Kingdom of Cambodia

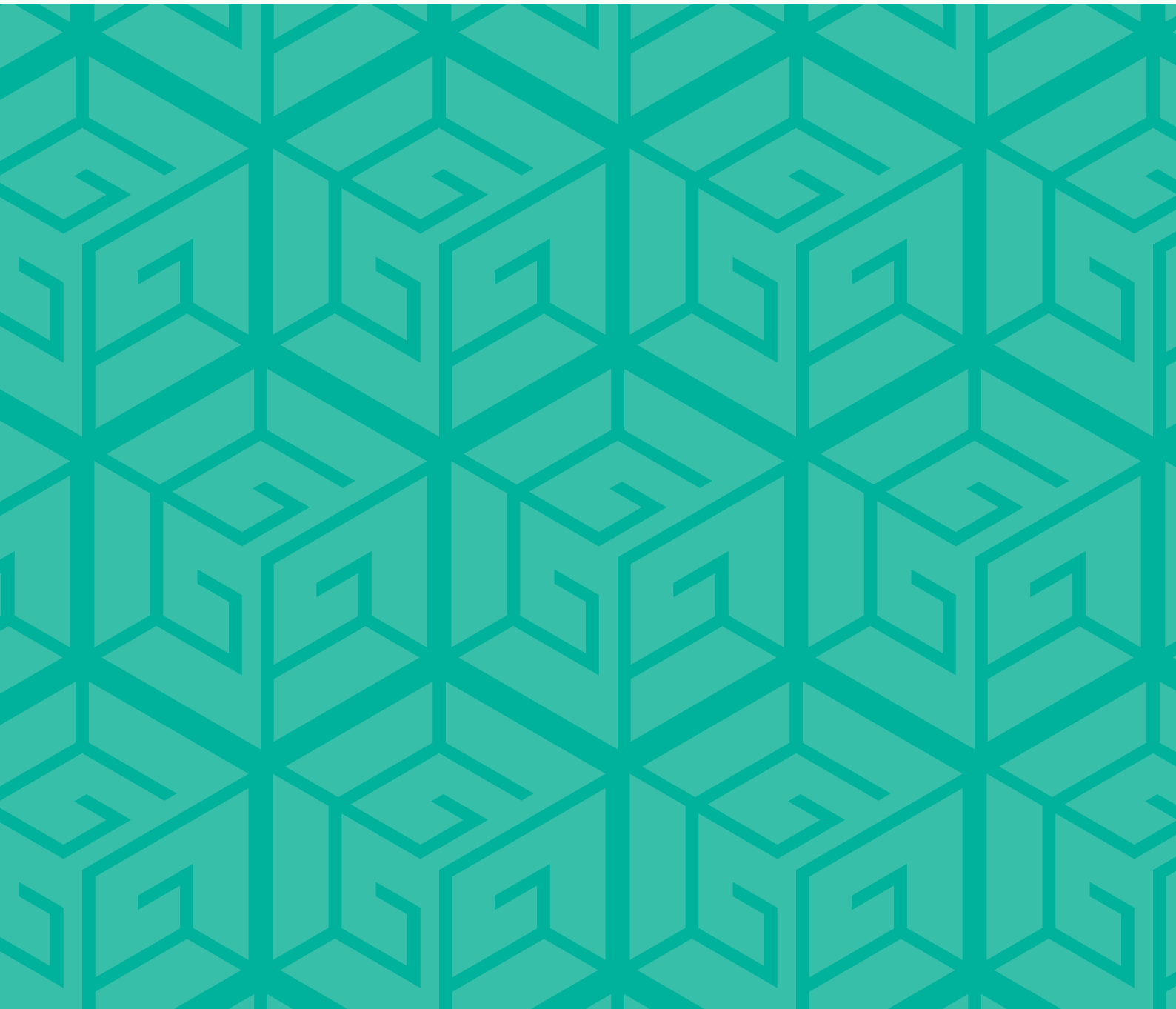
Nation Religion King

Scaling Up Waste Recycling In

Battambang City

GGGI

SCALING UP WASTE RECYCLING IN BATTAMBANG CITIES



Acknowledgements

This report was commissioned by GGGI Cambodia and authored by Terra Michaels, Josselin Ravaz, and Piseth Sensamras from GRET, with inputs and supervision by Karolien Casaer-Diez, Jerome Fakhry, and Donovan Storey from GGGI.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Foreword By The Governor

Improving solid waste management is a high priority for the city of Battambang, as outlined in the list of priority actions in the draft Sustainable City Strategic Plan for Seven Secondary Cities 2019–2030.
In recent years, our city has made great improvements to address waste management issues and has participated in many initiatives as summarized in this report. Our city now has several options to manage recyclable materials, such as plastics and organics. We also have the newly constructed Material Recovery Facility, yet to be operational, and are aiming to build a new and improved landfill in the coming years. Of course, the thriving informal sector also contributes greatly to the recovery of recyclable materials in the city.

However, further improvements are required, as littering and the open burning of waste still occurs on a large scale, including at the existing landfill. To build on the past work and continue addressing current issues, the municipality welcomes this study on improving waste recycling. As outlined in the report, for a more efficient waste management system, source separation of wet and dry waste is critical. This will enable more organic waste to be processed and more recyclables to be separated from the dry waste. Open burning and littering must also be prevented, with the proper implementation of Sub-Decree 113. These initiatives would not only improve the environment, public health, and beauty of our city but will also create economic opportunities and jobs. Increasing the quantity and quality of compost would also enable our farmers to conduct more sustainable practices by using less artificial fertilizers.

For this to occur, every citizen must play a part. Therefore, awareness raising and education will be important to ensure everyone is aware of their responsibilities and obligations, particularly with regard to compliance with Sub-Decree 113. Another critical aspect is waste minimization. As Cambodia is developing and wages are increasing, consumption is also increasing. This means more waste is generated; for example, single-use items made of plastic and Styrofoam. Sub-Decree 168 sent a signal to reduce the use of single-use plastic items; awareness campaigns must be conducted to encourage more efficient use of our precious resources.

I look forward to the implementation phase and a continued collaboration with NCSD, GGGI, and other actors in the waste management sector.

MR. PHENG SITHY
Governor of Battambang Municipality

Abbreviations

ADB	Asian Development Bank
BPP	Battambang Plastics Products (also called Recycling Plastic)
CINTRI	Private waste collection company in Battambang city
COMPED	Cambodian Education and Waste Management Organization (composting facility)
Et chay	Khmer name for informal waste pickers
GGGI	Global Green Growth Institute
HDPE	High Density Polyethylene Plastic
IGES	Institute for Global Environmental Strategies
Leap Lim	Private waste collection company in Battambang City
MEF	Ministry of Economy and Finance
MoE	Ministry of Environment
MoI	Ministry of Interior
MOP	Ministry of Planning
MPWT	Ministry of Public Works and Transport
MRF	Materials Recovery Facility
NCSD	National Council for Sustainable Development
PDoE	Provincial Department of Environment
PDRD	Provincial Department of Rural Development
PPE	Polyphenylene Ether Plastic
RGC	Royal Government of Cambodia
SWM	Solid waste management
UNIDO	United Nations Industrial Development Organization

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Executive Summary

NCSD and GGGI worked with Battambang city and selected other cities to develop the Sustainable City Strategic Plan. Under this planning exercise, the cities developed a vision and set of objectives for sustainable urban development. A project prioritization exercise was undertaken, and each city put forward a shortlist of 10 sustainable city projects. One of the interventions prioritized by Battambang municipality was to scale up waste recycling in the city.

To support the municipality in this effort, NCSD and GGGI worked together with the city to develop detailed options to establish a reliable supply chain (segregation, collection, transport, and on-sell of products) for recyclable waste in Battambang, with a focus on plastic and organic waste. With support of the consultancy GRET, the three institutions developed specific, realistic, and costed options ready for implementation. This report reflects an analysis of the waste management situation in the city and the recommendations formulated under the project to address the situation. Following the publication of this report, GGGI, NCSD, and the municipality of Battambang will work together on the implementation of these recommendations.

Section 1 of the report provides a general introduction to the project, its methodology, and some of the constraints. Section 2 provides an extensive analysis of the current situation. It presents comprehensive data on the waste situation in Battambang, followed by an overview of the national and local regulatory contexts as well as other waste management projects in the city of Battambang. This area covers lessons to be learnt from international experience and provides an analysis of current strengths, weaknesses, opportunities, and threats for waste management in Battambang, combined with a set of recommendations. Section 3 offers a practical, step-by-step and phased approach to implement these recommendations. Section 4 then provides profiles of local waste recycling businesses and directions on how to strengthen business viability. In the abovementioned sections, certain information was withheld for reasons of confidentiality.

Overall, the report serves as a basis for NCSD and GGGI, together with project partners, to support the municipality, as well as local businesses, in implementing these recommendations and running a waste separation trial.

1. Introduction

1.1 Background and Objectives

1.1.1 Background

Over the past five years, Cambodia has been among the fastest-growing economies in Southeast Asia, with an average annual GDP growth of 7%. An increase in solid waste and associated challenges in solid waste management is one of the many difficulties faced as a result of this rapid economic growth and subsequent rise in consumption. The amount of municipal solid waste increased sharply to over 4 million tons per year nationwide, with about 37% going to landfills, 12% recycled, and 51% illegally dumped or burned despite existing laws. The amount of waste disposed in landfills increased accordingly, from over 317,550 tons per year in 2004 to 1.5 million tons per year in 2017, and continues to grow[1]. Such a sharp increase in waste disposal, coupled with poor waste management practices (including storage, collection, transport, and landfilling) and a lack of community participation, presents serious challenges for the cities.

Battambang city, with an estimated population of about 160,000 inhabitants, is subject to several issues, including uncontrolled disposal and waste burning as well as a lack of coordinated waste separation and collection planning. In particular, the large quantity of organic waste produced poses a problem (which constitutes 50–70% of the waste in the city) and presents an opportunity for the development of resource recovery products. Additionally, disposal of plastics (about 10% of waste, with an average Cambodian city resident using an estimated 2,000 plastic bags a year) poses both public health and environmental issues but also provides potential collection and recycling opportunities.

While the city has two waste collection operators, an informal waste collection sector, and a few notable recycling facilities, there is a need to organize and optimize the sector as a whole.

1.1.2 Objectives

The purpose of this report is:

- To develop recommendations for the establishment of an efficient waste recycling system in Battambang city.
- To design improved business models for existing recycling facilities.
- To design a large-scale trial for the source segregation, collection, and transport of recycled waste (for one commune).

While this report focuses on source segregation and recycling, waste minimization is also critical in improving the situation; for example, by reducing the consumption of single-use items, such as plastic bags, cups, and Styrofoam boxes. While this report does not address this critical step, waste minimization will be incorporated into the implementation phase, particularly during awareness raising campaigns.

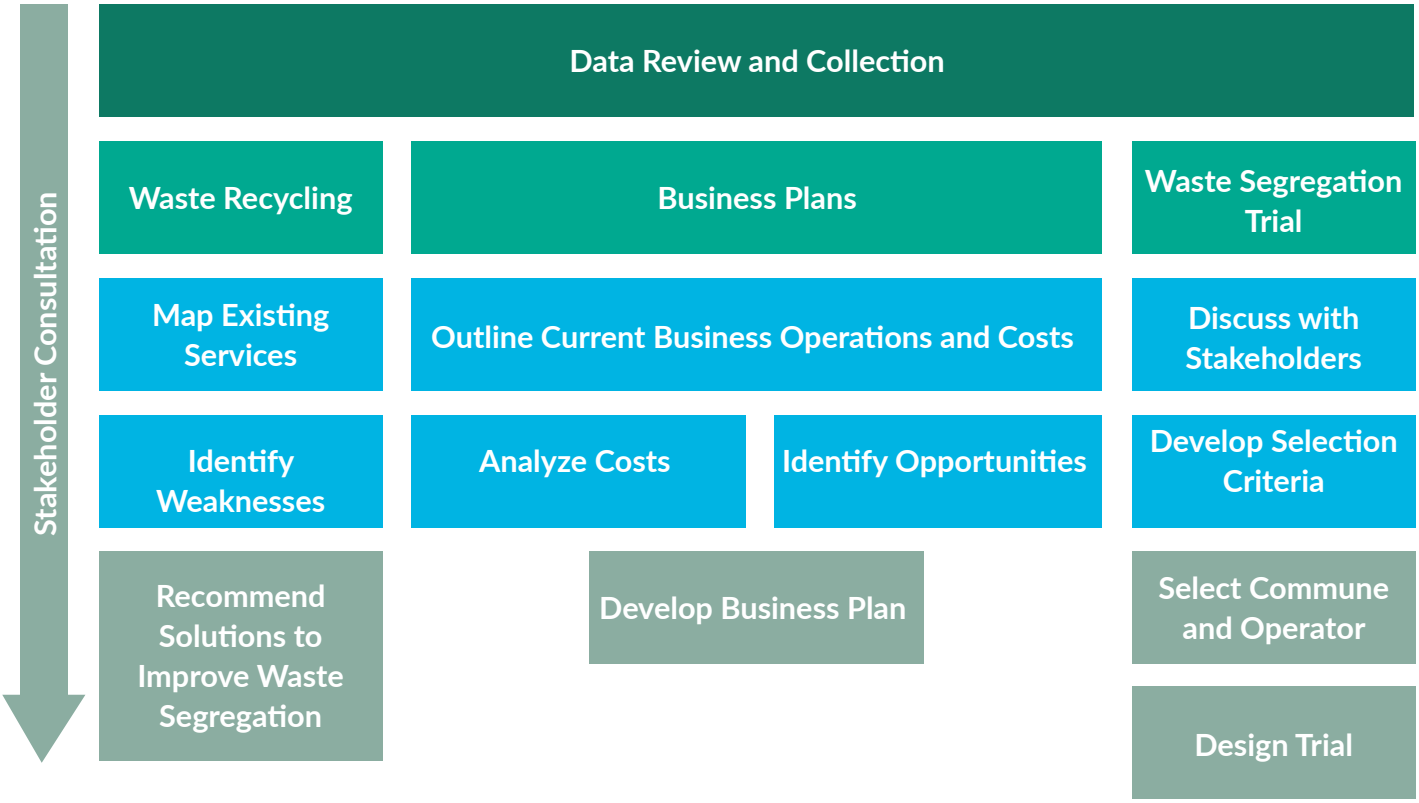
1.2 Methodology

The overall methodology for this project is presented in figure 1 below. Later, in "Section 2: Desk Review and Data Collection," the components of the current waste recycling system are presented—from generation through collection to disposal and recycling—followed by a strengths, weaknesses, opportunities, and threats (SWOT) analysis to formulate recommendations. The recommendations are further detailed with a more concrete work plan in "Section 3: Design of the Recycling System in Battambang City," which includes both the waste recycling sector and waste segregation trial, as they are intertwined and complementary. In general, the approach to the analysis was to provide simple, cost-effective recommendations that can be organized and implemented in a short time frame; however, there is also a section focused on long-term proposals.

[1] MOE, draft National Waste Management Strategy and Action Plan 2018–2030.

Section 4: Improvement for Recycling Businesses in Battambang provides a business analysis with recommendations for improving two recycling facilities and a discussion about potential activities for the new materials recovery facility. The subsections covering the two recycling facilities (the COMPED composting facility and Battambang Plastics Products, which recycles plastic bags) include a financial analysis with recommendations from waste management experts, with an outline of assumptions and details specific to each.

Figure 1: Overall project methodology



Finally, stakeholder engagement was a crucial element to ensure the outputs were appropriate for the sector and met the needs of important actors. The following subsections describe the data collection and stakeholder engagement undertaken to facilitate project implementation.

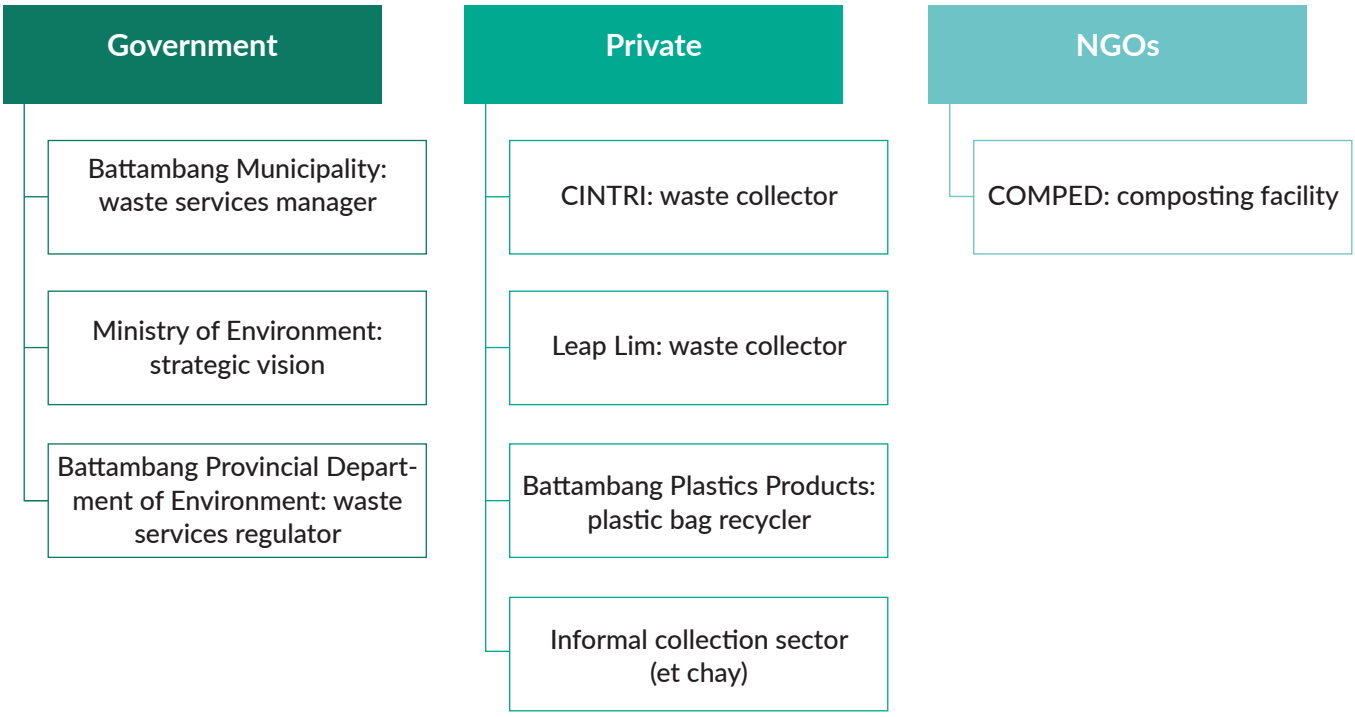
1.2.1 Key Stakeholder Meetings and Interviews

Several meetings and interviews with key stakeholders in the waste sector were held to gain an understanding of the existing waste recycling system and business models and their respective capacities and approaches. This includes understanding the value chain, such as the steps of the recycling process from waste production, the uses of recycling/recovery products from waste facilities, and the breadth of the market demand.

The following figure shows the major stakeholders in the waste management and collection sector in Battambang, all of which are described in detail later in the report. Annex 1 provides a list of meetings held during the study.

In addition to the key stakeholders listed above, GGGI coordinated closely with the United Nations Industrial Development Organization (UNIDO), which provided equipment upgrades to recycling facilities and undertook a promotional campaign in Battambang city. GGGI and UNIDO signed an MOU in February 2019 to coordinate efforts.

Figure 2: Major stakeholders in the waste collection and management sector



1.2.2 Field Visit for Understanding the Waste Sector

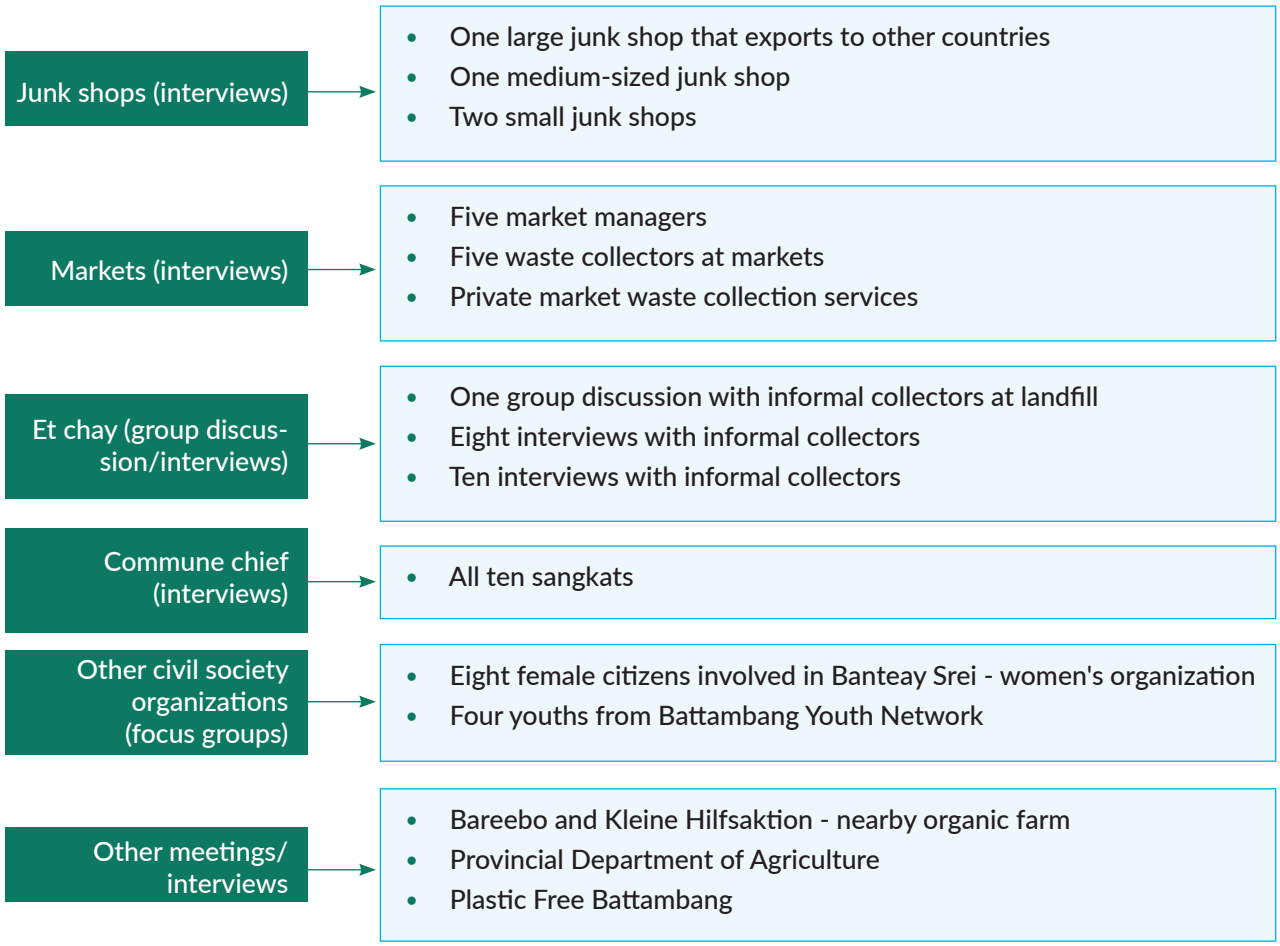
Several key groups were identified that had activities or interests in the waste sector in Battambang city, and a field visit occurred from 29 January to 2 February 2019. A few civil society organizations were included to supplement understanding of the general population's willingness to sort waste and pay for waste services. Annex 2 provides a detailed list of the stakeholders, the associated methodology for collecting data, and the sample size of each group.

1.2.3 Additional Discussions for Understanding Waste Markets

Several interviews or discussions were held to gain an understanding of the demand for waste products outside of Battambang city, including the potential demand in Cambodia for both plastic pellets and final plastic products and interest for composted materials. Some meetings were held in Phnom Penh and others were conducted via email and/or phone; a detailed list of the contacts, dates, and subjects is included in Annex 1.

- Federation of SMEs (FASMEC) – identified relevant businesses for the recycling market
- GoGreen Cambodia – explained their phone application used in Phnom Penh for waste collection
- Cambodian Organic Agriculture Association – presented potential for organic farming
- KAS – reviewed a previous study on waste separation and collection in Battambang
- CAVAC – managing an agricultural project that may have connections to organic farming
- AIMS – running a project that develops agricultural supply chains
- Green Move Consulting – provided information on waste resource recovery for SMEs in Battambang

Figure 3: Stakeholder focus groups and interviews for data collection



1.2.4 Stakeholder Consultation Workshop

The project objectives, key findings, lessons learned from solid waste management projects in other cities worldwide, and preliminary recommendations for improving solid waste management in Battambang city were presented. A discussion was held with four groups of attendees—government stakeholders, commune chiefs, market managers, and collection entities—to gain feedback. The insights and recommendations resulting from the workshop have been incorporated throughout the report.

1.3 Project Limitations and Constraints

1.3.1 SocioEconomic Data

To fully understand the potential for consumer interest in waste separation and assess/quantify the full value chain, a detailed socioeconomic and willingness-to-pay survey would be necessary. However, a full socioeconomic survey was not undertaken—only a market survey of selected groups or entities.

Some socioeconomic data was identified in a CDIA report from 2017,[2] and the raw data collected during 2017 through a short survey to understand public perceptions on wastewater and solid waste activities for the ADB Tonle Sap II project was used. However, both data sets are general, posing a limitation to understanding more comprehensive demands and willingness.

To balance this, the et chay (informal waste collectors) and some civil society organizations were interviewed. Overall, this data provides a general understanding of the needs and concerns of waste generators throughout the

[2] CDIA TA-8556: Pre-feasibility Studies for Second Tonle Sap Integrated Urban Management Project (47285-001), 2017.

city; however, there are still limitations in effectively generating greater understanding, such as the best marketing messages and tools or concrete ideas on motivations for household separation.

1.3.2 Technical and Economic Data from Facilities

Most of the technical and economic information was received through the abovementioned methodology, with support from GGGI and the local authority. However, certain sensitive data was not provided, such as detailed financial information of the private sector (particularly BPP, CINTRI, Leap Lim, and COMPED), including operational expenses and investment costs for raw materials purchasing, human resources, gasoline, electricity, and water, among others. Consequently, some assumptions had to be made.

In addition, the sensitive information that was provided and the business modeling for the recycling companies have been removed from the report to enable its publication.

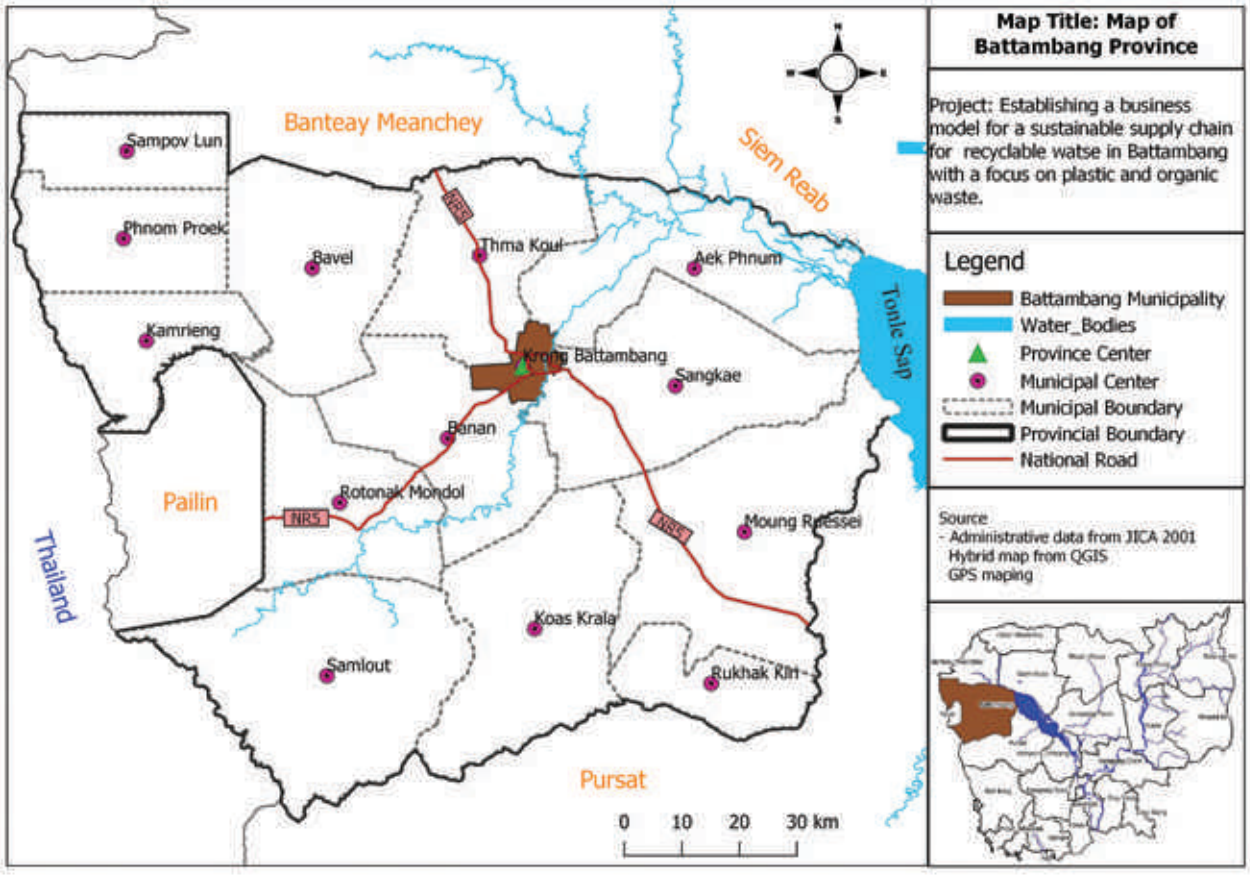
2. Desk Review and Data Collection

2.1 Battambang City

Battambang municipality is the third largest city in Cambodia, located in the western part of the country about 100 kilometers from Thailand. It has an estimated population of 160,000 inhabitants and is comprised of ten communes. Agriculture dominates the nearby rural areas, though the municipality supports hotels, restaurants, guesthouses, and a small handicrafts industry, largely for tourism.

The city, like many others in Cambodia, is subject to several waste management issues, including uncontrolled disposal and waste burning as well as a lack of waste separation and collection planning. Battambang Municipality is responsible for the management of waste collection services, and the Provincial Department of Environment (under the Ministry of Environment) is responsible for regulation and the provision of technical advice. The laws and regulations governing each entity and waste management are described in the following subsection.

Figure 4: Map of Battambang[3]



[3] IGES, Participatory Waste Management Approach for Climate Change Mitigation: The Case of Battambang City (June 2018), 2.

