed coffee husk sheets, and compressed rice straw sheets.<br>- Repurposing Doi Tung paper coffee cups into paper boxes.<br>- Creating keychains from fabric and thread scraps.<br>- Reusing double-sided used paper to make new notebooks.<br>- Transforming cardboard boxes into Mulberry paper (Sa paper). |

| No. | Waste Management KPIs | Description | MFLF Status (Yes/No/Planned) | 2024 |
|---|---|---|---|---|
| 9 | Sustainability | Number of households implementing practices like segregating waste, composting, recycling etc. | Yes | Waste separation in 24 villages as in 2024, record of achieving ZWTL for last 7 years and still expanding in the DTDP. with consistent monitoring of waste not being sent to landfills. |

This analysis revealed high levels of waste segregation compliance in areas near roads (92.5%) but lower rates in border villages, emphasizing the need for targeted interventions in underserved regions. Challenges such as high waste bag costs and irregular hazardous waste collection emerged as critical barriers. Strengthening local waste services and addressing affordability can enhance overall system efficiency and equity. By aligning with SDGs and existing national waste strategies, these improvements can contribute meaningfully to more sustainable, inclusive, and effective waste management practices.

## *SDGs Contribution*

The DTDP's waste management approach has been committed to sustainable practices aligning with various United Nations SDGs.

1. **Zero-Waste-to-Landfill:** This approach supports SDG 11 (Sustainable Cities and Communities) by minimizing waste pollution, SDG 12 (Responsible Consumption and Production) by ensuring sustainable resource use, and SDG 13 (Climate Action) by reducing landfill emissions and mitigating climate change impacts.
2. **Burn Only Necessary:** Limiting incineration to unavoidable waste aligns with SDG 13, as it reduces greenhouse gas emissions, and SDG 3 (Good Health and Well-Being) by lowering air pollution.

3. **Circular Economy (4R to Upcycling):** Transitioning to a circular economy reinforces SDG 12 by promoting recycling, reuse, and upcycling, reducing reliance on virgin materials, and supporting SDG 9 (Industry, Innovation, and Infrastructure) by fostering sustainable industrial practices.
4. **Make the Most of Everything (Zero Waste):** Maximizing resource efficiency aligns with SDG 12, ensuring that resources are reused and recycled to their fullest potential, and supports SDG 15 (Life on Land) by reducing environmental degradation.
5. **Reduce/Stop Using Single-Use Plastics:** Phasing out single-use plastics addresses SDG 14 (Life Below Water) by reducing plastic pollution in oceans, as well as SDG 11 and SDG 15 by protecting terrestrial ecosystems.
6. **Produce Environmentally Friendly Products:** Creating eco-friendly products advances SDG 9 through sustainable innovation, SDG 7 (Affordable and Clean Energy) by potentially incorporating energy-efficient processes, and SDG 12 by encouraging sustainable production patterns.

These actions collectively promote a sustainable, low-carbon economy that conserves resources, protects ecosystems, and fosters responsible production and consumption, addressing critical global challenges outlined by the SDGs.

## *Existing policies, Management and Systems*

Thailand has been actively working on improving waste management, primarily through national policies which focuses on waste reduction, segregation, recycling, and proper disposal. However, despite these initiatives, challenges like lack of proper waste segregation, public awareness, and infrastructure gaps exist. The policies set by Ministry of Natural Resource and Environment (MONRE) while the laws and the implementation are under Ministry of Interior. The actual implementation depends on various local governments, most of them lack human resource and budget and political will to invest on separate collection systems and MRFs. At source waste reduction, Ministry of Interior has set up KPIs for local governments to promote green cones for organic waste composting and recycling banks for recyclables, but no KPI have been established for setting MRFs or promoting private sectors to operate MRFs.

The Material Recovery Facility (MRF) Learning Center has become one of the best practices which has been successful in campaigning and training on waste segregation from source to disposal. The center received 1074 people in 2024 for training and study visits. Various environment activities such as 100 percent treatment of wastewater, 100 percent water reuse along with 25 percent rainwater, reducing use of new material by 40 percent, upcycling products from used plastics and broken class are demonstrated. This initiative indicates the implementation of green cones for organic waste composting and recycling banks for recyclables at village level.

The DTDP initiative is vital to the model of community waste management as the MRF provides a range of economic, social, and environmental benefits that support communities and reduce landfill dependency. Economically, MRF generate revenue through the sale of recycled materials, create local jobs in waste processing and management, and reduce

landfill disposal costs, extending the lifespan of landfill. Socially, they foster community engagement and awareness about sustainable practices, improve living conditions by reducing waste-related pollution, and promote healthier environment Environmentally, MRF conserve natural resources by recyclir materials, minimize greenhouse gas emissions, and redu pollution from landfills. Collectively, these benefits contribu to a circular economy, enhance community well-being, ar support long-term sustainability.

**These findings provide a roadmap for scaling sustainable waste management practices across the region. By leveraging community strengths, addressing gaps, and fostering partnerships, the Mae Fah Luang Foundation can continue to lead the way in achieving Zero Waste to Landfill and advancing global sustainability objectives.**

05

# BEST PRACTICE OF WASTE MANAGEMENT IN THE COMMUNITY

This chapter highlights successful community-level waste management practices under the Doi Tung Development Project (DTDP), showcasing strategies that can serve as models for other regions aiming to achieve Zero Waste to Landfill (ZWTL).

# Ban Huay Nam Kun Moo 17 Waste Management

The initiative of waste management at the village level began with the conceptualization of plan from the Doi Tung Development Project and the local subdistrict administrative organization (SAO). Initially, the Mae Fah Luang SAO disposed of waste at the landfill in Huai Khrai Subdistrict. However, the landfill reached its full capacity, and SAO could no longer dispose of waste there. This situation forced the community to look at potential waste problem in the area and build awareness and develop future action plans for handling waste management more efficiently.

