3.2 Action Plan

COSTED FEASIBILITY MODELS AND ACTION PLAN FOR IMPLEMENTING COMPOSTING AND RECYCLING OPTIONS FOR PRIMARY WASTE COLLECTION IN MONROVIA, PAYNESVILLE, AND SURROUNDING TOWNSHIPS

FUNDED BY THE EUROPEAN UNION

Cities Alliance
Cities Without Slums

HOSTED BY UNOPS

This study was conducted within the context of implementation of the project "Delivering Climate Resilient Solid Waste Management Services in Greater Monrovia, Liberia through Community-Based Enterprises"

Title:
Costed Feasibility Models and Action Plan for Implementing Composting and Recycling Options for Primary Waste Collection in Monrovia, Paynesville, and Surrounding Townships

3.2 Action Plan

Cities Alliance – 2021

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CONTENTS

ILLUSTRATIONS

TABLES

ACRONYMS

Acronym	Definition
CBE	Community Based Enterprise
CLUS	Cheesemanburg Landfill and Urban Sanitation
CMT	Community Management Team
EPA	Environment Protection Agency
EMUS	Emergency Monrovia Urban Sanitation Project
EU	European Union
FTE	Full Time Equivalent
GoL	Government of Liberia
ICEA	Ingénieurs Conseil & Economistes Associés
IMPAC	Improved Primary Solid Waste Collection in Poor Communities of Monrovia Project
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LRTF	Liberia Reconstruction Trust Fund
MCC	Monrovia City Corporation
NACOBE	National Association of Community Based Enterprises
NDC	Nationally Disclosed Contribution
PCC	Paynesville City Corporation
SME	Small and Medium Enterprise
SWM	Solid Waste Management
UNOPS	United Nations Office for Project Services
UNDP	United Nations Development Program

1. INTRODUCTION

1.1 The project

In March 2019 after an international tendering process, UNOPS/Cities Alliance selected ICEA, in partnership with Espelia, to carry out a study on "Costed Feasibility Models and Action Plan for Implementing Composting and Recycling Options for Primary Waste Collection in Monrovia, Paynesville and Surrounding Townships." A first field visit took place in April 2019, and in Inception Report was submitted on 6 May.

The study area covers Monrovia, Paynesville, and the surrounding townships known as **Greater Monrovia**. This area has no administrative existence, but comprises:

- **Two municipalities:** Monrovia City Corporation and Paynesville City Corporation
- **Twelve Townships:** Barnersville, Brewerville, Caldwell, Congo Town, Dixville, Gardnersville, Garwolon, Johnsonville, New Georgia, New Kru Town, Virginia, and West Point.

The Township of Cheesemanburg is the site of the proposed new Cheesemanburg landfill. The existing Whein Town landfill reaching its capacity, the construction of a new landfill is planned under the Cheesemanburg Landfill and Urban Sanitation (CLUS) Project, a World Bank operated project co-funded by the Liberia Reconstruction Trust Fund (LRTF) and the GoL.

The study covers municipal solid waste, i.e. solid waste generated by households, administration, commercial and industrial activities. It does not include medical or hazardous waste that needs to be collected and treated separately.

Cities Alliance (hosted by UNOPS) is implementing EU-financed projects on Primary Waste Collection and Waste-to-Energy Alternatives for Greater Monrovia. These two projects aim to support Liberia's Nationally Disclosed Contribution (NDC) to the United Nations Framework Convention on Climate Change by improving the primary waste collection system as well as providing viable alternatives such as waste recycling, composting, and Waste-to-Energy alternatives.

These two projects seek to work directly with Community Based Enterprises (CBEs) to ensure that solid waste management in Liberia is viewed as a value chain from the household to the landfill site. This project builds on the experiences of the Improved Primary Waste Collection in Poor Communities (IMPAC) project – funded by the Bill and Melinda Gates Foundation – which established and trained CBEs and Community Management Teams (CMTs). The IMPAC project demonstrated that the CBE model is successful for primary solid waste collection and that it would benefit Monrovia, Paynesville, and surrounding townships in their mandate for waste collection.

In parallel to this study, two other studies have been carried out. Both are linked to the development of composting/recycling activities in SWM systems.

1. The *Action Plan for horizontal and vertical expansion of the Community Based Enterprise (CBE) system for Primary Waste Collection* aims to "develop a costed and financially viable Action Plan for the horizontal and vertical expansion of the CBE system, including an indicative budget for full horizontal expansion and vertical expansion into Composting and Recycling." It includes a market demand analysis for composting and recycling systems to "determine initiatives which could be implemented as pilot projects to diversify the economic model of the CBEs."
2. The *Feasibility Study on Waste-to-Energy Options* aims to develop a small pilot scheme based on dry anaerobic digestion, working with organic waste. To be successful in the long run, it will require a system for organic waste separation, most likely at source. One of the products from the system will be digestate, which can be used as composting material. The study develops concepts for organic waste separation as well as the market for, and potential value of, compost.

1.2 Context and objectives

After the civil war, a simple but robust waste collection system was introduced in Monrovia and gradually improved. A sanitary landfill and two transfer stations were built, and the collection system was upgraded to cover a significant part of the municipal waste generated.

The Monrovia City Corporation and Paynesville City Corporation, which are responsible for solid waste service delivery as well as oversight and supervision, have been outsourcing different parts of the service to the private sector. Two collection contracts are in place with two private operators, and the sanitary landfill is operated by a third one. Pre-collection is undertaken by CBEs.

Identified as one of the highest priorities of the national and local governments, the municipal solid waste management system has also benefited from the strong support of international donors, with financing for several important projects: the World Bank's Emergency Monrovia Urban Sanitation Project (EMUS); Cities Alliance's Primary Waste Collection and Waste-to-Energy Alternatives for Greater Monrovia projects; and the Bill & Melinda Gates Foundation's Improved Primary Solid Waste Collection in Poor Communities of Monrovia Project (IMPAC).

It is clear that the CBE model is successful, and that the SWM system in Monrovia has emerged from the emergency phase. Continuous efforts are being made to expand the area served and reduce illegal dumping.

The challenge is now to offer durable solutions to improve SWM, including prolonging the longevity of the landfill, improving livelihoods, creating jobs, and generating internally alternative financial resources for stakeholders. The vertical expansion of the CBE system into composting, recycling, and reuse is the way to achieve these objectives.

1.3 The Action Plan report

The study began in mid-April, and an Inception Report was submitted and approved at the end of April.

A Feasibility Study Report (FSR) was submitted on 2 June. Its overall objectives are to:

- **Examine the existing municipal SWM cycle and value chain** in Monrovia, Paynesville, and surrounding townships; and
- **Identify waste flows and composting/recycling value chains to prioritise** for improving the SWM system.

A workshop was held in Monrovia on 4 July to:

- **Share SWM diagnosis and priorities and build a consensus among stakeholders**; and
- **Prepare an Action Plan to develop value chains** through two participatory sessions to identify constraints and prerequisites, as well as actions that could be implemented to mitigate them.

In this context, this Action Plan Report (APR) proposes a comprehensive action plan for implementing the identified strategy and actions. It presents:

- **The composting/recycling value chains strategy for Greater Monrovia**; and
- **The action plan itself for developing composting/recycling value chains.**

A draft version of the Action Plan was submitted on 26 July 26, and presented and discussed during a workshop in Monrovia on 1 August. A second report was submitted on 8 August that integrated the comments received on the draft version. A final round of comments was received on 30 September and are included in the final report.

2. COMPOSTING/ RECYCLING VALUE CHAIN DEVELOPMENT STRATEGY

2.1 General objectives

A simple but robust SWM system has been implemented in Greater Monrovia and Paynesville with the strong support of international financial institutions. It has been demonstrated that this model, under constant evolution, is successful and that the SWM system has emerged from the emergency phase.

The challenge is now to offer durable solutions for improving solid waste management in Greater Monrovia that prolong the lifespan of the landfill, improve livelihoods, create jobs, and generate internally alternative financial resources for stakeholders.

Developing composting/recycling value chains is identified as a main part of addressing this challenge. Vertical expansion of the CBE activities into composting, recycling and reuse is the proposed way to achieve this objective.

A feasibility study has identified targeted waste flows and value chains to focus on, including collection, transfer, manufacturing process and marketing methods. It provides priorities for developing composting/activities and offers recommendations. This analysis covers municipal waste generated by households and businesses; it does not cover hazardous or medical wastes that need to be treated separately.

The objective of this report is to present a comprehensive action plan to implement the strategy for developing composting/recycling activities.

2.2 Targeted waste flows and value chains

2.2.1 POTENTIAL QUANTITY OF RECYCLABLES

In 2018, it was estimated that 532 tons of waste are generated every day in Greater Monrovia, of which 202 tons are recyclables. Only a minor part of the waste generated is currently recovered; 348 tons are disposed in the landfill, 184 tons are dumped in illegal dumping sites, and 10 tons are recycled or composted. The major part of waste recovered is metals (almost 60%).

The analysis of waste volume and composition shows that there is a high potential quantity of recyclables. Taking into consideration improvement of the collection ratio, the quantity of recyclables collected is estimated at 121 tons/day in 2020 and is expected to increase to 245 tons/day in 2040. Of these recyclables, 40% is composed of clean organic waste and 33% of plastics.

FIGURE 1: Waste flows chart in Greater Monrovia (2018)

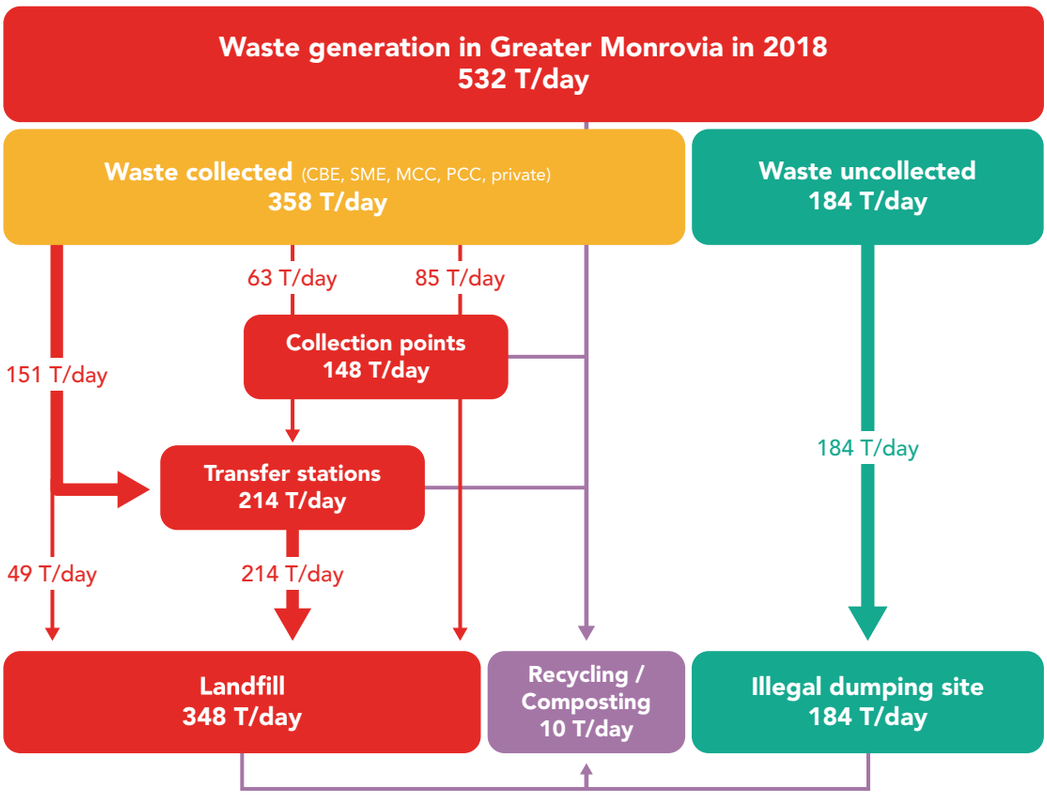
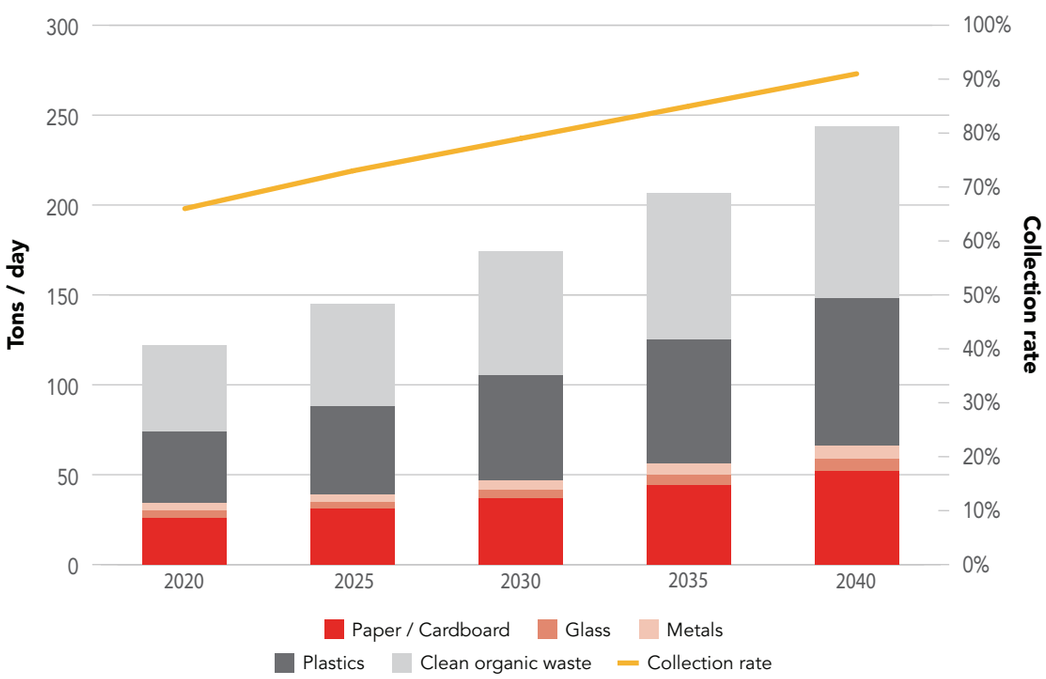


FIGURE 2: Potential quantity of recyclables



2.2.2 TARGETED WASTE FLOWS

A SWOT analysis of each waste flows subject to recycling/composting has been carried out. A decision-making grid sorts out waste flows to focus on with the objective of developing composting/recycling activities. Five criteria are used:

- **Availability:** Ease of collection/separation
- **Quantity:** Potential stockpile for the waste generation
- **Quality:** Quality of the stockpile to be composted/recycled
- **Actors:** Existence of recycling/composting actors on the market
- **Demand:** Existence of a solid demand for the product
- **Gender:** Capacity to develop activities undertaken by women

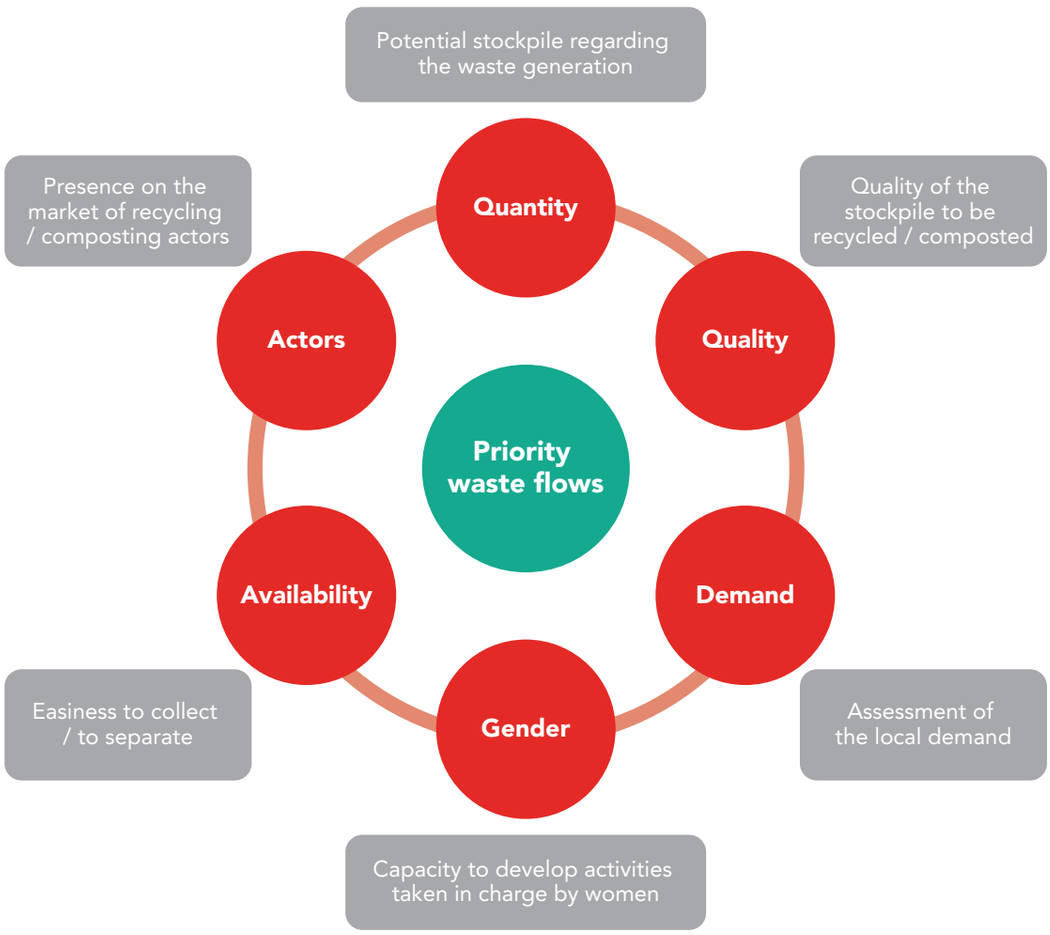
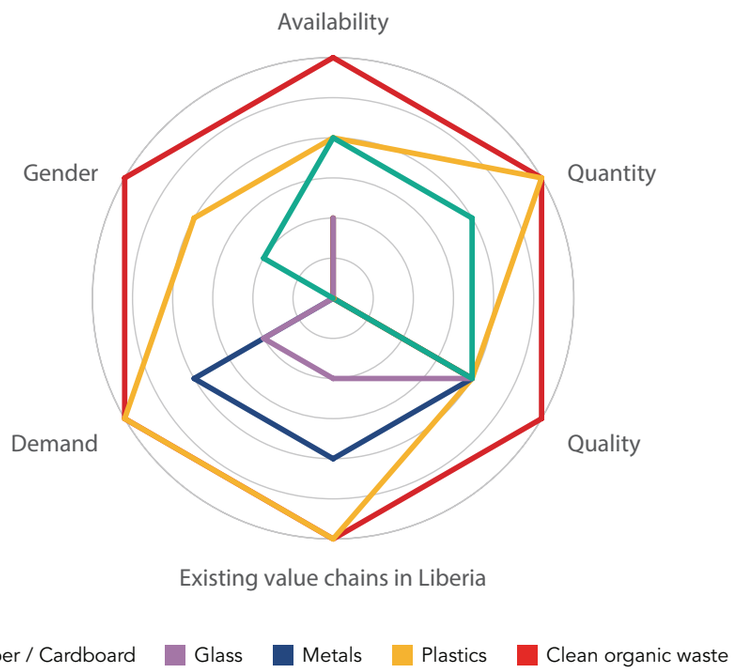