2.2 Laws and Regulations

Sub-Decree 113: management of urban garbage and solid waste

Issued on 27 August 2015, this sub-decree applies to the separation, storage, cleaning, collecting, transporting, recycling, and management of waste and landfills in Cambodia.

Institutional roles

Under the Royal Government of Cambodia, two ministries and their sub-administrations are involved with solid waste management responsibilities.

Figure 5: Institutional roles under Sub-Decree 113[4]

Ministry of Interior Supports the functioning of the management entities	**Provincial Administration**	Prepares any legal instruments required Supports the municipality in action planning, budget planning, and creation of services Approves landfill selection and use
	Municipality	Overall management of urban garbage and solid waste in their territory Has the right to delegate tasks to communes and share services with nearby municipalities or the private sector (with contracts of less than 10 years) Can collect service fees for waste management purposes Must provide enough bins and services in public places Approves recycling activities or other uses of waste
Ministry of Environment Prepares policies, national strategic plans, legal instruments, and technical guidelines Provides technical advice and capacity building to the municipality	**Provincial Department**	Provides technical advice to the municipality Collaborates in planning and implementing laws, legal instruments, and promoting citizen education Approves landfill selection and use

[4] English translations of Khmer legal documents use the words “garbage” and “waste” interchangeably.

Control measures

- Generators must separate, package, store, and discharge their waste; they must also pay for collection services if organized.
- Waste disposal and burning is forbidden on public streets, fields, in the sewage system, in public water sources, or on privately-owned land.
- Managers/owners in business places must provide enough bins and necessary services.
- Defines penalties for various relevant stakeholders and activities for noncompliance as shown in table 1.

Table 2.1. Noncompliance activities and corresponding penalties

No	Noncompliance activities	Penalty amount[5]
1	Improper waste separation and packaging	10,000 to 200,000 riels
2	Placing waste for pickup along public roads/places at inappropriate times	20,000 to 400,000 riels
3	Non-payment of waste collection, transport, and landfill fee	Monthly fee doubled
4	Waste littering	20,000 to 400,000 riels
5	Waste burning	50,000 to 1,000,000 riels
6	Lack of proper management by event manager for waste generated from special events	200,000 to 2,000,000 riels
7	Insufficient bins and necessary services for businesses	400,000 riels
8	Lack of proper management of construction waste	400,000 to 800,000 riels
9	Sludge emptying service without permit letter from local authority	400,000 to 1,000,000 riels
10	Mixing solid waste with hazardous waste in storage and packaging	500,000 to 1,000,000 riels

Inter-Ministerial Prakas No. 8682 BR.K on waste management penalties

The Inter-Ministerial Prakas[6] No. 8682 BR.K, issued by MoI, MEF, and MoE on September 10, 2019, directs the management and use of funds from penalties for offenses against Sub-Decree 113. The Prakas sets out mechanisms to allocate the funds received through penalties. It gives the power to municipal and district administrations to set up a transitional working group to implement the joint Prakas.

[5] 1 USD = 4,100 riels.

[6] A Prakas is a proclamation issued by a minister in Cambodia.

Deika on solid waste management[7]

Issued on 13 November 2017 by the governor of Battambang, the development of this Deika (provincial ordinance) for Battambang was supported by KAS (German think tank) in conjunction with commune chiefs, the municipality, and the provincial departments. It includes 26 articles in compliance with Sub-Decree 113 and has the following objectives, though there is no clear action plan. It outlines the following goals:

- Transform Battambang into a green city.
- Strengthen efficient implementation of roles and obligations of solid waste management.
- Promote public awareness and participation of the population in solid waste management.
- Strengthen solid waste collection and transport.
- Determine transparent solid waste collection and transport fees corresponding to the current situation in Battambang.
- Implement 3R principles: reduce, reuse, and recycle.

A producer or owner of waste can apply for an exemption from the obligation to make waste available in the case that he/she can dully prove recycling according to safe and environmentally friendly standards, checked and confirmed by the Department of Environment, with exemptions submitted to the municipality.

The residents must support the service provider by cleaning littered areas.

If roads are not accessible, residents must use public collection points for disposal.

Inter-Ministerial Circular No. 1070: implementation of sub-decree on management of urban garbage and solid waste management

Issued 12 November 2015 by MoE and MoI, this document clarifies the roles of relevant ministries, the sub-national administration, and the Department of Environment to ensure implementation of Sub-Decree 113.

- National level: MoE and MoI must coordinate with MEF to establish an inter-ministerial team to facilitate the decentralization of solid waste management to the district/municipality. This team is responsible for the following:
  - Disseminate the contents of the sub-decree.
  - Prepare regulations and other technical documents.
  - Study, collect data, and prepare plan for transferring and implementing the activities.
  - Follow up, evaluate, and prepare a reflections and lessons learned workshop.
  - Prepare progress reports and challenges to ministers of MoE, MoI, and MEF and the government.
- Provincial Administration:
  - Disseminate the content of the sub-decree to relevant stakeholders.
  - Hand over the solid waste management activities to the district/municipality.
  - Work with relevant stakeholders to revise contracts accordingly.
  - Instruct, facilitate, and push the municipality/district to plan.
  - Push and support the municipality/district to check the situation of the current landfill and find a location for a new landfill.
  - Follow up and evaluate the implementation of solid waste management.
- District/Municipality Administration:
  - Disseminate the content of the sub-decree to relevant stakeholders.
  - Check the feasibility of the decentralization of solid waste management.
  - Check the existing contract and work with relevant stakeholders to revise contracts accordingly.

[7] Deika text provided by KAS.

- Arrange waste management services if they are not yet available.
- Study current solid waste management, such as the sources and quantity of waste generated.
- Prepare plans and measures to promote waste generation reduction and disposal.
- Promote awareness among the population on waste separation at source, packaging, and disposal.
- Provide a sufficient number of public bins to ensure efficiency of waste collection and transport.
- Work with relevant stakeholders to check the situation of the current landfill and find a location for a new landfill.

• Commune/sangkat level:

- Disseminate the content of the sub-decree, regulations, and other technical documents to the population and relevant stakeholders.

• PDoE:

- Disseminate the content of the sub-decree, regulations, and other technical documents to their staff.
- Collaborate with relevant stakeholders to efficiently disseminate the content of the sub-decree, regulations, and other technical documents to the population and stakeholders.
- Participate in the contract arrangement.
- Participate in checking the current landfill and feasibility of waste recycling.
- Work with the subnational level to prepare plans for waste management.
- Participate in studying and consultations to find a location for a new landfill.
- Carry out environmental impact assessments.
- Push the implementation of Sub-Decree 113.

Prakas 195: maximum fee of urban garbage and solid waste

Issued 6 June 2018 by MoE, MoI, and the Ministry of Economy and Finance (MEF), this Prakas includes nine articles for subnational administrations to determine garbage and solid waste management service fees in their territory. The fee covers cleaning, collecting, and transporting urban garbage and solid waste as well as landfills. It is divided into 15 waste generators (see table 2) and three categories of locations: Phnom Penh, municipalities, and districts. Fees are slightly higher in Phnom Penh while lower in the districts. On 26 February 2019, the new collection fee, in compliance with this sub-decree, was publicly issued in Phnom Penh, with an effective date of 1 April 2019.

The table below shows the maximum fees for municipalities, which are coherent with this study.

Table 2.2. Maximum fees for urban solid waste management in municipalities

No.	Categories of Waste Generators	Maximum collection fee for municipality (riels/month)
1	Housing	6,400–57,200 riels
2	Businesses/shops	50,400–114,400 riels
3	Hotels/guesthouses (counted by # of rooms)	9,600–33,600 riels
4	Entertainment places	242,800–6,267,200 riels
5	Business centers/marts/markets (counted by m^2)	1,600–2,800 riels
6	Hospitals/health centers/clinics (counted by # of beds)	12,800–19,200 riels
7	Private/non-governmental educational institutions	151,600–1,349,200 riels
8	Public educational institutions	348,000 riels
9	Private companies	140,000–759,200 riels
10	Petroleum stations	133,600–323,600 riels
11	Goods storage/transportation places (counted by m^2)	800–4,400 riels
12	Factories/handicrafts	196,000–1,958, 400 riels
13	Embassies/consulates/NGOs	392,000 riels
14	Public institutions	104,000 riels
15	Others	Varied

Sub-Decree 168: Management of Plastic Bags

Issued 10 October 2017, this sub-decree includes 32 articles with restrictions on importing, producing, distributing, using, and recycling plastic bags in Cambodia. The aim of the sub-decree is to reduce the use of single-use plastic bags and promote the use of more environmentally friendly alternatives. Under the sub-decree, plastic bags must now be purchased in supermarkets. In addition, plastic bags of a certain thickness are now banned from import and manufacturing while tax incentives will be put in place for the import or manufacturing of biodegradable bags.

Institutional roles

In addition to the two ministries involved in waste management activities (MoE and MoI), the Ministry of Economy and Finance (MEF) and Ministry of Tourism (MoT) are involved with the implementation of the plastic bag sub-decree.

Figure 6: Institutional roles under Sub-Decree 168

Ministry of Environment	Leads policy preparation, strategy, and legal instruments Provides technical advice to subnational administration Promotes the implementation of the sub-decree Approves VAT on biodegradable packaging Approves VAT for recycling and processing of plastic bags	**Provincial Department of Environment**	Supports subnational administration in managing plastic bag waste
Ministry of Interior	Collaborates with and facilitates meetings with relevant stakeholders	**Provincial Administration**	Supports, coordinates, and leads the implementation of plastic bag reduction-related activities and encourages recycling Can delegate responsibilities to the subadministration
Ministry of Economy and Finance	Sets tax, VAT, and other required procedures to support activity implementation Records annual plastic bag imports for MoE to evaluate Oversees implementation of VAT on biodegradable packaging Oversees implementation of VAT for recycling and processing of plastic bags		
Ministry of Tourism	Added plastic bag waste management as an indicator in the evaluation of clean cities Collaborates in promoting education on plastic bags		

Control measures

- Citizens are obliged to participate in reducing plastic bag use.
- Business or service providers are encouraged to reduce the number of plastic bags provided to clients.
- Supermarkets and commercial centers must charge for plastic bags.
- Imported plastic bags must meet certain size specifications.
- Describes penalties for noncompliance:
  - Issuance of a warning letter.
  - Temporary suspension of business.
  - Suspension and revocation of imports or domestic production.
  - Penalties.

2.3. Other Waste Projects Relevant to Battambang City

In addition to this project, there are several actors with recent, planned, or ongoing waste management projects in Battambang city or that have a scope that impacts solid waste management activities in the city.

UNIDO

UNIDO is providing support to CINTRI, BPP, and COMPED to upgrade facilities and improve source separation. Their scope and timeline are as follows

1. Assist CINTRI and Leap Lim in collecting dry waste for sorting at the MRF.
   a. Design and implement awareness campaign, including at schools. January to March 2019
2. Assist BPP in upgrading the facility to more efficiently process plastic bags and other types of plastics.
   a. Provision of four components for a new production line: a grinding machine, washing line, drying machine, and granulating line. Procure and install equipment in 2020.
3. Assist COMPED in upgrading the facility.
   a. Provision of three new machines: a shredder, turner, and screener. Equipment installed in August 2019.

Provision of new concrete foundations and a roof. Construct in early 2020. GGGI and UNIDO have developed the Technical Cooperation Agreement for the two projects to collaborate closely for the duration of the projects.

Institute for Global Environmental Strategies (IGES)

IGES, which previously worked with COMPED, has implemented waste separation and collection trials in Battambang. The initial project began in 2011, which led to a community-based waste management initiative with the idea of opening waste management planning, decision making, implementation, and monitoring to other key stakeholders in the sector. The initiative was expanded in 2014, which resulted in a study of short-lived climate pollutants and an associated work plan, which was finalized in 2017.

Throughout the project, several public workshops were held to receive feedback, and the feedback in the report indicated interest and involvement from the public. Additionally, it seems all of the key stakeholders were involved in the work planning and implementation, including the municipality, PDoE, CINTRI, COMPED, and the sangkats. One interesting recommendation was to add organic waste containers to the existing trucks for ease in separation collection, though it is unclear if this was attempted. The solid waste management work plan and trials were implemented in coordination with working groups, but it seems the public awareness campaigns were quite limited in duration (i.e., a few days within a short time frame). It appears there was also no clear monitoring and evaluation to determine the effectiveness of the campaigns and other project implementation components.[8]

One component of the project was targeting waste separation in three markets; however, it was only relatively successful at Boeung Chhouk. The separated waste was decided to be taken to COMPED, and IGES facilitated a negotiation between the market and CINTRI so the market could receive a discount for diverting waste. The conclusion was that the market would only pay landfill fees, which enabled them to purchase their own truck for waste collection. However, as landfill fees are still high, it does not provide an incentive to separate the waste.

World Bank[9]

In June 2019, the World Bank held a workshop to present and discuss a solid waste management project it plans on implementing. The project consists of a national-level legal, policy, and capacity-building component and piloting implementation in three cities. The World Bank is considering supporting a revision of Sub-Decree 113 to adjust the roles of stakeholders, include a database and reporting system, and set waste sampling and analysis procedures, among others. New policies may address plastics (including possibly banning single-use items) and packaging waste. Other capacity building and guidelines may include cost recovery, templates for contracts, support for environmental monitoring and enforcement, and guidance for landfill design and operations.

UNESCAP[10]

In 2012, UNESCAP, in partnership with COMPED, implemented an awareness raising program on source separation as part of a waste-to-resource program under the Pro-Poor and Sustainable Solid Waste Management in Secondary Cities and Small Towns in Asia-Pacific project, funded by the Bill and Melinda Gates Foundation from 2009 to 2015. The awareness raising program targeted three markets in Battambang Municipality: Nat/Thum, Thmey, and Boeung Chhouk. Market vendors, workers, and association members, as well as some households, were targeted on waste separation at the source.

Boeung Chhouk showed the greatest success, with 35% of vendors separating their waste within one year. Both market cleaners and CINTRI collected separated waste. However, the other two markets were reportedly less successful for several reasons. First, market management and cleaners (the latter of which there were too few) did not cooperate, resulting in waste being remixed. Furthermore, there was no financial incentive offered to vendors for separation, and bins were inadequate for waste separation. This project highlights the need for commitment from market managers and cleaners and that awareness raising campaigns cannot focus only on vendors.

Asian Development Bank (ADB)

There are two ongoing projects in Battambang associated with ADB: the development of the MRF under the Southern Economic Corridor Towns Development Project and the construction of a new landfill under the Tonle Sap Basin project.

The original scope of the MRF project was to develop a facility to sort a maximum of eight tons of dry waste with eight sorters per each eight-hour shift. The feasibility study called for a pay loader, a bailing machine, three weighing scales, eight high-density polyethylene (HDPE) bins, and a genset. The project was implemented in coordination with the Ministry of Public Works and Transport (MPWT) in coordination with Battambang Municipality. It also called for capacity building for staff. In December 2018, ADB informed the authors that a midterm review mission of the project had been held, and the capacity building on operation and maintenance of the MRF was planned for municipality staff and private operators, but the exact time frame was not yet known. There is no immediate plan or budget to install sorting equipment at the MRF.

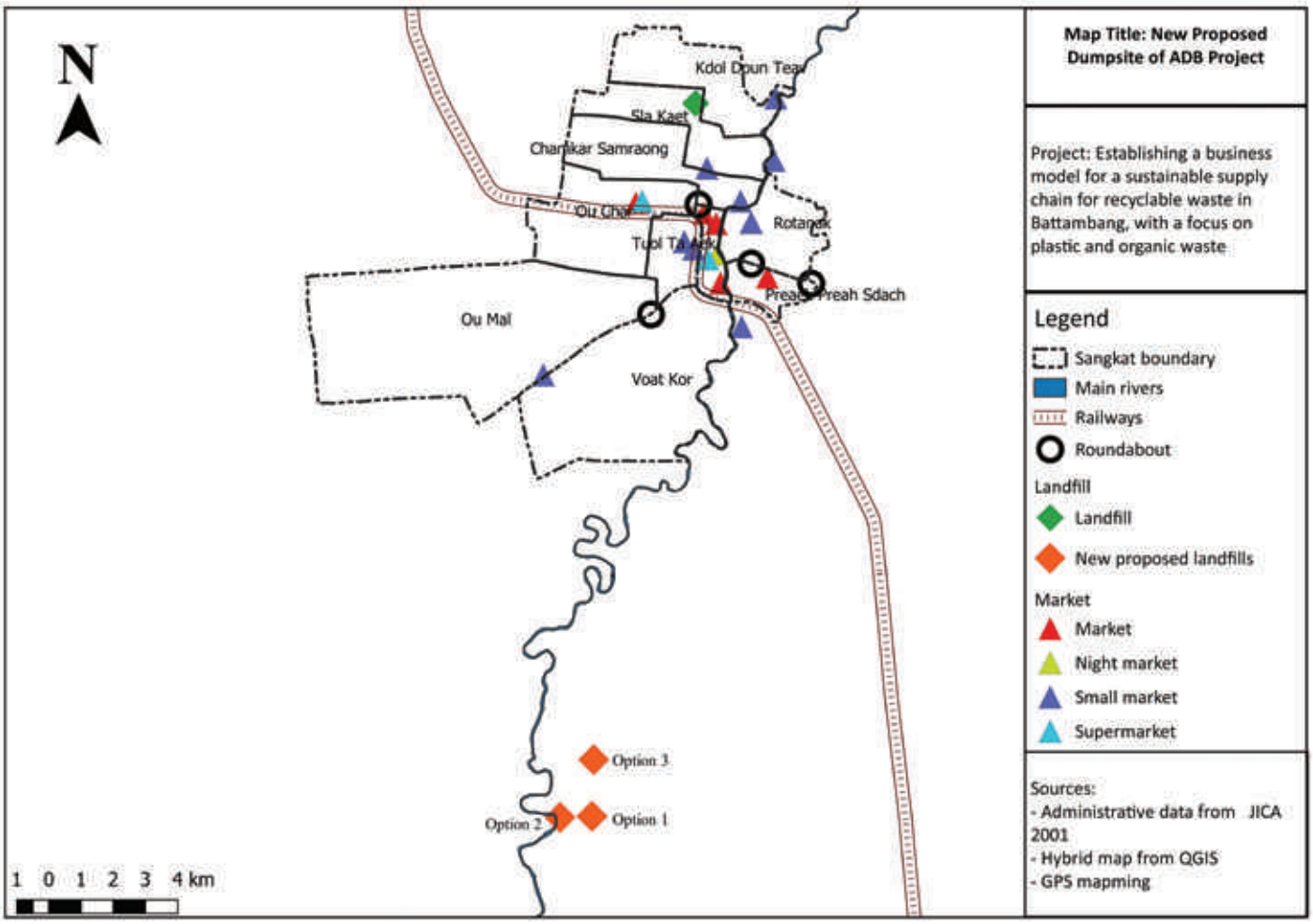
The Tonle Sap Basin project is overseeing the site selection and design for a new landfill, which is proposed to be located 21 kilometers south of Battambang city. It is tentatively projected to be in operation by 2022, with approximately a 30+ year lifespan and nearly 3 million meters^3 of volume. It is currently in the design stage with three proposed options; the option shown in figure 7 is the most favorable, but there has been no final selection.

[8] IGES/COMPED, Work Plan for Mitigating Short-Lived Climate Pollutants Final Report (February 2017).

[9] Information shared from GoGreen Cambodia, who attended the event. An attempt was made to reach the World Bank to gain further insight; however, there was no response as of finalizing the report.

[10] UNESCAP/WASTE CONCERN, Valuing Waste, Transforming Cities (2015).

Figure 7: New proposed dumpsites in ADB project



Konrad-Adenauer-Stiftung (KAS)

KAS is a German think tank that worked with the sangkats and provincial government in Battambang to develop a Deika, or local regulation, for solid waste management at the commune level in Battambang (described earlier in the "Laws and Regulations" section: "Deika on solid waste management"). The project was implemented in 2016 and 2017, resulting in a draft law that was officially approved by the provincial governor in 2018.[11]

The following were recommended to be implemented through 2030 to improve efficient waste management.

[11] Updates from KAS during a meeting held on 16 January 2019.

Figure 8: KAS recommendations through 2030[12]

Gain control over SWM	Strong Implementation	Awareness Raising and Public Management
• Fee collection in hands of municipality • Creation of own budget • Strongly reinforce the municipal capacity • Short-term contract with service provider (PPP) or international tendering • Monitoring mechanisms • Complete data collection and analysis	• Sweet: Awareness raising and education • Sweet: incentives for best practice activities • Sour: Law enforcement • Sour: Punishment of violations against the Deika	• Communication strategy • AIDA និង KISS • Green City Ambassadors • Plastic-free public sector • Clean city awards • Cooperation with NGOs • Cambodia Cleanup Website • (available upon 24.08.2017)

GoGreen Cambodia[13]

GoGreen Cambodia is a volunteer group based in Cambodia, originally part of the inSTEDD South Asia incubator group that enabled development of a free, public Android application for reporting waste management issues.

Figure 9: GoGreen Cambodia application[14]

Green Brick Movement

The Green Brick Movement project was established by a dynamic youth team through the Southeast Asian Leaders Initiative (YSEALI) program and ended in January 2019. The main objective was to reuse the plastic waste by turning it into eco-bricks through putting dry small plastics into plastic bottles. The activities included collaborating with two schools in Battambang to collect the dry plastic waste and form it into bricks, engaging organic farmers to use the plastic bricks (e.g., to build household composting facilities), and engaging youth at organic farms. The team has a strong youth network in Battambang.

[12] KAS, Deika on Solid waste management: A Case of Participatory Legislative Drafting at the Commune Level (2017), 18.
[13] GoGreen Cambodia, informal discussion with staff and information retrieval from GoGreen Cambodia's Facebook page, April 2019.
[14] Google Play, GoGreen Cambodia application, last updated 1 September 2017, https://play.google.com/store/apps/details?id=org.insteddilabsea.gogreen&hl=en.

Plastic Free Cambodia

Plastic Free Cambodia is a volunteer-based entity that focuses on plastic alternatives. It has activities in Battambang, including workshops on reducing plastic waste; cleanups during special events, such as water festivals; and promoting Plastic Free July.

Flemish Association for Development Cooperation and Technical Assistance (VVOB)

VVOB is Belgian Flemish organization that focuses on education for development. Based on a meeting with the staff, it is understood that the program works to promote Eco- and Plastic-Free Schools. The program will last until 2021. VVOB is targeting this activity in 20 schools, of which 11 are primary schools and 9 are junior high schools. At the beginning of 2019, VVOB had worked with 10 schools. Their main activities include providing bins (2 to 10, based on the schools' needs) decorated for different types of waste and educating school directors, teachers, and students about proper waste separation.

One Earth-One Ocean

In collaboration with COMPED, the German-funded One Earth-One Ocean has supported a cleanup activity for the Sangkae River in Battambang by providing a boat and other tools to COMPED for collecting litter in the water.

2.4 Understanding the Battambang Solid Waste Sector

From the initial desk review, meetings, and interviews, the current state of the supply chain and the associated actors are described in the following subsections. First, management is addressed, followed by an overview of the flow of waste as shown in figure 10, from generation—through storage, collection, and separation—to recycling and disposal. Finally, lessons from other international projects are presented for further inspiration. Figure 11 also presents a map of Battambang city, indicating key services and actors to be presented.

2.4.1 Governance

The Ministry of Interior (MoI), Ministry of Environment (MoE), Ministry of Tourism (MoT), and their sub-counterparts are the key management actors (see figure 12 below). Not pictured is the Ministry of Economy and Finance (MEF), which allocates funding for solid waste management services. The city municipality, under MoI, has the greatest responsibility for implementation; therefore, it is presented first.

Battambang Municipality: manager of waste services

Battambang Municipality has four technical staff members under the Office of City Beautification and Waste Management who run solid waste management activities. Aligned with Sub-Decree 113, the Royal Government of Cambodia, through the Ministry of Economic and Finance (MEF), has allocated a national budget for environmental cleanliness services, with Battambang Municipality receiving USD 87,000 in 2015 and around USD 140,000 each year from 2016 to 2019.

As designated by policy, the municipality oversees the management and enforcement of waste collection services (including the provision of bins in public places) but does not collect waste collection fees—a duty given to the entity by law. Instead, the city has contracted two collectors: CINTRI, which has collected waste (and associated fees) in eight communes since 2010, and Leap Lim, which is subsidized by the municipal budget to serve two communes and public areas since 2015. CINTRI's 10-year contract is set to be renewed in 2020 and Leap Lim's contract has been renewed annually from through 2019, with the whole municipal budget (about USD 143,000 in 2019) allocated to the services provided by the latter entity.

Regarding recycling and disposal services, the municipality owns the materials recovery facility (MRF), the construction of which was funded by ADB. The city has designated Leap Lim to manage the MRF, although there was no formal contract at the time of writing. There is no municipal budget dedicated to cover the operational costs of this facility. Furthermore, the municipality has

Figure 10: Battambang City Current Waste Flow Diagram

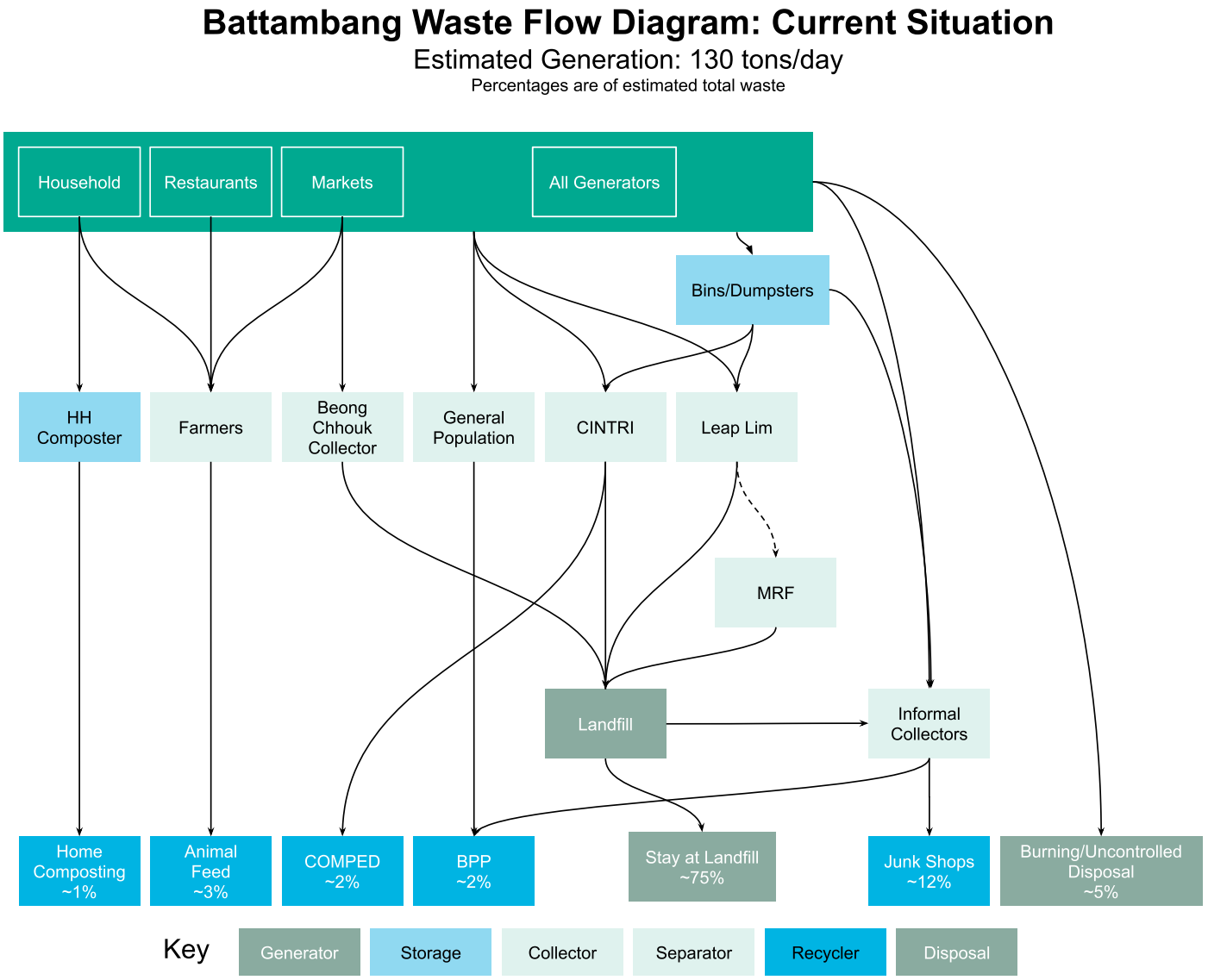


Figure 11: Map of SOLID WASTE MANAGEMENT collection areas and major stakeholders

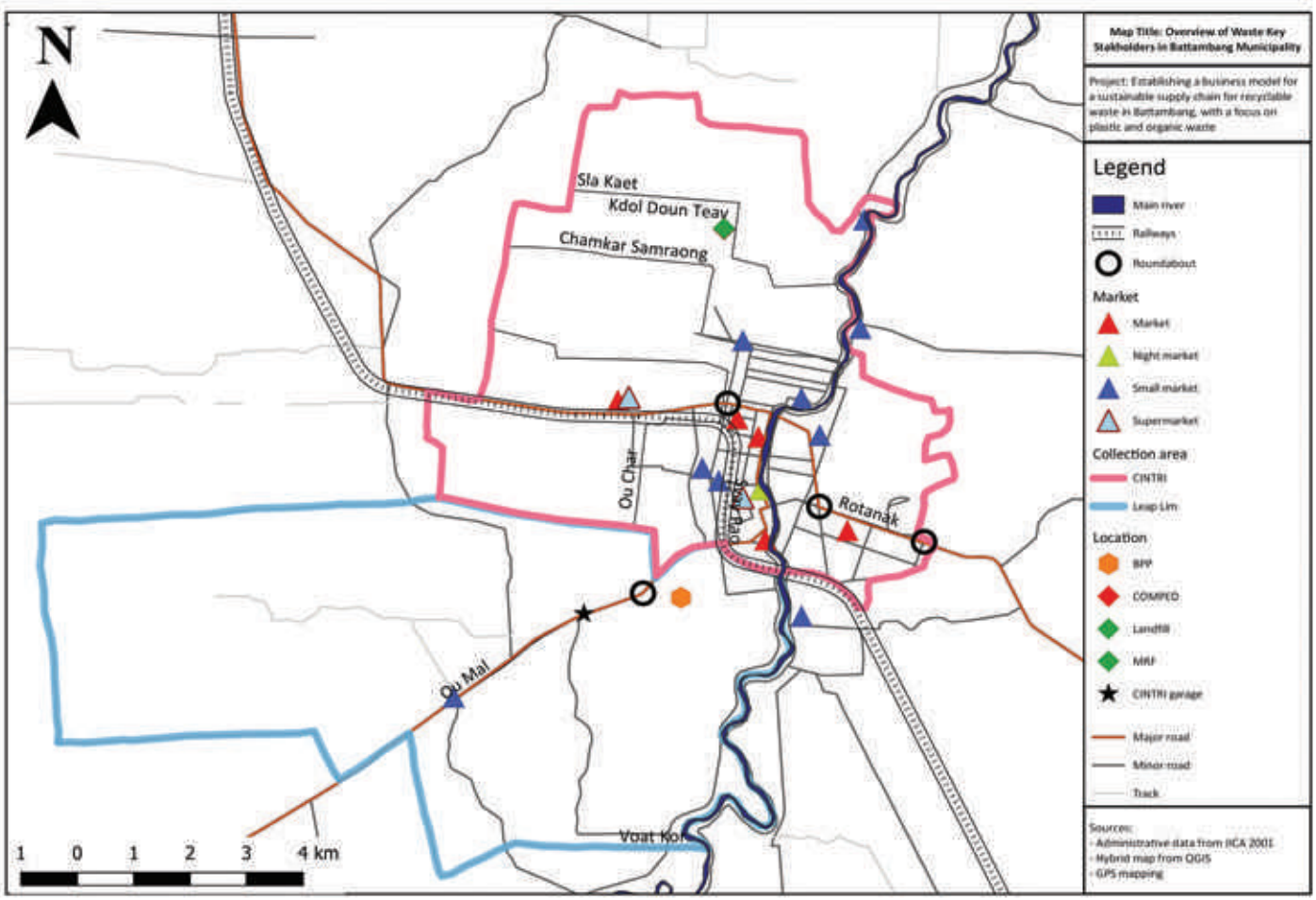
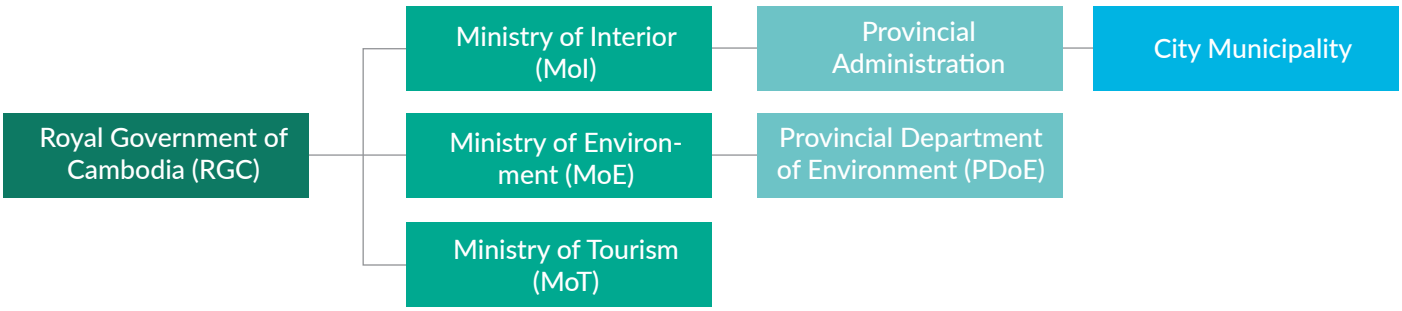


Figure 12: Key Management Actors



provided one hectare of land to CINTRI for the current landfill and one hectare of land to COMPED for the composting facility. The map in figure 11 shows the locations of these entities and the communes served by CINTRI and Leap Lim.