## Steps and Approach for Waste Management in the Community:

- Community meetings were initiated to understand waste management guidelines in Mae Fah Luang Subdistrict.
- On-site visits were performed to observe household waste management.
- Study visit to learn waste management from other model villages and adapt it to the community, such as a study visit to Ban Photharam, Mae Chan District, Chiang Rai Province.
- Planning waste management strategies.
- Presenting the waste management plan in the village meetings, which was revised several times until a consensus was reached.
    - The village has only one central waste disposal point.
    - Using clear bags provided by the SAO for community waste.

    - Every household has a “Green Cone” bin (for food scraps and vegetable waste). If a household has no space, the community has a central point for disposing of food scraps and vegetable waste. The village achieved 100% coverage of “Green Cone” bins (eco-friendly bins) in 2020.
    - Each household uses designated containers for leaves, branches, and weeds to compost.
    - Every household has at least three types of waste bins (dirty waste, recyclable waste, and energy waste).
    - All community events, including those at the Huai Nam Khun temple, follow the community’s waste segregation practices. For example, funeral ceremonies involve waste separation, and plastic bottle usage is minimized.
    - Every household separate toilet waste (tissues, diapers, sanitary pads).
    - Hazardous waste is taken to the village’s designated hazardous waste disposal point.
- Incorporating the community’s waste management plan into the village development plan under natural resources and environmental management
- Establishing village regulations and measures for waste management, such as:
    - A 500-baht fine for dumping waste in prohibited areas.
    - A 500-baht fine for discarding food scraps or waste in public waterways.
    - For not separating waste into six types: a warning for the first offense, and a 50-baht fine per subsequent offense, with the money going to the village fund.

    - A 5,000-baht fine and legal action for burning waste during the no-burn period.
- Training and educating villagers on waste segregation and providing necessary equipment for each waste type.

Figure 31: Community meeting and training

## Community Participation:

- Reducing waste from the source, such as:
    - Using baskets for shopping to reduce plastic bag usage.
    - Using reusable containers (food carrier) to reduce plastic bag use.
- Volunteers and youth groups help collect and sort waste.
- Monthly community cleanup activities and significant dates involve household representatives to clean the village.
- Environmental youth groups are involved in activities.
- Sorting recyclable waste and cleaning the donation point every second Sunday of the month.
- Waste sorting activities involving the elderly and children, initially held monthly, are now conducted every 2-3 months as waste levels decrease, fostering intergenerational relationships.

Using baskets for shopping to reduce plastic bag usage

Youth environmental activities

Monthly community cleanup activities

Figure 32: Community Participation

## Activities within the Community:

- "Star Shop" activities promote correct waste segregation and reduce plastic and foam usage by offering incentives to customers.
    - Village cafes offer discounts to customers who bring their own cups.
    - Village shops provide discounts for customers who refuse plastic bags.
    - Shops provide reusable cloth bags for customers.
- Competitions to promote ongoing waste management efforts, such as household waste management contests every four months.
- 4R (Reduce, Reuse, Recycle, Repair) activities, such as:
    - Villagers use reusable bags and baskets for shopping.
    - Reusing old pots, foam boxes, and plastic buckets for planting vegetables.
    - Repurposing old trash bins from the SAO as vegetable garden containers.
    - Using old fan grates as trash bins.
    - Collecting fabric scraps for recycling into clothing by the Doi Tung Development Project.

- Establishing a village recycling bank to collect and separate recyclable waste.
- Upcycling plastic waste, like HDPE plastic and caps.
- Creating recycled crafts from leftover materials.

- Innovations like household grease traps and vermiculture (worm farming) for organic waste management.
- "Exchange Dry Leaves to Eggs" initiative to reduce burning and promote composting.

Household grease traps


"Star Shop" activities

Figure 33: Activities within the Community

## *Applied Waste Management Practices*

Effective waste management at the community level is paramount for fostering sustainable living environments and enhancing public well-being. The applied waste management practices that are specifically designed for and implemented within communities. By emphasizing the collective effort of residents, local organizations, and technological integration, these practices showcase how systematic waste segregation, active participation, value-added initiatives, and a commitment to minimizing landfill

waste can transform community-level waste challenges into opportunities for resource recovery, environmental protection, and local economic benefit

## Good Management

- Segregate waste into 7 types including sellable waste, biodegradable waste, RDF, dirty waste, toilet waste, hazardous waste, and bulky waste.
- Collect waste according to daily timetable by using transparent garbage bags in order to be examinable.
- Toilet waste is disposed within the inner route villages using incinerator machine.
- Clean dirty garbage to reduce amount of RDF and increase amount of sellable waste.
- Biodegradable waste is disposed within villages.

## Participation

- Simple but professional as well as user-friendly and up-to-date machine.
- Establish community fund for collecting recycle waste.
- Every village and all local government organizations participate in waste segregation and waste management. (Mae Fah Luang Subdistrict and villages in Mae Sai District)

## Value-added

- Precisely segregate and make waste clean.
- Compost biodegradable waste into fertilizer or use as animal feed.
- Upcycling: concrete blocks and paver blocks from Thaibev packaging, glass, plastic, and non-recycle plastic.

## Zero Waste to Landfill

- Reduce greenhouse gas emission
- Promote government policy: Zero waste to landfill and repurpose waste
- Promote BCG policy, Bioeconomy, Circular Economy, and Green Economy

The waste management practices demonstrate a robust and integrated approach to handling various waste streams. From meticulous segregation at the source to innovative upcycling and composting methods, these practices emphasize the importance of community participation and technological application in achieving 'zero waste to landfill' goals. By reducing greenhouse gas emissions and promoting circular economy principles, these applied strategies not only mitigate environmental impact but also foster a more sustainable and resource-efficient society

## Collaboration with the Mae Fah Luang Foundation:

- The Doi Tung Development Project provides education on waste types and supports waste reduction equipment.
- Supporting funds for composting dry leaves to reduce burning.

## Successes and Challenges:

- A strong waste management committee is in place.
    - Community leaders, the SAO, and government agencies collaborate to set waste management guidelines.
    - Surveys are conducted to check waste disposal in each household and explain waste types.