FIGURE 3: Ranking of waste flows according to their composting/recycling potential



According to the ranking grid, the two priority waste components to focus on for developing composting/recycling activities are:

1. **Clean organic waste; and**
2. **Plastic waste.**

2.2.3 VALUE CHAIN ASSESSMENT

Several value chains can be developed based on the two targeted waste flows (clean organic waste and plastic waste):

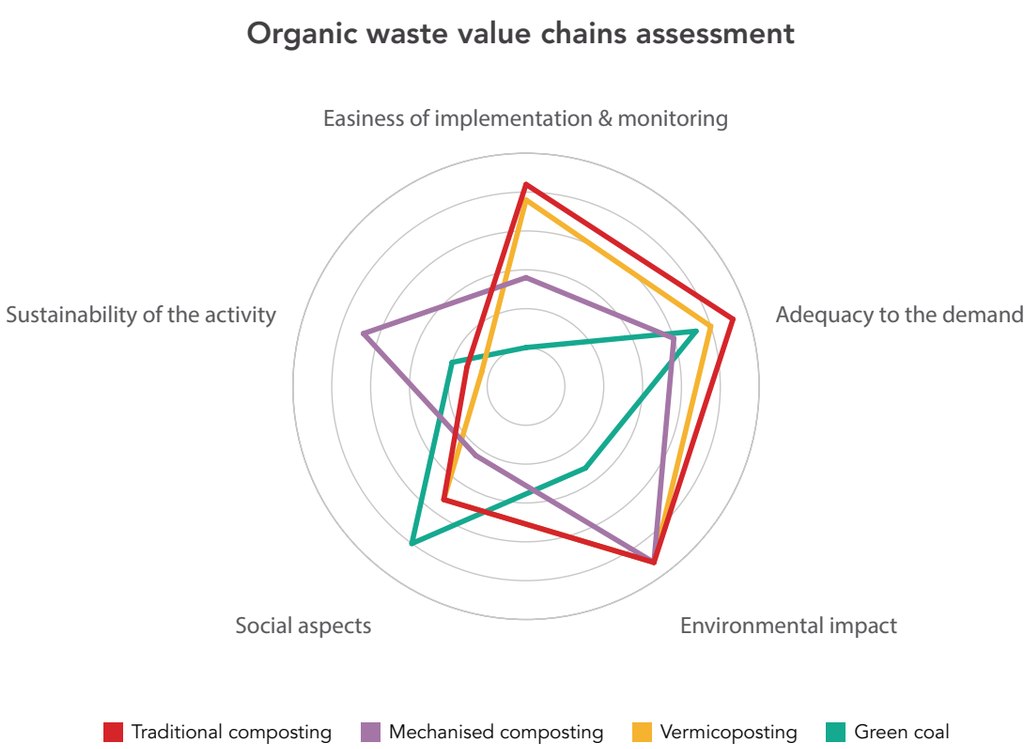
1. **Clean organic waste**
   - Traditional composting/co-composting
   - Vermicomposting
   - Mechanised composting
2. **Plastic waste**
   - Tiles and bricks production
   - Plastic pellets/HDPE granulates production
   - Manufactured plastic items

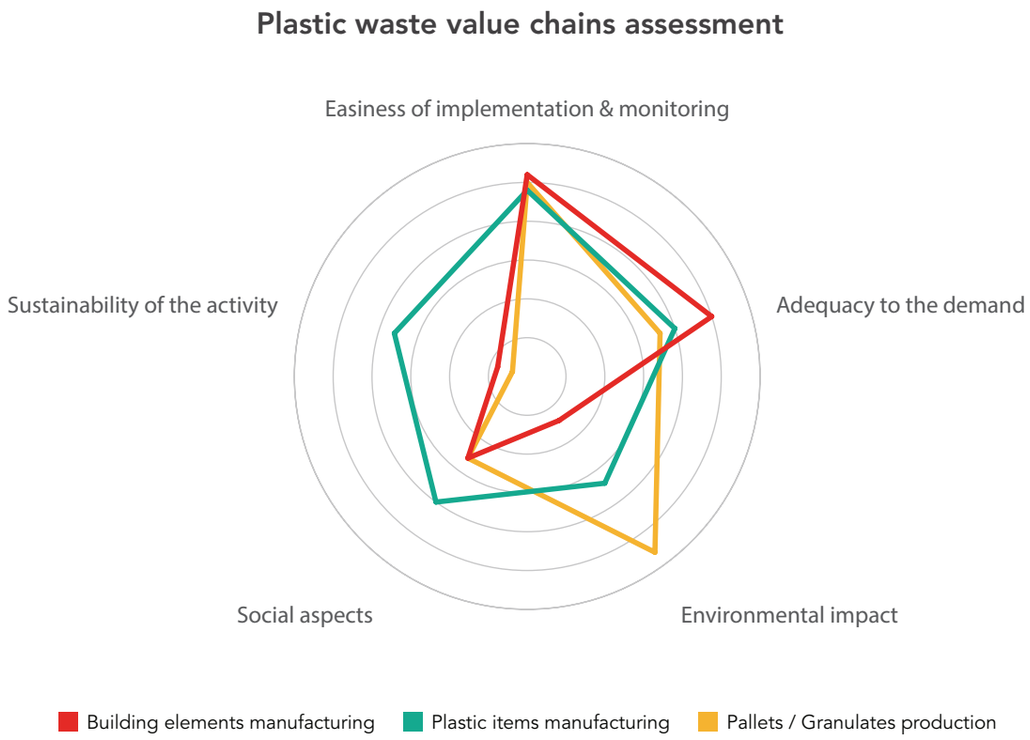
Based on the characteristics of the waste flows and the value chains, all the value chains are assessed according to several criteria:

1. **Ease of implementation and monitoring:** Land needed; investment required; awareness of the beneficiaries and waste generators
2. **Adequacy to the demand:** Existence of local demand; existing competition from local and/or imported goods; existing actors and maturity of these actors
3. **Environmental impact:** Waste diversion; recyclability and sustainability; mitigation measures to implement;
4. **Social aspects:** Employment creation; gender angle; accessibility of products to disadvantaged populations
5. **Sustainability of the activity:** Profitability; flexibility (capacity to develop the activities, diversification); institutional aspects (adequacy of the current SWM system and legal and institutional framework)

The value chain assessment shows that the primary value chains to focus on are traditional composting for organic waste and plastic item manufacturing for plastic waste. It does not exclude supporting the development of current recycling and composting activities in Monrovia, such as tile and brick production.

FIGURE 4: Value chain assessment





2.3 Implementation strategy

2.3.1 OVERVIEW

Taking into consideration these constraints and prerequisites, the development of recycling/composting activities is based on a three-phase strategy from 2020 to 2040, determined according to targets for waste tonnage and sources.

They must take into account the objectives of waste-to-energy targets in terms of volume and source of waste.

The development of recycling activities will also depend on the regulatory framework. For instance, a regulation to ban plastic bags would have an impact on recycling activities concentrated on this specific waste flow.

The indicators proposed to monitor the development of the value chains are:

- Quantity of organic waste at the entrance of the recycling/composting units;
- Quantity of plastic waste at the entrance of the recycling units; and
- Quantity of waste disposed at the landfill in order to assess the diversion from landfill rate.

The indicators are deliberately simple to facilitate data collection and monitoring. The unit used will depend on the existence of functional weight-bridge or other weighting systems.

2.3.2 COMPOSTING ACTIVITIES

The three-phase development strategy is as follows:

- **Phase 1:** From now to 2030, focusing on marketplace organic waste collection with the objective of increasing collection from the current 1% of organic waste to 10% in 2030.
- **Phase 2:** From 2031 to 2035, extension of organic waste collection to food businesses and identified pilot district with the objective to collect 30% of organic waste in 2035.
- **Phase 3:** From 2036 to 2040, gradually extending to all districts and generators with the objective of collecting 50% of total organic waste in 2043.

TABLE 1: Organic waste – objectives and strategy for composting

	Current	Phase 1	Phase 3	Phase 4
Target (% of clean organic waste collected)	1%	10%	30%	50%
Target (tons/day of waste treated)	2.4 tons/day	5.8 tons/day	20.7 tons/day	41 tons/day
Target year	2020	2030	2035	2040
Strategy		Focus on marketplaces	Extension to food businesses & pilot districts	Gradual extension to all districts and generators

2.3.3 PLASTIC RECYCLING ACTIVITIES

The three-phase development strategy is as follows:

- **Phase 1:** From now to 2030, focusing on businesses located in pilot districts and marketplaces with the objective of increasing collection from the current 6% of plastic waste to 15% in 2027.
- **Phase 2:** From 2031 to 2035, extending to households and administration in pilot districts and to businesses in other districts with the objective of collecting 25% of plastic waste in 2035.
- **Phase 3:** From 2036 to 2043, gradually extending to all districts and generators with the objective of collecting 35% of total plastic waste.

TABLE 2: Plastics – objectives and strategy for recycling

	Current	Phase 1	Phase 3	Phase 4
Target (% of plastic waste collected)	6%	15%	25%	35%
Target (tons/day of waste treated)	0.5 tons/day	6.9 tons/day	24.6 tons/day	48 tons/day
Target year	2020	2030	2035	2040
Strategy		Focus on businesses located in pilot districts and marketplaces	Extension to households and administration in pilot districts and to businesses in other districts	Gradual extension to every district *(marketplaces, businesses, administration and households)*

2.3.4 PILOT PROJECTS

It is proposed that Cities Alliance implement a pilot project for both activities within the first years of Phase 1. This pilot would be designed according to the budget available and deducted from the Cities Alliance contract No ENV/2017/393-690 through budget reallocation.

TABLE 3: Cities Alliance Contract No ENV/2017/393-690 budget reallocation [Extract]

Purpose	Budget (€)	Comments
Outreach Campaign	300,000	Awareness campaign, promotion, etc.
Sorting Station	300,000	3 sorting stations at € 150,000 each
Small Grant for Waste Reuse Pilot: Plastic	420,000	
Small Grant for Waste Reuse Pilot: Organic waste to composting	420,000	

Source: Cities Alliance

2.4 Constraints/pre-requisites for developing value chains

There are several identified constraints and prerequisites for developing composting/recycling value chains. Most were identified during the field survey and presented and discussed during a participatory session of the first workshop held in Monrovia on 4 July 2019.

These constraints and prerequisites concern every step of the value chain (collection, transport, manufacturing process, and marketing).

2.4.1 COMPOSTING – PRIMARY VALUE CHAIN

2.4.1.1 Availability of land

Land is necessary to sort, store and transform the organic waste. It must be close to waste generators to reduce waste transportation costs and to users to reduce delivery costs. It must be supplied with power and water.

Sorting plants, storage warehouses and composting plants can be located in different places but, for reasons of efficiency, land large enough to host all these facilities is preferable.

2.4.1.2 Lack of adapted tools and equipment

Sorting, transportation, and transformation of organic waste require appropriate tools and equipment. This includes motorised equipment for organic waste transportation from waste generators to the plants, for product delivery to customers, and for processing organic waste into compost.

2.4.1.3 Awareness of generators

In order to obtain a high-quality product, sorting at source is preferable. This requires awareness-raising measures and, if necessary, financial incentives. To improve the efficiency of organic waste collection, a first step should focus on big waste generators, such as marketplaces.

2.4.1.4 Human resource capacity

This activity must attract skilled and motivated workers and technicians, including women and young people. The workforce must be trained to guarantee the manufacture of high-quality products. This includes sales and marketing officers able to promote and sell products to customers. In this context, capacity building and training of human resources is essential.

2.4.1.5 Competition from imported chemical fertilisers

Organic fertilisers face competition from imported chemical fertilisers, which are widely used by farmers. To compete with imported products, organic fertilisers must demonstrate that they are efficient and adequate to meet farmers' needs. Awareness campaigns focusing on farmers, training for farmers, developing a demo-farm, and other activities are necessary to encourage the use of locally produced organic fertilisers instead of imported chemical fertilisers.

The price of organic fertilisers is also an issue; it must be competitive compared to imported chemical fertilisers if it is to be adopted by farmers in the long term.

2.4.2 PLASTIC ITEMS MANUFACTURING – PRIMARY VALUE CHAIN

2.4.2.1 Availability of land

Land is necessary to install the plant. This land must be close to waste generators to reduce waste transportation costs, but also close to users to reduce delivery costs. It must be supplied with power and water and be large enough to host a logistic and sorting platform, accessible to plastic waste providers.

2.4.2.2 Lack of adapted tools and equipment

Plastic item manufacturing is an industrial process that needs specific equipment to wash, dry, shred, and mold plastics. A specific investment must be made to develop an appropriate plant. The process selected must also be environmentally friendly and avoid negative impacts on the environment and health (gas emission, smell, residues) as much as possible.

Transportation equipment is also needed to transport plastic waste from generators to the plant and from the plant to selling points.

2.4.2.3 Awareness of generators and collectors

In order to ease the manufacturing process, sorting at source is preferable. It requires awareness raising measures focusing not only on generators but also on collectors to introduce sorting at source and separate collection, including, if necessary, financial incentives.

2.4.2.4 Lack of cooperation/mutualisation between operators

The plastic item manufacturing value chain is more profitable at a large scale, due to economy of scale at the collection, transport, manufacturing, and marketing levels. Collecting a large amount of plastic waste requires cooperation and/or pooling of resources between operators.

2.4.2.5 Human resource capacity

This activity must attract skilled and motivated workers and technicians, including women and young people. This workforce must be trained to guarantee the manufacture of high-quality products. This includes sales and marketing officers able to promote and sell products to customers. In this context, capacity building and training of human resources is essential.

2.4.2.6 Competition from imported plastic items

Locally produced plastic items face competition from imported products. To compete with these imported products, specific promotion and awareness campaigns focusing on environmentally friendly and "made in Liberia" products are necessary. For these items, price is also an issue; pricing must be competitive with imported plastic items.

2.4.3 TILES AND BRICKS MANUFACTURING – SECONDARY VALUE CHAIN

2.4.3.1 Lack of processing equipment

The recycling facilities are generally manual (not industrial) and done without smoke treatment. The lack of mechanised facilities negatively impacts the working conditions of the operators.

Melting plastic – as long as it is not burned – does not contradict major international directives. Nevertheless, prolonged exposure of workers to plastic waste smoke could have irreversible health impacts. If the process is not equipped with a smoke treatment system, the facility should at least be equipped with a chimney pipe and workers with adapted masks and glasses.

There are two other points to keep in mind about this particular process. There is currently no study on the micro-plastics content of storm water. Moreover, when building elements produced from plastic waste become waste themselves, it will release the plastic into the environment with detrimental impacts.

Other equipment could be necessary to improve the processing line, such as a secured storage area to protect the manufactured products which need to be dried and the metal tables to mold the tiles and bricks during the rainy season.

Collection and transportation equipment are also needed to transport plastic waste from generators to the plant, and from the plant to points of sale.