The municipality is also in charge of promotion for waste awareness and separation and aims to organize village competitions for environmental promotion activities, but no strategic plan has been developed to date to coordinate activities and implementation with communes. This was highlighted during the stakeholder consultation workshop on 2 May 2019, when the municipality agreed on the importance of this task and expressed plans to transfer roles to the commune level. The sangkat chiefs also expressed a strong willingness and interest to improve solid waste management.

Finally, though Sub-Decree 113 outlines enforcement guidelines and penalties that fall under the municipality's responsibility, no activities for enforcement have been undertaken by the municipality.

Battambang Provincial Department of Environment (PDoE): advisor and implementer

PDoE's Office of Environmental Protection has three staff members and a budget of approximately USD 750 to 1,000 per year. As defined in relevant policies, the Battambang PDoE is to collaborate with the municipality in the planning and implementation of laws and public awareness campaigns as well as provide technical advice to the municipality and support the management of plastic bag waste. Additionally, PDoE is also responsible for implementing penalties for noncompliance. However, it appears that PDoE currently does not enforce any noncompliance measures.

Additionally, the Battambang PDoE provides environmental waste separation certificates to entities, though, so far, it has only awarded them to restaurants and other SMEs. PDoE indicated that other types of entities, perhaps the informal sector, may also be eligible to receive this recognition.

Provincial Administration of Battambang

Although the municipality in Battambang is the main implementer of solid waste management services, the provincial administration has a few responsibilities, according to Sub-Decrees 113 and 168. First, it supports the municipality in budget and action planning as well as the creation of services. Second, it leads the implementation of plastic bag reduction-related activities (including recycling), though these responsibilities can be delegated to the sub-administration. To date, however, the provincial administration has only been involved with UNIDO's recycling activities. Regardless, the provincial administration is a key decision-making actor when developing solid waste management planning and policy.

Ministry of Environment

MoE has a variety of national-level responsibilities, but of particular interest is the implementation and enforcement plan[15] of Sub-Decree 168 on plastic bags. At the time of writing, main business centers and supermarkets were informed by the Department of Solid Waste Management that businesses are expected to charge for plastic bags. A representative at the ministry also shared that some small markets and mini-markets have imposed the charge. The department plans to expand this practice to local markets between 2020 and 2022.

The Department of Solid Waste Management has begun to prepare a sub-decree on management of food containers, including plastic cups, straws, and Styrofoam. This is important because it targets the largely unrecyclable materials that are not captured by the dynamic informal waste sector. It is unclear when this sub-decree will be finalized and implemented, or how it will be regulated.

The Department of Environmental Education undertakes the planning and implementation of public awareness campaigns. During an interview in March 2019, the department provided information about an upcoming campaign, for which it developed radio, TV, and newspaper components, in addition to billboards, flyers, posters, and bumper stickers. However, it seems these events only run for a short time, and no monitoring is undertaken (nor has been in the past) to determine their impact.

[15] Department of Solid Waste Management, MoE, meeting with deputy director, April 2019.

Ministry of Tourism

Though not readily discussed in the implementation of waste management activities, MoT is worth mentioning for several reasons. First, tourism often has a large impact on demand for public services (such as in Siem Reap, where there is greater demand for waste management due to the high volume of tourists at the Angkor complex). Second, MoT has responsibilities in the management of plastic bag waste in Sub-Decree 168, including promoting education on plastic bags. It has also added plastic bag waste management as an indicator in the evaluation of the clean city awards, which is managed and issued by MoT.

2.4.2 Generation

The population of Battambang municipality is estimated to be 160,000. Previous estimates of the amount of waste produced per day range from 87 to 130 tons per day,[16] and although it varies seasonally, more recent reports (from 2017) estimate higher amounts of generated waste, up to 130 tons per day. Under this study, the waste generation was estimated to be even higher; therefore, 130 tons per day are assumed throughout this report.

Generator profile

Based on the 2016 commune database, Battambang Municipality consisted of 10 communes, 29,720 families, and 161,072 inhabitants (see table 3 below). Svay Pao is the central commune where most of the public and private institutions are located. Table 3 illustrates the types of businesses in Battambang Municipality.

Table 3: Demographic information and number of businesses in Battambang Municipality[17]

Sangkats	Families	Inhabitants	Super Markets	Markets	Small Markets[18]	Night Markets	Restaurants	Health Clinics	Hotels	Guesthouses	MFI Institutions	Bank Institutions
Chamkar Samraong	3,755	20,942	0	0	2	0	1	2	0	5	0	0
Kdol Doun Teav	2,325	10,536	0	0	1	0	1	0	0	0	0	0
Ou Char	3,041	18,222	1	1	0	0	0	0	1	6	2	1
Ou Mal	2,775	12,583	0	0	1	0	0	0	0	0	1	0
Preak Preah Sdach	2,561	14,101	0	1	0	0	2	1	1	21	3	1
Rotanak	2,997	16,554	0	0	1	0	7	2	18	16	6	1

[16] Low estimate predicted in the August 2010 CDIA Urban Environmental Infrastructure Improvement Project Report, Part B Appendix 2; the upper estimate is from the 2017 IGES/COMPED Work Plan for Mitigating Short-Lived Climate Pollutants Final Report. Other sources estimated totals between these two figures.

[17] Ministry of Interior 2016 Commune Database and revision on markets based on interview with sangkat chiefs, March 2019.

[18] Small markets are considered as markets that are not open all day (only in the morning and late afternoon).

Sla Kaet	1,378	8,847	0	0	1	0	5	0	1	3	0	0
Svay Pao[19]	3,440	21,799	1	3	0	1	9	10	19	34	4	10
Tuol Ta Aek	4,054	19,206	0	0	2	0	1	3	1	4	0	0
Voat Kor	3,394	18,282	0	0	0	0	8	1	0	7	0	0
Grand Total	29,720	161,072	2	5	8	1	34	19	41	96	16	13

According to data collected in 2017, around 74% of the population prefers a separate bill for the solid waste collection fee rather than having it part of the water or electricity bill. On average, this survey also indicated that there are households willing to pay around USD 2 per month for improved solid waste management services.[20] This is more or less in line with the law, which provides a tariff range for waste collection at households between USD 1.6 and USD 14, depending on the size and type.

Generator habits

For households and businesses, door-to-door collection services are provided by formal collections; however, not all areas are reached. In markets, vendors either put waste into plastic bags or place it directly on the ground for the market cleaners to pick up. Discussions have anecdotally revealed that the reason waste separation campaigns have failed in the past is because generators observe collectors remixing their waste, therefore determining separation a waste of time. Additionally, interviews with vendors in the markets indicated that the vendors are aware that in other countries (e.g., Thailand), market spaces are kept clean to avoid littering fines.[21] This indicates that both improved collection activities and enforcement are important parts of developing the solid waste management sector in Cambodia and that communication on how the segregated waste is specifically processed is important so that producers can understand why the waste needs to be sorted.

Furthermore, a study done for the SWITCH Asia project in 2015 regarding 17 triggers on behaviors related to reducing plastic bag waste noted some interesting facts about generators.[22] Overall, the study found that there was a high awareness of the health and environmental impacts of improper waste management (burning and littering), with 97% of consumers indicating respiratory problems from waste burning. Interestingly, students had both the highest awareness of the impacts and the highest probability of littering, and individuals were also more likely to litter than families.

Regarding plastic bags only, markets contributed nearly 50% of all bags received. Market vendors expressed discomfort about asking people to combine items into one bag and did not want to be perceived as being stingy.

The reasons indicated for not improving waste management were the following:

- It's somebody else's problem.
- It's somebody else's job.
- Rubbish bins are not always available where needed.
- Plastic bags are convenient for carrying on motorbikes.
- Individuals do not want to be associated with the negative image of being a waste picker.

[19] This is the central commune of the municipality.

[20] Socio-economic survey database collected at the end of 2017 for ADB Tonle Sap II Project.

[21] From discussions from data collection trip, December 2018.

[22] SWITCH ASIA, 17 Triggers Reducing Plastic Bag Waste in Major Cities of Cambodia Behavior Change

[23] Pillippa Lally et al., "How are habits formed: Modelling habit for formation in the real world," European Journal of Social Psychology (16 July 2009).

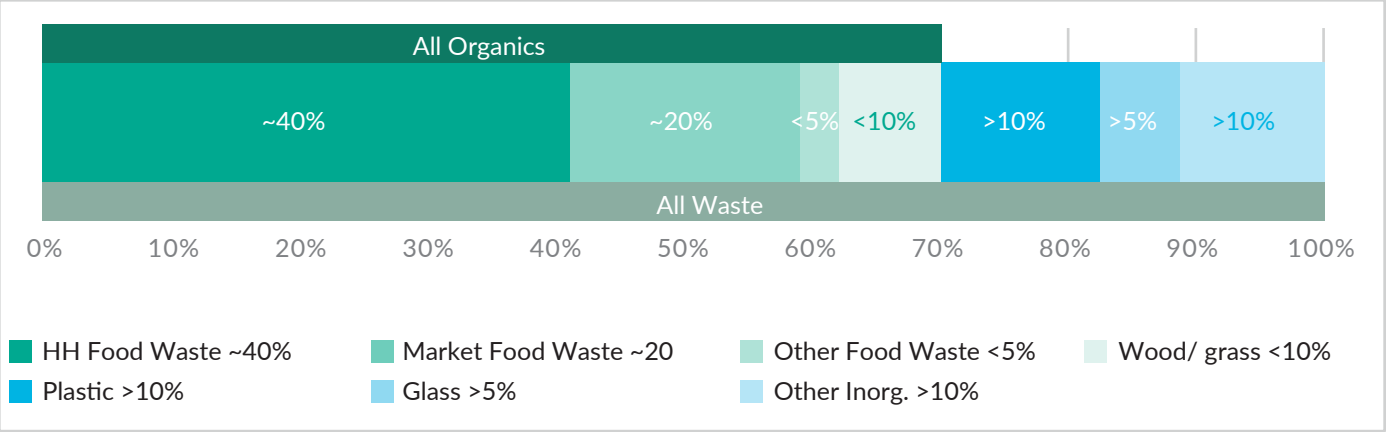
The study also suggested that monks could perhaps influence the older generation, but celebrities are more likely to influence youth. Additionally, markets want to promote and be involved in campaigns to improve waste management, though vendors have deeply engrained habits.

Overall, it is quite difficult to instill new habits unless individuals place high importance on this issue, and long-term engagement is necessary to truly develop new habits. One psychology study from 2009[23] concluded that, while it varies among individuals, it takes an average of 66 days to develop a new habit. This should be taken into consideration when developing trials and long-term implementation plans.

Waste composition

Up to 80%[24] of waste is estimated to be organic, most of which is food waste derived from households and markets (together, it constitutes an estimated 95% of total food waste). However, sources vary greatly, as the IGES/COMPED[25] study estimated that only 61 tons of food waste is generated in total each day, which represents only 47% of the estimated total waste generated of 130 tons per day. Given this wide discrepancy, the waste composition is roughly presented in the figure below based on an average composition of 70% organics, 30% other waste, and relative percentages for the subcomponents.

Figure 13: Rough estimate of waste composition in Battambang city[26]



2.4.3. Storage, Collection, and Separation

Storage

Most generators do not separate and store all waste; however, it is remarkable that 88% of households do separate specific recyclables to sell to the et chay for an average income of around USD 2 per household per month, with the most common recycled good being aluminum cans.[27] It is also known that around 60% of generators store waste in plastic bags, 15% in bins, and the rest use other means or no storage at all. Additionally, some households compost their own waste.[28]

It should be noted that the income of USD 2 per month from recycling sales to the et chay is the same amount that the average household is willing to pay and is within the range of allowed collection fees as outlined by the law. This effectively means that waste collection is null for small households.

[24] Estimates from several sources, notably from UNIDO's notes and the COMPED website, accessed 26 December 2018, https://comped-cam.org/wastesurvey.php.

[25] IGES/COMPED, Work Plan for Mitigating Short-Lived Climate Pollutants Final Report (February 2017).

[26] Food waste estimates: IGES/COMPED, 2017. Other estimates: average from UNIDO's notes and the COMPED website, https://comped-cam.org/wastesurvey.php.

[27] Socio-economic survey database collected at the end of 2017 for ADB Tonle Sap II Project.

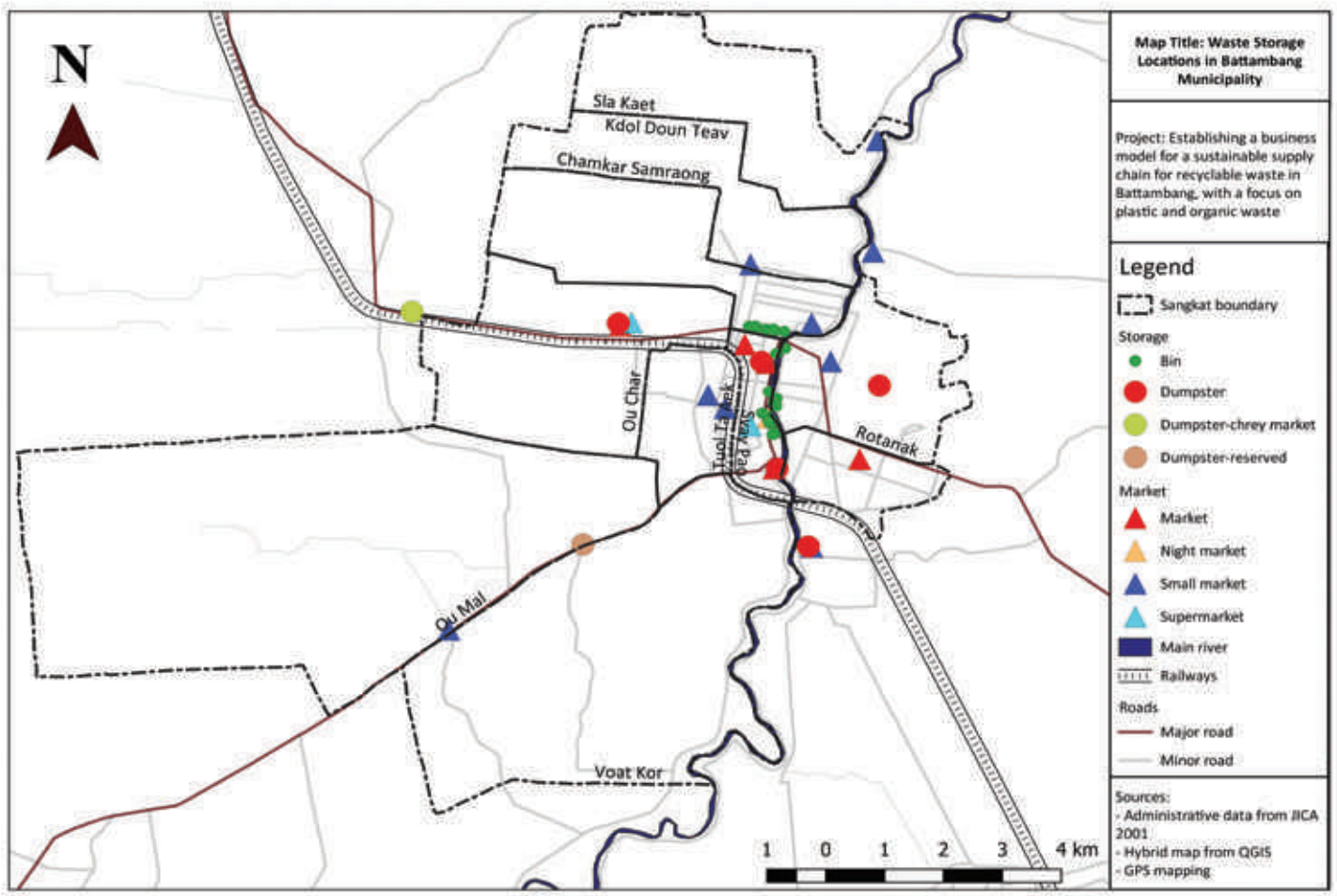
[28] IGES/COMPED, Work Plan for Mitigating Short-Lived Climate Pollutants Final Report (February 2017).

Provision of Public Bins

The two private collection companies are responsible for providing public waste storage:

- **CINTRI:** Based on a meeting with the CINTRI Battambang branch manager, CINTRI provides 45 public bins (30 that are 140 liters and 15 that are 240 liters) scattered in a few public gardens. The manager also stated that there are nine dumpsters at the markets. However, one dumpster is at Chrey Market in a neighboring district named Thmor Kol and another dumpster is being kept at the CINTRI garage for temporary maintenance. Furthermore, as observed during market interviews, one dumpster that was supposed to be at Boeung Chhouk Market was not found. Therefore, only six dumpsters are currently used for waste storage: two at Phou Puy Market and one each at Nat/Thum/Central, Leu, Borey Romchek, and Voat Ta Meum Markets (shown in figure 14).
- **Leap Lim:** Following the municipality's scope for Leap Lim's work in 2018 and verified with the owner, there are 150 bins (100 of 60 liters and 50 of 240 liters). The municipality management called for putting these in public gardens, some schools, and several pagodas in three central sangkats: Svay Po, Ratanak, and Preak Preah Sdach. It was noticeable that some bins had been stolen or broken. It is estimated that, during data collection, around 50% of the bins (approximately 100 bins) are remaining, and they are located mostly in the public gardens, as seen in figure 14.

Figure 14: Map of public waste storage locations in Battambang Municipality



Use of Bins and Dumpsters

It should be noted that the lack of arrangement and the height of the dumpsters do not facilitate their use. It was found at Pou Puy Market that the cleaners did not use the dumpsters (even when they were almost empty) and continued to unload the waste (mainly organic) on land nearby the market (see photos in figure 15).

Figure 15: Photos from Pou Puy Market

Specifically, for the markets, there is no waste storage inside the markets; therefore, it is thrown on the ground for the cleaners to pick up. Outside the market, there is one bin (one market has two bins) provided by CINTRI, which is not sufficient for separating the waste, causing an excessive pile up of waste around the dumpsters. Furthermore, there is an issue with neighbors dropping off their waste at these bins, instead of using street collection services.

- Only the main sangkat, Svay Po, has public storage.
- Nat/Thum/Central Market has only one dumpster, which results in piles of waste surrounding the dumpster and requires CINTRI to spend much time for collecting.
- Thmey has only open dumping (directly on the ground).
- Phou Puy has two dumpsters, but there is no separation between dry and wet waste. Furthermore, cleaners sometimes do not put the waste inside, even when it is not full, because of the height of the dumpsters.

Collection

Collection services are divided into two main categories:

- Formal collection includes CINTRI for eight sangkats, Leap Lim for two sangkats, and self-service collection for Boeung Chhouk Market.
- Informal collection (called et chay) includes individual collectors, medium/small junk shops, and large junk shops.

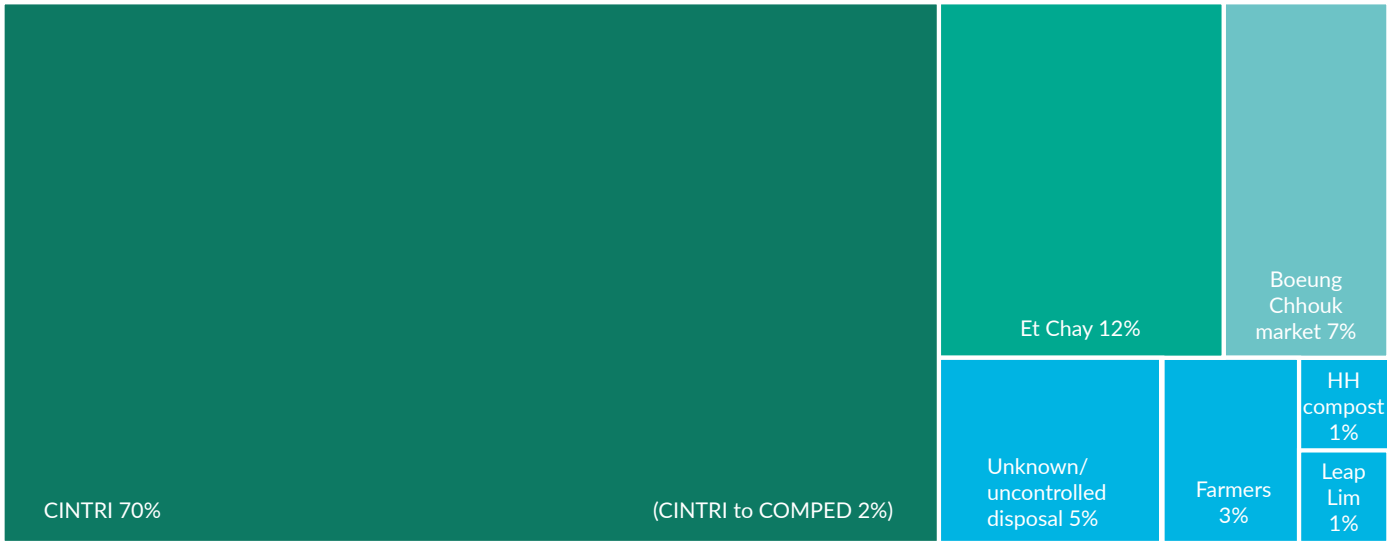
Other small collectors not investigated deeply in this study include farmers who collect scrap food waste for feeding livestock, household composting, and uncontrolled or burning of waste. The estimated amount of waste collected by all collectors listed above is represented in figure 16.

CINTRI: waste collector

CINTRI, which has been operating in Battambang since 2010, holds a 10-year contract with the Battambang Municipality to provide services in the city through 2020. Under the terms of the contract, CINTRI is to collect waste in all 10 communes and public spaces, although 2 of these 10 are contracted and serviced by Leap Lim. A map of CINTRI's service areas and frequency of collection is shown in figure 17. The contract was updated in 2017 and is up for renewal again in 2020.

Based on the collection route and schedule and individual interviews and group discussion with informal pickers at the landfill, the waste amount collected reaches up to 102 tons per day (which would be equal to 78% of the total waste, though it is estimated that at least 8% is from outside of Battambang city) as described in table 4. To compare this with other sources, the ADB Feasibility Study noted that CINTRI collection estimates ranges from 140–148 tons per day and Battambang municipality

Figure 16: Estimates of collected waste[29]



has reported that CINTRI's collection amounts to around 80 tons per day.[30] The lack of consensus in collection rates was also noted in the ADB report, which further estimates that a collection rate of 100 tons per day is a reasonable estimate given the number of trucks and distance to the landfill, yielding a collection efficiency of around 76% of total waste.

The scarcity of reliable data shows the weaknesses of the monitoring system and the municipality's ability to control the effective contract implementation. This issue should be overcome by including some specific articles in the new contract that would distribute more duties to CINTRI, in terms of reporting and transparency.

Overall, CINTRI Battambang has 72 staff members, 17 vehicles, and additional tools to operate their service in Battambang. The collection fee generally varies from USD 0.5 to USD 50 for households and businesses, as shown in Annex 3, with a market fee of around USD 150 to USD 230 per month.[31] It is estimated that about one quarter of households are paying for waste collection services in the city.

While around 70% of the total waste generated is collected, several areas are reported to have limited or no service, despite being in CINTRI service areas. For example, areas of Ratanak commune never see collection services, and the area near the train station has notoriously poor service.

[29] Sources discussed in the following sections. CINTRI amount based on ADB Tonle Sap estimate of 100 tons per day, but could be much less, increasing the amount of unknown/uncontrolled waste.

[30] IGES, Participatory Waste Management Approach for Climate Change Mitigation: The Case of Battambang City (June 2018).

[31] Meeting with CINTRI branch manager, 22 February 2019.

Table 4: Estimated waste amount collected by CINTRI[32]

Type of operating truck	# of trucks	Collection frequency per day, per truck	Estimated waste amount per truck (tons)	Estimated collected waste (tons/week)	Estimated waste collected per day (tons/day)
Compactor trucks – 5 tons	5	-Monday to Saturday: 3 times -Sunday: 2 times	5	500	71
Compactor trucks – 11 tons	2	-1 time every day	11	154	22
Trucks for market – 4 tons	1	-Monday to Saturday: 3 times -Sunday: 2 times	3	60	9
Total				714	102

Leap Lim: waste collector and MRF operator

Leap Lim was selected through a bidding process in 2015 to provide services of waste collection in two sangkats and other environmental cleanliness activities throughout the town. Since then, the contract has been renewed yearly and is expected to continue through 2020. Furthermore, the municipality has asked Leap Lim to run the MRF near the landfill, though the duties are not formally outlined in the agreement. The detailed activities, as agreed upon with the municipality, include waste collection with trucks in two communes, waste collection with bicycles in 14 specified areas of all communes, cleanup and collection in ten public areas, tree trimming and grass cutting in three public areas, education and awareness raising activities (including the purchase of 200 bins of different sizes and over 2,000 large plastic bags, presumably for public use and special events), and some minor wastewater activities. The municipality provided 581 million riels (about USD 145,000) to Leap Lim for these services in 2018 and 575 million riels (about USD 143,000) in 2019. This corresponds with the amount reported to be provided by MEF to the municipality (USD 140,000).

A map of Leap Lim's and CINTRI's service areas and frequency of collection is shown in figure 17.

The ADB MRF feasibility study estimated that 10 tons of waste per day is collected[33] by Leap Lim, though the owner estimates that only around 4 tons per day are taken to the landfill. However, based on the sizes and number of trucks collecting waste, as reported by Leap Lim, it is estimated that only around 2 tons of waste are collected each day as shown in table 5.

In addition, Leap Lim is providing waste collection services in two districts that are outside of the responsibility of the municipality.

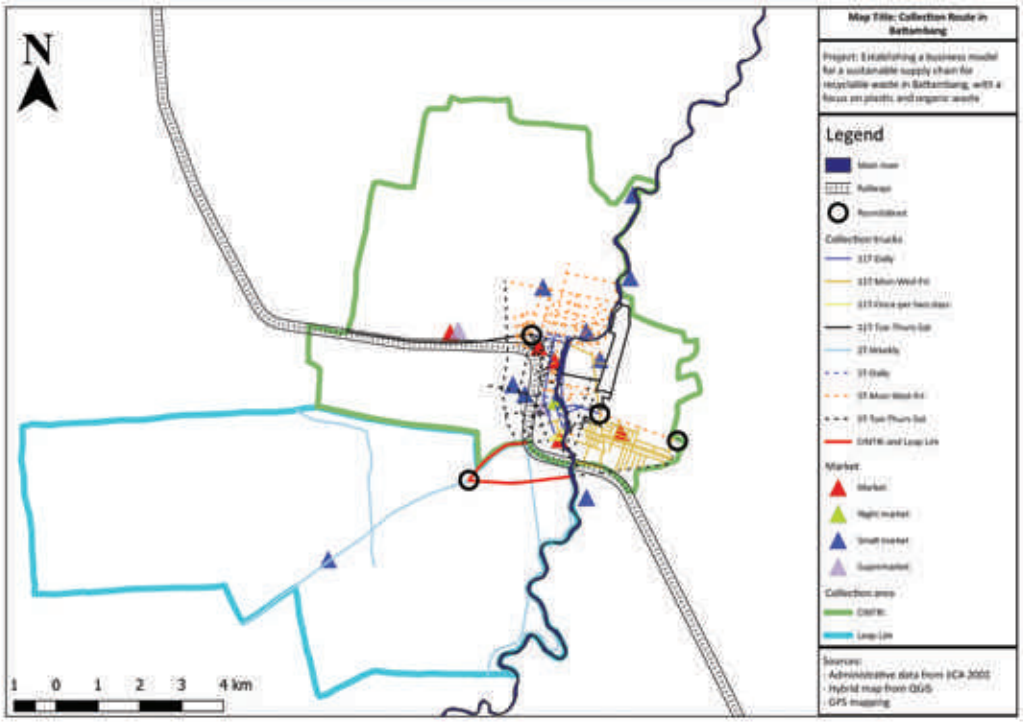
[32] Estimated by interview with et chay at landfill on the number of trucks reaching the landfill each day.