    - The village committee oversees correct waste segregation, such as assisting at waste sorting points.
    - Regular meetings to review and improve waste-free community activities, held quarterly to ensure suitability and continuity.
    - Quarterly household visits to identify waste management problems.
    - Monthly monitoring of waste volumes by the SAO.
- Continuous communication with the community.
    - Reviewing waste segregation before monthly village meetings.
    - Engaging in waste segregation quizzes with rewards like reusable bags and baskets.
    - Addressing issues in village meetings for communal awareness.
- Some of the villagers work on the Doi Tung Development Project and have received prior training on waste segregation.
- Competing for waste-free village awards at district, provincial, and national levels.

## Challenges:

- Ensuring sustainability through community participation.
- Passing on practices to the younger generation.
- Maintaining continuity in waste segregation efforts within the community.

Moo 17 has become a model community, providing learning opportunities for neighboring communities and external organizations. This success is due to the village's ability to adapt over time, improve its environment, and create a cleaner, healthier living space. Strong leadership and consistent follow-up from community leaders have been crucial, especially through clear communication, such as sharing waste data with villagers to show progress. Cooperation and understanding among residents, alongside a strong sense of community spirit, have also contributed to these efforts.

**1. Policy / Vision**

1. Zero waste to landfills by 30 September 2020
2. Determine methods for managing all 6 types of waste
3. Every household has a Green Cone trash can (food, vegetable, fruit scraps), branches, leaves, wood scraps to be discarded in the bins and DTDP manage next step
4. Every household has a bin for separating at least 3 types of waste
   - spoiled bags, spoiled paper
   - clean bags (garbage can be sold/reusable)
   - snack bags (energy/waste)
5. Every household separates sanitary waste (tissues, diapers, sanitary napkins)
6. Every household places hazardous waste in the disposal point
7. Use coolers instead of plastic water bottles in the community activity and have a waste separation

**6. Competition / Award**

1. Village Competition
   - reward cloth bags and certificates to starred households/shops
2. External Competition
   - Waste-free village contest

**5. Follow up**

1. The working group follows up on waste separation once a month (random monitor)
2. Follows up amount of each type of waste every month (the SAO collects the data.)

Continuous focus on awareness rising, shared vision, and unified action has effectively integrated waste management efforts. Villagers have become familiar with the process through hands-on participation. Support and motivation from both the Doi Tung Development Project (DTDP) and the SAO have played key roles, including rewards and recognition, which boost morale. Being part of the DTDP area has fostered a sense of ownership and pride within the community.

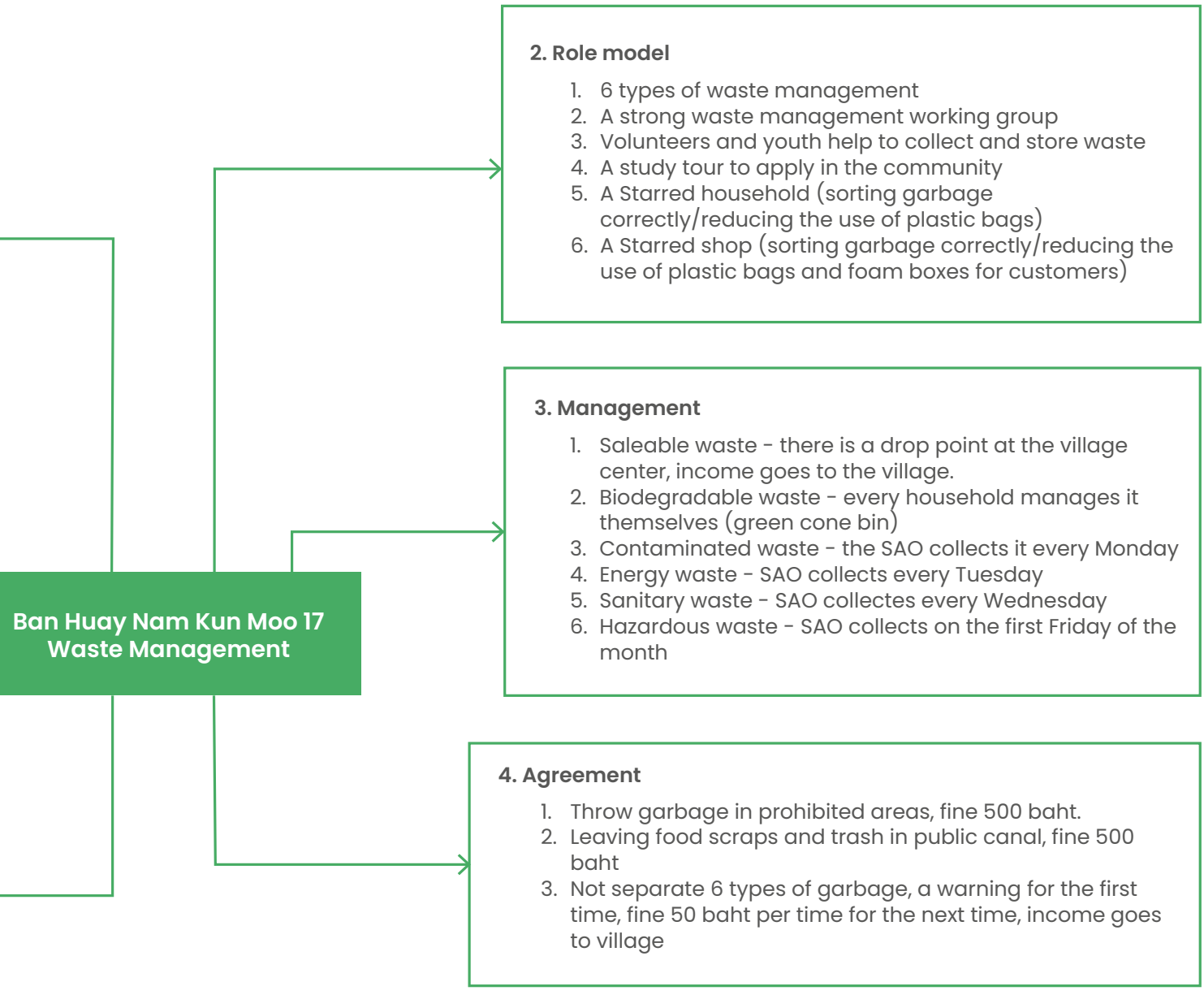


Figure 34: Community waste management model

## Awards and Rewards as "Zero Waste Village"

A committee comprising of staff from the Environmental Department, Public Relation Department, Mae Fah Luang SAO, and from Mae Fah Luang District Health Office awarded Baan Huay Nam Khun Moo 17 village as the 2nd runner up in the competition.