2.4.3.2 Lack of awareness of recycling operators on environmental mitigation measures

This activity must attract skilled and motivated workers and technicians, including women and young people. This workforce must be trained to guarantee the manufacture of high-quality products. It includes sales and marketing officers to promote and sell products to customers, and workers trained in sanitary aspects and the implementation of environmental impact mitigation measures.

The current operators also need to develop technical skills and formalised operating procedures. They are currently not able to determine the quantity of plastic waste needed for production. In this context, capacity building and training of human resources is essential.

2.4.3.3 Evolution of the regulatory framework

The EPA intends to issue a decree banning plastic bags and sachets (to be confirmed). This measure could directly impact the tile and brick manufacturing value chain, as the resources used by the current operators are mostly composed of plastic bags and water bags. Plastic bottles are used less because they are difficult to meld.

2.4.3.4 Low manufacturing capacity and profitability

The production capacity of the plastic tile and brick manufacturer in Greater Monrovia is currently low and the process line rudimentary. Evergreen can produce at most 200 roofing tiles per day and 25 bricks per day. CEPWAMAR (Center for the Plastic Waste Management and Recycling) could manufacture at most 100–150 tiles per week (production concentrated on Sunday).

The current operators have not yet begun selling the manufactured products. The value chain is therefore not profitable at the moment.

According to the current operators, if the durability is higher for tiles and bricks manufactured from plastic waste than for traditional cement elements, the current collection and manufacturing systems do not allow competitive selling prices. According to the market assessment by CEPWAMAR, the prices applied on the market are around 75 L$ per piece.

Selling the recycled products will consequently need intensive awareness and communication campaigns.

2.5 Value chain descriptions and business plans

2.5.1 COMPOSTING VALUE CHAIN

2.5.1.1 Current composting operators in Greater Monrovia

There are currently two composting operators in Greater Monrovia: Organic Matters and Green Cities. They both have a production site near or in Paynesville. Their composting activities are not profitable at the moment.

To secure and develop their composting activities, they both need support to do awareness campaigns and training sessions for farmers on organic fertiliser interests and good agrarian practices.

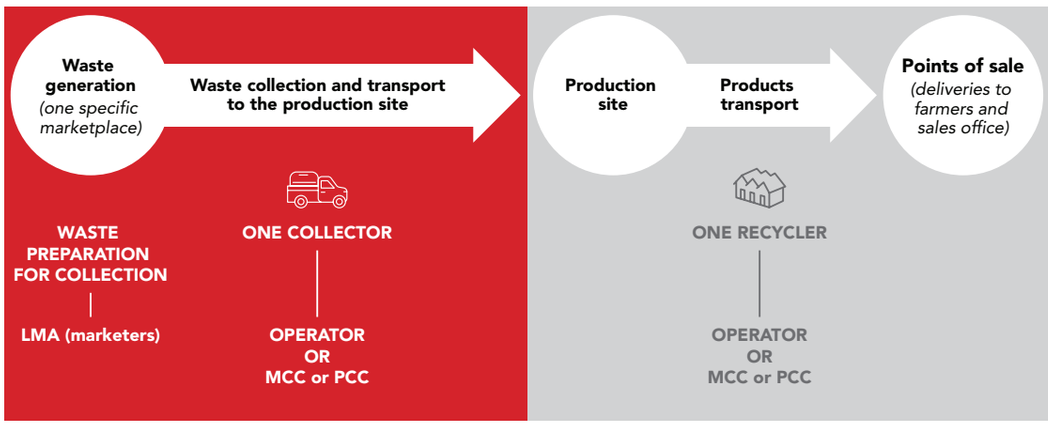
In interviews, some private operators expressed interest in developing composting activities: NC Sanitor's & Services (SME), Environmental Services Enterprise Inc (CBE), OCEAN (CBE). Currently, none of them have a production site, adapted equipment, or secured clean waste.

TABLE 4: Presentation and needs of the current composting operators of Greater Monrovia

	Organic Matters	Green Cities
Status	SME	SME
Creation	2015	2012 (but business launched in 2014)
Employees	34 employees	23 employees (for waste collection, manual sorting and washing of inorganic waste, composting and recycling).
Diversification	Anti-erosion grass, nursery, composting and vermicomposting (with a demo-farm) booster, production of green coal, mulching.	Composting, farming, plastic/metal/e-waste recycling.

	Organic Matters	Green Cities
Organic waste collection	Collection at the Red Light market of clean organic waste (food, leaves, fruits, all vegetables) sorted by the market agents (agreement with the market: US $20 per truck). Collection with trucks. Not working anymore with CBEs (problem with waste quality).	Collection of businesses (mainly hotels). Separation at source in three components (3 bins provided): organic, inorganic recyclables (glass, metals, plastic), residual waste. Collection with trucks and/or working with CBEs.
Equipment	Trucks 1 composting platform in Paynesville 1 demo-farm 1 sales point	Trucks 1 composting platform in Paynesville 1 farm
Treatment performances	Process of 3-4 months Capacity: 90 tons/month. Current production: 13 tons/month.	Two-month process Current production: 5-6 T/month
Compost client	Farmers close to the office (greatest distance is 40 km). Reluctance among farmers, even if the chemical compost is more expensive. Lack of trust in the product. There is potential demand, but it is not effective. Difficulties in finding big clients. Not profitable activity (needs marketing study to identify affordable prices and to raise awareness among farmers on the benefits of organic fertiliser benefits).	Compost sold from the farm and from the office (to farmers and gardeners) and used directly at the farm of Green Cities
Expressed needs	Support for awareness-raising among farmers of the benefits of organic fertilisers. Support for finding big clients. Marketing/communication tools. Development of a sales points network (partnerships with agrodealer). Training clients on good practices. Communication/awareness in the countryside.	Lack of space in the city. Needs advanced technologies to increase efficiency and produce secured, marketable compost.

FIGURE 5: Composting value chain organisation



2.5.1.2 Value chain organisation

The organisation of the composting value chain is presented in Figure 5.

Organic waste collection and sorting at source in the marketplaces

The pilot composting value chain will first focus on organic waste generated in one or a few food marketplaces. The organic waste quantity target for collection is 100 tons/month.

The identification of the marketplace(s) for collection must consider the existing actors and not impact their sustainability. Therefore, the targeted marketplace(s) cannot include the Red Light market, which is already collected by Organic Matters. Moreover, the selection of the marketplace(s) has to be done as part of the strategy for developing the waste-to-energy activities, which also target organic waste generated by the most important marketplaces.

The marketplaces are managed by the Liberia Marketing Association (LMA), which will manage raising awareness among market vendors of good practices and preparing waste for collection (separate gathering and secured temporary storage before collection), with an assistance of the MCC/PCC and/or the collection operator.

Some adjustments could be necessary to facilitate and secure the organic waste collected in the marketplaces. The marketplace skip buckets are currently used by nearby households and businesses. It is important to ensure the quality of the organic waste collected to define and secure a location for a skip bucket (or other container) dedicated to organic waste generated by the market vendors. The feasibility and design of marketplace fittings or construction of a dedicated and secured collection point should be integrated in the detailed study recommended to define the whole organisation of the organic waste collection system.

The collection could be done either by the MCC/PCC (depending on where the selected marketplaces are located), or by a private operator (SME or CBE) selected through a tender process launched by MCC/ PCC with the capacity to ensure the assigned activities (human and technical resources, in particular mechanised vehicles). The private operator selected could be the CBE currently operating in the area where the marketplace is located, if the CBE is able to prove that it has the capacity to ensure both household and marketplace waste collection. The second option is recommended to encourage the development of the CBE/SME operators.

Waste preparation must be done throughout the day while the market is open. Collection, however, should be done while the market is closed.

The methanation residues, which could be integrated in the composting process, could either be collected by the selected operator (or MCC/PCC depending on the option preferred), or transported to the composting unit by the methanation operator.

The workforce needed for waste preparation and collection should be determined by LMA and the operator selected. The staff required will depend on the collection system and vehicles used.

Composting process

Composting is the process of biological transformation of organic materials (green waste, food waste, manure, etc.) under aerobic conditions, allowing the production of a compost for agriculture use. Composting is applicable to a wide range of organic wastes. Residence times are typically longer for ligneous components and woody waste.

Waste accepted in composting units is household or similar waste, non-hazardous, mainly composed of putrescible/compostable organic waste. Non-compostable waste is removed by sorting at source (by the waste generators) or by sorting at the composting unit. Table 5 presents the compostable and non-compostable waste.

TABLE 5: Compostable and non-compostable waste

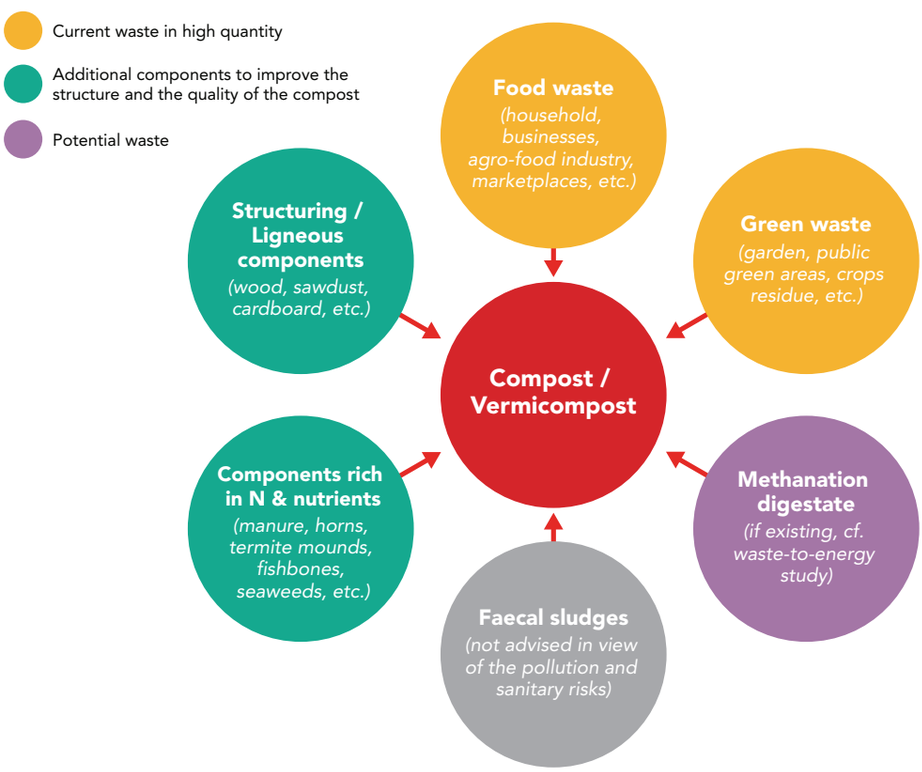
Compostable	Non-compostable & Non-hazardous	Non-compostable & Hazardous
Food waste (household, businesses, agro-food industry, etc.), green waste (from garden, public green areas, etc.), organic waste from marketplaces, water plants (seaweed, water hyacinth, etc.), paper/cardboard, crop waste, manure, animal residue (bones, horns, rumen, etc.), etc.	Plastics, textile, metals, inert waste (glass, stones, earth, sand, dust, etc.), packaging, etc.	WEEE (waste of electrical and electronic equipment), aerosol, batteries, chemical products, and contaminated packaging (such as phytosanitary products, paint cans, etc.), healthcare waste (medicine, needles, etc.)

Compost is a soil improver, rich in organic matter, which stabilises the structure of agricultural soils (role of physical fertiliser). Compost also has a secondary function of organic fertiliser. This product has three major characteristics:

- Constancy of composition, that is to say the stability and invariability of the product
- Agronomic effectiveness (under appropriate conditions of use)
- Safety (with regard to humans, plants, animals and the environment), or the absence of sanitary risks in terms of pathogenic germs, parasites, weed seeds, or various pollutants (such as heavy metals and synthetic organic pollutants)

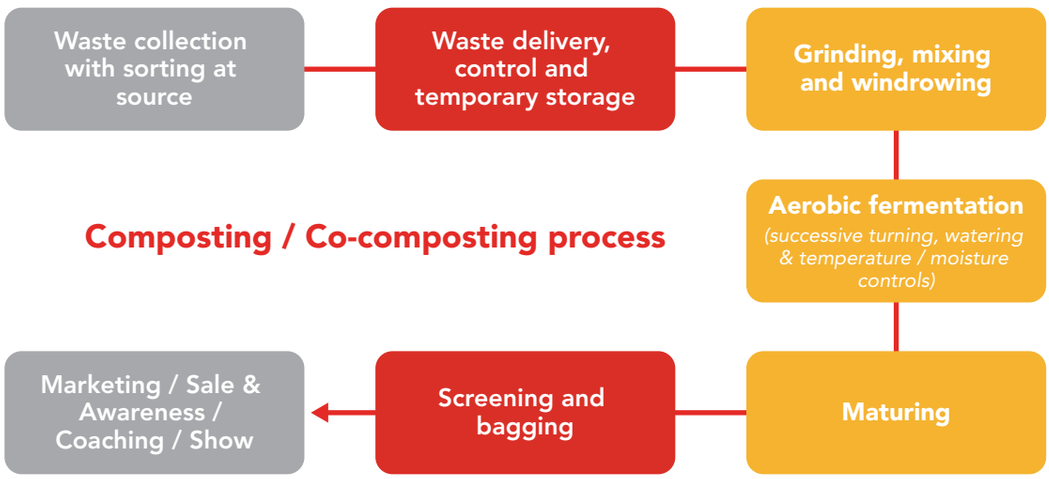
Figure 6 synthesises the waste that could be integrated in the composting processes.

FIGURE 6: Waste integrated in composting processes



The composting process is schematised below. There may be variations to this process. It could also be applied to manual composting units and industrial mechanised plants.

FIGURE 7: Composting/co-composting process steps



Control & Sorting	The quality of the compost depends on the quality of the waste integrated. It is essential, during the waste delivery or collection, to do a visual control to identify unwanted elements (hazardous waste and inorganic waste such as plastics, metals and glass). These elements would be extracted during a preliminary manual sorting. The staff should be equipped with personal protective equipment (in particular gloves, security footwear and masks). A sorting table is recommended to facilitate the work (good working conditions). In case of subpar quality (to define), the composting operator could refuse to collect or accept the waste delivery or apply a tariff reduction. Every refusal or tariff reduction has to be justified and discussed with the waste generator or collector. The sorting operations should be reinforced in case waste collection is extended to households.
Grinding, mixing and windrowing	Waste can be crushed roughly before being windrowed. Grinding increases the ratio surface/ mass and promotes the activity of microorganisms. Grinding of mixed household waste is not recommended (risk of crushing glass, plastics, batteries, etc.). The quality of the sorting ensures the absence of undesirable elements (only presence of putrescible components) safe for grinding. The presence of glass in the grinding product can also lead to premature wear of the grinders.

Grinding, mixing and windrowing	Grinding is particularly useful for the ligneous components of organic waste, such as wood, which are more difficult to biodegrade, but which are useful as a structuring agent favoring aeration of the windrow. Waste is put in windrows (circular or in length) in order to allow fermentation and maturation of the organic matter. The production of windrows in length saves space. However, for low capacity units, the circular windrowing can be sufficient. A windrow gathers sorted waste for up to 2 or 3 days.
Fermentation	The fermentation phase is the first phase of composting. During this phase, the most easily biodegradable organic matter is converted into carbon dioxide and water through the action of microorganisms initially present in the waste. This activity is characterised by a strong rise in temperature (hence the term hot fermentation), a loss of moisture and high oxygen consumption. Therefore, this phase requires control of humidity, temperature and air supply. Aeration can be done by turning or by air insufflation. Insufflation can be done passively using a perforated pipe that runs through the windrow or forced by a mechanized ventilation system. Insufflation systems are not currently used in low- and middle-income countries. The fermentation phase lasts from one to three months, depending on type of waste and climate conditions.
Maturing	Also done under the windrow form, the maturation of the compost does not require any reversal of the material (passive aeration is sufficient because the need for aeration is less than in the fermentation phase), or watering during the necessary period required for stabilisation. The duration of the maturing phase is around one month.

The following equipment is needed for the various steps of the composting process:

- A sorting table, in particular if the organic waste collection is extended to household generation
- A grinder to prepare the waste after a basic visual control and manual sorting (to extract unwanted elements if necessary)
- Personal protective equipment (in particular gloves, security footwear and masks) for all operating staff. This equipment has to be replaced at least every year. There must be an awareness campaign on the importance of wearing the safety gear and it must be strictly controlled.
- Small equipment such as wheelbarrows (to transport waste and compost during the different steps of the process), shovels to return the windrows and to load the wheelbarrows, watering cans, and thermometers to check the temperature during the different fermentation stages.
- Water supply to add water during the fermentation phase
- A screening (or a rotary trommel) for standardised compost
- A bagging machine
- Covered areas to protect waste, windrows and compost from wind, sun, and bad weather (see details of the areas below). A secured, covered area to store the compost bags and eventually a point of sale at the production site.