[33] SCE/Gret/Group Huit, ADB Tonle Sap Basin Feasibility Study (March 2018), 160.

Table 5: Estimated waste amount collected by Leap Lim

Size of trucks (m^3)	Waste density (tons/m^3)	Frequency and Schedule	Waste amount from number of trucks per week	Estimated waste collected (tons/week)	Estimated waste collected (tons/day)
6	0.3	Once per week (Sundays, Mondays, and Tuesdays)	7	12.6	2

Figure 17: Map of CINTRI and Leap Lim's services



Notes:

- Size of the trucks of CINTRI: a solid line refers to an 11T truck and a dotted line refers to a 5T truck
- Schedule for CINTRI collection: Blue for daily; orange for Monday, Wednesday, and Friday; yellow for once per two days; and black for Tuesday, Thursday, and Saturday.
- Red lines represent an overlap between CINTRI and Leap Lim

Private market waste collectors

Boeung Chhouk Market has its own private waste collection service that operates three times per day (around 5 am, 2 pm, and 5 pm) as established under the IGES project. They have two open 3-ton trucks and around 12 staff members dedicated to this service. The market still pays CINTRI for landfill services, which is around USD 200 per month as confirmed by CINTRI. The manager stressed that this service collects a total of 10 tons per day, which is higher than the amount of waste estimated to be generated at the market.

Table 6: Estimated waste amount collected by Boeung Chhouk Market

Size of trucks (tons)	Estimated waste amount per truck (tons)	Waste amount based on number of trucks per day	Estimated waste amount collected (tons/day)
3	2	5	10

Informal collection: the et chay

The informal collection sector has a very active collection stream for recyclables in Cambodia, collecting around 10–15% of the waste generated in Battambang city. The flow of the informal collection activities is shown in figure 18; this section focuses on the collectors, rather than the junk shops, as they provide a door-to-door collection service.

Figure 18: Flow of informal collection

The number of individuals for each type of informal collector is not commonly known. By gathering information from various stakeholders, it was assumed that there were around 50 to 60 waste pickers at the landfill (50% were women and 30% were children from around 8 to 12 years old) and around 150 to 200 waste pickers in the town (though there may be more). Through interviews, it is estimated that both types spend 6 to 8 hours per day working and earn around USD 30 to USD 50 per week, which is comparable to the minimum wage in the garment industry, of USD 182 per month in 2019.

Regarding junk shops, there are around 20 small/medium-sized junk shops and two big junk shops in the Battambang area. Normally, small/medium-sized junk shops have a profit margin of 10 to 15%.

Aside from the landfill, et chay collectors are frequently scattered and difficult to located. However, there are two noticeable locations where informal collectors have agglomerated, which are shown in figure 19. The first is nearby Battambang Provincial Referral Hospital in Preak Moha Tep village, which is also close to a small junk shop, and the second is along the Sangkae River near Dragon Peace.

It is estimated that the amount of waste collected by the informal sector in Battambang through the junk shops accumulates to 17 tons per day (refer to table 7). Overall, the situation seems to be better for the et chay in town. There are better working conditions and a higher quality of waste, which yields a higher price. In contrast, the et chay at the landfill have second choice for recyclable materials. However, this causes them to focus on plastic bags since households and/or the et chay in the city cannot or do not want to handle them.

It is estimated that 2 to 2.5 tons are sourced from informal pickers at the landfill, 5 to 7 tons from informal pickers in the town (though this could be up to 10 tons or more), and the rest is presumably directly from households, industry, or outside of the municipality.

Figure 19: Some locations of informal collectors in Battambang Municipality

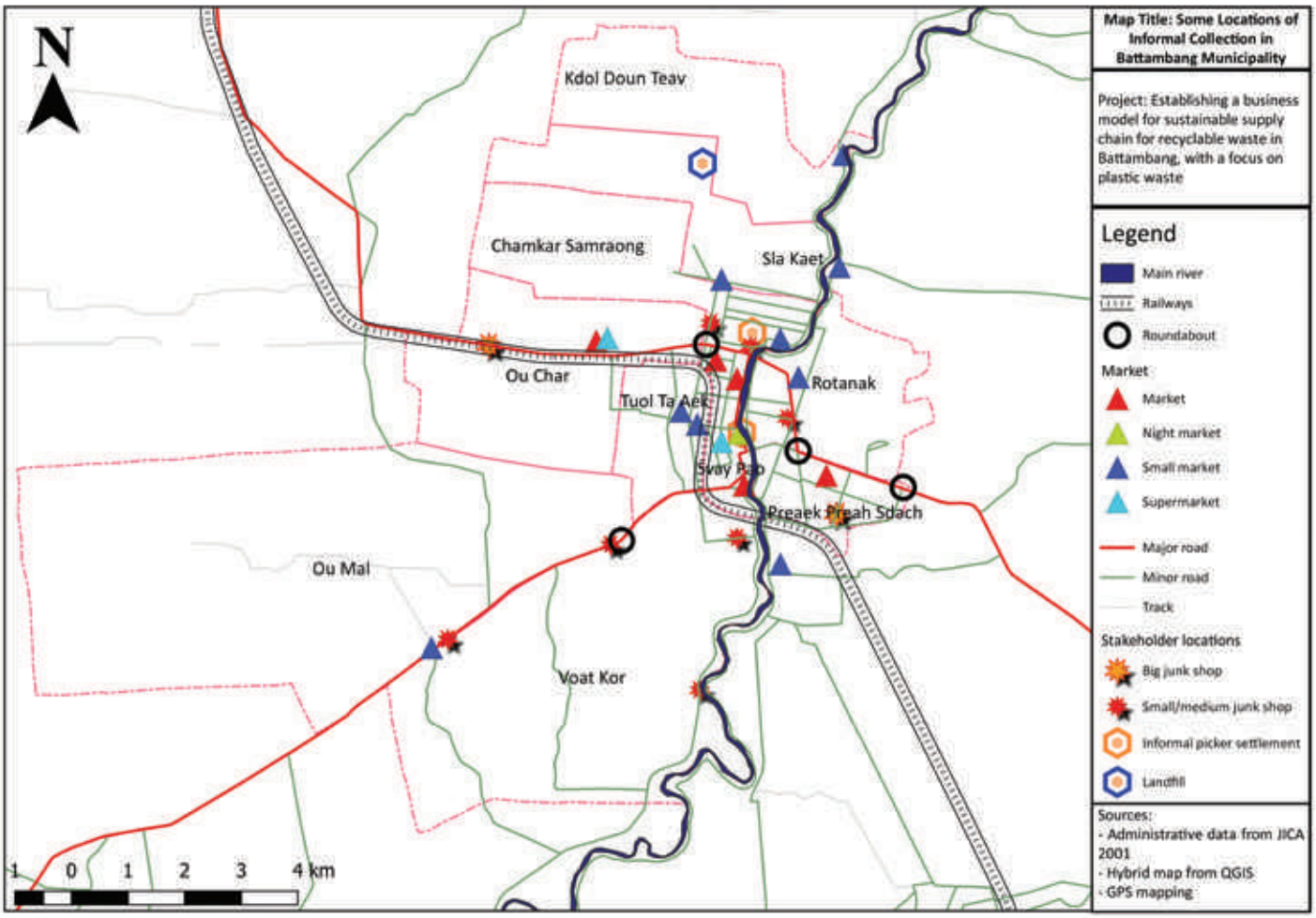


Table 7 shows the type of waste, price, and amount collected by the respective levels of informal collection. Prices are subject to fluctuation.

Table 7: Prices and amounts of recyclables paid by collectors to small/medium-sized junk shops

Recyclable waste	Price[34] ($/kg)	Waste collected per informal picker at landfill (kg/day)	Waste collected per informal picker in town (kg/day)	Waste collected per junk shop (kg/day)
Aluminum cans	1.00	0.9	0.9	82.5
Aluminum debris	0.63	0.4	0.7	10.5
PET, such as drinking water bottles	0.25	5.1	6.4	107.5
Mixed plastic (HDPE, PP, and LDPE)	0.20	6.9	4.2	70.0
PVC	0.05	0.0	0.0	20.0
Plastic bags	0.08	12.4	0.0	0.0
Steel1 (harder)	0.20	1.8	2.4	135.0
Steel2 (softer)	0.15	1.6	1.8	70.0
Zinc, such as milk cans	0.10	4.2	2.6	82.5
Glass	0.06	3.7	3.0	10.0
Paper-cardboard	0.08	3.1	12.1	260.0
Copper	4.13	0.1	0.1	2.0
Average waste collected per individual per day		40	34	850
Estimated number of collectors		50 to 60	150 to 200	20 (small/medium)
Total waste collected per day		Around 2 to 2.5 tons	Around 5 to 7 tons	Around 17 tons

Remarkably, junk shops do not buy and sell plastic bags, which are only collected by informal waste pickers at the landfill for several reasons:

[34] This price is paid by small/medium-sized junk shops to collectors for the goods. The price paid by et chay collectors to households is about 10% lower. When small/medium-sized junk shops sell to large junk shops, the price is raised 10–15%. It is unknown what the export rates are.

- Some informal pickers in the town do not know that plastic bags are purchased by BPP for recycling.

- Some are aware of the ability to sell plastic bags, but they are not willing to collect them because the price is low (only 300 to 500 riels/kg) and it takes time and space to collect and store them.

Overall, the solid waste sector should further enable high-value segregated materials to be collected by informal waste pickers, instead of CINTRI or Leap Lim, as they provide door-to-door services where they pay for the high-value recyclable waste. Waste separation will enable more recyclables to be recovered as they become more obvious; consequently, the communication campaign should highlight the recovery of recyclables to the et chay and organic waste for COMPED. Furthermore, a system for allowing the et chay to collect recyclables (instead of pilfering through mixed waste and creating a mess) should be established.

It should be noted that involving the et chay is not easy, as they have no central organization and are disbursed throughout the city. Yet there is a need to address health and hygiene, waste separation, and public cleanliness, among others, as well as understand their challenges and opportunities. An opportunity was presented during the stakeholder consultation workshop when the sangkat chiefs agreed to coordinate with the et chay. They should, therefore, be considered as a key point for improved interaction.

2.4.4 Recycling and Disposal

Battambang Plastics Products:[35] plastic recycler

BPP (also called Recycling Plastic) is three years old and creates plastic pellets for recycling from plastic bags only. BPP picks up plastic bags from the et chay at Battambang and Siem Reap landfills, although the preferred source is Siem Reap because the bags are larger. Others deliver directly to BPP, including the general population and a junk shop in Banteay Meanchey. BPP pays between 200 and 800 riels per kilogram, depending on cleanliness and whether or not they are delivered (detailed further in figure 20).

The production capacity would be 1.8 tons per day (about 45 tons per month) if the plant were operated 24 hours, but it is currently only processing about 25–30 tons per month. The minimum salary is USD 150 per month for 35 staff members; one challenge is that some positions have a high turnover (such as the position that requires cutting the plastic bag handles) but others do not.

Though the list of equipment for BBP has not yet been finalized during this study, UNIDO plans to upgrade BPP's system to 4 to 5 tons per day (100–125 tons per month) by providing:

- A grinding machine and accessories
- A washing machine (two/three stages, including friction washing) and accessories
- A drying machine and accessories
- A granulating (pelletizing) line

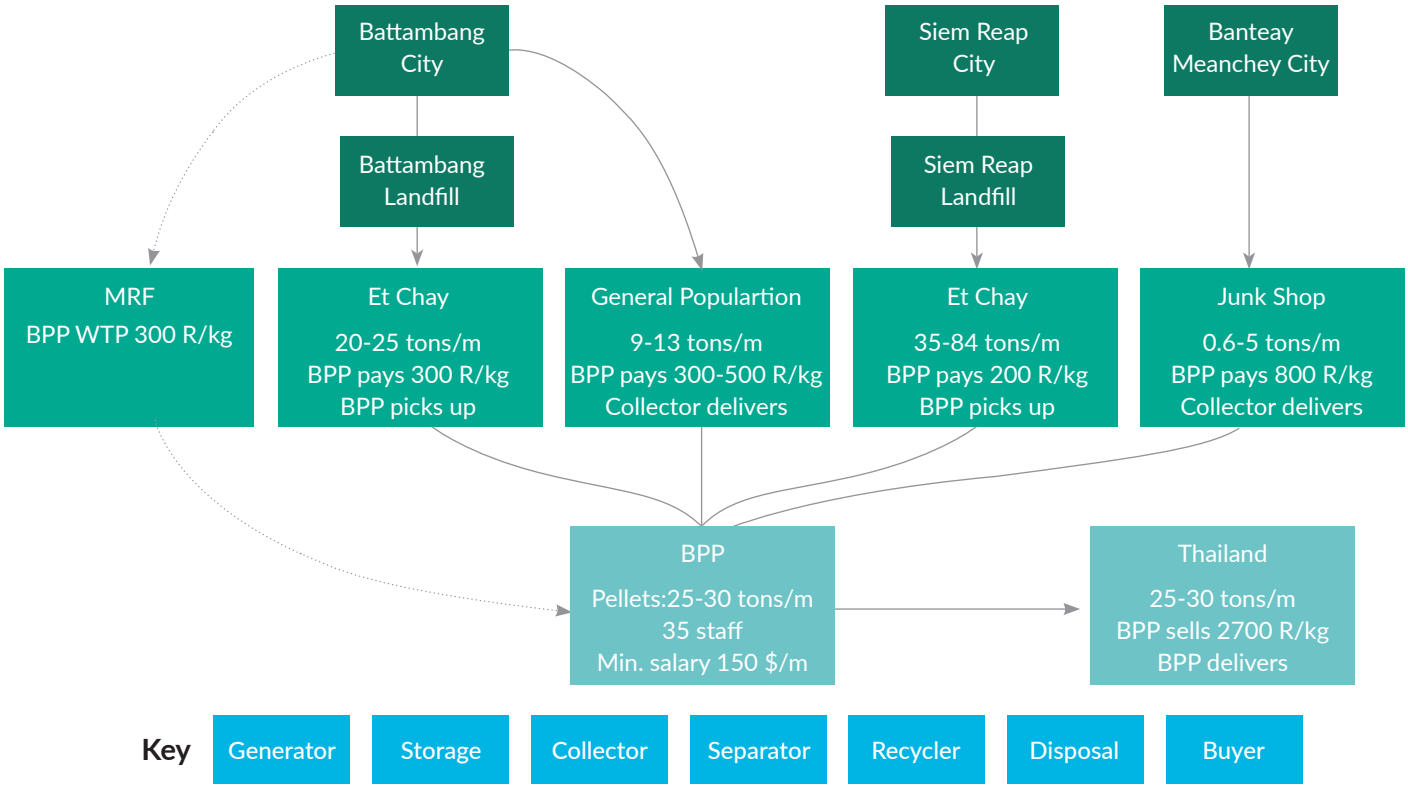
At the time of writing, BPP was selling their pellets to Thailand. As a lump sum to cover transportation, border fees, labor, and import taxes, BPP commonly spends 26,100 baht (around USD 830) to export 12.5 tons of plastic pellets. It is presumed that the upgrades to be provided by UNIDO will improve the overall quality of the pellets, enabling access to this producer and cutting out the foreign middlemen.

BPP reopened in August 2019 under the new name "Recycling Plastic" in Tapuong village, Tameourn Commune, in Banteay Meanchey Province. They upgraded their production line and are now also manufacturing heavy-duty plastic bags as well as exporting pellets to Thailand. While, in theory, they will be able to accept other types of plastics following the UNIDO upgrade, they are keen to maintain their focus on soft plastic bags—in particular, the industrial type.

BPP is filling the niche in the market (there are no competitors in the area), which allows some control over the prices. The company also said that they do not want to compete and disrupt the supply chain involving the et chay and junk shops, nor do they have the cash flow to pay the higher prices for HDPE and LDPE. The process of recycling HDPE is the same as LDPE but requires higher temperatures. It is possible to mix the two during the recycling process.

[35] The company generally known as Battambang Plastic Products (BPP) is officially registered as "Plastic Processing Handicraft."

Figure 20: BPP's current supply chain



COMPED: Composting facility

COMPED is an NGO that runs a composting facility next to the existing landfill on land (one hectare) that was provided by the municipality. Currently, COMPED receives about four to six tons of mixed waste per day, collected by CINTRI from Pou Puy Market, a wholesale market in the central part of the city. This waste is separated by COMPED onsite, resulting in about two and half tons of useful organic waste (approximately 50%). However, much of the waste that comes directly from the vendors (inside the market) is less mixed (see figure 21); therefore, it is clear that the waste is becoming mixed during market cleaning and waste collection. Because of this, COMPED must hire staff to sort the waste brought in by CINTRI, which increases production costs and decreases the price competitiveness of the compost. Mixed waste can also endanger the quality of the final product—organic material may be polluted by chemical waste during transportation.

Figure 21: Example of waste in Pou Puy Market

COMPED reports that the composting operation currently does not generate profit and is sustained by other revenue from the organization's consulting activities.

Occasionally, Leap Lim also delivers up to 10 tons per month of carbon-rich organic waste (tree clippings, part of which are sold as firewood); however, COMPED has no means for cutting this waste into smaller pieces, which is necessary to obtain a certain carbon-to-nitrogen ratio. The challenge is that there is competition for these materials (cement and brick factories and household use, such as materials for burning).

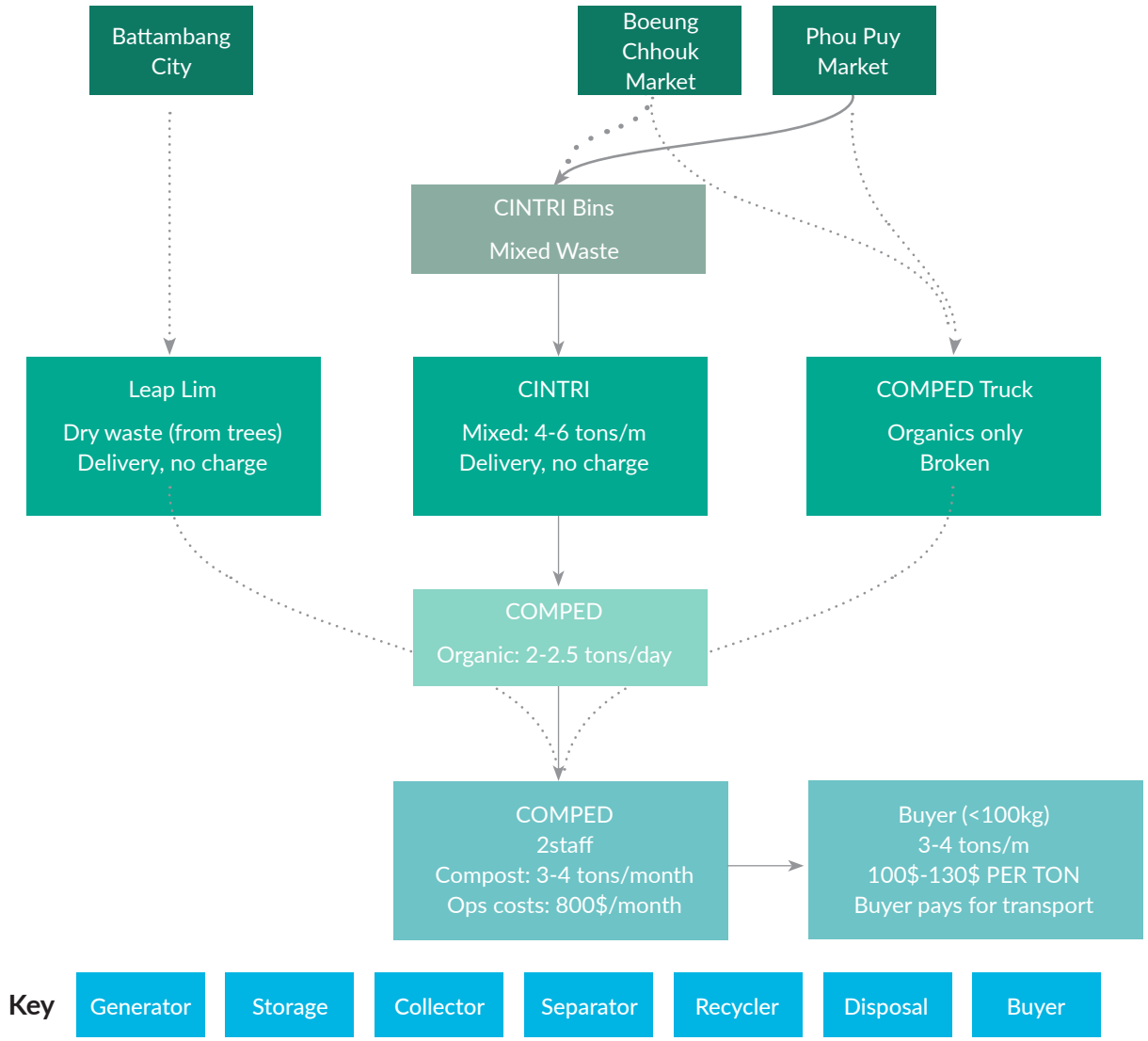
The maximum capacity is estimated to be an intake of approximately 8–10 tons of organic waste per day. The current roof/concrete area for composting is about 400–500 square meters, but the piles are currently too high, there is not enough staff to increase operations, and increasing the turning of the piles is too expensive. To improve operations and output, UNIDO plans to provide the following equipment:

A small-scale manually fed shredder for larger, carbon-rich waste, such as coconut shells or tree clippings.
A turning machine to turn the compost piles more efficiently.
A screener.

Increased covered area to an estimated 600 m^2 (currently in the tendering phase).

It is estimated that with the upgrades, the capacity could be increased to receive 10–12 tons per day by late 2019.

Figure 22: COMPED's current supply chain



MRF

Construction of the materials recovery facility (MRF) was finalized in October 2018. It is designed to take eight tons per day; however, the operations are limited as observed multiple times from December 2018 through June 2019. Leap Lim brings waste about once per week for separation and hires the et chay at the landfill nearby to pick through the waste. Only two individuals are currently fully employed at the facility, though the *et chay* are hired in exchange for collection of the recyclable waste and plastic bags (200 riels per kg). Other individuals are hired occasionally, although they report making more money from informal collection at the landfill; therefore, it is a less desirable job. Under the ADB MRF project, the staff will receive training in both management and separation.

Overall, for the MRF to function, there is a need for better coordination between CINTRI, Leap Lim, and the *et chay*. The local authorities must carefully initiate and organize collaboration between CINTRI and Leap Lim to improve collection services, better the functioning of the MRF, and ensure interaction with stakeholders (including the *et chay*). If they do not, the quantity of input for the MRF could still be limited to Leap Lim's collection capacity, and the overall solid waste management sector could suffer.

It seems likely that the MRF can only sustainably operate (from a financial point of view) if it receives additional income for the treatment service (price per ton, for example). If not, the income only coming from recyclable materials will not be sufficient to cover the operational costs. Currently, the most valuable materials are collected by the *et chay* directly from the producer in the city (with no need to sort the domestic waste), and it is important to maintain this valuable door-to-door service. Therefore, the MRF will only receive less valuable materials.

Landfill

The current landfill is operated by CINTRI as an open dump with no environmental controls. It has been in operation for around 15 years and is located four kilometers north of the city. Estimates indicate that it will reach capacity between 2020 and 2025. Waste is not compacted or covered in soil, and 80% of waste is believed to be burned onsite,[36] which causes a public health concern. The site has no operational or management plan and is difficult to access during the rainy season as roads are unpaved. This means that the waste is dumped on the access roads during the peak of the rainy season and cleared at the start of the dry season.

The land is partially owned by CINTRI (six hectares) and partially by the municipality (one hectare). According to the contract with the municipality, CINTRI is supposed to hand over the landfill to the municipality once full.

Leap Lim has also recently opened a new landfill, operated as an open dump, as an alternative to the CINTRI landfill. It is located in O Muni Pir village, Anlong Vil commune, in Battambang province.

The ADB Tonle Sap project has proposed that the new landfill site be located about 21 kilometers south of the city. The closing of the existing landfill could have a significant impact on the MRF, the et chay, and COMPED. At that time, no additional waste will be brought by the formal solid waste management to this location; therefore, COMPED, the MRF, and the et chay must prepare for this potential impact. However, it is also likely that because the MRF and COMPED are only five kilometers away, as opposed to 21, there will be a financial advantage for CINTRI to bring the waste to this location.

2.5. Lessons Learned from International Waste Projects

Solid waste management strategies in four cities that have been internationally recognized for improved waste management were reviewed to understand the lessons learned, for implementation in Battambang city.

Phitsanulok, Thailand[37, 38]

Phitsanulok uses a community-based approach with a heavy focus on training to educate municipal staff, markets, communities, schools, and hotels on waste and climate change. Community-based environmental protection volunteers are trained to build awareness and can

[36] SCE/Gret/Group Huit, ADB Tonle Sap Basin Feasibility Study (March 2018), 163.

[37] Climate and Clean Air Coalition Municipal Solid Waste Initiative, Solid Waste Management City Profile: Phitsanulok Municipality, Thailand (2014).

[38] Sarintip Tantanee and Suthi Hantrakul, Municipal Waste Management Challenges of Urbanization: Lesson Learned from Phitsanulok, Thailand (January 2019).

be promoted to a training-of-trainers program. There are several phases of public awareness events, including campaigns, workshops, and door-to-door activities. Specific topics of training include recyclable materials and their prices, use of household bins, composting, formal collection fees and services, and the polluter-pays principle.

The very active informal sector does not receive direct incentives from the government but instead is supported by training, waste banks, and recognition as important actors for environmental protection.

For city-level inputs, the municipality typically issues a "request for cooperation" for enforcement, rather than fines, but can issue fines as well. The city is also continually expanding and diversifying solid waste management treatment facilities to accommodate the waste streams. From 1999, the city received support for seven years from the German government to develop and implement the improved solid waste management program.

As of 2013, nearly 20% of the city's waste was being diverted, mainly by the informal sector. The following are highlighted as critical points leading to success:

- A comprehensive, community-based system that has appointed volunteers with specific roles and detailed training/awareness raising in many phases
- An active informal sector that is promoted but not directly incentivized
- Enforcement without fines
- Long-term technical assistance to develop a comprehensive solid waste management plan
- Strong involvement of local authorities
- A long-term awareness raising and communication campaign

Surabaya, Indonesia[39]

Surabaya focuses on a community empowerment-based approach by supporting socialization/counseling campaigns focused on the 3Rs, the establishment of facilitators, and cooperation between residents and environmental NGOs. It also distributes bins, composting containers, and trash carts for free and has diversified treatment facilities, including waste banks and composting facilities. For awareness, each province in Indonesia selects a Sanitation Ambassador every year, and the city holds competitions where communities are judged by their cleanliness and how many trees are planted. All actors (public, private, and non-profit) collaborate in awareness campaigns, and the government hires full-time staff to ensure the programs run.

Nearly one sixth of the city's waste has been diverted with improved solid waste management. It was determined that the keys to success are the following:

- The competition provides cash incentives and has created pride in the communities.
- A bottom-up meets top-down approach showed that waste reduction and separation can be achieved and sustained across the city with support of all actors.
- Capacity building for all stakeholders has proven to benefit the sector as a whole.

La Pintana, Chile[40]

In La Pintana, vegetable waste makes up the largest waste stream (55%); therefore, the city decided to focus on organic waste and composting. The government spent time and resources on identifying the relevant actors and planning, which resulted in targeting market waste separation and the provision of bins for households to separate vegetable waste, with the two waste streams being collected on alternating days. The government also has ongoing door-to-door campaigns to raise awareness, which are done by hired individuals with a background in environment. The composting facility (of which about one third is vermiculture) was gradually expanded with phases of funding. It is also strategically located closer to the city than the landfill, saving the collection company costs by diverting waste that would otherwise be going to the landfill. Citizens receive incentives in the form

[39] IGES and UNEP, Planning and Implementation of Integrated Solid Waste Management Strategies at Local Level: The Case of Surabaya City (May 2017).
[40] Cecilia Allen, La Pintana, Chile: Prioritizing the Recovery of Vegetable Waste (June 2012).

of free compost and improved public facilities, such as parks and maintenance of sports clubs, among others. It is estimated that only 28% of households separate their waste, despite the city having conducted campaigns that reached the majority of them—the city addresses this with ongoing campaigns.

Of the environmental and waste management budget, 40% is spent on municipal waste collection (including public services and cleaning in markets), 36% on MSW disposal, 2% on education, 1% on compost facility operations and maintenance, and 17% on other environmental programs (clean commune program, protective equipment, etc.).

An estimated 20% of the total city's waste is composted. The reasons for success are as follows:

- Focusing on one waste recovery stream, which is also the largest.
- Ongoing education programs with public incentives for households.
- Targeting organic waste from markets and supporting market cleaning costs.
- Dedicating ongoing costs for education and environmental programs.
- MSW disposal is a significant cost for the municipality; therefore, the municipality is willing to support composting to reduce costs.

Mumbai, India[41, 42]

Mumbai has a thriving informal waste sector. Since the city is so large, widespread planning is too complicated; consequently, a decentralized approach allows for flexibility and customization. Each ward is responsible for its own waste collection, with communal collection points and door-to-door collection. The informal sector, which India has been moving toward formalizing for some time, collects and treats the waste, earning income from collection fees and the sale of recyclables. A local NGO provides training programs for the informal sector—including contract negotiation, composting, cooperative organization, and sorting and handling waste—and cooperatives organize contracts for collection services. Biogas is the preferred composting technology, as it can be applied at very localized levels with a smaller available area and does not smell.

Though implementation of the decentralized approach takes longer, the municipality benefits by saving money form the waste diversion. Key points related to this program's success are:

- Strong support, promotion, and organization of the informal sector.
- Allowing the wards within the city to implement what works best for them.
- Setting up community collection points and fees for collection services.

[41] Virali Gokaldas, Mumbai, India: Waste Picker-Run Biogas Plants as a Decentralized Solution (June 2012).

[42] Sarintip Tantanee and Suthi Hantrakul, Municipal Waste Management Challenges of Urbanization: Lesson Learned from Phitsanulok, Thailand (January 2019).

Lessons Learned

Overall, there were several key lessons learned and certain innovative strategies that could be useful for implementation in Battambang city, which are outlined in the figure below.