The assessment criteria for Zero Waste Village are based on multiple criteria such as:

- Policies, Plans, and Support
- Local Participation and Volunteers
- Solid waste management service in community using 4Rs principle
- Success stories of implementing zero waste community and sustainability
- Waste management activities according to the Sufficiency Economy Philosophy and Net zero greenhouse gas emission

The scores are arranged in sequence from highest to lowest. The highest score will get the first prize of 10,000 baht in cash and a certificate followed by others as below:

- First prize: 10,000 baht in cash and a certificate
- First runner up: 7,000 baht in cash and a certificate
- Second runner up: 5,000 baht in cash and a certificate
- Honorable mention (2 awards): 5,000 baht in cash and a certificate

This competition provided great enthusiasm and motivation for the community members to take this initiative forward contributing towards sustainable waste management practices. This also helps in building community network and better engagement for accumulation more knowledge through competitions like green households and green villages.


Figure 35: Awards and Rewards as "Zero Waste Village"

## *Lessons Learned and Key Takeaways*

This study highlights several important lessons for advancing sustainable waste management. First, community leadership emerged as a key driver of success—local ownership and participation foster greater accountability and long-term commitment. Second, ongoing training and awareness-raising are vital to ensure that sustainable practices become part of everyday life, especially as community dynamics and waste patterns evolve. Third, the findings underscore the urgent need for robust infrastructure and consistent financial support, particularly in remote or underserved areas where service gaps remain. Finally, the value of regular monitoring and open communication with stakeholders cannot be overstated; sharing progress and challenges helps build trust, encourages innovation, and strengthens collaboration.

## *Call to Action*

Looking ahead, these insights show that communities can be powerful agents of change in building sustainable and inclusive waste systems. By applying and adapting these best practices, similar projects can be replicated and scaled in other parts of Thailand and beyond. Investing in people, partnerships, and place-based solutions is essential to achieving broader environmental goals. Together, these efforts support global commitments such as SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production).

Now is the time to act—by empowering communities, strengthening systems, and scaling solutions, we can take meaningful steps toward a zero-waste, circular future.

**These best practices underscore the potential for communities to play a central role in sustainable waste management. By replicating and scaling such initiatives, regions across Thailand and beyond can work toward a zero-waste future.**

06

# FUTURE ACTIONS FOR STRENGTHENING INTEGRATED WASTE MANAGEMENT

# Effective Strategies for Scaling up

Scaling up community waste management practices faces several infrastructure challenges, primarily related to the lack of adequate service delivery systems and institutional support. One of the key issues is the insufficient capacity of public entities to effectively reach underserved communities, particularly in informal settlements. This gap leads to a reliance on informal private entities, which often provide substandard services at unregulated prices. Additionally, many areas lack proper waste collection systems and treatment facilities. Existing infrastructure, such as waste segregation systems, recycling plants, and waste-to-energy facilities, is either outdated or non-existent. Another challenge is the inadequate integration of public-private partnerships, which have shown promise but are often unstable due to long-term contractual uncertainties. Moreover, the absence of proper waste transportation networks and landfill sites further exacerbates the issue, preventing efficient waste management practices at the community level. Lastly, the lack of community awareness and participation in waste management systems is a critical infrastructural shortfall, as successful scaling often depends on strong local involvement and decentralized systems.

Experiences from other cases in the region indicate community engagement as key, integrating informal practices, fostering public-private partnerships, and decentralizing waste management systems tailored to local needs are essential for scaling these practices.

Community-led MRF can provide a blueprint for efficient MRF operation and localized resource recovery. Scaling up this initiative would require involvement of local governments to allocate resources and potential partnerships with private enterprises for investment and technical support.

Utilizing one of the economic instruments that applies the Polluter Pay Principle (PPP) for setting a waste fee could work as an effective strategy. The concept of Pay-As-You-Throw (PAYT) can be useful as it breaks the traditional perception of treating trash services similarly to utilities like electricity or gas. PAYT schemes, by charging households for non-recyclable waste, have been shown to decrease waste volumes and incentivize better segregation practices at the source. When the households pay a variable rate depending on the amount of service they use or the waste they generate, it will contribute to reducing waste. The communities with PAYT can charge residents a fee for each bag or can of waste they generate.

Extended Producers Responsibility (EPR) can be another critical factor in supporting MRF development by holding producers accountable for the lifecycle of their products, including post-consumer waste. EPR regulations could require manufacturers to use recyclable materials, reducing the environmental footprint of their products and supporting the circular economy. Producers could financially support MRF operations or design products that are easier to recycle, creating a more sustainable material loop. Enforcing EPR regulations in Thailand would ensure that businesses contribute to the cost of waste management and encourage the use of materials recovered by MRF.

The PPP projects on WtE from Ministry of Energy work on the principle of selling electricity with subsidy 'Feed-in Tariff program', similar initiatives by the government to work on MRF with mandatory waste segregation at source could be a turning point towards sustainable waste management. Governments can stabilize PPPs by offering guarantees for investments, reducing risks through long-term contracts, and ensuring fair profit-sharing models. Governments can encourage investments in MRF technologies through:

- Subsidies or grants for upgrading sorting and recycling technologies.
- Tax incentives for companies investing in advanced MRF facilities.
- Establishing national recycling goals and penalties for non-compliance to push industries toward supporting MRF.
- BOI's tax incentives can be offered to recycling industries.
- Government procurement policies can prioritize the use of recycled materials in public sector projects.