According to the Africompost program,[1] 10,000 tons per year of waste can be composted without mechanisation. The pilot composting unit will be a small-scale, mainly manual plant. The pilot unit will be divided into the following areas:

TABLE 6: Required space for composting plant processing 100 tons of waste per month

Type	Required Area	Roof
Waste unloading and sorting area	40 m²	yes
Storage of rejects	30 m²	yes
(Storage of recyclables)	10 m²	yes
Composting pad	400 m²	yes
Maturation area	150 m²	yes
Screening and bagging area	35 m²	yes
Compost storage area	25 m²	yes
Sub-total composting area	**690 m²**	
Office	16 m²	yes
(Sanitary facilities)	10 m²	yes
Tool shed	10 m²	yes
Water supply point	4 m²	no
Vehicles parking area	30 m²	no
Green buffer zone (trees/bushes)	50 m²	no
Total area	**810 m²**	

Source: "Decentralised Composting for Cities of Low- and Middle-Income Countries, table 6.2"

These areas must be arranged to ensure efficient workflow of the composting process. The organisation of these areas depends on the characteristics of the plot (for example, the office site can be on the production site or outside). Since local conditions strongly influence final composting plant design, the description provided should be used merely as guidelines and recommendations. The final setup of the site depends heavily on the local conditions.

Local construction experts should be consulted, and the use of materials adapted to the local context, but always related to the key functions of each component. These elements will be considered in the design study of the composting unit (study integrated in the action plan).

[1] Africompost is financed by the Agence Française de Développement (AfD) and the French Global Environment Fund (FFEM).

The production site has to fulfil these requirements:

- **Reasonable distance from the collection areas and from the customers** (mainly farmers) to reduce transport costs. The composting unit must be located near the targeted marketplaces (at most 30 km). It is also important to consider proximity to the beneficiaries (in particular farmers located in periphery of the city, especially around Paynesville).
- **Proximity to roads** to ensure the accessibility of the waste collection vehicles and compost delivery trucks.
- **Possible water supply necessary for the composting process** (power supply is not necessary but recommended to avoid water failure by using a power generator).
- **Sufficient space** to implement the areas described above and eventually demo-farm to test the compost produced and demonstrate results to customers/farmers who may be reluctant. It is also important to have an adapted waste absorption capacity. Solid waste collected from various areas reaches the plant site at a variable rate depending upon the distance of collection point. The storage must absorb the fluctuations in the waste input to the plant. The value of the storage capacity depends on the schedule of incoming trucks, the number of shifts, and the number of days the plant and solid waste collection system operate.

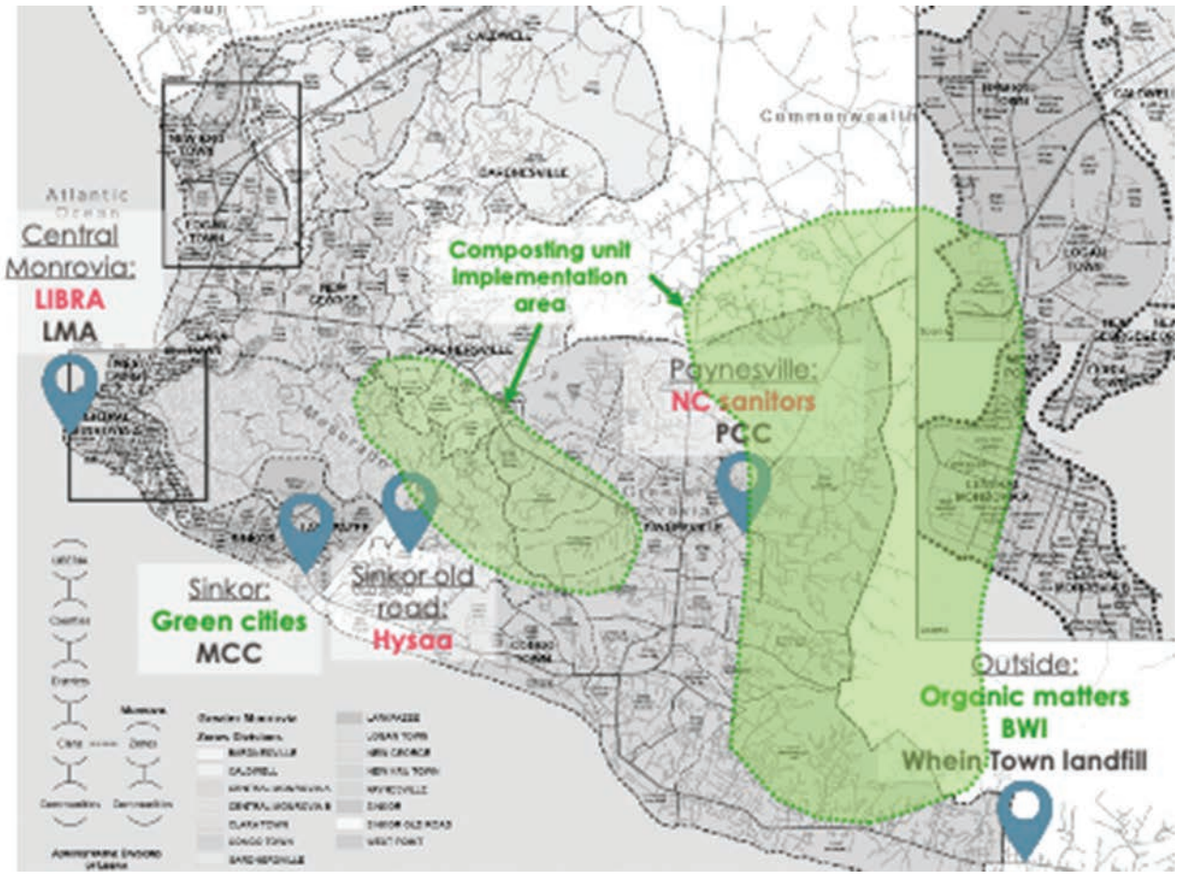
Figure 8 shows two areas identified as relevant for the pilot composting unit implementation. The area located around Somalia Drive is preferable to the one located in Paynesville, because there is no competition for organic waste there.

Identification of the marketplace(s) for collection must consider existing actors and not impact their sustainability. Therefore, the targeted marketplace(s) cannot integrate the Red Light market, which is already collected by Organic Matters.

The selection of the marketplace(s) must be in line with the strategy for developing waste-to-energy activities, which also target organic waste generated by the most important marketplaces.

Plots in MCC or PCC are preferred in order to ensure land availability and reduce potential delays in procuring building permits and starting production activities.

FIGURE 8: Composting unit implementation area and existing actors



Compost marketing

The development of composting activities will be successful only if the products meet demand. On the supply side, this implies that the product should be adapted to demand in terms of marketing mix (product, price, place, promotion). Producers must be aware of the absolute necessity to develop a customer-oriented product. Some support could be provided to the operator of the pilot unit by:

- Assisting them in developing the marketing component of their business plan and strategy
- Evaluating customers' ability to pay (in particular small farmers) and adapting the tariff grid
- Identifying and structuring the compost distribution system. Delivery on-site must be available for customers without the necessary means of transportation means. Order grouping must be suggested to optimise transportation and reduce related costs. The composting operator also has the option to sell the compost directly onsite at its own points of sale, or to use an existing distribution network.

The operator needs to purchase delivery trucks (see details in the action plan) and have at least one point of sale.

On the demand side, customers must be aware of the product quality, efficiency, and value for money compared to others (compost vs chemical fertilisers, recycled materials compared to original ones, etc.). Promotion campaigns, demo-farms, and testing could be implemented to prove the appropriateness of the product for customer use. At the beginning of the composting activities, some samples of compost could be distributed to influential or strategic farmers, with coaching to ensure the use of the good agricultural practices.

2.5.1.3 Preliminary business plan

A short business plan has been developed. It is based on the collection and treatment of 100 tons of organic waste per month, able to produce 40 tons of compost per month, considering the waste is reduced by 60% during the compost process.

The preliminary business plan includes a gradual increase in activity, from 50% of full capacity during the first year of operation (2021) to 100% in the third year (2023). The total capital expenditures are estimated at US $255,000.

Capital Expenditures

Capital expenditure for developing the composting value chain consists of land acquisition and servicing, construction of facilities, and equipment for collection, production and transportation.

- **Land acquisition and servicing:** The production site surface required is assessed on the basis of the benchmark carried out in the feasibility study (Africompost, decentralised composting for cities of low- and middle-income countries). According to this benchmark, on average, **1 000 m² is needed to process 1,000 tons per year**, 500 m² for 500 tons per year, and 10,000 m² for 10,000 tons per year. Based on this information, it is estimated that a minimum of 1,200 m² is required for processing 100 tons of organic waste per month. It is assumed that the land is provided by MCC or PCC and is already serviced. If not, there could be additional costs for MCC or PCC as well as Cities Alliance financing.
- **Facility construction:** It is assumed that the facility uses 60% of the land surface, i.e. 700 m². The construction cost is US $15 per m² (lightweight building). Including the construction permit and clearance costs, the facility construction cost is estimated at **US $10,500**. This cost is covered by Cities Alliance.
- **Equipment for production:** It is estimated that **US $10,000** is required to buy equipment for the composting process. This equipment purchase cost is covered by Cities Alliance.
- **Equipment for collection and deliveries:** Two trucks are necessary for the transportation of waste from generators to the composting plant and for product delivery. The cost of each truck is estimated at US $65,000, **US $130,000** in total. The truck purchase costs are covered by Cities Alliance unless they are provided by MCC or PCC.
- **Equipment to do sorting and temporary storage in marketplaces:** Marketplaces must be equipped to ease **waste sorting at source and collection**. The cost of this equipment is estimated at **US $30,000**, depending on the equipment already installed and how it is managed.

TABLE 7: Composting value chain – Capital expenditures

	Cost (USD)	Comments
Land acquisition and servicing	Not available	• 1,200 m² Provided by MCC or PCC
Building costs	10,500	• 60% of the land surface • US $15 per m² (lightweight building) • Funded by Cities Alliance
Equipment for production	10,000	• Lump sum • Funded by Cities Alliance
Trucks	130,000	• Trucks • Funded by Cities Alliance
Equipment in marketplaces	30,000	• Cost depends on the existing equipment and how it is managed • Funded by Cities Alliance
Capital Expenditures	**180,500**	

Operating expenditures

Operating expenditures consist of supply expenses and production and marketing expenses.

Supply expenses for the composting operator correspond to the costs incurred by the collector. It includes:

- **Fuel:** The number or round trips per month is assessed based on carrying 1.5 tons per round trip. The kilometers travelled are assessed assuming that the distance between the marketplace and the production site is 10 km (20 km for each round trip). With an average fuel consumption of 20 l/km at a unit fuel cost of US $0.78 per liter, the total expenses for fuel are US $208 per month, i.e. **US $2,434 per year**.
- **Provision for renewal:** Provisions for equipment renewal are based on a 10-year lifespan for trucks, i.e. **US $6,500 per year**.
- **Maintenance:** Maintenance costs are equal to 2% of the truck's purchase price, i.e. **US $1,300 per year**.
- **Salary expenses:** Two FTE are needed per truck for collection at a unit cost of US $140 per month, i.e. a total cost of **US $3,360 per year**.
- **Remuneration of LMA or marketers:** Waste is gathered by marketers or LMA employees before being put in the truck by the collector. Based on the prices currently applied by organic waste collectors in marketplaces, the remuneration assessed is 50 LD per 100 kg gathered, equal to US $3 per ton. The total cost is **US $4,755 per year** for 1,200 tons collected.

Operating expenditures consist of supply expenses and production and marketing expenses.

Production and marketing expenses include:

- **Fuel:** It is assumed that 80 kilometers are travelled per round trip, and that each round trip delivers 10 tons. With an average fuel consumption of 20 l/km at a unit fuel cost of US $0.78 per liter, the total expenses for fuel are **US $600 per year**.
- **Provisions for renewal:** This concerns facilities (lifespan of 15 years), trucks (lifespan of 10 years), production equipment (life span of 10 years). The total provisions for renewals are **US $9,785 per year**.
- **Maintenance:** Maintenance costs represent 2% of the building, truck and production equipment costs, i.e. **US $1,550 per year**.
- **Salary expenses:** Based on the benchmark presented in the feasibility study (compost production sites in Liberia, Togo, Madagascar, Cameroon and Ivory Coast), eight FTE are needed for compost processing and marketing at a unit cost of US $140 per month, i.e. a total cost of **US $13,440 per year**.

As a result, total operating expenditures are estimated at US $47,895 per year in full capacity.

TABLE 8: Composting value chain – Operating expenditures

	Operating expenditures USD/ year
Supply expenses	**18,349**
(i) Expenses for fuel	2,434
(ii) Provisions for equipment renewal	6,500
(iii) Maintenance of the truck(s)	1,300
(iv) Salary expenses	3,360
(v) Remuneration of LMA/marketers	4755
Production and marketing expenses	**25,375**
(i) Expenses for fuel	600
(ii) Provisions for equipment renewal	9,785
(iii) Operating and maintenance	1,550
(iv) Salary expenses	13,440
Total Operating Expenditures	**43,724**

Income

It is assumed that the 100 tons of organic waste collected each month produce 40 tons of compost (480 tons/year), given a 60% reduction ratio during the process. The average unit price of compost sold is **US $100 per ton**. As a result, the revenue of sales is expected to be **US $48,000 per year in full capacity**.

Profit and Loss Account

Revenue, fuel costs, production and marketing staff costs are linked with the tonnage of waste collected, treated and sold. (Provisions for renewal and maintenance costs are not impacted.)

After the first two years, the activity is profitable and generates an operating margin of almost US $5,000 per year at full capacity, representing 9% of the revenue.

Several previous experiments to develop composting value chains failed in Greater Monrovia. According to the stakeholders, the quality of the compost was not good enough to compete with chemical fertilisers. To ensure the quality of the compost produced and secure market access, it is necessary to:

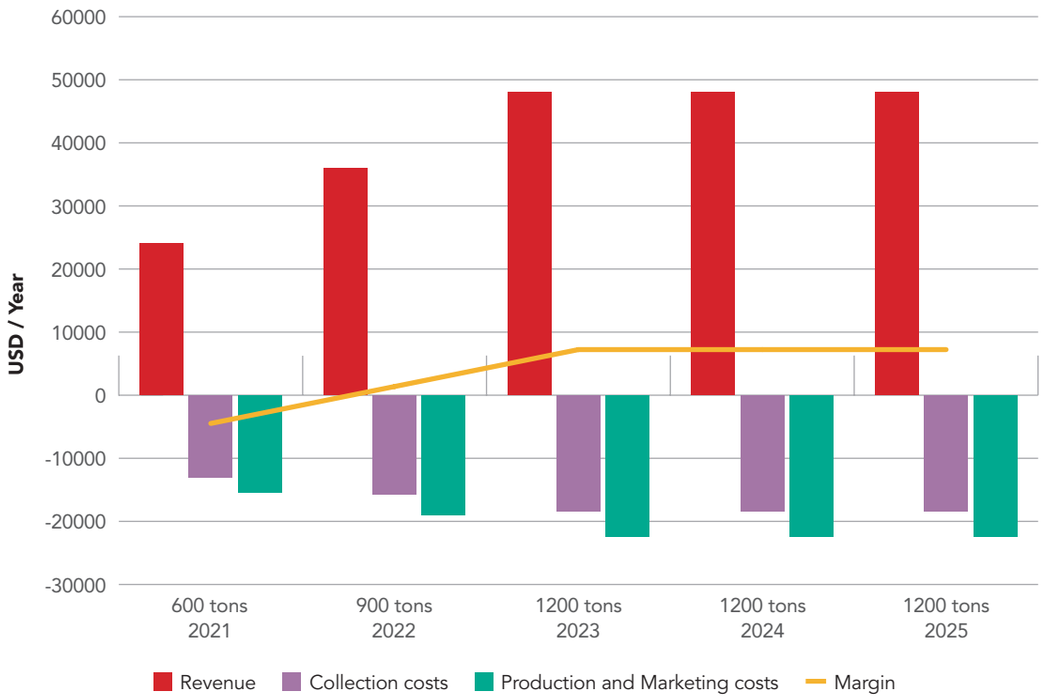
- Invest in mechanised secured systems, which attract higher investments than the solutions currently observed in Greater Monrovia; and
- Avoid using mixed waste and sort at source to collect clean organic waste.

The profitability and sustainability of the composting value chain depends on the quantity of clean organic waste treated. According to similar projects in other African countries, the optimal capacity of treatment of non-industrial composting units is 100 tons/month.

TABLE 9: Composting value chain – Profit & loss account (in USD/year)

	2021 600 tons	2022 900 tons	2023 1200 tons	2024 1200 tons	2025 1200 tons
Revenue	24,000	36,000	48,000	48,000	48,000
Collection costs	-13,074	-15,712	-18,349	-18,349	-18,349
Production and marketing costs	-18,355	-21,865	-25,375	-25,375	-25,375
Margin	-7,430	-1,577	4,276	4,276	4,276
% Revenue	-31%	-4%	9%	9%	9%

FIGURE 9: Composting value chain – profit & loss account



2.5.1.4 Composting value chain structuring

Monrovia City Corporation and Paynesville City Corporation have the mandate from the national Ministry of Internal Affairs to collect, treat and dispose of solid waste within their respective city limits. Beyond that, their responsibilities include the enforcement of ordinances regulating solid waste management practices, the regulation of private sector activities, education and awareness initiatives, and the maintenance of public areas.