Keys to success:

- Long-term technical assistance.
- Long term awareness raising and communication campaign.
- Strong involvement of local authorities.
- Long-term training and implementation programs.
- Expansion and diversification of treatment facilities.
- Decentralized or community-based approach.
- Cooperation across all actors for public awareness.
- Thriving informal sector that is promoted and trained.

Potential strategies:

- Fines are rare; instead "requests for cooperation" are issued.
- Provincial Sanitation Ambassador/ community environmental protection volunteers selected to increase awareness.
- Clean Community Competition based on planted trees and cleanliness.

2.6. SWOT Analysis and recommendations

The previous components of “Section 2: Desk Review and Data Collection” provided an overview of the laws and regulations and an understanding of the solid waste management sector (from management and generation through recycling and disposal) in Battambang city. It also highlighted other projects targeting the sector and success stories from different cities worldwide. The following analysis highlights strengths, weaknesses, opportunities, and threats leading to recommendations for improvements to the solid waste management sector.

Strengths	Weaknesses	Opportunities	Threats
• There are several existing policies that define the management and implementation of solid waste management activities. • Sub-Decree 113 specifically outlines fines for noncompliance, based on type of activity (including burning and littering). • The municipality is currently supporting public services in various ways.	• There is a lack of coordination among the many stakeholders who are implementing waste management initiatives. • There is little involvement of sangkats and villages in solid waste. • The noncompliance law is not enforced. • There is no monitoring of solid waste management activities.	• The municipality has a budget of about USD 143,000 annually dedicated to solid waste management and wastewater activities. • Sub-Decree 113 gives the municipality the right to delegate to the communes. • The communes are enthusiastic about participation in waste management. • Monitoring applications exists but needs updates. • Enforcement with warnings has been successful in other countries.	• There is no clear enforcement plan within Sub-Decree 113: who should collect, who should fine, how to manage the revenue, etc. • MEF does not recognize municipal contracts, which makes it difficult to enforce them. • There may be no improvement in the sector without technical assistance. • Unplanned and unpublicized enforcement could increase open dumping or burning.

2.6.1 Governance

There is a solid foundation of policies and delegation of authority to entities for management of solid waste management services in Battambang, which are enabling the sector to function in its current state; however, the following recommendations would improve the governance of solid waste management services based on the SWOT analysis on governance above.

There is a need for sector coordination, particularly related to the involvement of the sangkats. The law clearly allows for delegation, and willingness is strong from the sangkats and other related stakeholders to better coordinate, but stronger reasoning for doing so is necessary. The following are recommended to improve this:

- Quarterly meetings are needed to foster coordination and dialogue. They should be hosted by the municipality.
- Appointed sangkat representatives dedicated to solid waste management will facilitate better implementation throughout the city. They must have a clear scope of work that is agreed upon and recognized by the municipality.
- Social media is popular in Cambodia, especially Facebook and Telegram; these resources are free and should be used to increase publicity and coordination.
- The municipality should make an effort to support solid waste management events organized by other stakeholders, as it increases the public trust and involvement.
- The municipality should dedicate a staff member to manage the points listed above.

Monitoring and enforcement of noncompliance activities are nonexistent. The laws outline noncompliance activities and fines, but the mechanism, management, and means are not clearly identified. The following are recommended to improve this:

- The municipality should set up a monitoring team to oversee the service providers (CINTRI, Leap Lim, and other stakeholders involved in the solid waste management sector).
- An enforcement plan is a necessary component of solid waste management; however, due to a lack of clarity regarding roles and responsibilities, it is recommended to be done in stages with a warning system. In particular, the example from Phitsanulok, Thailand has shown that entities are responsive to "requests for cooperation"—a sort of warning system that rarely leads to fines.
- To allow for improved enforcement, it is also necessary to establish useful indicators for monitoring. Ideally, these indicators are agreed upon nationally, but pilots can be implemented in Battambang.
- Tools are necessary to optimize monitoring, through apps such as GoGreen Cambodia. Furthermore, there is a potential need for an application that can be privately used by government entities for monitoring purposes.
- The PDoE should appoint one staff member for implementation and monitoring services.

2.6.2 Storage and Separation

Some support is provided for public bins and awareness raising, but, overall, it is limited and not well planned. The SWOT analysis above on storage and separation led to the following recommendations.

Strengths	Weaknesses	Opportunities	Threats
• The municipality subsizides some public bins. • Segregation activities already exist, as the informal sector provides door-to-door services for the recovery of recyclables. • Campaigns have achieved limited success with organic waste separation in the past.	• Large storage bins are lacking at markets and unserved areas. • There is a lack of arrangement to facilitate use of dumpsters. • Awareness of waste issues is relatively high, yet people choose not to improve their habits. • Past campaigns have been too short and left out important stakeholders, such as market managers. • Many components of waste management (e.g, knowledge of the laws and an understanding of recycling activities) are not well understood by the public.	• There is public funding available for solid waste management activities. • Improved marketing and training activities (including training of trainers) has proved successful elsewhere. • Most markets and large businesses are located in the central sangkat, Svay Pao, making it ideal for the starting activities. • The city (especially markets) generates a significant amount of organic waste, and there is an existing composting facility ready to receive it.	• Increasing public dumpsters could decrease payment for formal collection services. • Leaving key stakeholders (such as market cleaners) out of the planning and training processes causes a gap in knowledge and commitment. • Providing poorly planned tools, information, and services to generators leads to poor separation habits. • Lack of formal agreements could lead to failures in parts of the value chain.

There is a need for a planned increase in public storage bins and dumpsters. With the integration of sangkat solid waste management representatives, identifying locations for bins can be made easier, as can the recovery of collection fees.

- Public dumpsters are needed in areas of the sangkats that are not well served. To mitigate the threat of nonpayment for collection services, the municipality should authorize sangkat solid waste management representatives to collect monthly fees to be paid to CINTRI, especially where public bins are located.
- Waste separation is minimal, aside from the thriving informal recycling sector. To increase waste separation habits, separate bins and dumpsters should be provided and/or indicated.
- It is important that stakeholders—such as market managers, cleaners, collectors, and sangkat representatives—provide input on bin and dumpster locations to ensure they meet their needs.

Education and awareness raising needs to be a long-term effort with improved tools. Several awareness raising campaigns have been implemented in the past, yet even if waste separation was achieved, it only lasted for a short time.

- Campaigns should be implemented over a longer term, rather than just a few days. It is recommended that they last 60 days, with a series of events and training activities. These campaigns should also include waste minimization messages, particularly in markets and schools (bringing reusable bags and containers, etc.).
- Training-of-trainers events increase the knowledge base and therefore the amount of information disseminated. Sangkat representatives, municipality and PDoE staff, volunteers, and market managers, among others, are ideal candidates to become trainers and should thus receive certification.
- Implementation activities must be targeted at generators, cleaners, and collectors because they are the weakest points in the system. In particular, this includes market cleaners, market vendors, businesses, staff of CINTRI and Leap Lim, and households.
- General knowledge on important topics could be improved. The campaigns should include a broad array of topics, such as enforcement laws, recycling facilities, the importance of the et chay, and other recycling facilities.
- Marketing efforts in the past have been limited in both the implementation duration and instilling a sense of responsibility. Accordingly, marketing materials and efforts could be greatly improved.

Implementation of storage and awareness raising should be in planned phases, targeting a specific waste stream. With so many generators across the city, implementing a storage increase and awareness raising can be done in more manageable parts, focusing on the most recoverable waste stream. The following is recommended:

- Markets are the largest generators in the city and produce a significant portion of organic waste. It is recommended that the largest ones are targeted first and specifically for recovering organic waste for the composting facility.
- With the central sangkat having a high population and a large number of businesses, it should be the next highest priority.

2.6.3 Collection

While the formal and informal collection sectors are quite active and the authorities are indeed providing support, there is a lack of coordination, training, and public involvement. The SWOT analysis above on collection led to the following recommendations.

Strengths	Weaknesses	Opportunities	Threats
• The formal collection operators are recovering a significant portion of the city's waste. • Public areas are maintained with a public subsidy. • The informal sector is the second largest collector, very active, and primarily recovering recyclables.	• Formal collection services are not consistent and not well advertised. • Many generators have a poor view of the formal collection services. • Many generators are not paying waste collection fees. • Formal collectors spend too much time picking up scattered market waste that is not in bins.	• There is public funding available for solid waste activities. • The public authority has the right to collect solid waste management fees. • The informal collection network is strong, and examples in other countries have shown that engaging them can lead to greater waste recovery efforts.	• Failure to recognize and incorporate all waste collectors as part of the solid waste management value chain leads to lower waste recovery. • Poor coordination and agreements with formal collectors, when making changes to collection activities, threatens the sustainability of those services. • Door-to-door segregation is often limited in success.

The most efficient way to support door-to-door waste segregation is to promote and further enable the active informal collection sector. As 80% of the street and landfill collectors are women and children, the provision of training and tools will enable them to better perform their services in a safer manner. It is recommended that:

- Regular training events are undertaken to educate about health matters, formal collection services, and littering and enforcement laws, among others.
- Engagement is necessary to understand their challenges and find solutions to aid in a more organized and greater waste recovery.

Formal waste collectors should print and publicize their services and update them to reflect changes. Providing a clear schedule and consistent services can improve their public image and perhaps even the recovery of fees. In particular, the following is recommended:

- Print schedules on monthly invoices and share with the municipality for further publication on social media.
- It is understood that formal collectors have already agreed to collect separated waste. As services are further negotiated, the service schedules should be updated to reflect the agreements (which should also be formalized).
- A discussion should be opened on whether sangkat representatives can collect and pay collection fees on behalf of underserved areas.

2.6.4 Recycling and Disposal Facilities

The recycling and disposal facilities are assessed in further detail in "Section 4: Improvements to Recycling Businesses in Battambang"; however, the following points reinforce the recommendations provided previously in this discussion subsection. In particular, it is clear that there is a need for improved awareness among the et chay and generators, coordination between sector stakeholders, and improved waste separation. For long-term goals, the development of a new landfill with proper environmental standards is critical.

Strengths	Weaknesses	Opportunities	Threats
• BPP recovers plastic bags; a recycling service that the junk shops are not providing. • COMPED provides a composting service, which other cities in Cambodia are lacking.	• Few et chay, aside from those at the landfill, are collecting plastic bags for BPP. • Mixed waste is currently delivered to COMPED, causing higher operational costs. • The MRF is currently underused. • Operational costs are higher than the selling price for compost. • There is no mechanism or budget (at the local authority level) to (co)finance sorting and recovery activites.	• The general public and some et chay do not seem to know that plastic bags can be recycled. • Markets generate a significant portion of organic waste. • If the new landfill is moved 15 kilometers farther than the current one, it will create opportunities for collectors to save money by bringing them waste.	• A lack of coordination before the closure of the landfill could impact the operations of COMPED and MRF.

2.6.5 Campaign Area Selection

Regarding the selection of campaign (trial) areas of the sangkat for piloting awareness raising activities, it is important to present background and important indicators.

Previous pilot projects for separation, collection, and composting

Boeung Chhouk, Thmey (13 Makara), Nat/Thum (Central Market), and Phou Puy Markets previously collaborated with COMPED for the waste segregation, transport, and composting of organic waste.[43] CINTRI oversees organic waste collection and transport for COMPED. Results showed that the trials were successful for a short time, but eventually waste separation stopped, and although it seems no monitoring and evaluations were conducted, it is likely the trials failed to last because they were too short, there was not enough interaction between stakeholders (including local authorities), and financial incentives were lacking.

The first two issues are relatively easy to improve with dedicated efforts: the trial can be lengthened with added activities, and stakeholders can be involved from the beginning. This is one reason why agreements with market managers and formal collectors should be established

[43] IGES, Participatory Waste Management Approach for Climate Change Mitigation: The Case of Battambang City (June 2018).

before the implementation of any campaign, as their support and understanding is essential to success (particularly with collectors, as the remixing of waste during collection discourages separation at the source altogether).

Financial incentives, however, are more difficult to tackle without a clear funding source that is part of the existing system. Although one case study from the IGES project indicates the ability to negotiate savings, related to waste being diverted away from the landfill (which was achieved with Boeung Chhouk Market), it is more complicated for a larger number of beneficiaries. Therefore, it is likely more difficult and a longer process with CINTRI and is not recommended for immediate implementation but should be considered for long-term planning. A better alternative would be to promote competition, pride, and public recognition in the short term, as seen in Surabaya.

Furthermore, as generator and collector habits are difficult to change, long-term campaigns with phased implementation would be favorable, with a planned increase in bins and dumpsters as well as marketing, training, and awareness raising. Having a full-time staff to implement the activities ensures full interaction with the generators to increase awareness and answer questions.

Recommended target areas for campaigns

Carrying out the waste separation trial through a focus on organic waste recovery in two phases is recommended: first, at the five large local markets and, second, in the central sangkat of Svay Po. The reasons are as follows:

Local markets:

- High waste generation (up to 20% of the whole city's waste), most of which is organic.
- Existing solid waste management system, such as market cleaners, storage, and collection.
- Some households bring their waste to dump at markets but having relatively few monitoring points will improve monitoring and enforcement (and, perhaps, fee recovery).
- Many community members shop at the markets, thus the marketing campaign will have a very wide reach.
- Informal pickers from throughout the town come and collect recyclable waste, also creating a wider reach and a means to collaborate.

Sangkat Svay Po:

- It has the highest population and a large number of businesses.
- It has three of the five largest markets.
- It is the most visited place by both local and international tourists.
- It has agglomerated private and public institutions.
- Previous promotional campaigns on urban solid waste management were done mostly in this sangkat, especially along Roads No. 1, No. 2, and No. 3.

2.6.6 Broader Lessons On Country-Wide Implementation of Decentralized Waste Management

Issued on 27 August 2015, Sub-Decree 113 on the Management of Urban Garbage and Solid Waste establishes roles and responsibilities within all levels of the government, with the objective to decentralize waste management responsibilities to the local level. The sub-decree also outlines requirements for the separation, storage, cleaning, collecting, transporting, recycling of waste, and management of landfills. Requirements to pay fees and penalties for noncompliance with the law are outlined. Drawing on the analysis of the situation in Battambang, several broader lessons for the implementation of Sub-Decree 113 emerge.

Delegation to sangkat and commune levels

One of the key objectives of the sub-decree is to decentralize waste management responsibilities to the subnational level. This remains to be implemented fully. In the case of Battambang, the municipality has been given responsibilities for waste management; however, there is no further delegation to the sangkat/commune level, despite their appetite to be involved. Further delegation would be very effective for communicating information and conducting activities at the local level. Capacity building at the subnational level is also lacking, and, in general, there is a very low understanding of technical and policy issues, with little training provided.

Better targeted awareness raising

Educational campaigns have been achieving much progress; for example, those initiated by the Department of Environmental Education at MoE. However, these campaigns are short (usually one day) and have a limited impact. For the community to change long-term habits, campaigns should be implemented over a longer term, rather than just a few days. Ideally, 60 days is recommended, with a series of events and training activities. An option would be for the government to focus efforts on one city, working with the subnational level, and then conducting Monitoring & Evaluation (M&E) on the effectiveness of the campaign in order to replicate it in other cities.

The sub-decree is comprehensive and clear on requirements for managing waste (separation, packaging, storage, and disposal). However, it is generally not well communicated to waste generators (households, shops, restaurants, etc.). Most people do not know that separating recyclables and other garbage is a legal requirement or that waste must be packed properly. As part of the awareness raising campaigns, practical tools should be implemented, and waste minimization principles should also be incorporated. For example, apartment buildings and boreys should be required to have separate bins for either formal collection or access by the et chay. Residents must be educated on what wastes can be collected/sold to the et chay (for example, with leaflets and posters), and the work done by these informal collectors should be recognized. Another option would be to pack recyclables in transparent bags so that the et chay can view the contents easily, instead of opening every bag and spilling waste onto the ground.

Management plans, yearly action plans, and budgets

Budgets allocated to cities are generally low. Moreover, cities do not always use the budgets effectively. In the case of Battambang, USD 140,000 was given to one private operator with a loose contract and no reporting requirements. With these small budgets, better guidance on how to spend the money would ensure greater value for money. The central government and subnational levels should agree on a detailed budget plan with clear deliverables. Additionally, a list of priorities needs be established, followed by an action plan and a detailed budget for the chosen activities. Once the budget is allocated to the municipalities, transparent contracting, reporting, and monitoring should be required.

More precise contract requirements for private service providers

As most of the waste management tasks are outsourced to the private sector, municipalities should be more precise with their requirements and contracts. Output-based contracts, where private service providers can be held to account, are recommended. For example, municipalities should work with the private sector and in consultation with residents to establish and communicate collection schedules and itineraries. People will then know when the waste is being collected, which could also facilitate the collection of recyclables and improve the beauty of the cities. This would enable generators to comply with the sub-decree by storing their rubbish in their homes until collection day. The municipal authorities still face a degree of confusion relating to the extent to which MEF recognizes municipals to contract waste management service providers.

More competition and accountability from the private sector

More transparent and competitive contract allocation processes are recommended. Generally, only one private operator is responsible for waste collection in a city (two in Battambang). Enabling more competition within the waste collection services with output-based transparent and public contracts of a limited time (5–10 years) would improve services. Waste contractors should be monitored to ensure they collect waste in all areas contracted for. In the case of Battambang, entire areas, such as Ratanak commune, are not serviced at all. Setting the rubbish on fire to gain space at the landfills should be prohibited as directed in the sub-decree. This should be included in future contracts.

Consistent monitoring and fining of burning and littering

The sub-decree is clear on the requirements not to burn or dump rubbish (littering), and the environment and public health impacts of these activities are well known. Burning and dumping waste will always be cheaper than appropriate disposal and is often observed in rural areas with no collection systems. In urban areas, these practices are still widespread despite availability of services, and without education and government intervention, this will continue. Stronger monitoring, together with educating people on the possible threat of fines, can be effective (See enforcement plan in Section 3). Positive campaigns on the benefits of stopping these activities should be conducted.

In Battambang, many people dump their rubbish at the markets. There should be signage and presence to indicate that this is illegal and that fines could apply.

Even if fines are not issued, warnings that people could be fined or "requests for cooperation" can be effective if well communicated as people are currently not even aware of the possibility of being fined. Enforcement plans should be developed over time and in stages, starting with monitoring by PDoE staff and a warning system.

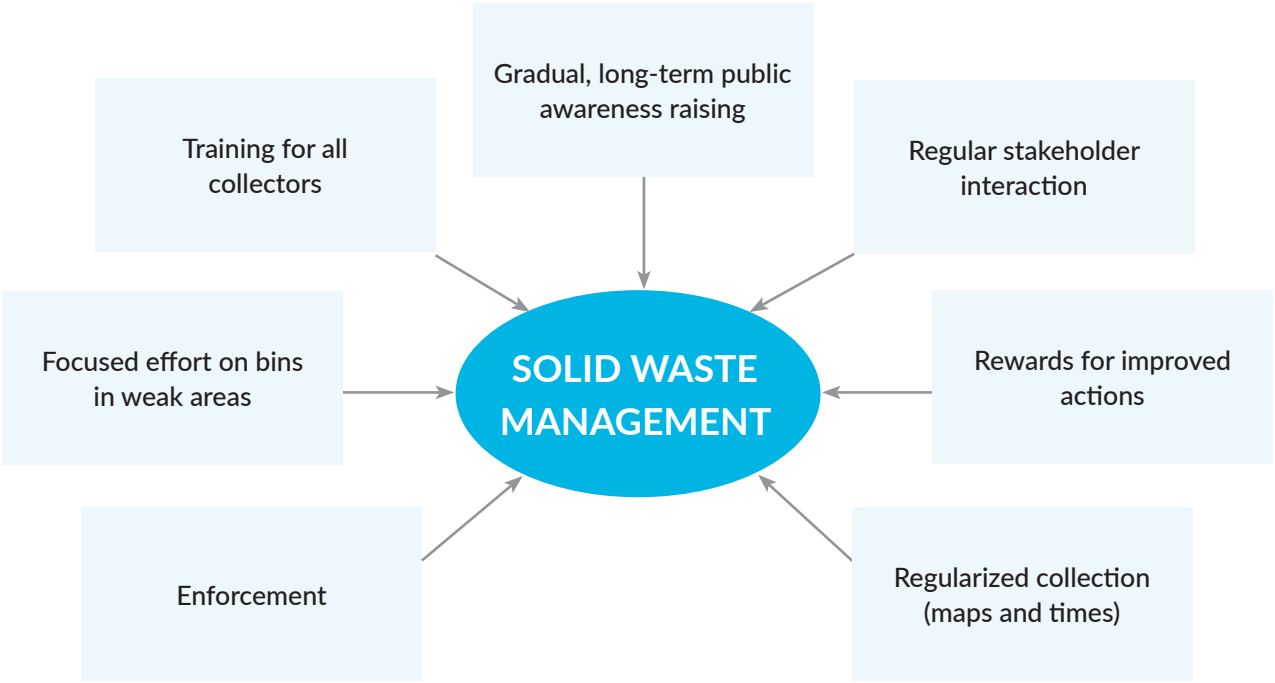
Fee payment

This is critical to the proper implementation of the sub-decree. As most of the waste management tasks are outsourced to the private sector, these businesses need to be financially viable. In Battambang, it is estimated that only about 25% of waste generators pay for waste management services. While there are many reasons for this (inability to pay, dissatisfaction with the services, etc.), it is difficult for the private operators to provide a good service if they are not being compensated. It should be noted that in Battambang, 88% of the population sells at least some items to the et chay. Each household earns, on average, USD 2 per month from those sales, which is within the range of allowed collection fees as outlined by the law. This effectively means that waste collection should be null for small households.

It would be more useful to have efficient mechanisms for collecting the fees. For example, fees could be collected by the municipalities or combined with electricity (like in Phnom Penh) or water bills and redistributed to the collection contractor according to the quality of their service. Certain money should also be allocated for the operation and maintenance of the landfill—not just for collection. Sangkats could also be responsible for collecting fees from households in areas served by public dumpsters.

2.6.7 Conclusion

Overall, there is a distinct lack of planning regarding solid waste management in Battambang city. However, there is a relatively high level of interest from important stakeholders and many opportunities to develop a successful solid waste management system in the city. Improved solid waste management can be achieved in Battambang city with advances in long-term planning and coordination that involves clear steps to improve the management, storage, separation, training, public awareness, enforcement, and collection service.



3. Design of Recycling System in Battambang City

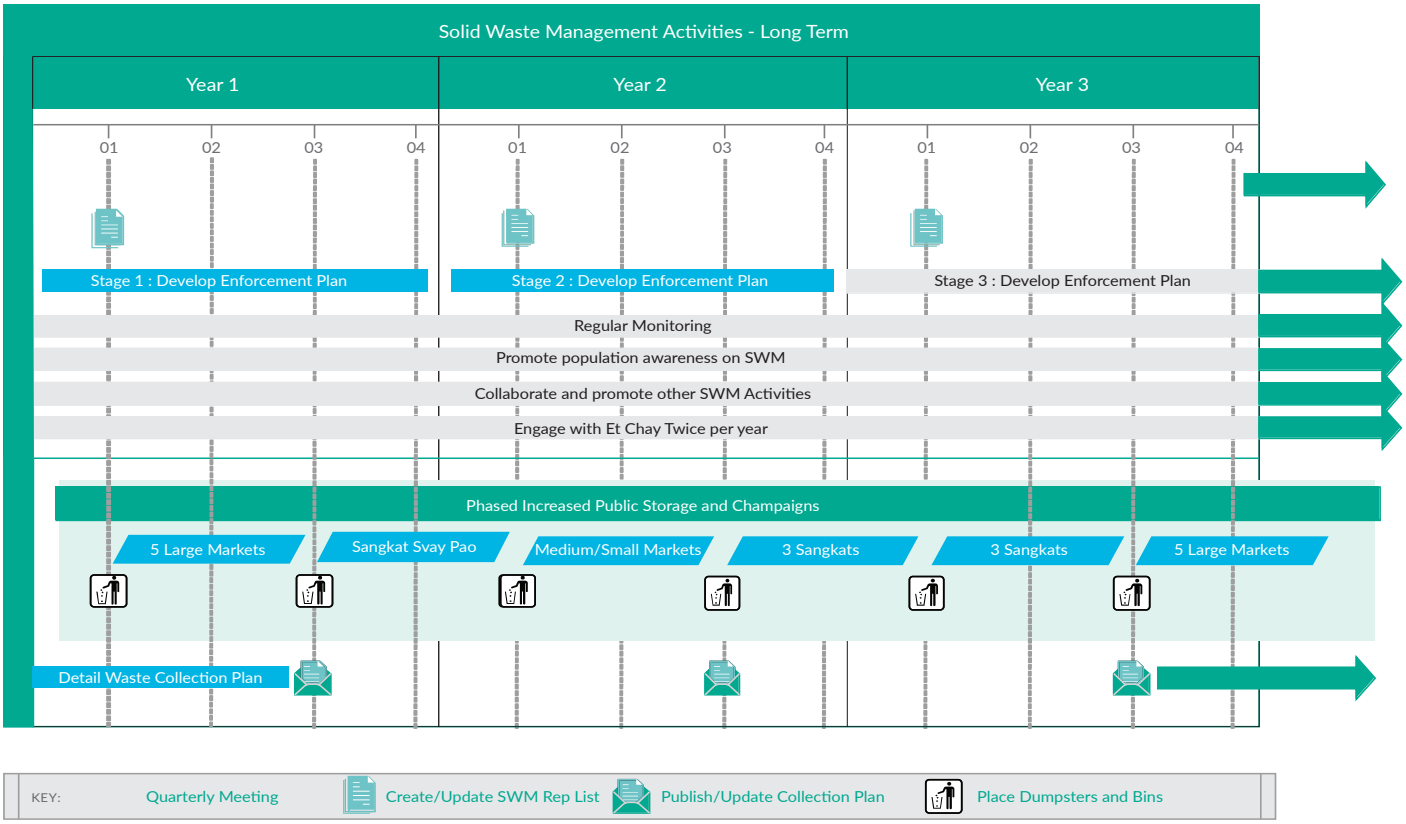
3.1 Design Of Efficient Waste Recycling System

This report, up to this point, provides an aggregate of existing data for the city as a whole. In this section, recommendations are provided for the improvement of the solid waste management system in Battambang city. This approach organizes the solid waste system without major changes to the conditions and budgets available in the city, ensuring ease of implementation, with some donor and technical assistance to help realize the implementation of the project.

The city's SWM system is addressed in the first section, which can be used as a template for establishing a more comprehensive SWM strategy. The second section details SWM public campaigns in two phases, which both focus on an increase in storage, improvement to collection services, and awareness raising. Then, in the third section, more detailed activities for technical assistance projects are discussed. Finally, the last section outlines the costs for the previous three sections, which are presented according to stakeholder funding.

All stakeholders agree that separation at the source is key to improving waste management in Battambang city. There are several key components to this, including improved management and planning activities, increased storage and separation, and improvements to the collection services. Figure 23 shows the proposed activities for the next three years; however, only the first year will be discussed in detail, though many subcomponents can—and should—easily extend into the future.

Figure 23: Proposed SOLID WASTE MANAGEMENT activities in Battambang city



3.1.1. Governance

As discussed in previous sections, stakeholder coordination and community engagement are key to improving solid waste management services. Additionally, improved monitoring and enforcement efforts motivate citizens to improve their habits. The recommendations in this subsection are aimed at supporting these two efforts.

Recommendation 1: Monitoring of solid waste management activities

Enforcement plan

- Phase 1: Develop enforcement plan
  - Make implementation plan, who and how often
  - Recommended to allow sangkat solid waste management reps to report to the PDoE
  - Use a warning system: official warning given two times, then fined
  - Publicly educate about fines for burning and littering; inform the public of future plans to implement it
  - Include component for discounts for waste separation as an incentive
- Phase 2: Test enforcement plan
  - Begin enforcement after sufficient public education
  - Implement official warning system
  - Sangkats to collect fines after approval from the PDoE
- Phase 3: Implement enforcement plan
  - Hold workshop with relevant stakeholders to review and refine plan
  - Implement fines

Monitoring indicators

It is important to develop clear and useful indicators for monitoring. Frequently, monitoring indicators are too numerous and not useful. Recommended solid waste management indicators include:

- Quantity of waste collected (number of trucks coming to the dump site)
- Frequency of collection
- Neighborhoods benefiting from the service
- Percentage of solid waste management fees collected
- Quantity and percentage of waste composted by COMPED (to assess the quality of the source separation)
- User satisfaction rate (assessed via a regular survey)
- Waste production per person, per day

Monitoring applications

There are two types of applications useful for monitoring: a public one for encouraging involvement of the general population and another for use by the public authorities. Applications allow indicators, complaints, or successes to be collected, consolidated, and reviewed quickly and easily.

Currently, the GoGreen Cambodia app is available to the public for use in Battambang. Although the capabilities are currently limited (it has three reporting capabilities: areas that need pickup, that are well serviced, and where bins are needed), it can be used for immediate monitoring purposes, such as campaigns, where the app's happy faces would indicate separated waste and the unhappy ones indicate unseparated waste. The app's information on trash bins could also be useful for the sangkats and authorities to understand where problem areas lie.

However, the application needs to be improved to allow for temporal monitoring (improvements to the back-end). GoGreen Cambodia is currently seeking funding to do this and has shown interest in collaborating with authorities. It is also possible to develop the same application for detailed monitoring data to be collected by the authorities.

Regular monitoring

Ideally, one individual at the PDoE should be assigned to monitoring activities. It would be useful to gradually increase the activities, in conjunction with the campaign implementation, so the monitoring is clearly communicated to the public before activities begin.

- The PDoE should hire and train full-time staff in conjunction with the start of campaign planning.
- The staff should be kept full time even after the campaign ends.
- One staff member should be responsible for reporting challenges and other information related to the monitoring activities.
- The staff should use the GoGreen Cambodia app to track and investigate public reporting.
- Activities at the landfill should be monitored at least once per week.
- All sangkats should be monitored at least once per month.

Recommendation 2: Increase stakeholder coordination

Quarterly meetings

The most important and simple activity suggested is to hold quarterly meetings to establish communication among the community of relevant stakeholders for solid waste management in Battambang. Inspired by the monthly WATSAN meetings held by the Ministry of Rural Development in Phnom Penh, the following format was proposed:

- Sangkat representatives will present successes, challenges, and proposals for improved solid waste management.
- Other stakeholders (NGOs, collectors, implementers, etc.) will then provide briefs on their programs and upcoming events, indicate where they need the municipality's support, and seek where the NGO can support municipalities and sangkats.
- If possible, one stakeholder should also present in detail about a recent study and results from implementation, among others. The first meeting can be used to present the plan for developing an improved waste recycling system; at following meetings, other stakeholders can rotate presentations.
- Hold an open discussion session for questions, sharing thoughts, and agreeing on joint actions.