## Why Thailand and the World Need this Kind of Waste Management System?

Although Thailand promotes the Bio-Circular-Green (BCG) Economy Model through various policies and initiatives, there are not sufficient projects evolving to improve segregation, recycling and recovery rate. There is a need to introduce cost effective technologies for treating and managing waste.

The low level of household participation in waste segregation is a key challenge, largely due to inadequate financial and technical support. Coordination among stakeholders need to strengthen to address the shortage of skilled staff for managing advanced waste systems. Private sector might invest in waste-to-energy projects but are hesitant due to a lack of understanding of waste management in the financial sector. The informal sector's role is not formally recognized, highlighting the need for a policy framework. Venturing into Public-Private Partnership (PPP) projects could help in facilitating modern recycling facilities making waste management sustainable and effective.

Thailand also faces several challenges in scaling up Material Recovery Facilities (MRFs). These include limited infrastructure, high operational costs, and a lack of public awareness

and proper waste segregation at the source. Additionally, integrating informal waste pickers into formal systems remains difficult. While there are established Key Performance Indicators (KPIs), such as increasing recycling rates and reducing landfill dependency, their implementation and monitoring can be inconsistent.

The challenges faced by communities in implementing waste management practices at the ground level are multifaceted, involving infrastructure deficits, financial constraints, lack of public awareness, institutional weaknesses, and the integration of the informal sector. Addressing these challenges requires a holistic approach that involves investment in infrastructure, public education, policy reforms, and the empowerment of local communities to actively participate in waste management initiatives. Only through concerted efforts at multiple levels, sustainable waste management practices can be successfully implemented.

The case of ZWTL from the DTDP can contribute as role model to highlight benefits of decentralized waste management at community level and the benefits of establishment of Material Recovery Facility (MRF) at the local level. It also emphasizes the strength and collaborative approach of stakeholders at the community level.

Material Recovery Facilities (MRFs) are key to sustainable waste management, offering significant environmental, economic, and resource recovery benefits. The draft Sustainable Packaging Management Act proposes that producers and importers manage packaging throughout its lifecycle, aiming to reduce the burden on local authorities and promote recycling. The Act is scheduled for enactment in 2027. The Action Plan on Plastic Waste Management Phase II (2023–2027) outlines a timeline for EPR implementation in Thailand. Some recent pilot EPR initiatives are also seen in Chonburi

province as a collaboration between local administrative offices and Thailand Institute of Packaging and Recycling Management for Sustainable Environment (TIPMSE). A strong policy and political will from the government can make such initiatives successful and sustainable in the long run.

Scaling up MRFs will require coordinated efforts between governments, private sector players, and communities. By adopting strategies such as public-private partnerships, technological innovation, policy reform, and community engagement, and decentralized MRFs, it is possible to build a robust material recovery system that supports the goals of a circular economy.

**By prioritizing investments in decentralized MRFs, fostering public-private partnerships, and implementing robust policy frameworks, Thailand can lead the region in transitioning to a circular economy. This transformation is not only crucial for Thailand but also serves as a global example of sustainable waste management.**

# Appendices

Appendix 1: FGDs questionnaire for village representatives.
Appendix 2: FGDs questionnaire for local agencies.
Appendix 3: FGDs questionnaire for the DTDP office employees.
Appendix 4: Data coding for survey.
Appendix 5: Questionnaire for survey.
Appendix 6: Questionnaire for discussion with policy experts.

# Appendix

## i. Guided questions for the (DTDP) community

### 1. Overall waste management

- **Waste generation**
    - Where does most of the waste in the community come from? (For example, cooking, agriculture, online shopping, convenience stores, and markets)
    - What types of waste are there and in what quantities? Which type of waste is the most?
    - What activities in the community do you think generate waste? (What types of waste are mostly generated from those activities?)
        - What activity in the community generates waste the most?
        - How is waste in your community activities managed? (Ask them to describe to see if they actually do it, to what extent, and whether there are any measures such as plastic-free and waste segregation)
- **Waste segregation**
    - What was the starting point of waste segregation?
        - When did waste segregation begin?
        - How did it start? How was the conversation in the community? What was the feedback from the community?
        - What are the challenges and enabling factors to drive waste segregation in the community?
    - How many types of waste are there in the community? (How are they sorted? For example, sorted according to the Doi Tung Development Project's (DTDP) method into 6 types, or according to the Subdistrict Administrative Organization's (SAO) schedule for waste collection each day)
        - Are there waste disposal spots in the community?
        - How many waste disposal spots are there?
        - Are there any problems with each spot, or are they managed smoothly?
    - Does the community manage waste at the source? How? (Waste at the source means managing waste within a household. How is it carried out in each community?)

- What methods or tools/technologies/innovations does the community have for waste management?
- What guidelines/projects does the community have to reduce waste?
- Does the community have waste management guidelines based on 3R/4R? (Please describe the process)

- **Rules and regulations**
  - What rules and regulations do the community have regarding waste management?
  - How is it verified whether people in the community segregate waste correctly?
  - Does the community establish fines/penalties for those who do not comply with the rules? How?
    - How are the rules enforced in the community?
    - Are there any cases in the past? Please describe the most recent or significant cases in the community.

## 2. Participation/Collaboration

- **Within the community**
  - How do people in the community participate in waste management?
  - Is there training on waste segregation provided within the community?
- **Outside the community**
  - Is there any collaboration with external agencies for waste management, and in what aspects?

## 3. Successes/Challenges in waste management

- What do you think success in waste management is, and what does it result from?
- What are problems/obstacles encountered in waste management, and what are plans/guidelines for addressing them?
- Challenges in waste management

## 4. Way forward

- What are the plans for waste management in the future?