As a result, MCC and PCC are the project owners of composting activities to be implemented in the cities with the support of Cities Alliance. During the implementation phase, Cities Alliance will act as project co-owner. The facilities developed through the project and funded by Cities Alliance will be owned by the municipalities.

MCC and PCC will have to determine the appropriate model to operate the service and facilities developed under the project. According to the current model, based on private sector participation involving CBEs and SMEs for solid waste management, it is suggested to delegate some steps of the system to private operators.

The recommended composting value chain structure is as follows:

- **Sorting, collection and transport:** The organisation of the organic waste sorting-at-source at marketplaces and the collection and transport of organic waste to composting plants is delegated to private operator(s) selected through a competitive tendering process. Eligible competitors could be CBEs or SMEs already involved in SWM or LMA and marketers involved in market management.
- **Comporting unit operation:** The composting unit, as a pilot, can be operated directly by MCC or PCC with their own staff and resources, or delegated to a private operator that specialises in composting activities. It is recommended to delegate the composting unit operation to a private operator and benefit from its technical and commercial expertise. This could be implemented after a "probation" period of direct operation aimed at validating the business model, its sustainability and profitability.

TABLE 10: Composting value chain structure

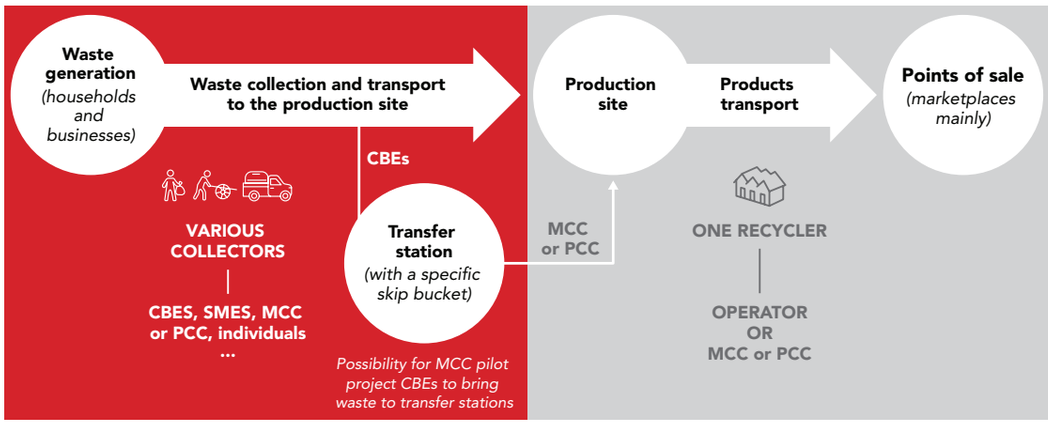
	Leader	Comments
Project ownership	MCC or PCC	Cities Alliance during implementation with the support of LMA and public authorities (Ministry of Agriculture, land authority, EPA, Ministry of Public Works, etc.)
Facilities ownership	MCC or PCC	Cities Alliance during preparatory and investment phases, transferred to MCC of PCC
Operation – sorting, collection and transport	Private operator	Delegation by MCC or PCC after a competitive tendering process
Operation – composting unit	Private operator	Delegation by MCC or PCC if needed after a "probation" period and a competitive tendering process
Funding	Cities Alliance	

2.5.2 PLASTIC ITEM MANUFACTURING VALUE CHAIN

2.5.2.1 Current plastic recycling operators in Greater Monrovia

During interviews, some private operators expressed an interest in developing plastic recycling activities: NC Sanitor's & Services (SME), Environmental Services Enterprise Inc (CBE), Hysaa (SME), Libra Sanitation (SME). None currently has a production site, adapted equipment, financial resources, or secured clean waste.

FIGURE 10: Plastics recycling value chain organisation



2.5.2.2 Value chain organisation

The organisation of the plastics recycling value chain is presented in Figure 10.

Plastic waste collection and sorting

Waste generators targeted for the development of plastic recycling activities are businesses and households. During the pilot phase, two main collection circuits for plastic waste are possible:

a. Plastic waste is separately collected by CBEs, SMEs, individuals and eventually MCC and PCC, and directly transported to the recycling plant. Collectors could do a specific collection for plastic waste (on a dedicated day).

b. Plastic waste is separately collected by CBEs and transported to the two MCC transfer stations, where plastic waste is controlled and temporarily stored in a dedicated, secured skip bucket (8m^3). When the skip bucket is full, MCC will transport it to the recycling plant. This collection circuit needs some adjustment of the transfer stations. The skip buckets cannot be located outside, due to the risk of pollution by households putting mixed waste in it. It also requires a system to weigh the plastic waste transiting through the transfer station.

The transportation to the recycling plant should be done during the evening or early in the morning in order to avoid traffic jams.

The tariff grid applied to plastic waste will depend on the cleanliness and the quantity. The tariff applied to the CBE using the second collection circuit would be lower due to the necessary transportation costs supported by MCC. CBEs are thus encouraged to transport the plastic waste collected directly to the recycling plant.

TABLE 11: Presentation and needs of the current plastic recycling operators of Greater Monrovia

	Duraplast	Evergreen Recycling Institute	
Statut	SME	NGO	
Creation		2017	
Employees	20-25 employees in Monrovia.	15 people: volunteers (including 5 collectors)	
Recycling activities	Plastic bags (blue and black): garbage bags, agriculture bags	Roofing and interlocking tiles, bricks, fuels and gasoline, paint thinner (solvent)	
Plastic waste collection	No plastic collection Plastic waste provided by individuals in Monrovia: 80 to 100 tons/month Every plastic (water bags, buckets, etc.) excepting plastic bottles. Purchase of the plastic waste. Prices depending on waste cleanliness	Materials found in the street (2 to 3 m^3 per day): PET (bottles), PTT, water bags	
Equipment	One industrial line in Monrovia (+ 2 in Ghana) equipped with: overband, conveyor, crusher, conveyor, washing machine, dryer, storage heater in order to produce plastic granules.	Manual and small-scale process line Unsecured (might be harmful for the environment and human health).	
Treatment performances		Non-industrial recycling (very manual) & Slow process 200 tiles per day 25-28 bricks per day	
Expressed needs	High cost of production Maximal capacity reached (necessary new production line: US $1,200,000). Problems during the rainy season (quality of waste). Plastic recycling activity not profitable Needs of regular suppliers and of higher quality of plastic (clean and not mixed).	Lack of equipment for transport Non-profitable activity	

	Green Cities	CEPWAMAR
	SME	Corporation
	2012 (but business launched in 2014)	2017
	23 employees (for waste collection, manual sorting and washing of inorganic waste, composting and recycling)	10 employees
	Composting, farming, plastic/metal/e-waste recycling.	**Interlocking tiles** (of different colours: brown, green, red, black) **Products they plan to make:** • Roofing sheets: • Fuel.
	Collection of businesses (mainly hotels) Separation at source in 3 fractions (3 bins provided): organic, inorganic recyclables (glass, metals, plastic), residual waste. Collection with trucks and/or working with CBEs. 4 to 5 T collected/month	LDPE (plastic bags, water bags) and also plastic bottles (compressed): 8 m^3/week Awareness campaign realised (500 households in 5 communities, communities, elementary schools, community leaders)
	Trucks 1 plastic recycling platform in Monrovia (with manual sorting)	One manual line
	HDPE and LDPE recycled (washed, crushed and treated for obtaining little chips) in order to make products that could be sold (rules, squares, plastic jars, ...)	Permit in progress. Plastic + Sand 100-150 tiles per week (from 4 m^3 of plastic waste). Exact percent of plastic put in the process unknown
	Lack of space in the city Need of advanced technologies for increasing productivity	Lack of collection equipment Lack of financial resources (to use as incentive mechanisms to encourage households to do sorting-at-source) Lack of vehicles for the transport During the process: lack of equipment (in particular need of a metal table and of a secured area during the rainy season)

According to the results and findings of the pilot phase, **logistics platforms** could be implemented to optimise plastic waste transportation. This system would allow **intermediary storage** of the plastic waste collected by the CBEs **and eventual first sorting** (by polymers and/or color), as required by the participants of the workshop. Logistics platform could be built by MCC/PCC and managed by a consortium of CBEs to increase their revenues. For now, it is **not recommended to implement washing lines** on these platforms. Washing operations are expensive and have a great impact on the profitability of the collection system. The collectors are rather **encouraged to find an incentive system and raise awareness among waste generators about sorting at source**.

The quality and quantity of solid waste collected and targeted for plastic recycling depends largely on the sorting at source done by the solid waste generators (households, markets, businesses, etc.). A proper sorting reduces dirt, the presence of unwanted waste, risk of contamination (because of the contact with hazardous waste) and also facilitates recycling.

The local and national authorities should assist the CBEs and SMEs in making waste generators aware of how to sort their own waste. Communication with waste generators is an integral part of the local authority recycling service (MCC/PCC); to participate fully, residents need to know clearly what their services are, what their service rules are, and what happens to their recycling after it is collected. This is also part of the national institution service (Environment Protection Agency), which can define messages to be passed on and lead national communication campaigns.

Local and national authorities should produce documents (guidelines for recycling) and use a range of communication materials: recycling point signs, vehicle panels (for collection vehicles), and stickers. Municipalities can also communicate through local actors including community leaders, religious leaders, and griots.

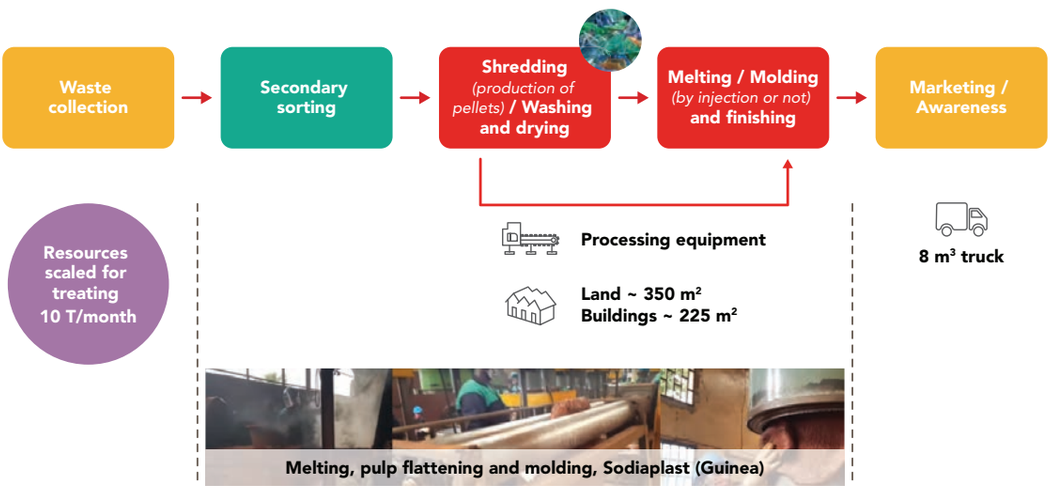
Communicating about sorting is an opportunity to make households aware of solid waste prevention, which:

- Improves resource security and well-being
- Reduces the costs for the actors who operate during the different steps of the value-chain: collection, sorting, transport, valorisation/landfilling activity
- Encourages job creation and creates value from waste through increase of repair, reuse and manufacture activities

Plastic recycling process

The plastic recycling process is presented in Figure 11.

FIGURE 11: Recycling activity value chains



Sorting, shredding, washing and drying

As explained previously, it is recommended to segregate plastic waste at the source to reduce the sorting and washing activities and thus related costs.

During the waste delivery by CBEs/SMEs, it is essential to do a visual control to identify unwanted elements (all elements which are not plastic, in particular hazardous waste). This also involves the recycling operators on the production site and MCC at the transfer station.

If a quantity of unwanted waste is too important or cleanliness too low, the MCC or the recycling operator could refuse to collect or accept the waste delivery or apply a tariff reduction. Every refusal or tariff reduction must be justified and discussed with the waste generator or collector.

At the production site, sorting operations must be performed to extract eventual unwanted waste and to prepare waste for the production process at the recycling unit: segregation by polymer and/or by color. The sorting instructions will depend on the type of waste collected and the intended recycled products.

Staff must be equipped with personal protective equipment (in particular gloves, security footwear and masks). A sorting table is recommended in order to facilitate the work of the people performing this task (good working conditions).

The sorted plastic waste is shredded. The flakes obtained can be put in water to wash them and further segregate the plastic: flakes of plastic caps float, and flakes of bottles sink. After cleaning and drying, these flakes are ready to be recycled.

Melting, molding

The production process is divided in two main steps: melting and hot molding. There are different recycling technologies depending on the type of intended products and plastic waste upstream.

The extrusion step (or granulation) is optional. It is a continuous process used to manufacture long pieces such as tubes, pipes, or semi-finished products such as profiles (for windows for example), chopsticks, fiberoptics, plates, or leaves. The transformation is done under pressure with suitable temperature conditioning. There are three variations of extrusion:

- The extrusion/spinning is done in a longitudinal stretch that aligns the molecular chains and significantly improves the mechanical properties (rigidity, resistance to deformation in the axis of stretching, etc.) of the material. The technique of spinning the polymer in the molten state is the most used. It is used for the elaboration of textile fibers made of PP and PET.
- The extrusion blow molding is used to manufacture plastic films and garbage bags, for example.
- The blowing extrusion is used to manufacture hollow components such as plastic bottles.

The injection molding (or plastic injection) concerns thermoplastics, using plastic injection presses. The plastic is softened by heat, then injected into a mold and cooled. The productivity of the process is related to the duration of a molding cycle and the number of cavities in the mold. An eight-cavity mold makes it possible to produce eight pieces in a single cycle. The duration of the cycle is essentially related to the nature of the injected material, the quality of the parts to be produced, and the heating and cooling speeds. Injection molded components are found in a large number of manufactured products such as car bodywork, electrical goods, computer equipment, and furniture.

Thermoforming is a technique that consists of:

- Melting the plastic waste with a furnace (equipped with an endless screw to knead and homogenise the material) in order to obtain a ductile paste
- Flattening the paste obtained with steamrollers, with thickness adjustment depending on the desired product
- Shaping it with a mold

The material cools down, hardens, and keeps the shape of the mold. That is the kind of process used by Sodiaplast in Guinea to produce plastic bins and buckets.

An additional study should be done to evaluate the market (in particular the competition of imported products and the types of products to target to be in line with local demand) and to design the process line corresponding to the recycled products wanted.

Equipment needed for the various steps of the plastic recycling process include:

- A weighing system
- A sorting area with intermediary storage cells for segregating the sorted materials and prepared ones (shredded and washed)
- A shredder, washing lines and a dryer system (mechanised or not) to clean, do a second sorting of the materials, and dry them before melting operations
- Melting and molding facilities adapted to the targeted recycled products

- Personal protective equipment (in particular gloves, glasses, security footwear and masks) for all the operation staff. This equipment has to be replaced at least every year. There should be an awareness campaign for staff on the importance of wearing the safety gear, and its use should be strictly enforced.
- Small equipment such as wheelbarrows and shovels
- Water supply necessary for the washing operations and power supply necessary for the functioning of the production lines
- Covered area to protect production lines and stored materials from wind, sun and bad weather (See Table 12).

TABLE 12: Required space for plastic recycling plant processing 10 tons of waste per month

Type	Required Area	Roof
Waste unloading and sorting area	40 m²	yes
Storage cells for rejects and of sorted elements	15 m²	yes
Shredding	5 m²	yes
Washing line & dryer	20 m²	yes
Production line & finishing	90 m²	yes
Storage	30 m²	yes
Office and sanitary facilities	25 m²	yes
Sub-total composting area	**225 m²**	
Vehicles parking area	50 m²	no
Green buffer zone (trees/bushes)	75 m²	no
Total area	**350 m²**	

These areas must be arranged to ensure efficient workflow of the production process. The organisation of these areas depends on the characteristics of the plot (for example, the office site can be on the production site or outside). Since local conditions strongly influence final composting plant design, the descriptions provided should be used merely as guidelines and recommendations. The final setup of the site depends on the local conditions.

Local construction experts should be consulted, and the usage of materials adapted to the local context – but always related to the key functions of each component. These elements will be considered in the design study of the composting unit (study integrated in the action plan).