Sangkat solid waste management representatives

Furthermore, it is essential to ensure there are sangkat solid waste management representatives at all times to increase the dialogue between the generators and authorities. These representatives will have an important role of sharing updates in waste management with the community, such as collection services, locations of dumpsters, and new announcements from local authorities.

The following is the recommended scope of work for sangkat solid waste management representatives:

- Participate in quarterly municipality meetings and hold sangkat meetings immediately afterward to share information.
- Be a member of Facebook/Telegram pages set up by the municipality and share announcements and updates about solid waste management activities with the community.
- Contribute to a dissemination of Sub-Decree 113; particularly, the requirements to not litter or burn waste and to pay fees upon waste collection.
- Contribute to community education on the source separation of waste.

It is imperative that the municipality agrees and clearly delegates the responsibilities above. There should be a formal meeting and a signed agreement between the sangkat chiefs and municipality.

Social media

It is simple and costs nothing to set up and maintain social media groups as communication means for stakeholders to share information. Telegram and Facebook (a group for stakeholders and a page for the community) are recommended, as they are commonly used in Cambodia.

Recommended activities for social media management:

- The municipality should manage the social media accounts, with one individual appointed to do so.
- The accounts should be updated regularly, at least 2–3 times per week.
- All materials developed during the campaigns (see the next subsection) should be shared regularly.
- There should be a unified, creative hashtag that can be used during all events.
- The accounts should address the importance of recycling and composting and share information about the policies that affect the population, such as enforcement.

Dedicated stakeholder interaction/ social media staff

The activities listed above require a significant amount of coordination, planning, interaction, and activity updates. It is recommended that the municipality assign a dedicated staff member to organize quarterly meetings, manage social media updates, and interact with stakeholders (and attend their events). They will also be deeply involved with the implementation of the campaigns, including attending training-of-trainers sessions, learning about improved solid waste management marketing, assisting with et chay training and interaction efforts, and interacting with market managers and/or sangkat solid waste management representatives.

3.1.2. Storage and Separation

Availability and ease of storage, as well as clear marketing, can greatly improve public participation in separation activities. The following recommendations are provided to support this effort. The recommendations below are brief but discussed in detail in the next subsection, entitled "II: Campaigns."

Recommendation 3: Phased campaigns and targeted waste recovery

Phased campaigns are proposed to increase the storage and separation activities in Battambang city. This outline should be followed and adapted to achieve greater success during each phase of implementation. Furthermore, the focus on waste recovery (organics vs. dry waste vs. recyclables, etc.) should be adapted based on the type of waste produced and the most recoverable resources.

Markets and organic waste

The first target is the five largest local markets since markets are specific points that produce a large amount of waste and are easy to monitor. The markets also serve as a central component to life all over the city and thus can influence a very wide audience. Furthermore, it is recommended that organic waste be the main waste recovery resource since this is the largest waste stream. Marketing elements should specifically define organic materials suitable for COMPED and assume all other waste is placed in the second bin, which will go to the MRF.

Plastic waste can also be targeted in specific market areas where items such as clothing, shoes, and toys are sold. These areas primarily generate plastic waste that is mixed with food (from lunches and snacks) and liquid from drinks.

To incentivize the separation activities, the campaigns should encourage competition and issue awards to the most successful separation activities. Additionally, individuals—such as market vendors, cleaners, and managers—should be publicly recognized for outstanding activities throughout the campaign.

While the main recommendation in this report focuses on a large-scale competition covering all markets, it would be best to start with small-scale trials in two markets and use the results and learnings as a platform for scaling up to all markets. After the five main markets, the smaller markets and supermarkets can be targeted.

Another critical aspect is to incorporate waste minimization principles in the awareness raising campaigns; for example, by encouraging market goers to bring reusable bags.

Schools and plastic waste

Another early option is to implement the collection of plastics at schools. As well as having a positive environmental impact, it is also effective in educating children on environmental awareness. The Coca-Cola Company ran a successful trial in Kampong Thom province by providing large containers to collect plastic bottles around the school grounds along with signage and educational

messages to be delivered during school assemblies. Students were informed after they finished the national anthem in the morning and were reminded by teachers during class time. The schools could sell the bottles to the et chay and use the small budget for school activities. The trial is being scaled up across 17 schools in Kambol district, Phnom Penh, with the assistance of the Clean Cities Committee. Replication in Battambang has high potential, with the addition of separate bins for collecting plastic bags for BPP.

Sangkats and dry waste

After the market campaign, the focus can shift to the central sangkat, Svay Pao, with an emphasis on dry waste and recyclables. It is the most populous and touristic area of the city, thus generating a larger quantity of waste. The plan used during the market campaign should be adapted according to the needs of the sangkat and lessons learned, and the place and role of the et chay should also be determined.

Recommendation 4: Increase the number of public storage bins

Sufficient waste storage that allows for waste separation will have a major impact on the waste value chain. The increase of bins should be phased with each new campaign and linked to the recycling/recovery capacity of the MRF and COMPED's facilities (detailed in "II: Campaigns," which is designed to be revised and implemented for new areas).

Sangkat representatives and market managers/cleaners should identify locations for dumpsters together with Leap Lim and CINTRI as lead by the municipality. This will ensure that the best locations, usage, and rules are established.

Markets

Rearranging collection zones to improve access to the dumpsters would prove convenient for cleaners. One suggestion is to have a half-buried dumpster or ramp to ease bin access. Additionally, a specific kind of dumpster that can be closed when it is not in use (i.e., when markets are closed) could also prevent household dumping of waste, with appropriate signage to ensure awareness. These could replace the dumpsters that CINTRI already uses and can be serviced by their trucks.

Underserved areas of sangkats

There are notable areas in the city that are underserved for a variety of reasons, including streets too small for collection trucks or poor areas. However, it does not mean they should remain underserved; instead, the sangkat representatives should clearly indicate to the municipality these areas and where bins should be provided for easy collection.

A related issue is the provision of free services in some areas and paid services in others. Here, the sangkats should manage fee collection from the areas with public bins; this is discussed in later sections.

Recommendation 5: Education and awareness raising

The management of changing household practices must be a long-term intervention program that is clearly phased in conjunction with the increase in public bins if there is to be a sustainable result.

Training of trainers

A component of this recommendation is clear, detailed capacity building among local authorities and relevant stakeholders before starting field activities. In some cases, awareness raising activities dedicated to the local authority (municipality and sangkat/village) will be necessary to convince them about the usefulness of behavioral change.

The sangkat chiefs are a key target of the training of trainers. They are enthusiastic and have agreed to meet with the et chay and visit local homes as well as protect rubbish bins. They have requested tools and information to share the ideas.

Topics and materials for raising awareness

There are clearly certain topics of solid waste management that the general public has little knowledge of; in particular, the demand of recyclable and non-recyclable materials as well as solid waste management laws. The marketing for these components should be expressed through simple and fun materials. The key missing elements that must be communicated include:

- How to generate less waste (e.g., reusable bags).
- Penalties for littering and the burning of waste.
- Demonstrating (instead of commanding) how to separate waste (organic vs. everything else).
- Priorities (in order) of waste management: prevention, reuse, recycling, recovery, and treatment.
- Providing a full list of what can be recycled and how it is collected.
- Addressing waste items that may be confusing, rather than already-known items (general awareness that plastics and cans can be recycled but uncertainty regarding plastic wrap and Styrofoam).
- Benefits of waste separation, particularly personal health and materials
- The local authorities clearly support, participate, and endorse these activities

Furthermore, for markets, materials should have posters for separating waste into two types (organic and non-organic), showing which type of waste goes into each bin—specifically showing what to do with less-discussed items, such as dirty plastic bags and Styrofoam containers. In general, the education should address that most items can be recovered if clean. However, the messaging is limited to the local recycling facilities: for example, if a Styrofoam recycling facility is developed, then Styrofoam becomes a recyclable material. Such messaging, therefore, must be updated based on the services provided.

Dumpsters should be clearly decorated and marked as well. The approach should be to distinctly identify what is organic, and if an individual is uncertain, it should be placed in the other bin. Overall, the markets agreed with many of the issues presented, such as the need to educate sellers, a clear collection schedule that is adhered to, more bins, and additional education about different types of waste. In particular, it was requested that bin storage be included in the contracts with markets.

3.1.3 Collection

Recommendation 6: Engaging informal street pickers to better perform collection services

The informal sector is very strong in Battambang and contributes greatly to the recycling sector; furthermore, it is estimated that 80% of the street pickers are women and children. However, they are rarely considered when planning for solid waste management, nor celebrated or promoted as an important part of the waste sector. Improved separation will benefit this sector greatly, but they should also be embedded further into the solid waste management value chain.

Regular engagement (at least twice per year) with informal collectors at the two observed locations and nearby junk shops is suggested. The first item for discussion should be to identify a method for improving the recovery of recyclables, such as selecting a certain type of bag (e.g., clear bags for recyclables, opaque bags for mixed waste) and how to handle the waste (e.g., not to leave bags open, allowing waste to spill out, resulting in fines). Other training should include health and hygiene, laws and regulations, formal collection scheduling, and proper landfill management (reducing harmful fires), among others.

Recommended activities with the et chay include:

- Train the et chay once per year—using small incentives (e.g., phone cards, T-shirts)—on topics such as occupational safety, health and hygiene, landfill management, running a business, relevant laws, and options for obtaining health care.
- Facilitate an open discussion about how to help them improve the recovery of recyclables without scattering waste.
- Identify improved recyclable waste recovery methods (certain types of bags or bins to indicate presence of recyclables, reducing pilfering through all waste).
- Share updates from quarterly meetings, events, bins, and collection plans.
- Share laws and regulations, through creative social media means, particularly about littering and enforcement.
- Reinforce the sector's importance by celebrating them on social media after training.

The et chay should also be allowed to appoint a representative to attend stakeholder engagement activities (quarterly meetings, public campaigns, etc.) and share information with the whole community of collectors. Encouraging them to form an association will benefit the et chay in the long term (refer to section "IX: Long-Term Recommendations" about formalizing the et chay).

Recommendation 7: Detail waste collection plans

Waste collection plans are not widely shared with the community, though there is a general schedule. Both CINTRI and Leap Lim should clearly develop a map with their schedule and share it with the wider community through bills and the sangkat representatives.

During the waste separation campaigns, it is proposed that the improved collection schedules be recognized in a formal agreement between the municipality and formal collectors. The agreement should include provisions for separated nonorganic waste to be taken to the MRF for sorting and organic waste to be taken to COMPED; therefore, those stakeholders should be included in the planning and discussion.

The waste collection plans should be updated and republicized at that time. If successful, the contracts for both formal collectors should be formally revised to include the improvements. The agreements signed with stakeholders for each campaign should be treated as a template for the contracts but also be adapted according to lessons learned.

Any discussion about formal collectors providing discounts to generators that do separate their waste can begin, but it will likely take a long time to recognize the savings from agreed-upon rates and diverting waste. Therefore, this topic is addressed further in the subsection on discounts and recovery of solid waste management payment in the section "IX: Long-Term Recommendations."

Rationalize and detail an actual waste collection plan, updated to reflect the phased increase of bins.

- Update the collection plans at least every six months.
- Facilitate an open discussion about increasing the recovery of payment for services, including sangkats collecting and paying fees for public bins.

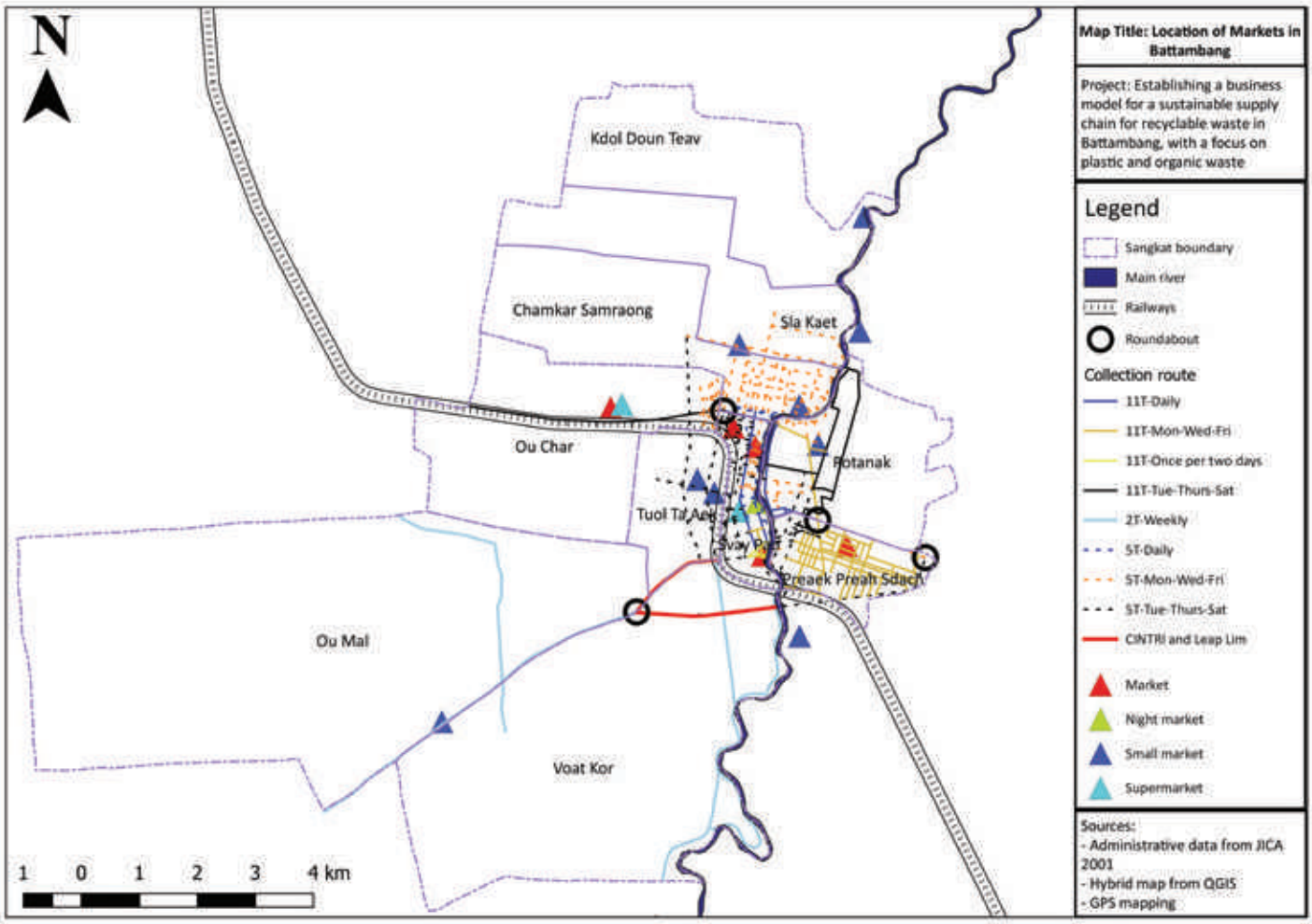
3.2. Campaigns

This subsection provides a presentation of the first two proposed campaigns. Each begins with background information useful for the understanding and planning of every area. This information will need to be compiled for the future phases not included in the report.

3.2.1 PHASE I: MARKETS

The five local markets recommended for the trial are shown in figure 25 in RED, including Nat or Thum, Boeung Chhouk, Phou Puy, Leu, and Thmey.

Figure 25: Location of markets, supermarkets, and small markets



The table below represents general information of those five markets.

Table 8: General information for the five marketså

MARKET NAME	Thmey	Nat or Thum	Phou Puy	Leu	Boeung Chhouk
Manager name	Chhun Sopheap	Sam Rey	Van Chamroeurn	Seng Sereivatanak	Sean Pivoan
Contact	12956624	12565234	86847475	17527287	11781467
Location	Village 13 Makara, Sangkat Preak Preah Sdach	Village Preak Moha Tep, Sangkat Svay Po	Village Anchanh, Sangkat Ou Char	Village Kamakor, Sangkat Svay Po	Village Preak Moha Tep, Sangkat Svay Po
Specialization of market	Mixed goods	Mixed goods	Wholesale vegetables and fruit	Mixed goods	Mixed goods and wholesale vegetables and fruit
# of total vendors	606	525	737	244	1,000
# of vendors selling food, vegetables, meat	200	202	600	148	400
# of vendors selling groceries, clothes, jewelry, etc.	406	323	137	96	600
Opening time	4 am–6.30 pm	5 am–6.30 pm	24 hours	6 am–6 pm	6 am–6 pm

Waste generation

Based on the interview with market managers, market cleaners, and waste collection services at those markets, waste could be simply estimated as the following:

Table 9: Waste generation for each market

MARKET NAME	Thmey	Nat or Thum	Phou Puy	Leu	Boeung Chhouk
Estimated waste generation (tons/day)	4	5.5	5.5	2	7
Estimated organic waste (%)	70%	70%	80%	70%	80%
Estimated organic waste generation (tons/day)	2.8	3.8	3.8	1.4	4.9

Altogether, approximately 17 tons of organic waste from the five markets is generated per day, which is higher than COMPED's current composting plant capacity of about 8 tons per day as well as the future capacity with UNIDO's upgrades of 10 tons per day. Therefore, planned expansion for the COMPED facilities is recommended in the coming years.

Cleaning services at the markets

Field data collection has shown that market staff commonly includes cleaners, who have two main roles: wiping and sweeping and collecting waste from vendors to place in outside bins for waste collection. Generally, vendors pay a small daily fee for this kind of service at markets. The detailed cleaning services for each market are shown in table 10.

Table 10: Market cleaning details for each market

MARKET NAME	Thmey	Nat or Thum	Phou Puy	Leu	Boeung Chhouk
Number of market cleaners	2	4	12	1	7
Average salary per cleaner (USD/month)	125	200	130	150	150
Cleaning service payment per vendor per day (USD/day)	0.125	0.05	0.125	0.125	0.125– 0.25
Total cleaning service fees collected per day (USD/day)	76	26	92	31	125–250

Storage

There are three types of storage methods that are commonly used: bins, dumpsters (normally provided by CINTRI), and open dumping. The use of these methods in each market is presented in table 11.

Table 11: Waste storage materials in markets

MARKET NAME	Thmey	Nat or Thum	Phou Puy	Leu	Boeung Chhouk
# of market bins	8	3	12	8	8
Bin size (kg)	30	30	15	15	15
# of open dumping points	1	0	1	0	Several
Description of open dumping	Size around 5m x 6m x 0.8m, surrounded by a concrete wall, directly on soil, east side of the market	None	Open space nearby dumpsters	None	Waste piles surrounding market
# of CINTRI dumpsters	0	1	2	1	0
Dumpster size (tons)	0	4	4	4	0
Separation bins	No	No	No	No	No

Waste collection

Formal collection

Of the five markets, Boeung Chhouk Market is the only one that operates its own waste collection services.

However, this market still pays CINTRI landfill fees, which is similar to the other markets. The performance of collection is described in table 12.

Table 12: Waste collection in markets

MARKET NAME	Thmey	Nat or Thum	Phou Puy	Leu	Boeung Chhouk
Collection company	CINTRI	CINTRI	CINTRI	CINTRI	Market
#Trucks operating waste collection	1	2	1	1	2
Description of collection trucks	Compactor truck	- Compactor truck for waste outside dumpster - Truck coming to bring dumpster	1 truck coming to bring dumpsters	1 truck coming to bring dumpster	1 or 2 trucks depending on amount of waste
% of waste collection	100%	100%	85%	100%	100%
Collection staff	5–6 staff members	6–7 staff members	1 staff member (driver only)	1 staff member (driver only)	12 staff members
Frequency of collection	Once per day	Once per day	Twice per day	Once per two day	Three times per day
Time of collection	3 pm–5 pm	4 am–7 am	5 am–11 am	Around 5 am	Around 5 am, 2pm–5pm

It should be noted that the reason Pou Puy and Leu Markets only require one collection staff member is likely due to the efficiency of collection with dumpsters. This system should be deployed in all the markets. To avoid waste littering, dumpsters should be easy to use for cleaners as suggested in task 1.

Informal Collection

Generally, recyclables, such as aluminum cans, are collected by informal pickers and the market cleaners themselves. On average, this generates an additional income of around USD 25 per month per cleaner. In addition, these markets are the key locations for informal pickers to come and collect recyclable waste, especially at the end of the market opening hours until later in the evening.

Recommendation for small-scale trials at markets
It is recommended to first perform small-scale trials at two markets to understand what aspects are most effective. The results can then be used as a platform for the large-scale campaign described below. Because organic waste is mixed in most markets and contains items—such as meat, bones, and fish—that cannot be efficiently composted by COMPED, the initial focus should be on Phou Poy. As a wholesale fruit and vegetable market located outside of the city center, it is quieter and better organized. The waste comprises mainly of fruit, vegetables, plastic, and cardboard. Therefore, source separation should be relatively straightforward if enough bins and signage are provided and with a long-term awareness raising campaign.

In a market such as Boeung Chhouk, it is proposed to target the inside of the market and immediate surroundings that exclusively sell dry items, such as clothes, shoes, and toys. Most of the waste will be dry (plastic, cardboard, Styrofoam, etc.), and the focus should be on eliminating food waste from lunches and snacks. For the trials to be successful, it will be critical to work closely with waste collectors to prevent waste from being remixed during collection, which happened in the past.

Recommendation for campaign design for these five markets

The commitment of markets is key to executing successful waste separation at the source. Planning for and setting up a 60-day[44] Clean Market Award Competition (detailed in table 13) for these five markets would be considered as a non-monetary incentive to encourage vendors, market cleaners, and market managers to carry out waste separation. If separation at the source is successful and compost production increases, certain collection fee discounts could be established.

A workflow for the market campaign is provided in figure 26 and includes the planning phases. Milestones are indicated by green diamond shapes and must be achieved before implementing the next activities. Activities are indicated by squares, and the start and end points are indicated by ovals.

[44] Psychology study from 2009 concluded that it takes on average 60 days to form a habit. Pillippa Lally et al., "How are habits formed: Modelling habit for formation in the real world," European Journal of Social Psychology (16 July 2009).

Figure 26: Workflow for market campaign

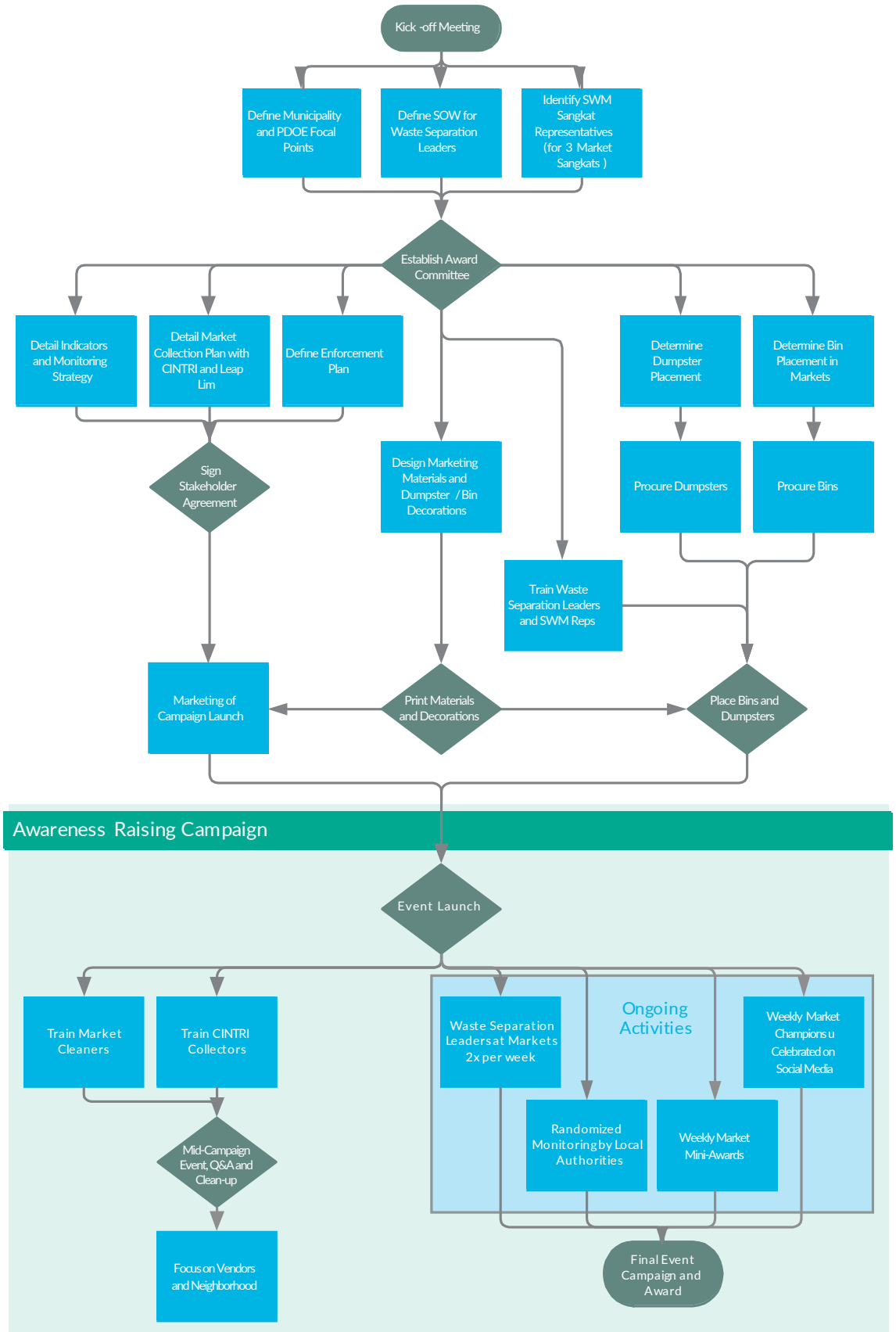


Table 13: Detailed recommendations for trial design for markets

No	Activities	Owner	Detail
1	Kick-off Activities	Municipality	Introduce campaign timeline and responsibilities of each stakeholder Involve all solid waste management stakeholders
1.01	Define municipality and PDoE focal points	Municipality, PDoE	Should be someone who works frequently on solid waste management: Office of Solid Waste and Beautification Will be committee leaders
1.02	Define and release SOW for Waste Separation Leaders	COMPED, PDoE	1 person hired by PDoE 1 person hired by COMPED (though they can designate other existing separation staff members to be involved during the campaign) Both full time for three months (including 1 month before the 60-day campaign) Must spend 90% of time at the markets, sending positive messages and encouragement to cleaners, vendors, and people who informally dump waste Provide a weekly public monitoring report for each market Dynamic, outgoing individuals
1.03	Identify solid waste management representatives for the three market sangkats	Sangkat solid waste management representatives	
1.04	Hold planning workshop	Sangkat solid waste management representatives	Detail roles and responsibilities Determine enforcement implementation
M1.1	Establish "Clean Market Award " Committee	Municipality	Committee management (Make decision) 1 Municipality focal point (leader) 1 PDOE focal point (deputy leader) 3 Sangkats solid waste management Reps (Sangkat Svay Po, Ou Char, Preak Preah Sdach) 2 Waste Separation Leaders Committee members (Part of planning) 5 market representatives 1 COMPED representative Volunteers from other solid waste management groups
2	"Clean Market Award Committee activities"		
2.01	Detail indicators for monitoring strategy	Municipality	Weekly reviews from two Waste Separation Leaders COMPED's review of organic waste received MRF's review of dry waste received GoGreen Cambodia app volunteer/public observations

No	Activities	Owner	Detail
2.02	Detail market collection plan with CINTRI and Leap Lim	PDoE	Should be per market's schedule CINTRI to collect organics (daily) Leap Lim to collect other waste and take to MRF (at least 3 x a week)
2.03	Define enforcement plan	PDoE	Focus on educating the public about fines for burning and littering; inform the public of future plans to implement them.
M2.1	Sign stakeholder agreement	Municipality	Market managers to agree to participate CINTRI to collect organic waste from markets at certain times Leap Lim to collect dry waste to take to the MRF Market managers, CINTRI, Leap Lim all to sign
2.04	Design marketing materials and decorations	PDoE, TA	Focus on non-wasteful marketing materials (i.e., few flyers) Make video Create hashtag for social media Educate on confusing waste items (dirty plastic, Styrofoam, etc.) Address what is organic and what is not Promote recyclable materials, including plastic bags and compost Encourage recovery of coconut shells, sugar cane leftovers, etc.
M2.2	Print dumpster decorations	Leap Lim	Should be printed on recycled materials, if possible
2.05	Determine dumpster placement	Municipality	Solid waste management reps and market reps discuss and determine dumpster placement and needs
2.06	Determine bin placement	COMPED	Interview market cleaners and managers to determine bin placement
2.07	Procure dumpsters	UNIDO	Should be easy for markets to use
2.08	Procure bins	Leap Lim	Municipality to ensure placement according to market managers
2.09	Training of trainers (Waste Separation Leaders and solid waste management representatives)	Municipality, PDoE, COMPED	Should include: - Laws and regulations, including enforcement (PDoE) - Environmental and health impacts (PDoE) - Understanding of organic waste and benefits of composting (COMPED) - Full solid waste management sector in city, including importance of et chay (municipality) - Introduce and build relationships with market managers - Specific education about Styrofoam and plastics (Plastic Free Cambodia)
M2.3	Place bins and dumpsters		
2.10	Marketing of campaign	Municipality	Social media
3	Launch of awareness raising campaign		

No	Activities	Owner	Detail
M3.1	Launch event		One-day event held at the five markets Whole CMA team should be present for one hour at each market Representatives, volunteers, CMA team divided and present right before and during market cleanups Important leaders participate in cleanup (governor, sangkat chiefs, etc.) Waste Separation Leaders introduced Et chay celebrated
3.01	Train market cleaners (weeks 1-2)	Waste Separation Leaders, solid waste management representatives	Half-day event held at the five markets Waste Separation Leaders provide training Solid waste management representatives must be present Print hats and T-shirts for all participants Training to include all topics in 2.09 Special focus on separation of unclear items (plastic wrap, Styrofoam, etc.)
3.02	Train CINTRI and Leap Lim collectors (week 3)	Waste Separation Leaders, PDoE	Half-day event held at the five markets Waste Separation Leaders provide training Solid waste management representatives must be present Print hats and T-shirts for all participants Training to include all topics in 2.09 Special focus on separation of unclear items (plastic wrap, Styrofoam, etc.)
3.03	Train et chay (week 4)	Waste Separation Leaders, PDoE	Half-day event held at the five markets Waste Separation Leaders provide training Solid waste management representatives must be present Print hats and T-shirts for all participants Training to include all topics in 2.09 Special focus on separation of unclear items (plastic wrap, Styrofoam, etc.)
M3.2	Mid-campaign event, Q&A, and cleanup	Municipality	Same set up as campaign launch event – rotate around five markets Celebrate successes Important individuals participate in clean up Allow Q&A session for clarifications
3.04	Focus on vendors and neighborhoods (weeks 4-8)	Waste Separation Leaders	Waste Separation Leaders to focus on discussions with vendors Understand challenges and share with CMA committee Observe neighborhood dumping around markets Approach shoppers and illegal dumpers to discuss separation and solid waste management
3.05	Regular presence at markets	Waste Separation Leaders	Waste separation leaders should be at each market at least 2 x per week Share solid waste management facts Participate in waste cleanups Answer questions Approach vendors to discuss separation Monitor separation activities
3.06	Randomized monitoring by local authority	Municipality, PDoE	Municipality and PDoE should perform random visits at least 1 x per week to assess separation

No	Activities	Owner	Detail
3.07	Weekly market mini-awards	PDoE	Every week, one market is celebrated on Facebook as the best market Selected according to the monitoring indicators
3.08	Celebrate weekly “market champions”	Waste Separation Leaders, solid waste management representatives	Every week, individuals (with permission) are celebrated on social media One from each market Should have a photo demonstrating a good habit Should be an et chay, market cleaner, market vendor, or shopper
M3.3	Final event campaign and award	Municipality	Held in central city area of Battambang Have booths and separation bins for cleanup Award best market based on indicators Share plans to expand waste separation

3.2.2 Phase II: Main Sangkat – Svay Po

Sangkat Svay Po (map shown in figure 27) has an urban population of 100%[45] and is the main sangkat of Battambang city, with the highest population and most businesses (table 3), public institutions, and public gardens.