## ii. Guided questions for local agencies in the area

### 1. Overall waste management

- **Waste generation**
    - Where does most of the waste come from? (For example, cooking, agriculture, online shopping, convenience stores, markets, and manufacturing in factories)
    - What types of waste are there and in what quantities? Which type of waste is the most?
    - What activities in the organization do you think generate waste? (What types of waste are mostly generated from those activities?)
        - What activity in schools/organizations generates waste the most?
        - How is waste in your school/organization activities managed? (Ask them to describe)
- **Waste segregation**
    - What was the starting point of waste segregation?
        - When did waste segregation begin?
        - How did it start? How was the conversation going? How was the feedback from students/parents/community/organization?
        - What are the challenges and ease factors to drive waste segregation?
    - How many types of waste are there in the organization? (How are they sorted? For example, sorted according to the Doi Tung Development Project's (DTDP) method into 6 types, or according to the Subdistrict Administrative Organization's (SAO) schedule for waste collection each day)
    - Does the organization manage waste at the source? If so, how?
    - What methods, tools/technologies/innovations do the organization have to manage waste?
    - What are your thoughts on implementing new technologies to improve waste management efficiency? (with or without budget)
    - What policies/guidelines/projects does the organization have for waste reduction?
    - Does the organization have waste management guidelines based on 3R/4R?? (Please describe the process)

- **Rules and regulations**
    - What regulations does the organization have regarding waste management?
    - How do you verify that people are sorting waste correctly?

      Does the organization impose fines or penalties for those who do not comply with the waste management regulations? If so, how?

## 2. Participation/Collaboration

- **Within the organization**
    - How are people within the organization involved in waste management?
    - Does the organization provide training or knowledge on waste segregation?
- **Outside the organization**
    - Which external agencies does the organization collaborate with on waste management, and in which aspects?
    - How is non-sellable or non-recyclable waste managed? (Send to other organizations/networks)
    - Does the division/department provide training on waste segregation to others?

## 3. Successes/Challenges in waste management

- What are successes in waste management, and what do they result from?
    - What does the school do to motivate students and staff to participate in waste segregation and achieve success?
    - Methods to encourage students to join waste sorting
- What are problems/obstacles encountered in waste management, and what are plans/guidelines for addressing them?
- Challenges in waste management

## 4. Way forward

- What do you think about the current waste management practices? (Are they appropriate?)
- How do you plan for future waste management practices?

## iii. Guided questions for the DTDP Office employees

### 1. Overall waste management

- **Waste generation**
    - Where does waste in the division/department mostly come from? (For example, cooking, agriculture, online shopping, convenience stores, markets, and collecting from the community)
    - What are they? At what quantity? What type of waste is the most?
    - What activities in the division/department do you think generate waste? (What waste is generated the most in the activities?)
- **Waste segregation**
    - What was the starting point of waste segregation?
    - How many types of waste are sorted in the division/department?
    - Does the division/department manage waste at the source? If so, how?
    - What methods/tools/technologies/innovations in waste management are used by the division/department?
    - What do you think if there are new technologies to manage waste efficiently? (with/without budget)
    - What policies/guidelines/projects does the division/department have to reduce waste?
    - Does the division/department have waste management guidelines based on 3R/4R? (Please describe the process.)
- **Environmental policies and measures of the organization**
    - Do you know whether the organization has policies concerning environment and waste management?
    - What do you think of the measures? Are they effective yet?
    - If this needs to be improved, what should be done? What would you like the organization/division/department to support?

- **Rules and regulations**
    - Do employees know that the organization has a common KPI to evaluate environmental practices in each division and department? What do you think about it?
    - What rules and regulations for waste management does your division/department have?
    - How do you verify if employees in the division/department and people in the community sort waste correctly?
    - Does your division/department establish fines/penalties for those not complying with rules and regulations? How?

## 2. Participation/Collaboration

- **Within the division/department**
    - How do employees in the division/department participate in waste segregation?
    - Is there any training about waste segregation in the division/department?
- **Outside the division/department**
    - Which external agencies do you collaborate with for waste management, and in what aspects?
    - How is non-sellable or non-recyclable waste managed? (send to other agencies/networks)
    - Do you provide training to other agencies?

## 3. Successes/Challenges in waste management

- What are successes in waste management? What are the contributing factors?
- What are the problems/obstacles in waste management? What are the plans/guidelines for addressing them?
- Challenges in waste management

## 4. Way forward

- What do you think about the current waste management? (Is it appropriate?)
- What are the future plans for waste management?

## iv. Data coding for survey

| No. Question | Title | Condition | Data Type | Variable Value 0 |
|---|---|---|---|---|
| 1.1 | Village Areas | | | Near main road |
| 1.2 | Village Name | | text | |
| 1.3 | Age | | number | |
| 1.4 | Sex | | text | Male |
| 1.5 | Number of Residents in Household | | | 1 person |
| 1.6 | Monthly Household Income | | | Less than 10,000 baht |
| 2.1 | Do you generate toilet waste? | | | No |
| | Number of big bags | | number | |
| | Number of small bags | | number | |
| 2.2 | Do you generate dirty waste? | | | No |
| | Number of big bags | | number | |
| 2.3 | Do you generate energy waste? | | | No |
| | Number of big bags | | number | |
| 2.4 | Where does most of your household waste come from? | rank 1-6 in order of most to least | list | |
| 3.1 | Does your household separate waste? | If no, skip to Section 4 | | No |
| | Why you do not separate waste? | | text | |
| 3.2 | Type of separate waste | | select more than one | |
| | Dirty waste | | | No |
| | Energy waste | | | No |
| | Recyclable waste | | | No |
| | Food scraps | | | No |