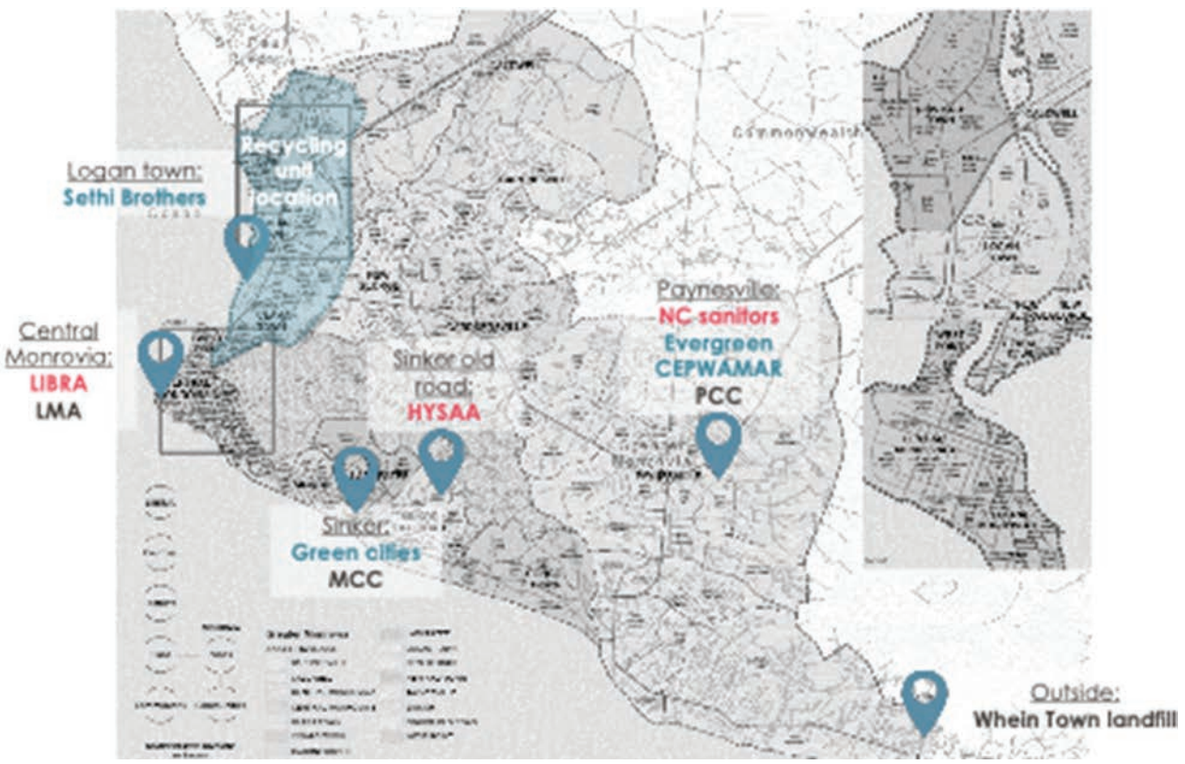
The production site must meet these requirements:

- **Reasonable distance from the collection areas and from the customers** (mainly marketers and businesses) to reduce the transport costs. The location for the plastic recycling plant was discussed with Hydroconseil, the consulting firm producing a study on expanding CBEs. Two locations were identified based on the presence of businesses and the ability of CBEs to collect the plastics separately: **New Kru Town and Clara Town**.
- **Proximity to roads** to ensure accessibility for waste collection vehicles and compost delivery trucks
- **Possible water and power supply necessary for the recycling process**
- **Sufficient space** to implement the requirements described above.

The following map presents the areas identified as relevant for the pilot composting unit implementation.

MCC or PCC plots are preferred to ensure land availability and to reduce delays in procuring building permits and starting production activities.

FIGURE 12: Area identified for the plastic recycling unit and existing actors



Recycled plastic item marketing

The development of composting activities will only succeed if the products meet an effective demand.

On supply side, this implies that the product is adapted to demand in terms of marketing mix (product, price, place, promotion). Producers must be aware of the absolute necessity of developing a customer-oriented product. Some support could be provided to operator of the pilot unit in order to:

- Assist them in developing the marketing component of their business plan and strategy
- Evaluate customers' ability to pay (in particular marketers and businesses) and then adapt the tariff grid
- Identify and structure the recycled products distribution system. Delivery on-site should be offered to customers without the necessary means of transportation. The recycling operator also has the option to sell the recycled products directly on-site, at its own points of sale, or to use an existing distribution network (such as marketplaces).

This means the operator needs to purchase delivery trucks (see details in the action plan) and at least one point of sale.

2.5.2.3 Preliminary business plan for plastic recycling unit

The pilot plastic recycling unit is based on the collection and treatment of 10 tons of plastic waste per month, producing 10 tons of plastic items (no losses).

The preliminary business plan includes a gradual increase in activity, from 50% of full capacity during the first year of operation (2021) to 100% in the third year (2023).

Capital Expenditure

Capital expenditure for the development of the plastic recycling value chain consists of land acquisition and servicing, facility construction, and equipment production and transportation.

- **Land acquisition and servicing:** The production site surface required is assessed based on the benchmark used for various plastic recycling sites (Sodiaplast, Proplast, Duraplast, Green Cities). 350 m² is required to develop the plant. It is assumed that the land is provided by MCC or PCC and is already serviced. Otherwise there would be additional costs for MCC or PCC or funding needed from Cities Alliance.
- **Facility construction:** It is assumed that the facilities represent a surface of 225 m². The construction cost is US $60 per m² (higher mass construction). i.e. **US $13,500**. This cost is covered by Cities Alliance.
- **Production line:** The cost of a complete production line dimensioned for 10 tons per month is estimated at **US $115,440**. The line purchase is covered by Cities Alliance.
- **Transportation equipment:** One truck is required for product delivery at a unit price estimated at **US $64,935**. The truck's purchase cost is covered by Cities Alliance, unless trucks are provided by MCC or PCC.

TABLE 13: Plastic recycling value chain – Capital expenditures

	Cost (USD)	Comments
Land acquisition and servicing	Not available	350 m² Provided by MCC or PCC
Building costs	13,500	225 m² US $60 per m² (higher mass construction) Funded by Cities Alliance
Production line	115,440	Funded by Cities Alliance
Trucks	64,935	1 truck Funded by Cities Alliance
Capital Expenditure	**193,875**	

Operating expenditures

Operating expenditures comprise supply expenses as well as production and marketing expenses

- **Supply expenses** for the recycling operator correspond to the remuneration of the collectors (individuals, CBEs, SMEs, etc.). It is assumed that the cost of plastic waste supply for the recycling operator is US $250 per ton, i.e. **US $30,000 per year** for 10 tons/month.
- **Production and marketing expenses include:**
  - **Fuel:** It is assumed that 10 kilometers are travelled to sell each ton of end-product. With an average fuel consumption of 20 l/km at a unit fuel cost of US $0.78 per liter, the total expenses for fuel are **US $150 per year**.
  - **Provision for renewal:** This concerns facilities (lifespan of15 years), trucks (lifespan of 10 years), and production equipment (lifespan of 15 years). The total provisions for renewals reach **US $14,190 per year**.
  - **Maintenance:** Maintenance costs represent 2% of the building, truck and production equipment costs, i.e. **US $3,878 per year**.
  - **Salary expenses:** Based on the benchmark of several plastic recycling activities (Sodiaplast, Proplast, Duraplast, Green Cities), 10 FTE are needed for plastic item processing and marketing at a unit cost of US $140 per month, i.e. a total cost of **US $16,800 per year**.

Total operating expenditures are estimated at US $65,017 per year at full capacity.

TABLE 14: Plastic recycling value chain – Operating expenditures

	Operating expenditures USD/ year
Supply expenses	**30,000**
Production and marketing expenses	**35,017**
(i) Expenses for fuel	150
(ii) Provisions for equipment renewal	14,190
(iii) Operation and maintenance	3,878
(iv) Salary expenses	16,800
Total Operating Expenditures	**65,017**

Income

It is assumed that the 10 tons of plastic waste collected each month produce 10 tons of plastic items, given there are no material losses during the process. The average unit price of plastic items sold is US $600 per tons. The revenue of sales is expected to be **US $6,000 per month**.

Profit and Loss Account

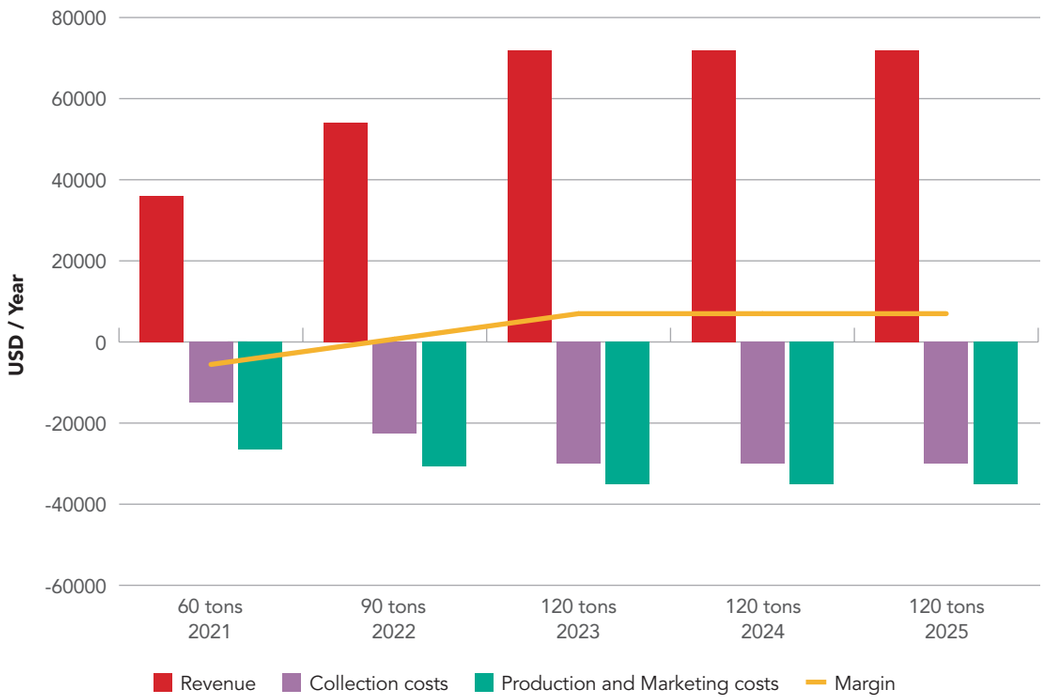
Revenue, cost of supply, fuel costs and production and marketing staff costs are linked to the tonnage of waste collected, treated and sold. (Provisions for renewal and maintenance costs are not impacted.)

After the first two years, the activity is profitable and generates an operating margin of almost **US $7,000 per year in full capacity**, representing 10% of the revenue.

TABLE 15: Plastic recycling value chain – Profit & loss account (in USD/year)

Tons/year	2021 60 tons	2022 90 tons	2023 120 tons	2024 120 tons	2025 120 tons
Revenue	36,000	54,000	72,000	72,000	72,000
Collection costs	- 15,000	- 22,500	- 30,000	- 30,000	- 30,000
Production and marketing costs	- 26,542	- 30,779	- 35,017	- 35,017	- 35,017
Margin	- 5,542	721	6,983	6,983	6,983
% Revenue	-15%	1%	10%	10%	10%

FIGURE 13: Plastic recycling value chain – profit and loss account



2.5.2.4 Preliminary business plan for plastic waste sorting

A logistics platform dedicated to the intermediary storage and initial sorting of plastic waste collected by CBEs is part of the global plastic waste recycling value chain. The preliminary business plan for one logistic platform is presented in the following sections. A logistic platform is sized to receive four to six CBEs (depending on their catchment areas).

Capital Expenditure

Capital expenditure for the development of a logistic platform for plastic waste storage and sorting consists of land acquisition and servicing, facility construction, and equipment for storage, sorting and transport.

- **Land acquisition and servicing:** The production site surface required is assessed based on the benchmark used at various plastic recycling sites (Sodiaplast, Proplast, Duraplast, Green Cities). 150 m² is required to develop the platform. It is assumed that the land is provided by MCC or PCC already serviced. Otherwise there could be additional costs for MCC or PCC or funding needs from Cities Alliance.
- **Facility construction:** It is assumed that the facilities have a surface of 100m². The construction cost is US $60 per m². i.e. **US $6,000** (simple facilities to protect the waste sorted from bad weather conditions). This cost is covered by Cities Alliance.

- **Sorting equipment:** The cost of the equipment needed for a logistics platform is estimated at **US $4,000**. It includes personal protective equipment, wheelbarrows, sorting tables and chairs, etc. The line purchase is covered by Cities Alliance.
- **Transportation equipment:** One truck is required for sorted plastic waste. Vehicles from MCC and PCC could be used. Skip buckets (at least two per logistics platform) are needed at an estimated unit price of **US $25,000**. The truck's purchase cost is covered by Cities Alliance, unless the trucks are provided by MCC or PCC.

TABLE 16: Plastic recycling value chain – capital expenditures

	Cost (USD)	Comments
Land acquisition and servicing	Not available	150 m² Provided by MCC or PCC
Building costs	6,000	100 m² US $60 per m² (higher mass construction) Funded by Cities Alliance
Sorting equipment	4,000	Funded by Cities Alliance
Storage equipment	50,000	2 skip buckets Funded by Cities Alliance
Capital Expenditure	**60,000**	

Operating expenditures

Operating expenditures consist of supply expenses and production and marketing expenses.

- **Supply expenses:**
  - **Fuel:** It is assumed that 10 kilometers are travelled to sell each ton of end-product. With an average fuel consumption of 20 l/km at a unit fuel cost of US $0.78 per liter, the total expenses for fuel are **US $400 per year**.
  - **Provision for renewal:** it concerns facilities (life span of 15 years), skip buckets (life span of seven years), production equipment (life span of five years). The total provisions for renewals are **US $5,800 per year**.
  - **Maintenance:** Maintenance costs represent 2% of the building, truck and production equipment costs, i.e. **US $1,200 per year**.

Total operating expenditures are estimated at US $7,400 per year at full capacity (to report to the number of CBEs involved, i.e. from 4 to 6).

TABLE 17: Logistic platform for plastic waste sorting and intermediary storage – operating expenditures

	Operating expenditures USD/ year
Supply Expenses	**7,400**
(i) Expenses for fuel	400
(ii) Provisions for equipment renewal	5,800
(iii) Operation and maintenance	1,200
Total Operating Expenditures	**7,400**

Income

It is assumed that the logistics platform will reduce transport costs and improve plastic waste quality, thus increasing income generated by plastic sales to recycling operator(s) (purchase prices applied higher). It is estimated that the reduced transport costs and increase in income will cover the charges generated by operating the logistic platform.

2.5.2.5 Plastic recycling value chain structuring

Monrovia City Corporation and Paynesville City Corporation have a mandate from the national Ministry of Internal Affairs to collect, treat and dispose of solid waste within their respective city limits. Beyond that, their responsibilities include enforcing ordinances regulating solid waste management practices, regulating private sector activities, undertaking education and awareness initiatives, and the maintenance of public areas.

As a result, MCC and PCC are the project owners of recycling activities to be implemented in the cities with the support of Cities Alliance. During the implementation phase, Cities Alliance will act as project co-owner. The facilities developed through the project and funded by Cities Alliance will be owned by the municipalities.

MCC and PCC will have to determine the appropriate model to operate the service and facilities developed under the project. According to the current model, based on private sector participation involving CBEs and SMEs for solid waste management, it is suggested to delegate some steps of the system to private operators.

The recommended composting value chain structure is as follows:

- **Sorting, collection, and transport:** Providing plastic waste to the recycling unit is the responsibility of waste collectors as a commercial activity. CBEs, SMEs, MCC or PCC and even individuals are in a position to carry and sell the plastic waste collected to the recycling unit. To ease and secure plastic waste grouping and storage, it is envisaged to create and equip intermediary platforms at the two transfer stations and in some collection points (to be identified). These platforms will be managed by MCC or PCC.
- **Recycling unit operation:** As a pilot, the recycling unit can be operated directly by MCC or PCC with their own staff and resources or delegated to a private operator that specializes in recycling activities. It is recommended to delegate the recycling unit operation to a private operator in order to benefit from the operator's technical and commercial expertise. This delegation could be done after a "probation" period of direct operation to validate the business model, its sustainability and profitability.

TABLE 18: Plastic recycling value chain structure

	Leader	Comments
Project ownership	MCC or PCC	Cities Alliance during implementation with the support of LMA and public authorities (Ministry of Agriculture, land authority, EPA, Ministry of Public Works, etc.)
Facilities ownership	MCC or PCC	Cities Alliance during preparatory and investment phases, transferred to MCC or PCC
Operation – sorting, collection and transport	Free business	CBE, SME, MCC, PCC, individuals, etc. MCC and PCC for the operation of intermediary storage platforms
Operation – plastic recycling unit	Private operator	Upon delegation of MCC or PCC, if needed after a "probation" period and a competitive tendering process
Funding	Cities Alliance	

3. ACTION PLAN FOR THE DEVELOPMENT OF THE COMPOSTING/ RECYCLING VALUE CHAINS

3.1 Objective and method

The objective of the action plan is to present comprehensively all the actions to be implemented for the development of composting/recycling activities. Its purpose is to monitor all actions and tasks to be done by different stakeholders and how they are done.

This action plans aims to answer the following questions:

Why? **The context.** The why and the reasons for the action plan are very important to make sense of what will be done.

The goals. What do we want to achieve by implementing these actions? We define the practical by formulating the finalities. It must, of course, be related to the context.

What? **The actions.** It briefly describes the content of the actions and the prioritization. Those that have the greatest impact on the overall goal are highlighted.

Who? **The responsible.** In other words: Who drives? Who reports? Other actors who can intervene or must be informed of the progress of the action are also specified.

How? **The resources.** It quantifies the budget and teams that will be mobilised.

When? **The timeline.** It sets the start and end dates. Milestones can be defined with deliverables. Tools like the Gantt chart are useful for this phase.

Results? **The impacts.** Specific criteria and indicators validate the success (or not) of an action and to take a new decision accordingly: to continue, to envisage a new action.

The action plan is presented in the form of a table and a Gantt chart to increase visibility of the task distribution over time and a finer management of sequences.