Waste generation

With a higher average of larger waste generators (by volume, 14% from households, 60% from large markets, 34% from other markets, and 38% from hotels and guesthouses), Svay Pao is clearly the sangkat generating the largest amount of waste (at least 15% of the city's waste, if not more).

Storage

As mentioned in task 1, the total public storage in Battambang is estimated to be around 100 bins, and most of them are located in the main sangkats. There are two dumpsters of four tons each provided by CINTRI at the markets. Currently, one is at outside of Nat Market, and another is outside of Leu Market.

Collection

Formal collection

CINTRI is in charge of waste collection and transport in this sangkat (the collection schedule is shown in figure 27), though this information is not publicly shared throughout service areas. Both waste and fees for collection are undertaken door to door; CINTRI staff distributes and collects bills directly to and from customers. Noticeably, Roads No. 1 and No. 3, as well as public gardens, are serviced by daily waste collection. Although there are some areas that are scheduled to receive collection services three days per week (either Monday, Wednesday, and Friday or Tuesday, Thursday, and Saturday), the collection is often only done once or twice per week. This is not enough to ensure good quality organic waste for COMPED.

Informal collection

The number of informal pickers throughout the town is not well known. However, based on interviews with three junk shops, all 10 sangkat chiefs, and 10 informal pickers, it is estimated there are around 150 to 200 informal pickers throughout Battambang Municipality. Noticeably, there are two locations in Svay Pao (shown in figure 28), where there are known groups of up to 50 to 60 informal collectors who are settled illegally. The first is near to the Battambang Provincial Referral Hospital in Preak Moha Tep village and the second is along Sangkae River near the Dragon Peace Garden and night market.

Local Authority Involvement

For 2019, the municipality has delegated Sangkat Svay Po to lead cleanup activities once per week on Fridays, mainly along Roads No. 1, No. 2, and No. 3 as well as at public gardens. This activity sends a message to the population that waste storage is necessary, and littering is not acceptable. There is neither a sangkat budget nor a focal person dedicated to solid waste management.

Previous educational campaigns

A series of awareness raising programs were conducted in Battambang city, including (1) distribution of brochures, voice announcements, and community workshops.[46] However, they were only conducted for a limited time and did not have a lasting effect.

Recommendations for campaign design of Svay Pao commune

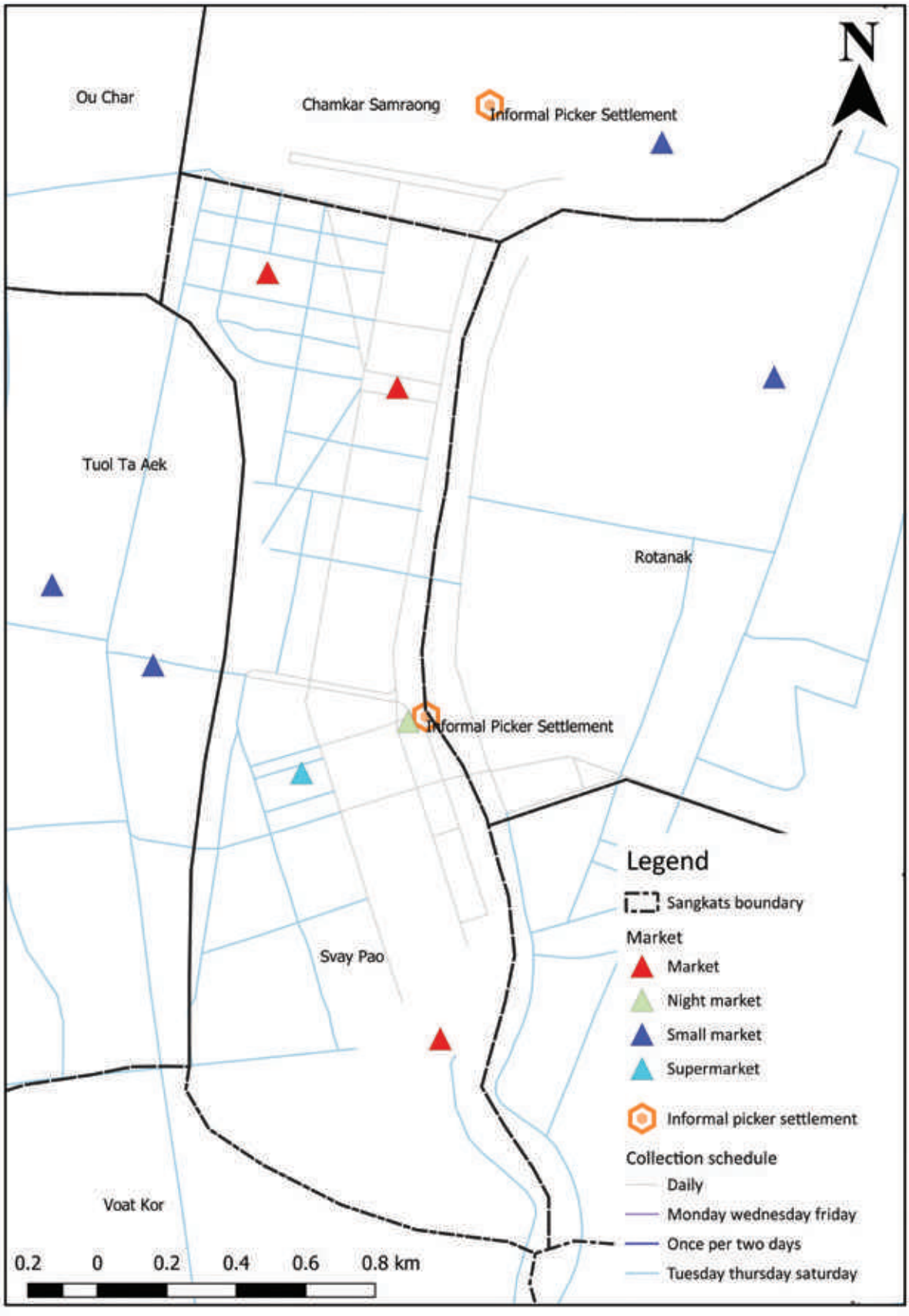
In general, the second phase of the trial must follow the first phase, but it must also adhere to the activities in task 1 first, such as identifying sangkat representatives, holding quarterly meetings, and detailing and publishing the waste collection schedules. A few additional tasks are outlined in the sections below.

[45] CDIA TA-8556: Pre-feasibility Studies for Second Tonle Sap Integrated Urban Management Project (47285-001).

[46] IGES, Participatory Waste Management Approach for Climate Change Mitigation: The Case of Battambang City (June 2018).

Figure 27: Waste collection schedule in sangkat Svay Po

Figure 28: Group of informal picker settlements in sangkat Svay Po



Revision 1: Focus on recycled waste

This phase of the trial should focus on improved separation of recyclable materials for the et chay. This is because the formal and informal collection services do not have to be altered—only enhanced—and there is clearly a need for improving the disposal, storage, and collection points for the et chay value chain. This will include the collection and separation of plastic bottles and bags in schools, as mentioned in Section 2, "Other Waste Projects Relevant to Battambang City."

While it is desirable to aim for total waste separation for households and businesses, in practice, it is not easy. In La Pintana, Chile, it was estimated that, even after years of campaigning, only 28% of households separated their waste. Furthermore, while it sounds attractive to target businesses, such as restaurants and hotels, it is difficult logistically to plan collection services for only certain entities, negotiate and organize these services, and ensure the collection workers actually monitor and only collect from the generators that are permitted.

Accordingly, the following actions are recommended:

- Focus on the recovery of recyclables for the *et chay*.
- Encourage household composting for disposal of organic waste.
- Engagement with the *et chay* for this campaign should include discussing challenges and sharing ideas, including:
    - Informing that opening bags and leaving scattered waste can lead to fines for noncompliance.
    - Seeking a solution that can help recyclables be easier to spot. Consider promoting two types of bags to indicate the difference, such as clear, untied bags for recyclables.
- If necessary, set up designated selling times and points for the et chay to recover recyclables in neighborhoods that are underserved.

Revision 2: Dumpster placement in underserved areas

It was noted during the study that there are particular areas of sangkats that are underserved, and sankgat chiefs agree that public bins would decrease littering and burning of waste. While the current door-to-door formal collection services should continue, it is recommended that the second campaign in Svay Pao include placing dumpsters in select locations, starting with schools. The purpose of this is to ensure that all areas benefit from waste collection services by maintaining well-managed and regularly emptied dumpsters to counterbalance littering.

Finding appropriate locations may prove to be a challenge, especially in dense areas. Figure 29 indicates locations recommended by the municipality, though more are likely necessary. It is essential that the sangkats hold public discussions to emphasize the importance of the bin placement to the public and allow their input on determining locations. The sangkat should then work closely with the municipality and PDoE to identify appropriate areas for these; in particular, serving areas where there is no roadside collection. It is recommended to identify up to three locations (other than markets), where some may require more than one bin depending on the amount of waste generated.

For households that still want to sell to the et chay, rather than simply disposing of recyclables, the public bins could serve to dispose less valuable recycling materials and/or as a public point for selling, potentially creating an opportunity to formalize their buying of recyclables in the future (such as in the waste bank model in Surabaya).

Figure 29: Suggested locations to place dumpsters in sangkat Svay Po

Revision 3: Fee collection for "public" dumpsters

One of the challenges of having community bins is the apparent provision of free services, which can cause issues in the wider community for households and businesses that do pay. However, the law enables the municipality to collect fees for services and to delegate tasks to the sangkats. Paying the solid waste management fee should be mandatory, so there is no conflict with public dumpsters being perceived as free, as compared to paid door-to-door collection. The price could be adapted (reduced) for places or sangkats that just have public bins service. Since the municipality is keen on delegating and the sangkats are enthusiastic to take on more roles, it is proposed that sangkats be responsible for collecting fees from households in areas served by public dumpsters. Door-to-door collection and payment in other areas will continue as normal, and overall nonpayment issues for CINTRI will be reduced.

Figure 29: Suggested locations to place dumpsters in sangkat Svay Po

A formalized agreement should be completed between the municipality, sangkats, and waste collectors to ensure long-term implementation. Also, as previously mentioned in the section about CINTRI, the contract with waste collectors should be updated to include reporting and monitoring requirements to ensure improved services are also achieved.

Revision 4: Awareness raising

First, the level of effectiveness should be determined before using the same tools again. The trial length may be made shorter only if the local community and businesses participated in Phase I thoroughly.

Awareness raising and behavioral change should focus on community events, workshops, and training activities open to the public. The et chay that serve the area should be the focal point to ensure improved collection, with the Solid Waste Leaders working to develop relationships with them and help establish appropriate connections with local authorities.

Households of all types should be targeted. Regular school activities are also a good option for this area of focus, and there should be workshops focused on working with restaurants and businesses to provide recommendations on how they can save money or make separation easier for their situation.

3.3 Long-Term Recommendations

Establish monitoring and tracking system for the collection of separated waste from households and businesses

If waste separation is to be expanded to households and businesses throughout the city, one of the challenges will be establishing a system for household waste separation and enforcement, including potential discounts. This requires waste collectors to look in the bins to check for proper segregation and "tag" the households that have not respected the rules, adding time and costs to collection services. Furthermore, training and quality control will be necessary, making the system very difficult and costly to set up from an operational point of view.

The preferred option is to set up decentralized points in the sangkats to collect a specific type of waste. Bins can be placed in designated areas, following discussion with sangkat representatives, serving as easier points to clearly monitor. This enables households and businesses to gradually participate in waste separation with greater awareness while removing the added complication of waste being remixed upon collection. Furthermore, with fewer overall points to oversee, the associated agreements regarding who will monitor, what the incentives are, and how often the monitoring is undertaken will be simpler. Collection services can be provided on a daily basis, and discounts or incentives can be awarded to whole sangkats, or even villages.

A more complicated option could include formal collectors establishing a QR code or application to indicate where household and business waste is collected and the rate of separation. However, there are several components necessary to address for this system to work:

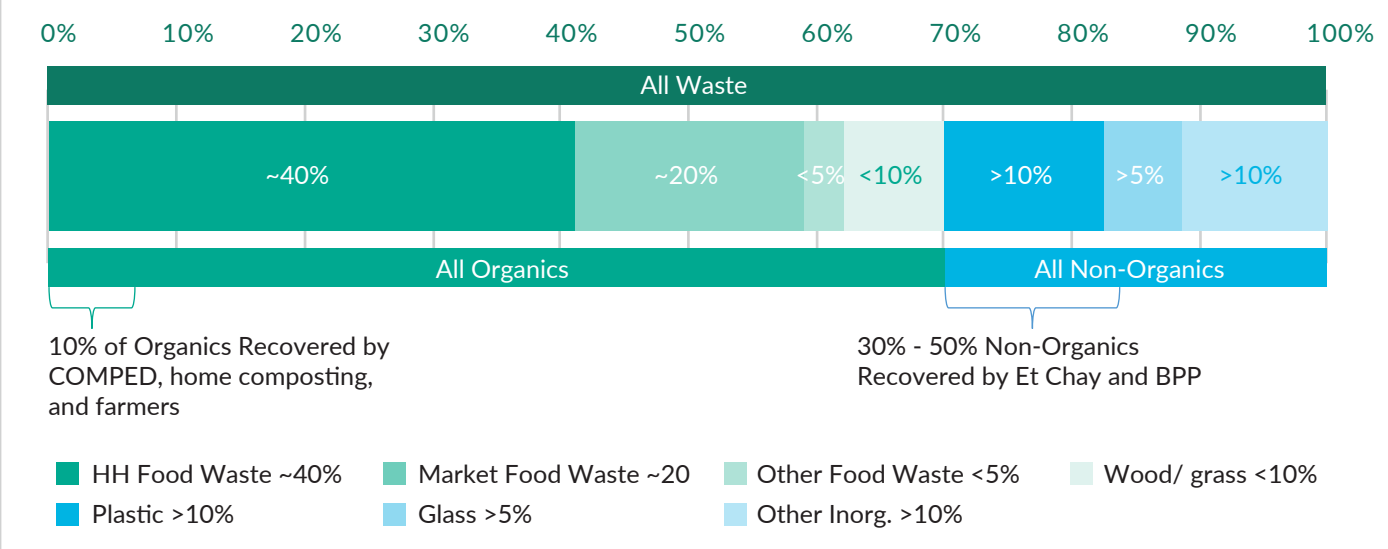
- The technology (QR code or application) needs to be developed, tested, debugged, and systematically rolled out to identify and tag households and businesses throughout the city. Ideally, it would have a system that automatically applies discount rates to the bills issued each month. This all requires technical expertise and time.
- A system would need to be in place for generators to indicate their separated waste. This could be done if the recyclables are in clear bags or if particular bins are provided for certain types of waste (i.e., bins for dry waste, with other waste discarded in bags).
- The responsibility for identification of separated waste is placed on the formal collection workers, and the system cannot function without them. Accordingly, training and incentives would be necessary.
- The collection trucks would need to be either replaced with ones that have separated waste compartments or outfitted with attached bins for dry waste (since the majority of waste is organic).
- Formal collection companies will likely have increased operational costs caused by increased time spent collecting, also requiring a subsidy or other incentive.
- The local authorities and/or donors would need to subsidize training, bins, trucks, etc. To ensure sustainability, the local authority and formal collection companies (rather than donors) must agree on discounts or penalties that would compensate for the increased operational costs and incentives for workers (see the next recommendation for more information).

Another option could be to collect separated waste on alternating days. However, this is not advised because waste collection services in Battambang are currently undertaken only three days per week at best, with many areas only receiving waste collection once per week or not at all. For alternating days to succeed, it is better to have collection services four or more times per week.

Focus on recovery of organic waste from households and businesses

As recommended for the campaign of Svay Pao, immediate impacts can be made by promoting the collection of recyclables by the et chay as door-to-door waste segregation is more complex. In conjunction with the preferred monitoring suggestion involving centralized bins, it is recommended that these bins are used to collect organic waste. The reason for this is that up to 50% of non-organics are already being recovered by informal collectors in the city (up to 15% of all waste generated) whereas only 10% of organics are recovered (represents up to 8% of total waste) (see figure 30). Therefore, recovering pure organics for further treatment will have a greater impact on the overall waste recovery system in the long term.

Figure 30: Recycled waste as percentages of total, organic, and non-organic wastes



Set up incentives and discounts for solid waste management services

One issue with implementing waste separation is developing sustainable incentives or discounts. A meeting with market managers indicated that it is not possible to discount the current charges for cleaning services, as they are already quite low (a maximum of USD 0.25 per day per vendor). Furthermore, placing penalties on vendors or households who do not segregate requires detailed and consistent monitoring activities, which entails a large amount of effort and funding (as discussed in the previous long-term recommendation). It is also ideal if the local authority is the enforcer, rather than markets or collectors.

The best and most sustainable incentive is one that could be developed with savings recovered from real treatment costs. This requires that treatment costs not be merged with collection costs (as they are currently) and a specific budget for solid waste management dedicated to the city. In this case, it is relevant to consider that sorting at source, recovery of recyclables, and composting can save on treatment costs as it reduces the quantity to be buried. These savings can then be proposed as a discount on fees payed by generators or to fund other incentives (such as the free compost provided to residents in the La Pintana example). However, there are several challenges to negotiating and agreeing upon this savings.

The amount saved by waste collectors depends on the location of the recovery/recycling center and who collects which waste stream. If the recycling/recovery center is located in the same place as the landfill (as is the case in Battambang), transportation costs are not saved—only compost production costs can be saved. However, with the facility recovering lower revenues than costs, a breakeven point must first be reached.

However, if the recycling/recovery center is closer to the city center than the landfill, which is likely to be the case when the new landfill is established, transportation costs can be saved. In this case, recyclable/recoverable materials are discharged in the recycling/recovery center located close to the city center, saving costs that would otherwise be spent on moving the waste those extra kilometers. For Battambang, CINTRI will benefit from transporting waste to COMPED because it is significantly closer than the new planned landfill (it is about a quarter of the distance, which is currently about USD 1 per ton, but could increase to USD 4 per ton with the new landfill). Furthermore, if the separation campaigns are successful and the MRF is proven useful, it will also be advantageous to divert waste there as well as encourage the et chay to collect more as previously discussed. Accordingly, it should be marketed that if waste is not separated, the waste collection fee will be multiplied by four.

Another alternative is incentive pricing, where the pricing of the service is based on the weight of waste produced. Households are thus encouraged to reduce the amount of waste produced to reduce their bills.

However, the implementation of incentive pricing (weight-based pricing) in cities where collection services are not available to all can be counterproductive. Households may be encouraged to reduce their bills by littering or burning their waste, which is counterproductive. Moreover, from a logistical point of view, the implementation of this pricing model can potentially be difficult to implement on a large scale in cities of developing countries.

In the case of Battambang, there is potential to test an incentive pricing model at the neighborhood level. The fee in this part of the city could be reduced, according to the ability of local authorities to cover this cost. The amount of this discount could be reviewed annually by a source sorting committee (composed of the operator, household representatives, and city authorities). Depending on certain performance indicators (quality of service, sorting, waste produced per inhabitant, etc.), the amount of the subsidy could change. The advantage of this type of committee is to introduce a shared performance assessment and thus encourage households to improve their practices in exchange for more reductions.

Improve recovery of solid waste management payments

It is estimated that only about a quarter of households pay for solid waste management services, which leaves a high rate of unpaid invoices. There is likely a vicious cycle underway: poor service causes fewer people to pay, the service quality further deteriorates, and even fewer people pay. To break this cycle, any enforcement measures must be preceded by visible changes in service quality or they will fail. This is why it is necessary to first establish and publish the collection routes, as well as a sound monitoring system (dedicated PDoE staff), to ensure the collection services are being adhered to.

Once both of those are established (which will require time), the formal service collectors and local authority can collectively send a message that service fees must be paid, or fines for nonpayment (which are allowed by Sub-Decree 113) will be issued. This message should be displayed through a communication campaign using several types of media and communication channels, such as community meetings, public messaging (TV, radio, public loudspeaker, etc.), posters, and social networks.

Another option is to enable the sangkats to collect funds to pay CINTRI for community bins on behalf of the population, as suggested in the phasing of the campaigns in the sangkats. The fees paid should be according to those listed in the law (see Annex 3).

Plans for the future landfill

In several years, it is expected that the current landfill will close and move to a new location. This will greatly affect COMPED and CINTRI as well as the whole waste value chain. A few options are discussed below.

It is expected that the new landfill infrastructure will have a weighbridge scale. The site will then likely be managed on the principle of a price per ton of incoming waste. Therefore, there is potential in preparing an advocacy campaign to promote compost as an alternative to sending it to the landfill. The objective is to raise aware-

ness that the local authority needs to reinvest all—or a part—of the savings achieved by reducing the volume of waste diverted to composting. This can be accomplished by subsidizing compost or granting a cost per ton paid to COMPED for the treatment service instead of landfill fees.

Finally, it is important to keep in mind the et chay at the landfill when it moves. This could be an opportunity to formalize their services by hiring them at COMPED or the MRF. This could also enable the education center at COMPED to continue.

Recognize and formalize the et chay

Finally, it is feasible to progressively include the et chay as more formal service providers. One option could be to license them to regulate their service or encourage organization. If they formed (or joined) an association, it would benefit them in the long run (such as the case of the cooperative of waste pickers subsidized by local authorities in La Pintana, South America). The reason for the association is that the National Social Security Fund is currently working on recognizing the self-employed sector and will likely be subsidizing benefits (health care and work injury) for recognized associations within the next two to three years. As it stands, self-employed workers are not recognized, though ID-Poor cardholders are eligible to register with NSSF on their own. The government should openly support the natural formation of an association, particularly because most street and landfill collectors are women and children.

Inviting the Independent Democracy of Informal Economy Association (IDEA) to present and meet with the et chay during training events would foster associations in Battambang among the informal collection sector. IDEA[47] is an association registered with the Ministry of Interior that was officially invited by the prime minister to collaborate with the government on informal worker rights, including informal street waste collectors.

Carry out a characterization study

A comprehensive waste characterization study is needed to define the real composition of solid waste and real production of solid waste. The greatest gain from this would be an improvement in the understanding of the real and potential collection of the et chay, enabling the formalization and regulation of the sector, if desired. Regardless, this study could enable a better understanding of the recycling sector and allow further improvements, such as diversification of treatment facilities (new composting facilities, biodigesters, etc.) and motivation to continue to recover waste in the long term.

[47] http://ideacambodia.org

4. Improvements for Recycling Businesses in Battambang

4.1 COMPED[48]

4.1.1 Market analysis

To achieve higher production rates, the financial analysis demonstrates that waste separation is a key factor, though increasing carbon-rich organic waste inputs and productivity further improves the business model.
It is clear that locating dry organic waste can be difficult; interviews with several stakeholders indicated that dry organic waste is in high demand for burning. For example, this is the case with rice husks, which brick manufacturers purchase at a competitive rate. With UNIDO's provision of a shredder, large carbon-rich organics can be broken into smaller pieces that are easier to compost; however, this deficiency could be further improved with the tree clippings from Leap Lim's city maintenance scheme, which are delivered at a rate of about 10 tons per month. Furthermore, there are a few opportunities to recover greater carbon-rich organic waste from markets, such as sugar cane waste or coconut shells. These should specifically be encouraged to be collected during the promotional campaigns.

It should be noted that if waste separation does improve, the COMPED facility will quickly reach intake capacity, limited by the covered composting area of about 600 m^2. At a minimum, the facility should be doubled in size within 1–2 years (to 1,200 m^2) to accommodate 20–24 tons per day and, in the future, further expanded to at least 2,500 m^2 to process 40–50 tons per day. Both UNIDO and the municipality should seek to subsidize additional land for this purpose in the future.

The market research done for this project indicates an interest in compost products, but that buyers want the quality to be clearly marketed and, if possible, purchased in larger quantities.

Currently, the compost is packed in relatively informal packaging. This may be a problem, especially for individual customers. Good packaging can strengthen customer confidence in the product, giving it a more professional appearance. If COMPED wishes to compete in this market, they should brand and market their materials to meet the local standard demanded by buyers who want to become familiar with the quality of materials (use of clear labels, packaging, indication of quality, etc.). It could also be useful to develop a leaflet so customers can compare their compost with other common market fertilizers and soil amendments or to define other attractive marketing materials.

COMPED also has no clear strategic marketing to promote their products. With a good knowledge of demand, it is more feasible to adapt a product and diversify the production (e.g., compost mixed with chemical fertilizer). One component of this marketing is regular testing and marketing of the results (including heavy metal content) to ensure quality. The data provided by COMPED during this study (found in table 14) indicated that it is competitive in the local market.

Regarding the market for compost, a representative from FASMEC specifically mentioned banana and mango farms that seek large quantities of compost (one banana farm in Kampong Cham was looking for 100 tons per month in early 2019). Several other farms in the Battambang and Pailin area are known to need compost. However, another interview with CORAA (which primarily serves pepper farms in the Kampot area) revealed that some farms produce their own compost. Furthermore, competition among chemical fertilizers is strong (table 14), though other international compost remains competitive. Regardless, it's clear that increasing materials and developing relationships with specific farms may be in the best interest of COMPED.

[48] The financial business modeling was removed (including in the annexes) for confidentiality reasons.

The compost market observation in Cambodia indicates that TWIN Agri Tech Company in Phnom Penh also produces windrow compost and sells it at a similar price to COMPED's compost (see table 14). However, COMPED's products are of a higher quality. In contrast, TWIN Agri also produces vermi-compost, which is of a higher quality and thus more desirable. COMPED should consider adding this type of composting to their facility to increase their competitiveness in the market. The main differences between TWIN Agri and COMPED is that the former acts as a waste collector at shops and restaurants, charging fees to collect waste, and has the ability to process a significantly large amount of waste (400 to 800 tons per month). Though COMPED has the ability to grow (see "Recommendation 4" below), the company's small size (economy of scale) presents a challenge to its role as a collector, causing operational costs to increase with collection. COMPED could, however, consider diversifying through vermi-composting to create more competitive products that can be sold at higher prices in the market.

Table 14: Comparison of COMPED and other organic fertilizer suppliers found in Cambodia

Indicators	COMPED	TWIN Agri Tech Co., LTD	MSG (Maly San Group Co., Ltd)	Ex-M-Cambodia Co., Ltd
Address	Chamkar Samrong, Battambang City	Street No. 131, Sangkat Phnom Penh Thmey, Khan Sensok, Phnom Penh	MSG Building, #258, Street 146, Sangkat Teuk Laok II, Khan Toul Kouk	Phnom Penh, No. 96Eo, Street. Jawaharlal Nehru Blvd (215), Sangkat Veal Vong, Khan 7 Makara
Production	Local	Local	Imported from Thailand	Imported from Belgium
Price				
USD/40 kg	6.25	8	13	15
USD/tons	130	125	325	330
Transportation fee	Free	Free only in Phnom Penh	Free	Free
Plant Nutrients				
N	2.26	1.8	1.3	4
P	2.26	1.51	1.59	3
K	3.54	2.01	1.11	3

Table 15: Comparison of COMPED with chemical fertilizer from Vietnam and organic fertilizer from Thailand

Organic fertilizer from COMPED	Chemical fertilizer from Vietnam	Organic fertilizer from Thailand
Compost Fertilizer - Compost (2.26:2.26:3.54):[49] USD 130/t	(1) Triangle Fertilizer Company - UREA (46:0:0): USD 340/t - DAP (18:46:0): USD 450/t - Kali (0:0:60): USD 360/t	(1) Krobey Kroham Fertilizer Company - Compost (6:3:3): USD 320-360/t
	(2) Cheam Tech Co., Ltd - UREA (46:0:0): USD 340/t - DAP (18:46:0): USD 440/t - Kali (0:0:60): USD 370/t	(2) MSG (Maly San Group Co., Ltd - Compost (1.3:1.59:1.11): USD 325/t
	(3) Bind Dien Fertilizer Co., Ltd - UREA (46:0:0): USD 386/t - DAP (18:46:0): USD 556/t - Kali (0:0:60): USD 420/t	

One issue that remains unclear is if the demand for compost from municipal organic waste will pose a limitation to sales, as it occasionally has a bad reputation and low attractiveness compared to compost from agricultural waste. The research done during this project did not point to any resistance against compost produced from domestic waste, though a more in-depth survey should be done to determine if this could affect the attractiveness of the product. The market study should consider the exact demand for compost produced from domestic waste and identify specific issues associated with it. Reasons for potential issues include the following:

- Compost made from domestic/market waste can be polluted by hazardous waste (batteries, chemicals used for domestic purpose, etc.) when stored at home or during transportation. As a result, compost made from domestic waste can contain heavy metals; however, the risk of waste from markets containing heavy metals is lower.
- If the sorting process is incomplete, compost can contain plastic scraps, broken glass, and other sharp objects.
- Compost produced from domestic/market waste may be less fertile than compost produced from animal waste (manure).

The market study of compost should include time for visiting and interviewing farms to clearly identify the market for products and a SWOT analysis of competing products, such as compost from animal waste, chemical fertilizers, and earthworm compost. This could also help define future product investments for the facility. It should be noted that two related studies will be conducted— one in the Siem Reap area for compost products and another in the Phnom Penh area for products from fecal sludge— in the coming months.