| Variable Value 1 | Variable Value 2 | Variable Value 3 | Variable Value 4 | Variable Value 5 | Variable Value 8 | Variable Value 9 |
|---|---|---|---|---|---|---|
| Near border | | | | | | |
| | | | | | | |
| | | | | | | |
| Female | | | | | | Do not wish to identify |
| 2-3 people | 4-5 people | More than 5 people | | | | |
| 10,000 - 30,000 baht | 30,000 - 60,000 baht | More than 60,000 baht | | | | |
| Yes | | | | | | |
| | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| | | | | | | |
| | | | | | | |
| Yes, regularly | Yes, sometime | | | | | |
| | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |

| No. Question | Title | Condition | Data Type | Variable Value 0 |
|---|---|---|---|---|
| | Toilet waste | | | No |
| | Hazardous waste | | | No |
| | Large items | | | No |
| | Other | | | No |
| 3.3 | Does your household have separate bins for each type of waste? | If no, skip to Section 4 | | |
| 3.4 | If there are separate bins, are they complete for each type? | If no, skip to Section 4 | | |
| 3.5 | Which types of waste bins do you have? | Select more than one | | |
| | Dirty waste | | | No |
| | Energy waste | | | No |
| | Recyclable waste | | | No |
| | Food scraps | | | No |
| | Toilet waste | | | No |
| | Hazardous waste | | | No |
| | Large items | | | No |
| | Other | | | No |
| 4.1 | Does your household manage organic waste? | If no, skip to Section 5 | | No |
| 4.2 | If yes, which types of organic waste do you manage? | Select more than one | | |
| | Food scraps | | | No |
| | Vegetable/fruit peels | | | No |
| | Leaves/branches | | | No |
| | Other | | | No |

| Variable Value 1 | Variable Value 2 | Variable Value 3 | Variable Value 4 | Variable Value 5 | Variable Value 8 | Variable Value 9 |
|---|---|---|---|---|---|---|
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |

| No. Question | Title | Condition | Data Type | Variable Value 0 |
|---|---|---|---|---|
| 5.1 | How often does your household reuse waste? | If never, skip to Section 6 | | No |
| 5.2 | How often does your household reuse waste? | | | |
| | Paper | | | No |
| | Plastic bottles | | | No |
| | Plastic containers/baskets | | | No |
| | Plastic bags | | | No |
| | Plastic cups | | | No |
| | Foam boxes | | | No |
| | Sacks | | | No |
| | Metal | | | No |
| | Other | | | No |
| 6.1 | How does your household dispose of hazardous waste? | | | |
| | Note: | | text | |
| 6.2 | Do you think the disposal of hazardous waste in the community is convenient? | | | Inconvenient |
| | Not convenient because | | text | |
| 6.3 | Do you think the disposal of hazardous waste in the community is sufficient? | | | Not sufficient |
| 7.1 | How satisfied are you with the waste collection service in your community? | | | |

| Variable Value 1 | Variable Value 2 | Variable Value 3 | Variable Value 4 | Variable Value 5 | Variable Value 8 | Variable Value 9 |
|---|---|---|---|---|---|---|
| Regularly | Sometime | Rarely | | | | |
| | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| At the community hazardous waste disposal point | In regular bins | In the garden/ forest | | | Other | |
| | | | | | | |
| Convenient | | | | | | |
| | | | | | | |
| Sufficient | unknowing of the community hazardous waste disposal point | | | | | |
| Very unsatisfied | Unsatisfied | Neutral | Satisfied | Very satisfied | | |

| No. Question | Title | Condition | Data Type | Variable Value 0 |
|---|---|---|---|---|
| 7.2 | Do you have any problems or suggestions for improvement regarding the waste collection service? | | | No problem |
| | Problems (please specify) | | text | |
| | Problems (please specify) | | text | |
| 8.1 | Do you try to reduce the amount of waste in your household? | If no, skip to Section 9 | | No |
| 8.2 | How does your household reduce the amount of waste? | Select more than one | | |
| | Use cloth bags/baskets | | | No |
| | Use food containers | | | No |
| | Reduce use of plastic bags/avoid receiving bags from stores | | | No |
| | Buy only necessary items to reduce waste | | | No |
| | Finish all food on the plate | | | No |
| | Repair items to reuse them | | | No |
| | Other | | | No |
| 9.1 | How well do you understand proper waste management? | | | |
| 9.2 | Where do you receive the most useful information about waste management? | rank 1-5 in order of most to least | list | |
| 10.1 | Do you participate in community cleaning activities or waste management education projects? | | | No |
| 10.2 | How can community involvement be increased in waste management initiatives? | | text | |

| Variable Value 1 | Variable Value 2 | Variable Value 3 | Variable Value 4 | Variable Value 5 | Variable Value 8 | Variable Value 9 |
|---|---|---|---|---|---|---|
| Problems | Sugggestions | | | | | |
| | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Yes | | | | | | |
| Not at all | Poorly | Moderately well | Very well | | | |
| | | | | | | |
| Yes | | | | | | |
| | | | | | | |

## v. Questionnaire for survey

**Questionnaire on Waste Management Practices of the Mae Fah Luang Foundation under Patronage**

Knowledge and Learning Centre and Environmental Department, in collaboration with Dr. Shweta Sinha from the Pridi Banomyong International College, Thammasat University, has created an English publication on waste management: "Waste Management – the case of zero waste to landfill" to widely disseminate the success of waste management in the Doi Tung Development Project area.

**Objective:** The questionnaire is created to understand and develop waste management practices in the community.

**Privacy Agreement:** Mae Fah Luang Foundation ("the Foundation") will collect and use the information you provide, including name, address, and photographs, for analysis and data processing purposes. The Foundation guarantees the confidentiality of your personal data solely for the specified purposes and will maintain the confidentiality of the data as long as necessary and will not disclose your information to anyone except as stated.