The action plan is based on an implementation strategy and takes into account several constraints and prerequisites. Participatory sessions at the workshop held 4 July 2019 provided insights that are further developed here.

3.2 Overview

Two action plans are presented: One related to the composting value chain, and the other to the plastic item manufacturing value chain.

For each plan, actions are presented in accordance with the step of the value chain considered (collection, transport, process or marketing) and with the phases of the projects (preparatory phase, investment phase, operating phase).

In the following parts, actions are presented by phase and numbered with a letter related to the step (C = Collection; T = Transport; P = Process; M = Marketing; G = General).

For both action plans, besides the construction and equipment of the composting/recycling units, there are several crucial issues:

- **The waste collection and quality of the source:** For both activities, it is crucial to have clean waste to able to process a good-quality product efficiently. Collection must be organised to provide clean waste, which means implementing sorting-at-source.
- **Land identification:** The identification of land available, large enough and close to waste source on one side and customers on the other, is a key issue in a city facing land pressure. Identification and acquisition of land is clearly critical to project implementation.
- **Capacity building:** Despite previous initiatives, recycling and composting activities are new in Greater Monrovia. Staff must be trained to develop and operate efficient value chains. Capacity building actions must be implemented at the preparatory phase.
- **Marketing:** Products must find their market and customers. All the components of the marketing mix, particularly the price and promotion, must be carefully determined to secure the adequacy of the product to the local market. This is particularly crucial for compost that will face strong competition from widely used chemical fertilisers.

3.3 Composting value chain action plan

3.3.1 OVERVIEW

The actions to be implemented focus on the following main issues:

- During the preparatory phase:
  - **Organisation of the collection:** The organisation of the collection, including sorting-at-source, is needed to ensure the quality of the organic waste. It includes the identification of targeted marketplaces, the organisation of the collection system within the identified marketplaces, the preparation of a tendering process, and the selection of a private operator for the collection and transport of organic waste to the composting unit.
  - **Identification of land** that meets the requirements in terms of affordability, accessibility, availability of facilities, closeness to waste sources and customers, etc.
  - **Preparation of plant construction** with a detailed design of the composting unit and the preparation of a tendering process and selection of a firm to build the facilities and purchase the equipment.
  - **Preparation of the composting unit operation** with the preparation of a tendering process and selection of a firm to operate the unit.

- **Elaboration of a marketing strategy** to analyse the demand and determine the appropriate product, price, promotion, selling channels, etc.
- **Capacity building of main actors** on clean organic waste collection and sorting-at-source, on composting basics and compost use (including study tour and demo-farm).
- **Adaptation of the existing regulatory framework** to make it more favorable to compost use in agriculture.
- **Call for projects** in order to support existing actors in the development of their composting activities.

- **During the investment phase:**
  - **Purchase and installation of equipment (sorting/storage areas)** in relevant marketplaces to ease collection and sorting-at-source.
  - **Purchase of transport equipment** for the collection and transport of organic waste from collection place to composting unit and the delivery of product.
  - **Land acquisition** to develop the composting unit.
  - **Construction of the composting plant**, including the land servicing, the construction permit acquisition and clearance, the facility construction, and the equipment purchase and installation.

- **During the operating phase:**
  - **Capacity building** of collection operators, composting unit staff, and sales agents and marketing officers.

The total budget for the implementation of these actions is estimated at **US $500,000**. It includes the development of one composting plant and two storage/sorting areas in two different marketplaces, awareness campaign, capacity building for collection and composting operators (CBEs and SMEs), and support for current composting operators to develop their activities (small grant).

In USD	Total amount	Outreach campaign/ Capacity building	Sorting station	Small grant
Preparatory phase	**200,000**	50,000	0	150,000
Investment phase	**200,000**	0	60,000	140,000
Operating phase	**100,000**	100,000	0	0
Total - OW	**500,000**	**150,000**	**60,000**	**290,000**

All these actions are detailed in the next section.

3.3.2 PREPARATORY PHASE

N°	Why? Constraints	What? Actions	
C1	Organisation of the collection & Sorting at source of organic waste	Identification of targeted marketplaces Organisation of the collection system: • Assessment of the quantity of waste generated • Capacity of storage • Equipment to install (secured skip bucket) and organisation • Collaboration with LMA	
T2	Organisation of the collection/ transport to the production site	Elaboration of tendering documents for waste collecting/ transporting to the production site (opened to various enterprises: CBEs or SMEs or LMA)	
T3	Organisation of the collection/ transport to the production site	Tendering to select an operator (CBE/SME) for collecting and transporting the waste from the marketplace to the production site	
P1	Land availability and location	Identification of land that is affordable, accessible, with water supply and close to the collection place (marketplace)	
P3	Plant building	Elaboration of the tendering documents to select firms in charge of: i. facility construction ii. equipment purchase	
P4	Plant building and operation	Design study: • definition of needs in terms of technical resources: equipment, facilities • sizing of the exploitation • calendar and financial planning	
P5	Plant building	Tendering processes for selecting firms for: i. Facility building ii. Equipment purchase	
P10	Operation	Elaboration of the tendering documents for selecting an operator for the service	
P11	Operation	Tendering process for selecting an operator for the service	
M4	Affordable prices of the products	Elaboration of a marketing strategy (demand, competition, price, promotion, etc.)	
C2	Lack of knowledge on sorting at source and separate collection	Capacity building of CBEs and marketers on clean organic waste sorting at source and collection	

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC or PCC, LMA	Cities Alliance (direct implementation)	0	Organic waste collection system determined and implemented
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Tendering documents prepared
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Operator for collection and transport selected
	MCC or PCC	Cities Alliance, Land Authority	MCC or PCC	0	Land identified
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Tendering documents prepared
	Cities Alliance		Cities Alliance (direct implementation)	0	Design study realised
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Firms selected
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Tendering documents prepared
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Firm selected
	Cities Alliance	MCC or PCC, Ministry of Agriculture, Ministry of Commerce	Cities Alliance (direct implementation)	0	Marketing strategy developed
	Cities Alliance	MCC or PCC, LMA, NACOBE	Cities Alliance (direct implementation)	0	CBEs and marketers trained

N°	Why? Constraints	What? Actions	
P15	Lack of knowledge on composting	Capacity building of CBEs/SMEs on composting basics including an Africompost study tour	
M3	Regulatory framework not adapted to compost use in agriculture	Analysis and revision of the legal and regulatory framework to make it more favorable to composting	
M5	Misuse of compost	Capacity building on demo-farms and awareness campaigns for farmers on the benefits and appropriate use of organic fertilisers	
G1	Lack of knowledge on solid waste management and value chain organisation	Capacity building of CBEs/SMEs on solid waste management basics, value chain organization, and environmental protection aspects	
G2	Development of existing actors	Call for projects to develop composting activities (intermediary storage areas dedicated to separate collection, allocation of collection vehicles, improvement of processes, marketing strategy development, etc.)	

3.3.3 INVESTMENT PHASE

N°	Why? Constraints	What? Actions	
C2	Accessibility to generators Marketplaces not well suited for waste sorting/ collection	Purchase and installation of equipment in marketplaces for collection (skip buckets for example) depending on the collection organisation	
T1	Lack of motorised equipment: Transportation equipment to move the waste from one point to another	Purchase of affordable and durable equipment (one truck) for the operator in charge of the collection/transport	
P2	Land availability and location	Land acquisition	
P6	Plant building	Construction permit acquisition and construction clearance: • Environmental clearance (EPA) • Geo-technical study/soil test • Topographical survey • Registering of the building	
P7	Plant building	Land servicing	

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC or PCC, LMA, Ministry of agriculture, BWI, NACOBE	Cities Alliance	50,000	CBEs/SMEs trained
	EPA	Cities Alliance, Ministry of Agriculture	EPA	0	Legal framework adapted
	Cities Alliance	Ministry of Agriculture, BWI, Organic Matters	Cities Alliance (direct implementation)	0	Farmers trained
	Cities Alliance	MCC/PCC, NACOBE, EPA	Cities Alliance (direct implementation)	0	CBEs/SMEs trained
	Cities Alliance	MCC/PCC, NACOBE	Cities Alliance	150,000	Development of composting activities of existing actors

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC or PCC, LMA	Cities Alliance	60,000	Equipment purchased and installed
	Cities Alliance	MCC or PCC	Cities Alliance	55,000	Collectors using adapted vehicles and equipment
	MCC or PCC	Land Authority, Cities Alliance	MCC or PCC	0	Land acquired
	Cities Alliance	MCC/PCC, EPA, Ministry of Public Works	Cities Alliance	10,000	Construction permit obtained
	MCC or PCC	Cities Alliance	MCC or PCC	0	Land serviced

N°	Why? Constraints	What? Actions	
P8	Plant building	• Facilities building • Occupancy permit • Registering of the building	
P9	Plant building	Equipment acquisition and installation	
M1	Transportation (deliveries)	Purchase of equipment for deliveries to farmers	

3.3.4 OPERATING PHASE

N°	Why? Constraints	What? Actions	
P13	Capacity building of the operator to improve the quality of the end-products	Capacity building on composting process (quality of end-products, good practices, maintenance, monitoring/control, environmental impacts, etc.): • Training of trainers • Training of staff • Technical assistance	
M2	Competition with imported chemical fertilisers	Capacity building of sales agents and marketing officers Awareness of customers (quality and practices)	

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC or PCC, Ministry of Public Works	Cities Alliance	10,000 (USD)	Facilities built Occupancy permit delivered Building registered
	Cities Alliance	MCC/PCC	Cities Alliance	10,000	Equipment installed
	MCC or PCC	Cities Alliance	Cities Alliance	55,000	Technical resources available for marketing

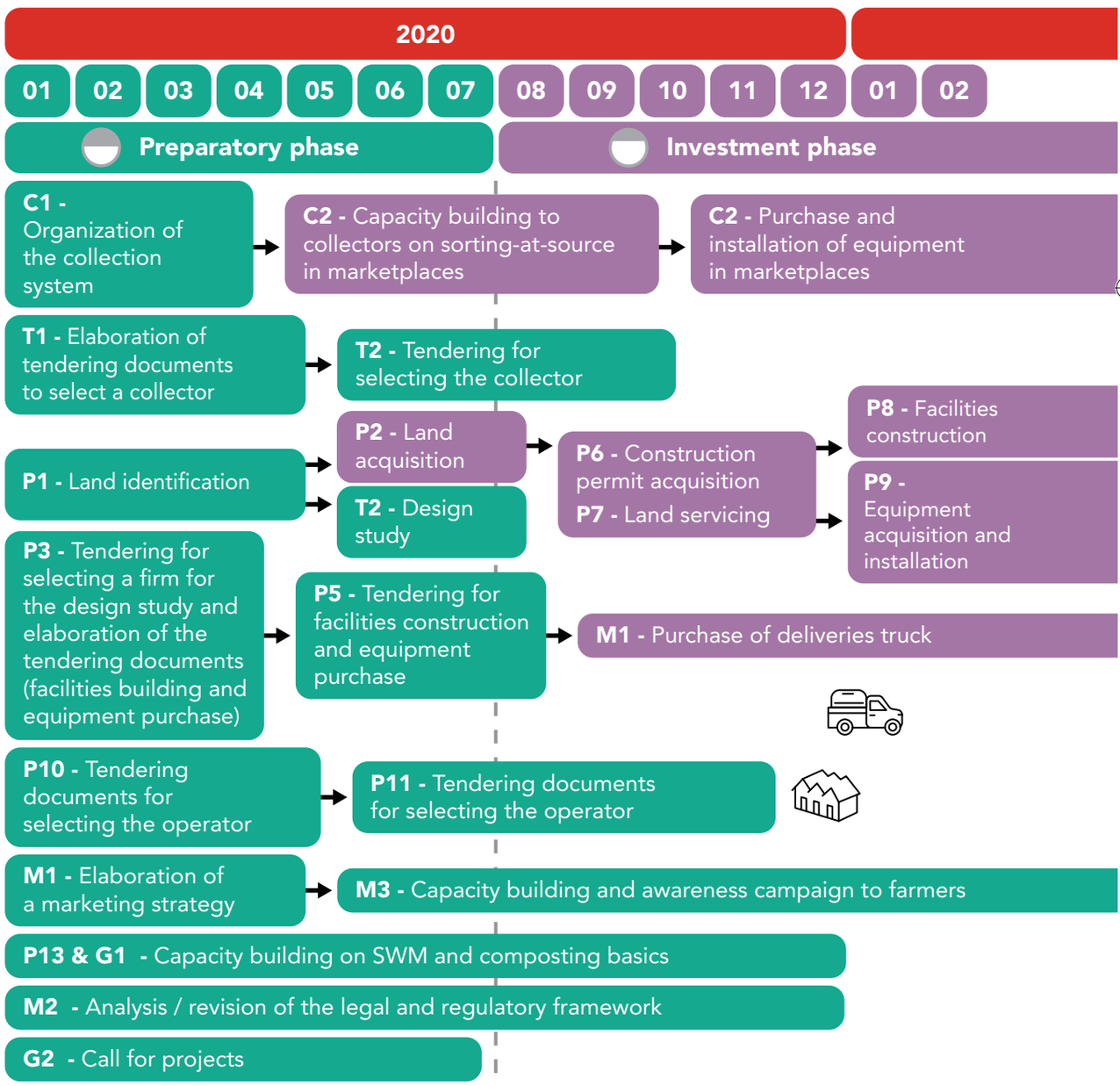
	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC/PCC, BWI, EPA	Cities Alliance	50,000	Trainers and operating staff trained
	Cities Alliance	MCC or PCC, Ministry of Commerce, Ministry of Agriculture	Cities Alliance	50,000	Sales agents and marketing officers trained to promote compost and good agricultural practices

3.3.5 TENTATIVE TIME SCHEDULE

The implementation of the action described in the action plan is expected to start at the beginning of 2020, ideally in January.

The preparatory phase is expected to start in January 2020 with the implementation of numerous actions: Land identification and plant design study, organisation of the collection system in marketplaces, drafting of tendering documents to select firms for collection, facility construction, equipment purchase and composting plant operation, etc. These are followed by the tendering processes themselves, elaboration of marketing strategy, and several capacity-building and awareness- raising campaigns.

FIGURE 14: Tentative time schedule for the implementation of the composting value chain action plan

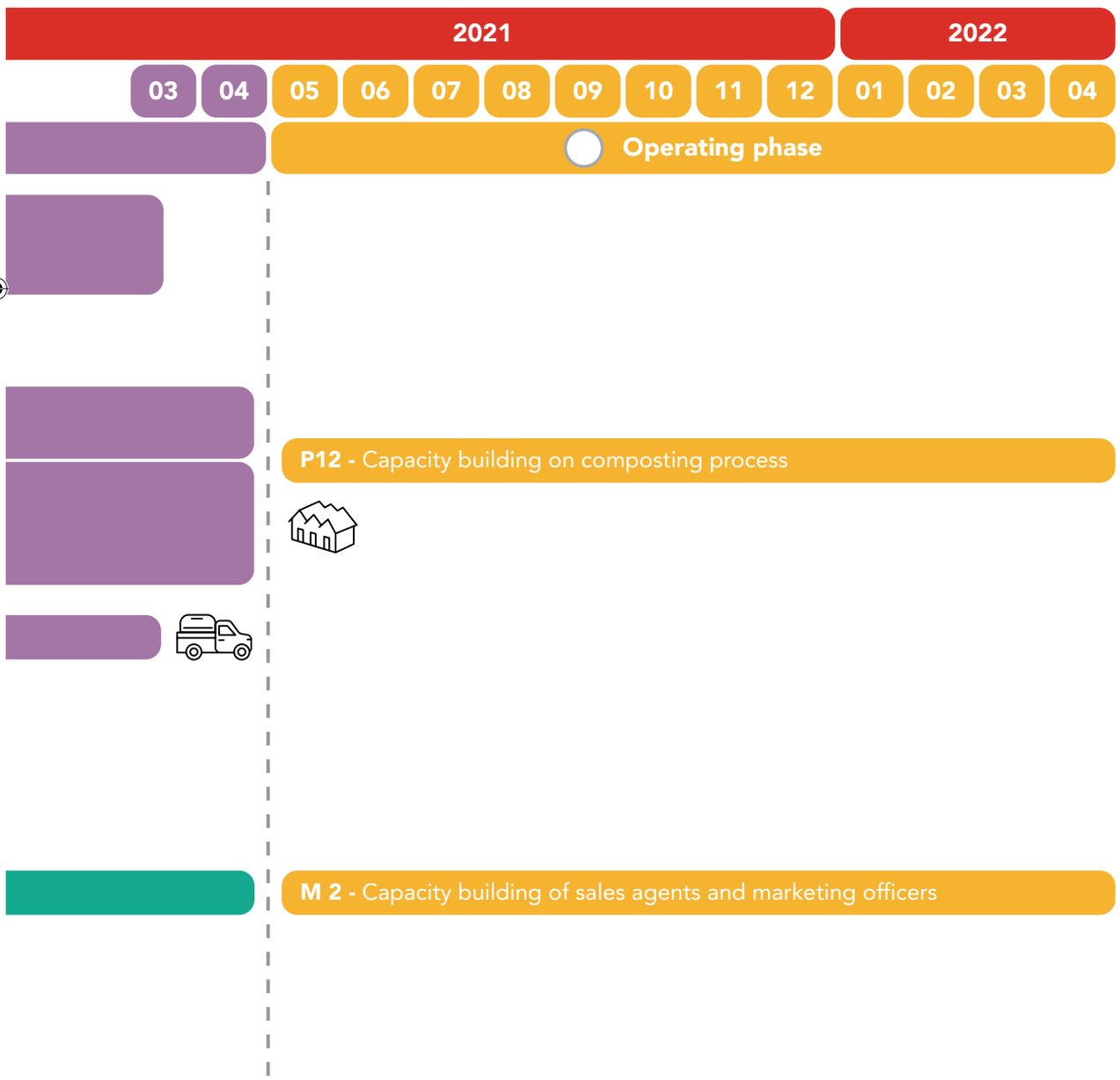


The actions in preparatory phase are critical, particularly the land identification and the organisation of the collection system.