[49] (2.26:2.26:3.54) represents is a value example of a nutrient content (N:P:K) in fertilizer.

4.1.2 Recommendations

Recommendation 1: Improve the quality of organic waste

It is in COMPED's interest to work closely with market managers, market cleaners, and CINTRI waste collectors regarding waste separation. Furthermore, it would benefit COMPED to collect waste from the other four large local markets, as these have more diversified products. This could help in obtaining more dry organic waste, such as coconut shells and sugar cane waste, which would in turn increase the compost yield and balance the carbon-to-nitrogen ratio.

Ideally, it seems the best way for COMPED to receive clean and fresh organic waste is to be involved in waste collection in the markets, as CINTRI has no incentive to enhance waste segregation at this time. If COMPED collected the waste on their own, this would allow COMPED to be involved directly in the quality of the material, raise awareness of the vendors and market cleaners, and potentially diversify its revenue.

However, since the current landfill is approaching maximum capacity, it will be in CINTRI's interest to collect separated waste, as the COMPED facility is much closer than the proposed new landfill site. This notion should be presented and discussed with CINTRI early on to ensure cooperation.

Recommended activities	Participating stakeholders
Engage regularly with market managers and cleaners, starting with Pou Puy Market.	Market managers and cleaners
Diversify market collection to other four large markets: first Nat and Boeung Chhouk, followed by the other two markets.	Municipality Market managers
Leap Lim assigned by municipality to bring more tree clippings from their services to COMPED.	Municipality Leap Lim
Procure trucks to collect organic waste directly from the markets and charge a small fee (only if CINTRI discounts market fees).	COMPED

Recommendation 2: Brand compost products and define marketing strategy

The market research done under this project indicates a clear interest in compost products; however, buyers want the quality to be clearly marketed and, if possible, purchased in large quantities.

It may also be necessary to carry out an in-depth market study of compost to clearly market the products. This would include a SWOT analysis of competing products, such as compost from animal waste, chemical fertilizers, and earthworm compost. This could also help define future product investments for the facility.

Regardless, COMPED should develop attractive packaging and branding with quality information to instill confidence in customers. It could also be useful to develop a leaflet so customers can compare their compost with other common market fertilizers and soil amendments or define other attractive marketing materials. For example, COMPED could create a field test for its compost and provide training sessions on how and why to use compost.

Recommended activities	Participating stakeholders
Conduct an in-depth market study of compost.	TA
Develop packaging and branding for the compost, with a logo and information about the quality of the compost (NPK).	AMK, AIMS
Develop leaflet to compare the benefits of compost with other fertilizers.	COMPED
Undertake regular testing of products to demonstrate product efficiency, potentially engaging with other implementation partners (CAVAC, Gret agricultural projects in Siem Reap).	Independent Laboratory
Communicate with AMK microfinance to upload their compost information to the Tonle Sap application as digital marketing to engage with farmers.	COMPED
Participate in the AIMS project to meet with farmers in Battambang through engagement events to promote the use of compost.	COMPED
Capacity building on sale skills, marketing strategy and resource mobilization	COMPED

Recommendation 3: Product diversification

There are several possibilities for diversifying products or services to increase income or attractiveness. One is starting services for waste collection and treatment. Since it is in COMPED's interest to have clean waste, transferring market waste management to COMPED is of interest. This would require trucks to collect the waste and would create an additional source of income, greatly improving the business situation. However, this may not be necessary since opening of the new landfill farther away will encourage CINTRI to collect separated waste for COMPED, as a cost saving strategy. Regardless, it will enhance competition for either COMPED's services or its receival of CINTRI's waste.

Depending on the specificities of demand, the following can be considered:

- Earthworm composting:
  - Need to adapt the design of the existing composting facility (earthworm bed).
  - The quality of earthworm composting is higher than the current practice and the attractiveness of this product could be higher, resulting in higher added value and additional income from the earthworms (food for fish/shrimp farms).[50]
- Compost mixed with chemical fertilizer:
  - Decreases the overall volume of synthetic fertilizer used. However, this method still has negative impacts on the environment. It should be clearly labelled as containing synthetic fertilizers and should only be used as an interim measure for agro-businesses.
  - Can increase the added value.

[50] http://earthwormvietnam.com/

Recommended activities	Participating stakeholders
Provide collection services, particularly at the markets.	Markets
Diversify products such as earthworm compost or compost mixed with chemical fertilizer	COMPED

Tonle Sap App was developed by AMK, in cooperation with several donors, and launched in the beginning of 2019. It is a digital platform that allows farmers to meet:

- Agri-inputs, such as fertilizers, pesticides, plastic mulch, drip tools, and others.
- Retailers and wholesalers of agri-inputs.
- Experts for agri-problem solutions.
- Creditors for capital and investment.
- Updated news related to agriculture.

Contact: Ms. Kim Davin

Email: davin.kim@amkcambodia.com

Accelerating Inclusive Markets for Smallholders (AIMS) is a six-year project financed by a loan from the International Fund for Agriculture Development (IFAD) and was implemented by the Ministry of Commerce to enhance prosperity of Cambodian smallholder farmers through increasingly profitable links to agri-businesses and markets until 2023. Battambang province is one the places of implementation.

Contact: Mr. Kim Huort – Battambang hub manager

Email: huort77@yahoo.com

Recommendation 4: Increase size of the composting facility

As previously discussed, if waste separation is achieved, the COMPED facility will quickly reach its intake capacity, due to size limitations of the covered composting area. At a minimum, its size should be doubled within 1–2 years (to 1,200 m^2) to accommodate 20–24 tons per day, which would divert an estimated 25% of organic waste and one sixth of the total waste in Battambang. It is possible to do this on the current property if carefully planned, as there is nearly a hectare of total land area. In the long term, it is highly recommended that the COMPED facility include a further increase in area to at least 2,500 m^2 to process 40–50 tons per day, allowing a diversion of over 40% of all waste in the city, with the possibility of even further expansion in the future. Both UNIDO and the municipality could seek to subsidize land in the long term.

In particular, COMPED indicated that the available area (in red in figure 31) below can be used for further increasing the facilities. It is recommended that UNIDO or another donor also fund expansion to this area. However, an increase of production capacity should only be considered after verifying the compost can be sold at a suitable price.

Figure 31: Overview of COMPED composting facility and MRF[51]

Recommended activities	Participating stakeholders
Double the composting area in the next year to at least 1200 m^2 (does not require more land if planned carefully)	TA, COMPED
Increase composting area to 2,500 m^2 in the medium to long term (3-5 years)	Municipality, COMPED, TA

Recommendation 5: Feasibility study of meeting carbon offsetting requirements

Another source of potential income for the composting facility is carbon offsetting. Composting can prevent GHG emissions; therefore, composting facilities are eligible for carbon offsets.

Uncontrolled decomposition of organic material from domestic waste produces methane (which is 21 times more powerful than CO_2 as a greenhouse gas). Composting of domestic waste can significantly reduce greenhouse gas emissions, allowing these facilities to benefit from carbon offsets (sold voluntarily on the market). Benefiting from carbon offsets requires a registration process on a specialized platform and certification that is relatively complex and costly. Project holders must be able to demonstrate that their facility can reduce greenhouse gas emissions compared to a situation without the facility. This document typically requires validation by an independent entity, which then allows the project to be registered on a platform as a carbon offset seller. Monitoring must be set up by the project to define the volume of greenhouse gases avoided, and the monitoring report must be verified by an independent entity.

As an example, Gevalor (an NGO who recently joined Gret in 2018) estimates that in Mahajanga, Madagascar, a 1,000-tons-per-year composting facility can avoid 15,954 t of equivalent CO_2 in 10 years. With an estimated price of USD 20/tons of equivalent CO_2, the composting facility can expect to receive approximately USD 320,000 during this period.

Recommended activities	Participating stakeholders
Carbon offsetting	COMPED

4.1.3 Conclusion

Improving waste separation in Battambang city—with a focus on recovering organic waste and, in particular, carbon-rich organics—greatly improves the business case for the COMPED facility. Without waste separation, the facility will require a large subsidy; therefore, it is highly recommended that all solid waste management actors engage in the report recommendations' proposed activities for improved solid waste management activities in Battambang city. Additionally, technical assistance must be provided to ensure these activities are thoroughly implemented.

Through certain improved marketing efforts, advanced quality control (testing), and an increase in production, the selling of compost will likely have positive results. An in-depth study is recommended to further analyze the markets for different types of products, some of

[51] Google Maps, https://goo.gl/maps/gSeCEd628VvN3ekF9.

which will be covered in other related projects in the near future. Additionally, it is strongly recommended that the composting area at the facility be increased to 1,200 m^2 in the short term, to facilitate the ability to produce greater quantities of compost and, if possible, for COMPED to obtain registration to benefit from a carbon offset program.

4.2 Battambang Plastics Products[52]

4.2.1 Market Analysis

The manufacturing of plastic products in Cambodia is quite limited, with most plastic products (recyclables and pellets) being exported to Vietnam and Thailand and other countries. For those who recycle in Cambodia (e.g., Gomi Recycling 110 Company, a Japanese company), high-quality source products (pellets) are required.

Phnom Penh is located slightly farther away than the market in Thailand but could offer additional opportunities. Table 16 lists several factories that have expressed interest in buying locally made recycled pellets; however, all were hesitant to fully commit to purchasing without viewing sample pellets to examine the quality. Furthermore, while there appears to be a plastic bags producer in the Battambang area, the pellets are not of high enough quality to be sold there, and the contact information was proved to be invalid. Unfortunately, without a clearer picture of the final quality of the products, further market analysis is difficult to clarify. Below is a list of buyers that did express interest if their standards were met; BPP should market to them first after beginning operations with the UNIDO upgrades.

Table 16: List of potential markets in Phnom Penh for BPP[53]

No	Company	Address	Contact	Current Suppliers
1	VSY Plastic factory	Russian Federation Blvd, Sangkat Tuek Thla, Phnom Penh	070 669 464, 095 665 464	China and Thailand
2	Modern Plastic & Packaging (Cambodia) Co., Ltd.	Road No. 2, Chakangrae Krom, Meanchey, Phnom Penh	023 425 234, 023 425 235	Thailand
3	UST Crafts	St. Lum, Prek Tapov, Prek Pra, Sba Ampov, Phnom Penh	097 97 07 573, 011 74 70 71	China
4	SHPP	No. 329, St. 245 Mao Se Tong Blvd, Sangkat Phsa Depot 1 Phnom Penh	078 786 667	Vietnam

The biggest risk to the market is that the enforcement of this decree on plastic bags will have a significant impact on BPP activity. However, changes regarding restricting the purchase of products in Thailand (such as banning plastic waste imports, as is already the case for China and Vietnam) will benefit the company and potentially counteract any changes to Cambodian law enforcement. Consequently, support should be provided to BBP to diversify its production (LDPE, HDPE, etc.). Furthermore, such changes would mean junk shops will have to pre-process their materials if they want to continue to sell it in Thailand or other foreign countries, making BPP a desirable client. This creates an opportunity for the Cambodian manufacturing market to improve a closed recycling loop within the country.

[52] The business modeling was removed (including in the annexes) for confidentiality reasons.

[53] There is one known manufacturer in Battambang; however, the contact information obtained was invalid and further information was unable to be located. Additionally, several others located in Phnom Penh were contacted, but they were not interested in buying recycled products.

4.2.2 Recommendations

Recommendation 1: Ensure promotion to public about plastic bag recycling

The single best possible improvement for BPP is to promote plastic bag recycling in the city. Most informal waste pickers in the town and population do not know that plastic bag waste has a market value, and many generators are also unaware of this. While it can be a challenge to collect and store plastic bags, compared to the low rates paid for their recovery, further promotion of the facility will increase awareness and likely improve BPP's ability to collect materials locally. Furthermore, educating about the higher pay rates for clean waste may increase recovery.

Two useful tools for promoting BPP include obtaining certifications from two ministries. The first certificate is provided by the PDoE, who has the ability to issue certificates to environmentally friendly entities. The dialogue between BPP and PDoE should advance awareness of plastic recycling in Battambang city as well as build the capacity of both the PDoE and BPP to improve health and hygiene management in recycling. One option to assist with this would be to provide health and hygiene training (as will be provided to the et chay) to BPP staff.

Secondly, the Ministry of Industry and Handicraft (MIH), which oversees industry operations and certifications, offers operations certificates for meeting standards. These standards are clear for common facilities, such as garment manufacturers, but may not be as clear for entities such as BPP. Regardless, BPP should engage with the ministry to understand the steps that can be taken to obtain the certificate.

Recommended activities	Participating stakeholders
Promote the need for plastic bag recycling to the population and informal pickers in the town, including information on how to clean the materials and the prices for clean bags.	Municipality Sangkats/villages PDoE
Organize a workshop to promote recycling in Battambang, with local authorities, junk shops, waste pickers, and operators involved in the recycling sectors.	Municipality PDoE
Seek an environmental practice certificate from the PDoE.	PDoE BPP
Train staff to carry out good hygiene practices at the facility.	BPP

Recommendation 2: Buy plastics from junk shops

One way to improve the market for BPP is to engage with and buy clean waste directly from junk shops, rather than competing with them to buy from et chay collectors. While plastic waste from the landfill is cheaper, it is dirtier so more time and money is needed to sort and wash it, nullifying the costs saved. The amount of raw, clean, sorted inputs is lower. Plastic waste from junk shops, in contrast, is more expensive but is well sorted and cleaner, which increases the price from 200 to 500 riels/kg while reducing overhead costs, and with UNIDO's upgrades to produce higher quality pellets, more money can be made from products sold at higher prices.
This would provide cleaner waste inputs, reducing BPP's overhead costs and also middleman processing fees. Due to a lack of knowledge and limited willingness of junk shops to share information with formal stakeholders, improved communication between BPP and junk shops is essential, pitching BPP as an entity that provides an added value by reducing the need for middlemen during on-sale to local or international entities.

Recommended activities	Participating stakeholders
BPP communicates with and encourages junk shops to buy and sell plastic bags by sending trucks to collect plastic bags.	BPP, junk shops, et chay collectors
Work with junk shops to source other plastics for processing, then on-sale to Thailand.	BPP
Propose services to junk shops to increase the added value of their activities (compaction, shredding, etc.).	BPP

Recommendation 3: Sell to local manufacturers

As mentioned in the market analysis section, the UNIDO upgrades will potentially allow BPP to sell to local manufacturers. As soon as the new products are available, BPP should immediately contact the manufacturers and take samples to them. The manufacturers have stated their interest in buying locally but need a better understanding of the product quality provided by BPP. Transportation costs must be accounted for, as most manufacturers are located in the Phnom Penh area. Overall, with the unpredictable future of plastic exports, it is in BPP's best interest to develop a relationship with at least one manufacturer in Cambodia in case of sudden changes internationally.

Recommended activities	Participating stakeholders
Send samples to manufacturing facilities in Cambodia (after UNIDO upgrades are implemented).	BPP
Develop relationship with at least one buyer in case of sudden changes in international plastic exports.	BPP
Capacity building on sale skills and marketing strategy	BPP

Recommendation 4: Support BPP to comply with the legal standards on recycling and environmental protection

While the facility provides important recycling activities, attention must be paid to the significant volume of wastewater produced by this factory and efforts made to reduce this environmental impact.

Recommended activities	Participating stakeholders
Hire a consultant and independent laboratory to carry out an environmental and social impact assessment.	BPP
Carry out recommended improvements to comply with existing standards.	BPP

Recommendation 5: Feasibility study to diversify the production

Based on a detailed feasibility study, BPP could consider diversifying its production by processing hard plastic and/or processing non-recycled materials such as Styrofoam. BPP could also develop certain pilot recycling activities (pyrolysis of plastic, production of SRF, etc.) to increase the quantity of materials to be diverted to the landfill.

Recommendation 6: Improve company governance and management

Good governance and transparency are significant factors in a company's success and scale. However, BPP is ran as a family business, it does not have a clear board structure and no management team. Further, the business is still not fully registered and is operating without proper book-keeping and financial system.

Recommended activities	Participating Stakeholders
Provide regular advice on business operations	BPP
Capacity building on financial systems	BPP

4.2.3 Conclusion

Promoting BPP's services locally to improve the intake of materials (cleaner plastics) and increasing marketing of BPP's products in Cambodia are both necessary. This will be even more crucial if the international market becomes more restricted, providing opportunity in Cambodia. Solid waste management projects should focus on plastics recycling and recovery within the country to close the recycling loop.

4.3 Materials Recovery Facility

Due to the vibrant informal sector in Battambang and the large quantity of organic waste, the MRF provides limited added value to the recovery of dry, high-value recyclables. However, the MRF, as a sorting chain, can recover lower value recyclable materials and contribute to diverting a significant amount of materials away from the landfill. The following are recommended to improve the functioning of the facility in the long term.

Regardless of the options pursued at the MRF, the first action is to establish an official agreement with a subcontractor to run the MRF. Without this, implementation will stagnate, and roles and responsibilities will not be clear. This agreement should clearly indicate who will operate the facility and outline a detailed action plan, including business modelling and resource mobilization.

Option 1: Begin Operations Immediately

As designed, the capacity of the MRF is to intake eight tons of dry waste per day with eight sorters working on a normal working schedule of an eight-hour shift for a six-day work week. Therefore, this requires having one sorter per ton per day. The et chay thus far are not keen on working at the facility because they make more money collecting waste rather than at the facility. However, with the implementation of the market campaign, it will be necessary to have a functional facility for sorting the non-organic waste.

It is suggested to have two sorters working full time with an average salary similar to the average monthly income of an et chay collector. As the amount of waste increases as the campaigns proceed, the amount of staff should increase accordingly, based on the amount of waste (one worker per ton per day). The opening of the new landfill may also provide opportunities to the et chay at the landfill, instead of leaving them without work. To facilitate this transition, the closure and planned move of the landfill must be communicated to the et chay.

Since 80% of the et chay are women, employing them provides the opportunity to bestow stronger livelihoods for women.

It is difficult to assess exactly how much of the funds can be recovered by the MRF from the collection and sale to junk shops, as it is unclear how much of the recyclable waste will make it into the bin. With so many variables and unknowns, one cannot reasonably define a breakeven point. However, it is believed that, due to the large activity from the et chay operating in the city, only the less valuable recyclable materials are currently going to the landfill. Therefore, while it is possible to divert these lower value recyclable materials before reaching the landfill, it seems to be very complicated (or impossible) to balance the MRF budget with only income from recyclable materials and highly likely that MRF operations will require a significant subsidy in the long term. To fully analyze how much of a subsidy is necessary, a characterization campaign must be carried out at household and landfill levels to determine the efficiency of the collection by the et chay and the value of the remaining recyclable materials.

Option 2: Function as a Junk Shop

There is an opportunity for the MRF to play a role as a junk shop. To do so, it would need to be equipped with the appropriate machinery, such as compactors, and find markets to export directly to Thailand or Vietnam.
The MRF would have to begin buying waste from the et chay. Buying from the et chay at the landfill would be ideal; however, there is a challenge in that they are currently obligated to sell to certain junk shops, so this exchange would require an agreement between the municipality, Leap Lim, and CINTRI.

Option 3: Clean Plastic Bags for BPP

Another option would be to buy, clean, and sell plastic bags to BPP. With the recent move of BPP, this could facilitate an added value simply because the MRF is located in the city. BPP would benefit from having cleaner waste, and the MRF would benefit by gaining income from the cleaner products.

This would require significant machinery and facility upgrades from a donor. It should be noted that a source of water is necessary to implement this activity.

A potential drawback is that BPP already frequently picks up plastic bags directly from the landfill. Additionally, it is unclear if this recommendation is simply adding the MRF as a middleman that would instead drive up prices. Much of this is dependent on the improved recovery of plastic bags overall, in conjunction with the campaign.

Option 4: Recycle Styrofoam

A further possible upgrade is for the MRF to fill a missing niche and recycle Styrofoam waste. A significant number of upgrades would be necessary, including a possible need for more space. The following are potential options for the recycling of Styrofoam:

- Recovery: This is a waste-to-energy option. Styrofoam can be crushed and sold as solid recovered fuel, which is the most common way to process Styrofoam.
- Recycling: This type of upgrade would require the crushing, dissolving, precipitating, and extrusion of the materials.
- Recycling: This process would only involve the crushing, washing, and extrusion of the materials.

The difficulty with Styrofoam is it has a low density, thus transportation for recycling is costly. This often makes it difficult to define a good business model. However, with the landfill nearby and the ability to separate the waste, this could be a desirable option. Furthermore, it is unclear if the location of the landfill being much farther away could also make a business case for this option, but it is clear that it would be difficult without separation of the materials.

Option 5: Upgrade to Another TYpe of Recycling Facility or a complete sorting chain

Another option could be to upgrade the MRF to an improved sorting chain to ease the sorting process. During the visit, it was noted that the site was not equipped to effectively sort the waste (only one baler, one glass crusher, one generator, and one loader). To optimize the sorting process, it would be necessary to invest in a trammel, some conveyors, some sorting tables, and an overband. This would allow waste to be effectively sorted before landfilling. The scenario requires support from donors for investment and will very likely require support from local authorities to subsidize operational costs. It could be easier to advocate in favor of this scenario when the new sanitary landfill opens, increasing treatment costs.

The final option is to drastically change into another type of facility that closes the manufacturing loop. One option would be to manufacture plastic products that are bought from BPP. However, the space may not be available for such activities, and a high subsidy would be required to buy the necessary equipment.

Alternatively, the space could be made part of COMPED or a separate organic recycling facility, perhaps serving as an area to have an alternative type of composting, such as vermicomposting. Again, this would require a high subsidy, though the large amount of organic waste generated by the city, if separated, will provide demand for another processing facility.

Annexes

Annex 1: References

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Annexes 2– List of Meetings with Stakeholders

Entity	Person	Date	Topics Discussed
Green Move Consulting	Sophanna Nun	10-Dec-18	Waste recovery and SMEs in Battambang
COMPED Phnom Penh	Sam Phalla	11-Dec-18	COMPED composting facility
BPP	Chheng Kimchheng	12-Dec-18	BPP recycling facility operations and tour
Battambang Municipality, Leap Lim, CINTRI, PDoE	Various	13-Dec-18	Project introduction, CINTRI and Leap Lim operations, recommendations for project
MRF	Leap Lim	13-Dec-18	MRF facility operations and tour
Small Junk shop in Battambang	N/A	13-Dec-18	Costs paid to et chay, interview et chay from neighborhood
COMPED Battambang	John Chek	13-Dec-18	Composting facility operations and tour
Plastic Free Battambang	Kim Knoaa	14-Dec-18	Waste collection observations, recommendations for more interviews
Battambang Municipality	Noy Chek	14-Dec-18	Information on Leap Lim and CINTRI contracts
CORAA (Cambodian Organic Agriculture Association)	Chihoko SUZUSHIMA	9-Jan-19	Understanding organic registration and members, learn about market for compost products
Ministry of Agriculture	Phan Pros	11-Jan-19	Understanding organic agriculture producers in Cambodia
Ministry of Environment	Dek Vimeanreaksmey	14-Jan-19	Understanding future implementation of sub-decree on plastics
FASMEC (Federation of SMEs)	Leksin Rithy, Ly Visal, Souk Mandy	14-Jan-19	Understanding small/medium-sized enterprises for compost and plastic recycling
KAS	Rober Hor	16-Jan-19	Understanding development of Deika (commune-level law) developed by KAS in Battambang

Entity	Person	Date	Topics Discussed
ADB	Ratha Sann	Email	MRF pre-feasibility and design
UNIDO, GGGI, MoE (Department of Hazardous Substances)	Various	13-Feb-19	Trial design
AIMS - Battambang Hub	Kim Huot, Eang Pan-haphеareak, Luy Sophea	21-Feb-19	Understanding the potential market of compost in Battambang
CINTRI- Battambang Branch	Long Phydyoun	22-Feb-19	Understanding current waste collection in Battambang Municipality
MoE, Department of Educational Environment	Various	1-Mar-19	Understanding promotional campaign design and planning for Battambang Municipality
GoGreen Cambodia	Natalya Rodionova	1-Mar-19	Understanding GoGreen application use and future plans
Chamber of Commerce	Unreachable, but used the website as a reference: https://www.ccc.org.kh/		Understanding the potential market of plastic pellets

Annexes 3– List Of Activities During The Data Collection Trip

No	Data Source	Methodology	#Samples
I.	Local authority		
	Commune chiefs	Individual interview	10
II.	Markets (5 local markets: Boeung Chhouk, Phou Puy, Nat, Leu, and Thmey)		
	Market managers	Individual interview	5
	Market cleaners	Individual interview	5
	Market waste collection services	Individual interview	4

III.	Recycling facilities		
	Battambang Plastic Products	Meeting	1
IV.	Informal waste pickers		
	Informal waste pickers at landfill (8 participants)	Focus group discussion	1
	Informal waste pickers at landfill	Individual interview	8
	Informal waste pickers around the town	Individual interview	10
V.	Junk shops		
	Large one that exports to other countries	Individual interview	1
	Medium size	Individual interview	1
	Small size	Individual interview	2
VI.	Other potential stakeholders		
	Bareebo and Kleine Hilfsaktion – nearby organic farm and funder	Phone call	1
	Plastic Free Battambang	Meeting	1
	Provincial Department of Agriculture	Meeting	1
	Battambang Youth Network (4 participants)	Focus group discussion	1
	Group of women (7 participants from Banteay Srey networking)	Focus group discussion	1
VII.	Mapping of public bins	GPS mapping	1

Annexes 4– Waste Collection Fees[54]

No	Description	Price USD
A. Flat		
1	Ground floor flat (E0)	$ 1.0
2	Upper floor flat from 1st floor up	$ 0.5
B. House with business		
3	Ground floor flat (E0)	$ 2.0
4	Ground floor (E0 with multiple houses)	$ 5.0
5	House with company banner	$ 10.0
6	Villa	$ 5.0
7	Villa rented by foreigner	$ 10.0
C. Restaurant		
8	Restaurant	$ 20.0
9	Karaoke	$ 20.0
10	Canteen	$ 10.0
11	Cinema	$ 10.0
12	Handicraft	$ 10.0
13	Petroleum station	$ 10.0
14	Car and motorcycle washing	$ 10.0
15	Motorcycle washing	$ 5.0
16	Public bus station	$ 20.0
17	Company bus station	$ 20.0

[54] Monthly waste collection and transport fee issued in January 2007 by provincial and district governors.

D. Hotel		
18	Hotel (less than 30 rooms)	$ 20.0
19	Hotel (30 rooms or more)	$ 50.0
20	Guest house (below 20 rooms)	$ 10.0
21	Guest house (20 rooms or more)	$ 20.0
22	Administrative hall	$ 1.0
23	Public school	$ 1.0
24	Private school	$ 10.0
25	Private clinic	$ 10.0
26	Private bank	$ 10.0
27	National bank	$ 1.0
28	Company advertising (per night)	$ 30.0
E. Market		
29	Starting at 200 riel/day for each business and seller at public places	

I.4	Operation staff	13	Including drivers, mechanics, etc.
I.5	Sweeping workers	13	Sweeping and collecting waste at public gardens
I.6	Collecting workers	29	Riding with collection trucks to put waste into the trucks
II.	Vehicle		
II.1	Trucks - 11 tons	2	Waste collection and transport
II.2	Trucks - 5 tons	10	Waste collection and transport
II.3	Trucks - 1.5 tons	1	Petroleum transport to landfill and
II.4	Trucks - 16 tons	1	Soil transport to landfill
II.5	Bulldozer - D30	1	Landfill operation

II.6	Bulldozer - D50	1	Landfill operation
III.	Others		
III.1	Cart	3	Sweeping and collecting waste
III.2	Bins for sweeping workers	15	Sweeping and collecting waste

Annexes 5– List of Attendees from the Stakeholder Workshop in May 2019

Workshop: Business Model for a Sustainable Supply Chain for Recyclable Waste in Battambang, with a Focus on Plastic and Organic Waste"

Registration Form

2-May-19

Place: Khemera Battambang Hotel 1

No.	Name	Position	Institution
1	Thin Phalla	Commune Council	Ratanak
2	Ear Kim Cheng	Deputy of Department	DOE
3	Moeun Vibol	1st Vice Chief	Ou Char
4	Che Chhorn	2nd Vice Chief	Toul Ta Ek
5	Phoung Samoeun	Officer	MOI
6	Hok Kimseng	Officer	MOI
7	Aing Kimseang	Database officer	GRET
8	Et Sothea	Tax collector	Nat Market
9	Nim Sour	Facilitator	GIZ/DAR
10	Soeung LyLy	Officer	DGE/GSSD

11	Oeurn Phanavit	Administration officer	DGE/GSSD
12	Teang Sovoeung	Councilor	Sla Kart
13	Khorm Sakhorn	Interpreter	Big taxt
14	Phon Theoun	Interpreter supporter	Big taxt
15	E Vuthy	DSG	NCSO
16	Sout Samdy	Officer	GGGI
17	Delasal	Director	SAMATOA
18	Kim KNORR	BTB Kad	PFC
19	MARCUSWOLL	Director	NEARADEI NGO
20	Tith Rotha	Assistant	Municipality
21	Beu Sok Thoeut	Councilor	Wat Kor
22	Oeun Panhaneat	Deputy of Department	GSSD
23	Nout Nivann	Manager	Department of Agriculture BB
24	Long Pidi oun	CINTRI	CINTRI
25	Peng Sopheap	Councilor	
26	Karolien Casaer	GGGI Country Rep	
27	Soeun Chamrong	Office of Beautification and Solid Waste Management	Battambang
28	Dek Vimeanreaksmey	Deputy of Department	MOE
29	Chin Somaly	Commune Council	Prek Preah Sdach
30	Sary Mithuna	Student	Youth Network BTB
31	Mey Phavorn	Student	Youth Network BTB
32	Sou Ara H'vatt	Battambang Provincial Governor	
33	Noy Chek	Administration Manager	Municipality

34	Sean Bophaphal	Assistant	Comped
35	Prak Monita	Administration officer	GRET
36	Em Oeurn	Commune Council	Svay Pou
37	Erm Si Yoeun	1st Vice Chief	kdol Dounteav
38	Yart Pok	Commune Council	Ou Mal
39	Seng Siri ratanak	Local market	Apsara Phsar leu
40	Leap Lim	Manager	Leap Lim Waste Collective
41	Touch Sokharith	Project Manager	GRET Siem Reap
42	Terra Michaels	TA	GRET
43	Sean Phivan	Manager	Beoung Chhuk Market
44	Hoeun Deou	Deputy Governor	Municipality-BTB
45	Som Rie	Deputy of Commune	Phsar Nat
46	Thit Metchor ra	Manager of Department of MOE	UNIDO
47	Tem Sokchan	Administration officer	

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