**Instructions:** The questionnaire has 10 sections and takes approximately 15 minutes.

---

**Section 1: Demographic Information**

1.1 Village Name: _____

1.2 Number of Residents in Household:

○ 1 person ○ 2-3 people ○ 4-5 people ○ More than 5 people

1.3 Monthly Household Income (please select the closest range):

○ Less than 10,000 baht ○ 10,000-30,000 baht

○ 30,000-60,000 baht ○ More than 60,000 baht

**Section 2: Waste Generation**

2.1 How many bags of waste does your household generate per week?

☐ Bathroom waste: Large bags: ____ Small bags: ____

☐ Contaminated waste: Large bags: ____

☐ Energy waste: Large bags: ____

2.2 Where does most of your household waste come from? (Please rank 1-6 in order of most to least waste)

- ☐ Kitchen food scraps
- ☐ Online shopping
- ☐ Department stores/convenience stores/supermarkets
- ☐ Grocery stores
- ☐ Grocery Mobile
- ☐ Fresh markets
- ☐ Other (please specify): _____

**Section 3: Waste Separation**

3.1 Does your household separate waste?

- ○ Yes, regularly
- ○ Yes, Sometime
- ○ No (If no, skip to Section 4)
  - ○ Why? _____

3.2 If your household separates waste, please specify the types of waste you separate (select more than one):

- ☐ Dirty waste
- ☐ Energy waste
- ☐ Recyclable waste
- ☐ Food scraps
- ☐ Toilet waste
- ☐ Hazardous waste
- ☐ Large items (e.g., cabinets, beds, mattresses)
- ☐ Other (please specify): _____

3.3 Does your household have separate bins for each type of waste?

- ○ Yes
- ○ No (If no, skip to Section 4)

3.4 If there are separate bins, are they complete for each type?

- ○ Yes (If yes, skip to Section 4)
- ○ No

3.5 Which types of waste bins do you have? (Select more than one)

- ☐ Dirty waste
- ☐ Energy waste
- ☐ Recyclable waste
- ☐ Food scraps
- ☐ Toilet waste
- ☐ Hazardous waste
- ☐ Other (please specify): _____

**Section 4: Organic Waste Management**

(Organic waste such as food scraps, vegetable/fruit peels, leaves, small branches, which can be returned to nature by methods such as placing in a green cone, spreading around the base of trees, or making compost)

4.1 Does your household manage organic waste?

○ Yes ○ No (If no, skip to Section 5)

4.2 If yes, which types of organic waste do you manage? (Select more than one)

☐ Food scraps ☐ Vegetable/fruit peels

☐ Leaves/branches ☐ Other (please specify): _____

**Section 5: Reuse Practices**

5.1 How often does your household reuse waste?

○ Regularly ○ Sometime ○ Rarely ○ Never (If never, skip to Section 6)

5.2 Which types of waste do you reuse? (Select more than one)

☐ Paper ☐ Plastic bottles ☐ Plastic containers/baskets

☐ Plastic bags ☐ Plastic cups ☐ Foam boxes

☐ Sacks ☐ Metal

☐ Other (please specify): _____

**Section 6: Hazardous Waste Management**

(Hazardous waste such as batteries, electronics, pesticide cans, chemical containers, light bulbs, etc.)

6.1 How does your household dispose of hazardous waste?

○ At the community hazardous waste disposal point

○ In regular bins

○ In the garden/forest

○ Other (please specify): _____

6.2 Do you think the disposal of hazardous waste in the community is convenient and sufficient?

○ Convenient ○ Inconvenient because _____

O Sufficient O Not sufficient

O Unaware of the community hazardous waste disposal point

**Section 7: Waste Collection Service**

7.1 How satisfied are you with the waste collection service in your community?

O Very satisfied O Satisfied O Neutral

O Unsatisfied O Very unsatisfied

7.2 Do you have any problems or suggestions for improvement regarding the waste collection service?

O No problems

O Problems (please specify): _____

O Suggestions (please specify): _____

**Section 8: Waste Reduction**

8.1 Do you try to reduce the amount of waste in your household?

O Yes O No (If no, skip to Section 9)

8.2 How does your household reduce the amount of waste? (Select more than one)

☐ Use cloth bags/baskets ☐ Use food containers

☐ Reduce use of plastic bags/avoid receiving bags from stores

☐ Buy only necessary items to reduce waste

☐ Finish all food on the plate ☐ Repair items to reuse them

☐ Other (please specify): _____

**Section 9: Knowledge and Understanding of Waste Management**

9.1 How well do you understand proper waste management?

O Very well O Moderately well O Poorly O Not at all

9.2 Where do you receive the most useful information about waste management? (Please rank 1-5)

☐ Government projects ☐ Local government campaigns

☐ Community projects ☐ Online sources

☐ Doi Tung Development Project ☐ Other (please specify): _____

Section 10: Community Involvement

10.1 Do you participate in community cleaning activities or waste management education projects?

○ Yes ○ No

10.2 How can community involvement be increased in waste management initiatives? :

_____

---

Thank you for participating in the questionnaire. Your answers will greatly help in understanding and developing waste management practices in the community.

## vi. Questionnaire for discussion with policy experts

1. From your perspective, what are Thailand's policies and implementation of waste management?
2. How do you think that the MRF (Material Recovery Facility) can help Thailand shape better waste management?
3. What are the main obstacles that prevent the MRF from expanding nationwide, and how can they be addressed?
4. How can Extended Producer Responsibility (EPR) frameworks better support the development and scaling of MRFs? What role can producers play?
5. How can community led MRF initiatives/pilot projects serve as models to scale up at national level? What could be the next steps?
6. Are there any specific policies that need reform or further development to enhance MRF scalability? (How effective have public-private partnerships been in the scaling of MRFs at the national level?)
7. How can governments at the national level encourage investment in advanced technologies for sorting and recycling within MRFs? Are there any existing national programs or subsidies that support this?
8. What incentives, either through policy or regulation, can be introduced at the national level to encourage industries and businesses to utilize materials recovered by MRFs, thereby promoting a circular economy?
9. In many developing countries, the informal sector plays a significant role in waste management. How can national policies be designed to formally integrate this sector into MRF operations without disrupting their livelihood?
10. How do you see the role of MRFs evolving in the next 5 to 10 years in the context of national sustainability goals and the circular economy?

# About the Author

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