The investment phase is expected to start during the second half of 2020, with the land acquisition, facility construction, and equipment purchase.

Operation is expected to start in September 2021. During the operating phase, some capacity building will be implemented to train staff on composting processes and compost sales.

The following diagram shows the expected time schedule for the implementation of all these actions.



3.4 Plastic items manufacturing value chain action plan

3.4.1 OVERVIEW

The actions to be implemented focus on the following main issues:

- **During the preparatory phase:**
  - **Sorting-at-source:** Implemented sorting-at-source is crucial to the efficiency of the plastic recycling value chain and the success of the project. With the support of CBEs, a first step would be identifying incentive mechanisms to implement, such as the distribution of recycling bins, awareness campaign on environmental responsibility, etc.
  - **Identification of land** that meets the requirements in terms of affordability, accessibility, availability of facilities, closeness to waste sources and customers, etc.
  - **Preparation of the plant construction** with a detailed design of the recycling unit and the preparation of a tendering process and selection of a firm to build the facilities and purchase the equipment.
  - **Preparation of the recycling unit operation** with the preparation of a tendering process and selection of a firm to operate the unit.
  - **Elaboration of a marketing strategy** to analyse the demand and determine the appropriate product, price, promotion, selling channels, etc.
  - **Capacity building** of main actors on plastic waste collection and sorting-at-source, on recycling basics, value chain organisation, and environmental protection, including field visits to similar recycling value chains in the region.
  - **Call for projects** in order to support existing actors in the development of their recycling activities.
- **During the investment phase:**
  - **Purchase and installation of equipment for intermediary storage platform** to ease plastic waste collection, secondary sorting, waste grouping and storage.
  - **Purchase of transport equipment** for the delivery of product.
  - **Land acquisition** to develop the recycling unit.
  - **Construction of the composting plant**, including the land servicing, the construction permit acquisition and clearance, the facility construction, and the equipment purchase and installation.
- **During the operating phase:**
  - **Capacity building** of collection operators, recycling unit staff, and sales agents and marketing officers; **awareness campaign** on sorting-at-source.

The total budget for the implementation of these actions is estimated at **US $960,000**. It includes the development of **4 logistics platforms** and **2 plastic recycling units**, **awareness campaigns**, **capacity building** for collection (also in charge of the sorting) and recycling operators, and **support for other plastic recyclers** (small grants) to develop their activities, **such as tile and brick manufacturing**.

In USD	Total amount	Outreach campaign/ Capacity building	Sorting station	Small grant
Preparatory phase	**250,000**	50,000	0	200,000
Investment phase	**590,000**	0	240,000	350,000
Operating phase	**120,000**	100,000	0	0
Total - PW	**960,000**	**150,000**	**240,000**	**550,000**

All these actions are detailed in the next section.

3.4.2 PREPARATORY PHASE

N°	Why? Constraints	What? Actions	
C1	Separation at source by the generators	Definition of incentive mechanisms for sorting at source (distribution of recycling bins, awareness on environmental responsibility, etc.)	
P1	Land availability and location	Identification of land fulfilling the requirements (preidentified location: Clara Town or New Kru Town)	
P3	Plant building and operation	Design study: • Definition of needs for technical resources • Sizing of the facilities	
P4	Plant building	Elaboration of the tendering documents for i. facilities building ii. equipment purchase	
P5	Plant building	Tendering processes for selecting firms for: i. Facility building ii. Equipment purchase	
P10	Operation	Elaboration of the tendering documents for selecting a firm to operate the plant	
P11	Operation	Tendering process for selecting an operator for the service	
M3	Affordable prices of the products	Elaboration of a marketing strategy (demand, competition, price, promotion, etc.)	
C2	Lack of knowledge on sorting at source and separate collection	Capacity building of CBEs/SMEs on plastic waste sorting at source and collection	
P12	Lack of knowledge on plastic recycling	Capacity building of CBEs/SMEs on plastic recycling basics including field visits to similar recyclers in the region	
G1	Lack of knowledge on solid waste management and value chain organisation	Capacity building of CBEs/SMEs on solid waste management basics, value chain organisation, and environmental protection aspects	
G3	Development of existing actors	Call for projects for developing plastic recycling activities (allocation of collection vehicles, improvement of processes, marketing strategy development, etc.)	

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	MCC or PCC, NACOBE	Cities Alliance (direct implementation)	0	Incentive mechanisms defined
	MCC and PCC	Cities Alliance, land authority	MCC or PCC	0	Land identified
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Design study realised
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Tendering documents prepared
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Firms selected
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Tendering documents prepared
	Cities Alliance	MCC or PCC	Cities Alliance (direct implementation)	0	Firm selected
	Cities Alliance	MCC or PCC, Ministry of Commerce	Cities Alliance (direct implementation)	0	Marketing strategy developed
	Cities Alliance	MCC or PCC, NACOBE	Cities Alliance (direct implementation)	0	CBEs/SMEs trained
	Cities Alliance	MCC or PCC, NACOBE	Cities Alliance	50,000	CBEs/SMEs trained
	Cities Alliance	MCC/PCC, NACOBE, EPA	Cities Alliance (direct implementation)	0	CBEs/SMEs trained
	Cities Alliance	MCC/PCC, NACOBE	Cities Alliance	200,000	Development of plastic recycling activities of existing actors

3.4.3 INVESTMENT PHASE

N°	Why? Constraints	What? Actions	
P2	Land availability and location	Land acquisition	
P6	Plant building (x2)	Construction permit acquisition and construction clearance: • Environmental clearance (EPA) • Geo-technical study/soil test • Topographical survey	
P7	Plant building (x2)	Land servicing	
P8	Plant building (x2)	• Facility building • Occupancy permit • Registering of the building	
P9	Plant building (x2)	Equipment acquisition and installation	
M2	Transport (x2)	Purchase of equipment to transport end-products to points of sale	
C3	Lack of intermediary storage platforms (x4)	Purchase and installation of secured equipment in transfer stations for collection (skip buckets for example)	

	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	MCC or PCC	Cities Alliance, Land Authority	MCC or PCC	0	Land acquired
	Cities Alliance	MCC/PCC, EPA, Ministry of Public Works	Cities Alliance	20,000	Construction permit obtained
	MCC or PCC	Cities Alliance	MCC or PCC	0	Land serviced
	Cities Alliance	MCC or PCC, Ministry of Public Works	Cities Alliance	30,000	Facilities built Occupancy permit delivered Registering of the building
	Cities Alliance	MCC or PCC	Cities Alliance	220,000	Equipment installed
	Cities Alliance	MCC or PCC	Cities Alliance	80,000	Delivery truck acquired
	Cities Alliance	MCC or PCC	Cities Alliance	240,000	Equipment purchased and installed

3.4.4 OPERATING PHASE

N°	Why? Constraints	What? Actions	
C4	Lack of awareness of generators (sorting at source)	Awareness campaign on sorting at source: • Door-to-door campaign • Large-scale communication (flyers, jingles on radio stations and other local medias)	
C2	Improvement of the quality of plastic waste collected	Capacity building for the CBEs/SMEs on plastic waste collection: • Good practices • Organisation of the collection • Incentive mechanisms	
P12	Improvement of the quality of end-products	Capacity building of operating staff on recycling process (quality of the end-products, good practices, maintenance, monitoring/control, environmental aspects, etc.): • Training of trainers • Training of staff • Technical assistance	
M2	Competition with plastic items	Capacity building of sales agents and marketing officers	

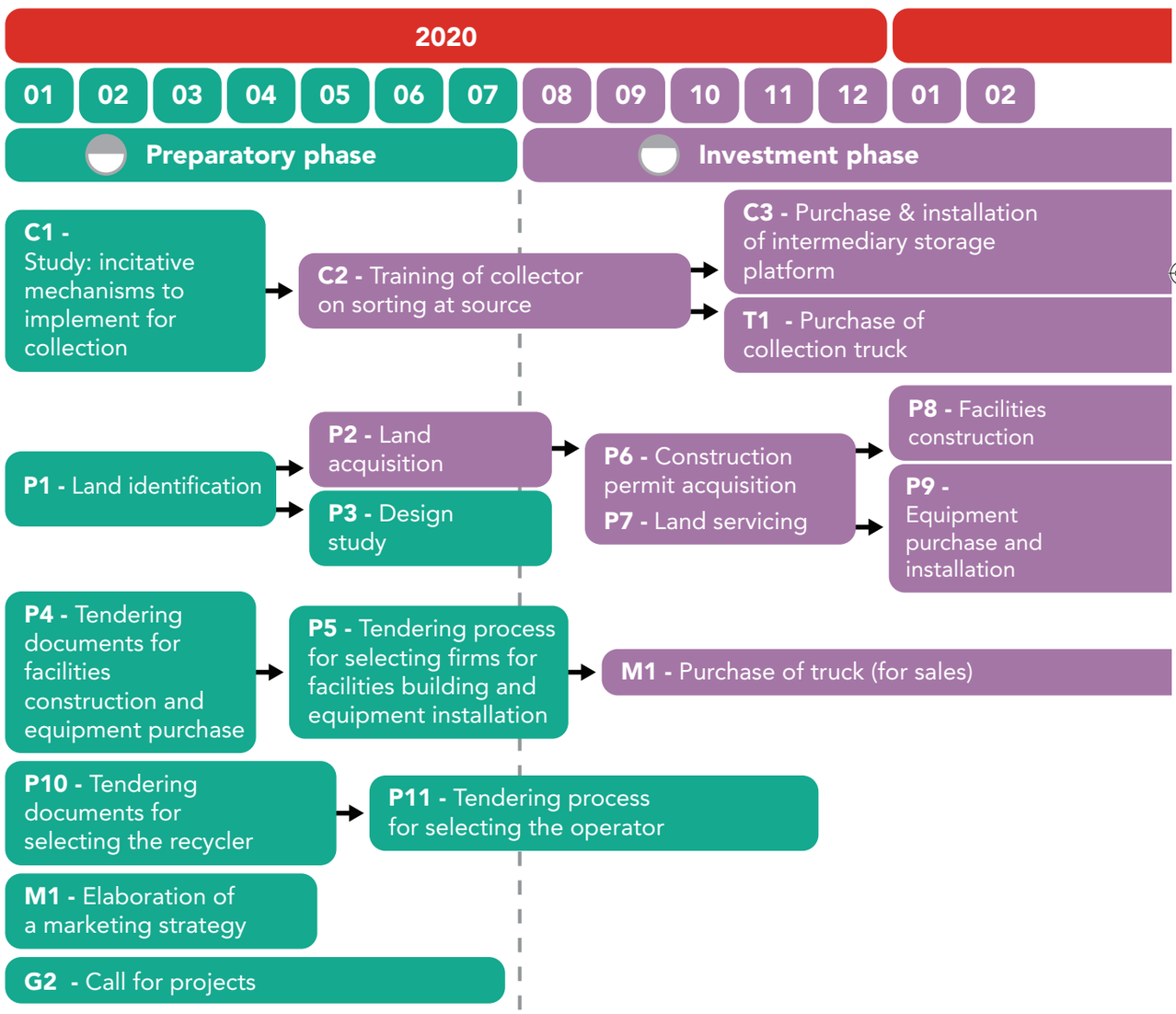
	Who? Leader	Who? Others	How? Resources	How? Budget (USD)	Results? Indicators
	Cities Alliance	CBEs/SMEs, NACOBE, MCC or PCC	Cities Alliance	50,000	Increase in the number of people aware and plastic waste collected
	Cities Alliance	MCC or PCC, NACOBE	Cities Alliance	20,000	CBEs/SMEs trained
	Cities Alliance	MCC or PCC, EPA	Cities Alliance	50,000	Trainers and operating staff trained
	Cities Alliance	MCC or PCC, Ministry of Commerce	Cities Alliance (direct implementation)	0	Staff trained

3.5 Tentative time schedule

The implementation of the action described in the action plan is expected to start before the end of 2019, ideally in September.

The preparatory phase is expected to start in January 2020 with the implementation of numerous actions: Land identification and plant design study, definition of incentives for sorting-at-source, drafting of tendering document to select firms for facility construction, equipment purchase, and recycling plant operation, etc. These are followed of the tendering processes themselves, elaboration of marketing strategy, and several capacity-building and awareness-raising campaigns.

FIGURE 15: Tentative time schedule for the implementation of the plastic recycling value chain action plan

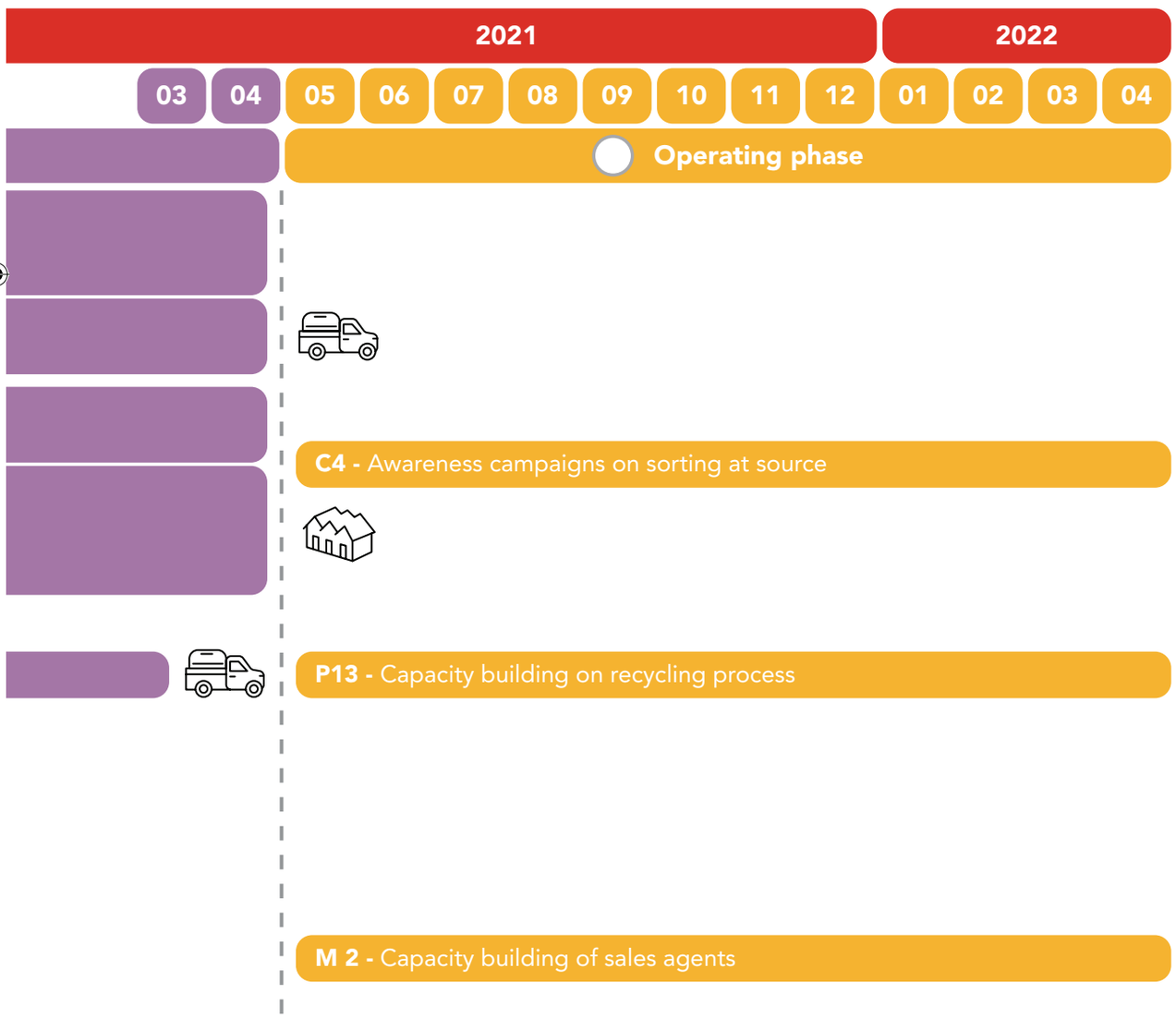


The actions within the preparatory phase are critical, particularly the land identification.

The investment phase is expected to start during the second semester of 2020, with the land acquisition, facility construction, and equipment purchase.

Operation is expected to start in September 2021. During the operating phase, some capacity building will be implemented to train staff on recycling processes and marketing. An awareness campaign will be needed to develop sorting-at-source.

The following diagram presents the expected timeline for the implementation of all these actions.



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